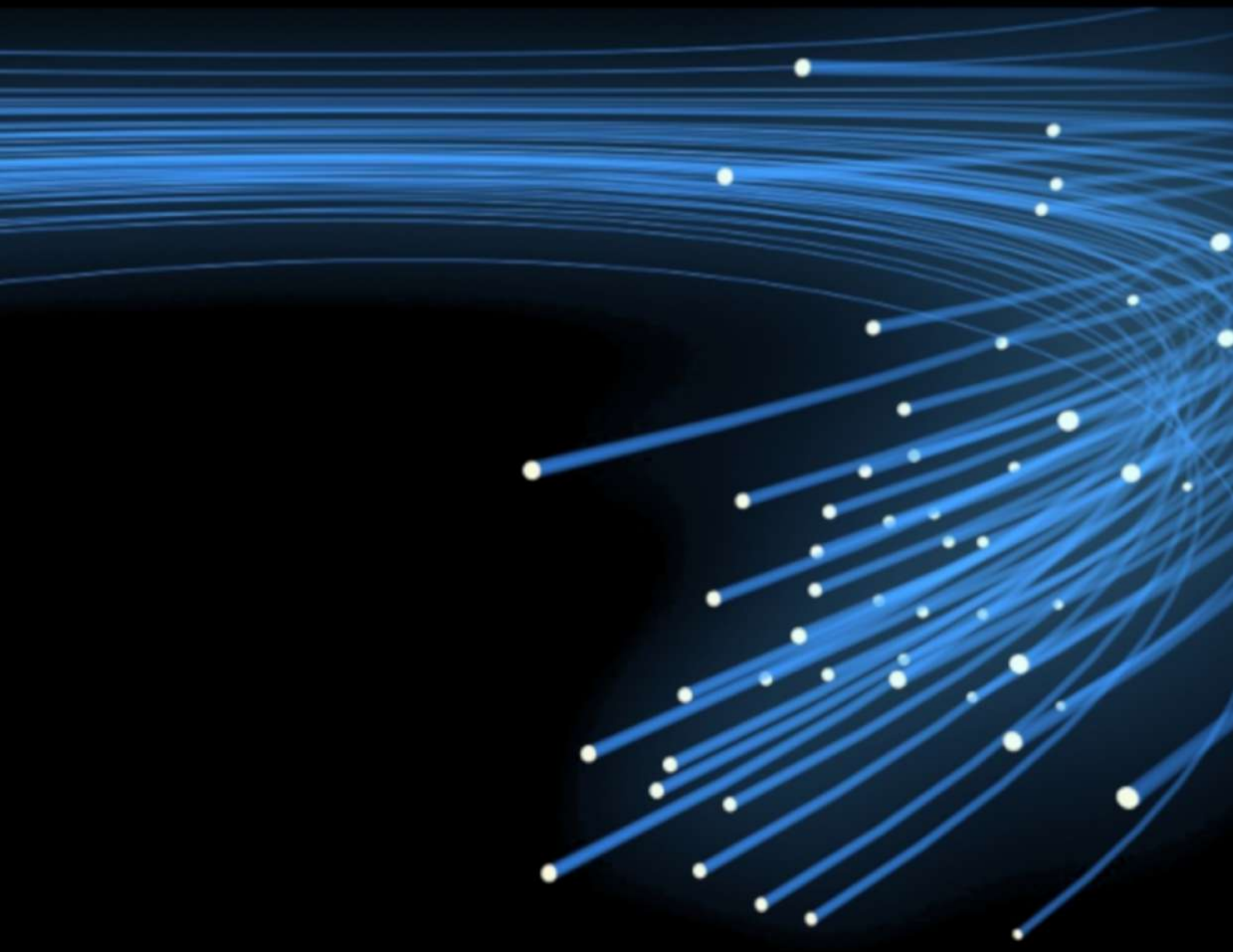
META 2021 Warsaw - Poland

The 11th International Conference on Metamaterials, Photonic Crystals and Plasmonics



Program

July 20 – 23, 2021
Warsaw - Poland

metaconferences.org

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META 2021 Warsaw - Poland

The 11th International Conference on Metamaterials, Photonic Crystals and Plasmonics

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Edited by

Said Zouhdi | Paris-Saclay University, France
Dorota Pawlak | ENSEMBLE3 Centre of Excellence, Poland
Andrzej Kudelski | University of Warsaw, Poland

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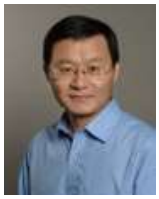

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META 2021 gratefully acknowledges the support of these institutions and companies for their contribution to the success of this conference.

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PLENARY SPEAKERS

Robert W. Boyd

University of Ottawa, Canada and University of Rochester, USA

How Light Behaves when the Refractive Index Vanishes

Robert Boyd received the B.S. degree in physics from the Massachusetts Institute of Technology and the Ph.D. degree in physics in 1977 from the University of California at Berkeley. His Ph.D. thesis was supervised by Charles Townes and involved the use of nonlinear optical techniques in infrared detection for astronomy. Professor Boyd joined the faculty of the Institute of Optics of the University of Rochester in 1977 and in July 2001 he became the M. Parker Givens Professor of Optics. In 2010, he became Professor of Physics and Canada Excellence Research Chair in Quantum Nonlinear Optics at the University of Ottawa. His research interests include studies of nonlinear optical interactions, studies of the nonlinear optical properties of materials, the development of photonic devices including photonic biosensors, and studies of the quantum statistical properties of nonlinear optical interactions. Professor Boyd has written two books, co-edited two anthologies, published over 200 research papers, and has been awarded five patents. He is a fellow of the Optical Society of America and of the American Physical Society and is the past chair of the Division of Laser Science of the American Physical Society.

Federico Capasso

Harvard University, USA

Structuring Light and Dark with Metaoptics

Federico Capasso is the Robert Wallace Professor of Applied Physics at Harvard University, which he joined in 2003 after 27 years at Bell Labs where he was Member of Technical Staff, Department Head and Vice President for Physical Research. He is visiting professor at NTU with both the School of Physical and Mathematical Sciences and Electrical and Electronic Engineering. His research has focused on nanoscale science and technology encompassing a broad range of topics. He pioneered band-structure engineering of semiconductor nanostructures and devices, invented and first demonstrated the quantum cascade laser and investigated QED forces including the first measurement of a repulsive Casimir force. His most recent contributions are new plasmonic devices and flat optics based on metasurfaces. He is a member of the National Academy of Sciences, the National Academy of Engineering, the American Academy of Arts and Sciences. His awards include the King Faisal Prize, the IEEE Edison Medal, the SPIE Gold Medal, the American Physical Society Arthur Schawlow Prize in Laser Science, the Jan Czochralski Award for lifetime achievements in Materials Science, the IEEE Sarnoff Award in Electronics, the Materials Research Society Medal, the Wetherill Medal of the Franklin Institute, the Rank Prize in Optoelectronics, the Optical Society Wood Prize, the Berthold Leibinger Future Prize, the Julius Springer Prize in Applied Physics, the European Physical Society Quantum Electronics Prize.

Nader Engheta

University of Pennsylvania, USA

4D Structured Waves

Nader Engheta is the H. Nedwill Ramsey Professor at the University of Pennsylvania in Philadelphia, with affiliations in the Departments of Electrical and Systems Engineering, Materials Science and Engineering, Physics and Astronomy, and Bioengineering. He received his B.S. degree from the University of Tehran, and his M.S and Ph.D. degrees from Caltech. His current research activities span a broad range of areas including nanophotonics, metamaterials, nano-scale optics, graphene optics, optical metatronics, imaging and sensing inspired by eyes of animal species, optical nanoengineering, microwave and optical devices, and physics and engineering of fields and waves He has received several awards for his research including the 2017 William Streifer Scientific Achievement Award from the IEEE Photonics Society, the 2015 Gold Medal from SPIE, the 2015 Fellow of US National Academy of Inventors (NAI), the 2015 National Security Science and Engineering Faculty Fellow (NSSEFF) Award (also known as Vannevar Bush Faculty Fellow Award) from US Department of Defense, the 2015 IEEE Antennas and Propagation Society Distinguished Achievement Award, the 2015 Wheatstone Lecture in King's College London, the 2014 Balthasar van der Pol Gold Medal from the International Union of Radio Science (URSI), the 2013 Inaugural SINA Award in Engineering, the 2012 IEEE Electromagnetics Award, 2006 Scientific American Magazine 50 Leaders in Science and Technology, the Guggenheim Fellowship, and the IEEE Third Millennium Medal. He is a Fellow of seven international scientific and technical societies, i.e., IEEE, URSI, OSA, APS, MRS, SPIE, and American Association for the Advancement of Science (AAAS). He has received the honorary doctoral degrees from the Aalto University in Finland in 2016 and from the University of Stuttgart, Germany in 2016.

Maiken H. Mikkelsen

Duke University, USA

Applications of metasurfaces : From multispectral imaging to optical communications and biosensing

Maiken H. Mikkelsen is the James N. and Elizabeth H. Barton Associate Professor at Duke University in the Department of Electrical and Computer Engineering, and by courtesy, in the Departments of Physics and Mechanical Engineering and Materials Science. She received her B.S. in Physics from the University of Copenhagen in 2004, her Ph.D. in Physics from the University of California, Santa Barbara in 2009 and was a postdoctoral fellow at the University of California, Berkeley before joining Duke University in 2012. Her research explores nanophotonics and new quantum materials to enable transformative breakthroughs for optoelectronics, quantum science, the environment and human health. Her awards include the Maria Goeppert Mayer Award from the American Physical Society, the NSF CAREER award, the Moore Inventor Fellow award from the Gordon and Betty Moore Foundation, Young Investigator Program Awards from the Office of Naval Research, the Army Research Office and the Air Force Office of Scientific Research, the Cottrell Scholar Award from the Research Corporation for Science Advancement, and the Early Career Achievement Award from SPIE – the International Society for Optics and Photonics.

Masaya Notomi

NTT Basic Research Labs., Japan

Integrated Nanophotonics for Optoelectronic Computation

Masaya Notomi received his B.E., M.E. and Ph.D. degrees in applied physics from The University of Tokyo, Japan in 1986, 1988, and 1997, respectively. He joined NTT Optoelectronics Laboratories, Nippon Telegraph and Telephone Corporation in 1988 and moved to NTT Basic Research Laboratories in 1999. Since then, his research interest has been to control the optical properties of materials and devices by using artificial nanostructures, and engaged in research on quantum wires/dots and photonic crystal structures. In 1996-1997, he was a visiting researcher of Linkoping University, Sweden. He was a guest associate professor of Applied Electronics in 2003-2009 and is currently a guest professor of Physics in Tokyo Institute of Technology. He was appointed as Senior Distinguished Scientist of NTT since 2010. He is currently a director of NTT Nanophotonics Center. He received IEEE/LEOS Distinguished Lecturer Award in 2006, Japan Society for the Promotion of Science (JSPS) prize in 2009, Japan Academy Medal in 2009, the Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology (Prize for Science and Technology, Research Category) in 2010, and IEEE Fellow grade in 2013. He served as a member of National University Corporation Evaluation Committee in the Japanese government. He is a research director of JST CREST program from 2015. He is also a member of the Japan Society of Applied Physics, APS, IEEE, and OSA.

Deirdre O'Carroll

Rutgers University, USA

Metasurfaces for Light Management in Semiconductor Thin Films

Deirdre O'Carroll is an Associate Professor in the Departments of Materials Science, Engineering and Chemistry and Chemical Biology at Rutgers University. Her research areas include nanophotonics, plasmonics, organic optoelectronics and energy materials. She obtained her B.E. in Electrical Engineering in 2002, and a PhD in Microelectronics in 2008 at University College Cork and the Tyndall National Institute, Ireland. Prior to joining Rutgers in 2011, she conducted postdoctoral research in plasmonics at California Institute of Technology in the US and at the University of Strasbourg and CNRS in France. She is a recipient of a National Science Foundation CAREER Award (2016), an American Chemical Society Young Investigator Award in Polymer Material Science and Engineering (2017) and a Science Foundation Ireland Future Research Leaders Award (2018). She is an associate editor for the SPIE Journal of Photonics for Energy and a member of the editorial advisory board for APL Photonics.

Vladimir M. Shalaev

Purdue University, USA

Empowering Quantum Photonics with Nanoplasmonics and Machine Learning

Vladimir M. Shalaev, Scientific Director for Nanophotonics at Birck Nanotechnology Center and Distinguished Professor of Electrical and Computer Engineering at Purdue University, specializes in nanophotonics, plasmonics, and optical metamaterials. Vladimir M. Shalaev has received several awards for his research in the field of nanophotonics and metamaterials, including the Max Born Award of the Optical Society of America for his pioneering contributions to the field of optical metamaterials, the Willis E. Lamb Award for Laser Science and Quantum Optics, IEEE Photonics Society William Streifer Scientific Achievement Award, Rolf Landauer medal of the ETOPIM (Electrical, Transport and Optical Properties of Inhomogeneous Media) International Association, the UNESCO Medal for the development of nanosciences and nanotechnologies, OSA and SPIE Goodman Book Writing Award. He is a Fellow of the IEEE, APS, SPIE, MRS and OSA. Prof. Shalaev has authored three books, thirty invited book chapters and over 500 research publications.

KEYNOTE SPEAKERS

Ali Adibi

Georgia Institute of Technology, USA

Analysis and Knowledge Discovery of Metastructures Using Deep Learning and Machine Learning Approaches in Reduced-dimensionality Spaces

Harry Atwater

California Institute of Technology, USA

Tunable and Time-Modulated Flat Optics

Konstantin Bliokh

RIKEN, Japan

A new spin for acoustics

Paul V. Braun

University of Illinois, USA

Volumetric microscale gradient refractive index lenses and waveguides for ultra-dense 3D optics

Hyuck Choo

Samsung Electronics Co., Ltd., Korea

Commercializing Metaphotonics

Miguel A. Correa-Duarte

University of Vigo, Spain

Photophysical Effects behind the Efficiency of Hot Electron Injection in Plasmon-Assisted Catalysis

Javier García de Abajo

ICFO-Institut de Ciencies Fotoniques, Spain

Nanophotonics with Two-Dimensional Materials

Hilmi Volkan Demir

Nanyang Technological University (NTU), Singapore

Semiconductor Nanocrystal Optoelectronics : Pushing the Limits

Alexander Govorov

Ohio University, USA

Optical and photochemical properties of chiral plasmonic nanostructures

Deep Jariwala

University of Pennsylvania, US

Tunable Light-Matter Coupling in Low-Dimensional Excitonic Semiconductors

Mona Jarrahi

University of California Los Angeles, USA

Wavelength conversion through plasmonic photoconductive nanostructures

Seokwoo Jeon

Korea Advanced Institute of Science and Technology, Korea

Fast, Low Cost Fabrication of Optimized 3D Nanostructures for Energy Transfer and Transport Properties

Philippe Lalanne

Institut d'Optique Graduate School, France

Rigorous modal analysis of micro and nanoresonators

Howard Lee

UC Irvine, USA

Active Epsilon-near-zero Photonics

Prineha Narang

Harvard University, USA

Hiromi Okamoto

Institute for Molecular Science, Japan

Chiral Near-Field Properties of Plasmonic Nanomaterials : Imaging and Functions

Sir John B. Pendry

Imperial College London, UK

Metamaterials that travel faster than light : putting the squeeze on photons

Junsuk Rho

Pohang University of Science and Technology (POSTECH), Korea

Dielectric metasurfaces for flat optics : wavefront engineering and future applications

Volker J. Sorger

George Washington University, USA

Strainoptronics : A New Degree of Freedom for 2D Material Device Engineering

Martin Wegener

KIT, Germany

3D Laser Nanoprinting of 3D Metamaterials

Rachel Won

Nature Photonics (United Kingdom)

3D Publishing in Nature Journals

Eli Yablonovitch

UC Berkeley, USA

The Challenge of META is (Aperiodic) Inverse Electromagnetic Design

CONFERENCE TUTORIALS

META 2021 features several technical tutorials instructed by world-leading experts on various topics of interest to the META community. Tutorials are intended to provide a high quality learning experience to conference attendees. The tutorials address an audience with a varied range of interests and backgrounds : beginners, students, researchers, lecturers and representatives of companies, governments and funding agencies who wish to learn new concepts and technologies.
The tutorials are part of the conference technical program, and are free of charge for the conference attendees.

Organizer

Prof. Ishwar Aggarwal, UNC Charlotte, USA

Tutorials & Instructors

Prof. Federico Capasso

Harvard University, USA

Tuesday 20th July
18:00 - 19:00 — Tutorial Room

Tutorial I : Metasurface Flat Optics : from components to mass manufacturing to systems

Flat optics based on metasurfaces has emerged in recent years as a promising alternative to refractive and Fresnel optics in many applications, due to the smaller footprint, mass-manufacturing using the same technology of semiconductor chips, easier control of aberrations and multifunctionality. I will cover recent advances in components and show how they have led to breakthroughs in cameras and other systems such as ultra compact spectrometers.

Prof. Harry Atwater

California Institute of Technology, USA

Wednesday 21st July
18:00 - 19:00 — Tutorial Room

Tutorial II : Design of Active and Reconfigurable Metasurfaces

A grand challenge for nanophotonics is the realization of comprehensively tunable metasurface nanoantenna arrays enabling dynamic, active control of the key constitutive properties of light – amplitude, phase, wavevector and polarization. Achieving this will open new photonics applications in phased-array optical beam steering, visible light modulation for communications and thermal radiation management. This tutorial will discuss design approaches for active and reconfigurable metasurfaces including selection of active materials, electromagnetic design and time-modulation. We will also survey status and outlook for electronically tunable and reconfigurable plasmonic and all-dielectric metasurfaces, whose elements are arbitrarily reprogrammable, enabling a wide array of functions, including steering, focusing, and frequency multiplexing of scattered radiation.

Prof. Ali Adibi

Georgia Institute of Technology, USA

Thursday 22nd July
18:00 - 19:00 — Tutorial Room

Tutorial III : Artificial Intelligence in Meta-optics

A survey of new artificial-intelligence-based approaches for analysis, design, optimization, and knowledge discovery in electromagnetic metastructures will be presented. Recent advances in using both deep learning and machine learning techniques, and their application to practical problems will be covered. These techniques will not only enable more efficient designs of the electromagnetic metastructures (e.g., photonic metasurfaces) but also provide valuable insight about the complex physics of light-matter interactions in such structures. Details of the training process for these algorithms as well as the challenges and limitations of these techniques for different classes of metastructures will be discussed. Knowledge discovery using these techniques includes the study of feasibility of a certain optical response from a given class of metastructures and comparing the roles of different design parameters to facilitate the inverse design process.

GUIDELINES FOR PRESENTERS

META 2021 Online - Don't miss a moment !

META 2021 will be held exclusively online and include both oral and poster presentations.

Oral presentations

Oral presenters at META 2021 will be required to submit a pre-recorded presentation (regular : 10-minutes duration, invited : 15-minutes, keynote : 25-minutes and plenary : 30-minutes) which will be made available to view by the participants up to four weeks after the conference.

All speakers have the possibility to give their talk **live** in the allotted time specified in the technical program. At the time of the presentation, the session chairperson will allow the speaker to share his/her computer screen with the audience (the pre-recording will be used as a backup in case of a no-show or technical difficulty). Speakers also have the option to have their **pre-recorded** presentation played during the live session. **However, all authors, no matter what format they select (live or on replay) should submit a pre-recorded presentation by the deadline of June 30th**.

For both live or on-demand presentations, a 5-minute live Question and Answer (Q&A) session will follow each presentation. The session chairperson will read questions submitted by participants. At least one of the paper's authors must be online to answer questions after the talk.

More information on oral presentations can be found below.

Poster presentations

Poster presenters will be required to submit a poster in **digital format**. They will also have the opportunity to provide a **pre-recorded presentation** (5-minute duration). Both poster and video presentations will be made available for viewing by participants up to three weeks after the conference. Questions can be posted at any time via special chat channels. During the conference, there will be poster sessions scheduled over different time zones where poster presenters will discuss their posters with the attendees via video conferencing. Additional information on poster presentations can be found below.

If a paper is not presented live in the allotted time or a pre-recorded presentation is not submitted by the deadline, then that paper will be considered a "no-show" and will not be published in the Conference Proceedings. If you are unable to make this deadline, please inform contact@metaconferences.org as soon as possible with the date by which your presentation will be available.

Online Platform

The online platform Whova will allow you to join the conference from the comfort of your own home or office and at the convenience of your own schedule all streamlined through one seamless platform. In addition to all poster and oral presentations from the **162 technical sessions**., the single interface will provide around-the-clock access to :

- ☐ 7 plenary lectures
- ☐ 21 keynote lectures
- ☐ 3 conference tutorials
- ☐ Breakout rooms for networking or further discussions 1-on-1 or in a group
- ☐ Social and networking activities

All live sessions and lectures will be recorded and available for our participants for viewing after the conference so that they don't miss a thing !

ORAL PRESENTATIONS

Please refer to our website for further details :
https://metaconferences.org/ocs/index.php/META21/index/pages/view/oral-presentations

POSTER PRESENTATIONS

Please refer to our website for further details :
https://metaconferences.org/ocs/index.php/META21/index/pages/view/poster-presentations

TECHNICAL PROGRAM

All sessions in the program are scheduled in Central European Time (CET/GMT+2/UTC+2).

The program has been put together considering the authors respective time zones.

Tuesday 20th July, 2021

08:45 - 08:45 — Victor Veselago Room

Session 1A1

Opening Address

09:00 - 09:35 — Victor Veselago Room

Session 1A2

Plenary Session I

09:00 : Plenary talk
Integrated Nanophotonics for Optoelectronic Computation
Masaya Notomi
Tokyo Institute of Technology (Japan)

In this talk, we show that integrated nanophotonics technologies enable energy-effective O/E and D/A conversions in an integrable fashion. In addition, it is essentially important to add integrable energy-efficient nonlinearities at appropriate places in linear-optic circuits. We present our recent results of such nonlinear elements based on OEO transistors and nanomaterial-loaded nanophotonics. finally, we will discuss possible applications of these technologies for optoelectronics computations.

Coffee Break and Exhibit Inspection

Session 1P1

Poster session I

09:35 - 10:20

P1: Anapole Excitations in Oxygen-Vacancy-Rich TiO2-x Nanoresonators: Tuning the Absorption for Photocatalysis in the Visible Spectrum
Ludwig Huttenhofer[1], Felix Eckmann[2], Alberto Lauri[3], Javier Cambiasso[3], Evangelina Pensa[3], Yi Li[4], Emiliano Cortés[1], Ian D. Sharp[2], Stefan A. Maier[1]
[1] *Ludwig-Maximilians-Universitat Munchen (Germany),* [2] *Technische Universitat Munchen (Germany),* [3] *Imperial College London (United Kingdom),* [4] *Southern University of Science and Technology (China)*

We realize engineered nanoantennas composed of photocatalytic dielectrics and demonstrate increased light harvesting capabilities in otherwise weakly absorptive spectral regions. In particular, we employ anapole excitations, which are known for their strong light confinement, in nanodisks of oxygen-vacancy-rich TiO2-x, a prominent photocatalyst that provides a powerful platform for exploring concepts in absorption enhancement in tunable nanostructures. This concept is general and can be extended to other catalytic materials.

P2: Photonic dualism of icosahedral quasicrystals
Artem Sinelnik, Ivan Shishkin, Xiaochang Yu, Kirill Samusev, Pavel Belov, Mikhail Limonov, Pavel Ginzburg, Mikhail Rybin
ITMO University (Russia)

Here we report on the first fabrication of 3D submicron-size dielectric icosahedral quasicrystals and show a photonic dualism of these structures. Relying on far-field measurements, we found pronounced patterns of unconventional Bragg diffraction, which indicates the existence of multiple photonic pseudogaps

P3: Optical properties of a spatiotemporally modulated surface
Daigo Oue, Kun Ding, John Pendry
Imperial College London (United Kingdom)

In this research, we develop a differential formalism [J. Chandezon et al., JOSA, 72, 839 (1982).] in order to analytically calculate the optical response of spatiotemporal metasurfaces.

P4: Electron energy-loss spectrocopy of hybrid silicon-on-gold nanoresonators
Artyom Assadillayev[1], Tatsuki Hinamoto[2], Minoru Fujii[2], Radu Malureanu[1], Tim Booth[1], Mark L. Brongersma[3], Soren Raza[1]
[1] *Technical University of Denmark (Denmark),* [2] *Kobe University (Japan),* [3] *Stanford University (USA)*

Using electron energy-loss spectroscopy (EELS), we show that high-refractive-index silicon nanoparticles on top of a thin gold layer give rise to low-loss hybrid resonances and strong plasmon launching. We characterize the surface plasmon (SP) modes which are launched by the spherical silicon nanoparticle in the presence of the thin gold layer and the Mie modes of the nanoparticle.

P5: Generating vivid colours from black disordered plasmonic network
Changxu Liu[1], Peng Mao[2], Shuang Zhang[2], Stefan A. Maier[1]
[1] *Ludwig Maximilian University of Munich (Germany),* [2] *University of Birmingham (United Kingdom)*

We design an optical platform that reconciles the two seemingly contradictory criteria, generating vivid structural colours from a disordered network with original black colour. By manipulating the coupling between the disordered system and its optical environment, the random plasmonic network switches from a broadband absorber to a system with tunable resonance. Not limited to the structural colour formation, the platform can be utilised for ultra-sensitive stimuli detection such as nanometer scale height fluctuation and minute refractive index variation.

P6: Self-detunable MRI Signal Enhancement Metasurface On-Bench Characterization
Endri Stoja[1], Diego Betancourt[1], Robin Niklas Wilke[2], Dennis Philipp[2], Simon Konstandin[2], Reiner Umathum[2], Jurgen Jenne[2], Thomas Bertuch[1], Matthias Gunther[3]
[1] *Fraunhofer FHR (Germany),* [2] *Fraunhofer MEVIS (Germany),* [3] *University of Bremen (Germany)*

A simple technique for the detuning during transmission (Tx) of an MRI signal enhancement metasurface is proposed. The metasurface itself is composed of a linear alignment of wire resonators, whereas the detuning is achieved via inductive coupling to a varactor-loaded loop which senses the RF field strength. On-bench measurements validate the detuning efficiency. Detuning during the Tx phase avoids excitation field distortion, targeted flip angle modification and limits patient exposure.

P7: Optical Extinction Cross-Section Enhancement of a Dielectric Cylinder through Meta-surface made of Graphene-Coated Spherical Nanoparticles
Shiva Hayati Raad, Zahra Atlasbaf
Tarbiat Modares University (Iran)

Graphene-coated spherical nano-particles are arranged around a dielectric cylinder in order to enhance its extinction cross-section. Initially, a 1D array of the particles is considered in different loci with respect to the incident wave. It is observed that regardless of the position of the particles, the extinction cross-section is considerably enhanced with respect to the bare cylinder due to the excitation of localized surface plasmons in shells. By increasing the number of particles, extinction cross-section is further enhanced.

P8: Absorption control in epsilon-near-zero hyperbolic metamaterials based on InAs
Michal Dudek, Alessandro Pianelli, Rafal Kowerdziej, Janusz Parka
Military University of Technology (Poland)

Here we present the possibility to control the epsilon-near-zero (ENZ) region by properly designing a hyperbolic metamaterial (HMM) based on InAs, which allows for an adjustable absorption in mid-IR. Numerical results show that by increasing thickness of the undoped InAs layers we are able to redshift the absorption by 14 microns. Also, transition from hyperbolic dispersion type I to ENZ and type II is observed. The designed HMM stack may provide a platform for perfect metamaterial absorbers in mid-IR.

P9: Photon Nanosources Using Low Energy Tunnel Electrons
Gérald Dujardin, Elizabeth Boer-Duchemin, Rémi Bretel, Shuiyan Cao, Eric Le Moal, Delphine Pommier
Université Paris-Sud (France)

We explore new types of electrically-driven photon nanosources based on the use of low energy tunnel electron excitations with the Scanning Tunneling Microscope (STM).

P10: Differential field Enhancement using Non-Reciprocal Material for Plasmon-Enhanced Upconversion at a Particular Wavelength

Jasvith Raj Basani, Nikhil Navaratna, Waseem A. Wani, Kannan Ramaswamy
Birla Institute of Technology and Science Pilani (India)

Upconversion, the process of changing the energy of a photon from a lower energy to a higher energy, is an area with a vast multitude of applications - from efficient hybrid solar cells to background-free bioimaging. Presently, however, upconverting techniques used are inefficient and are economically unfeasible. To maximize the efficiency of upconverting technologies, the system could ideally react to a band of frequencies - particularly, to have different enhancements for different frequencies, by introducing a nonreciprocal spacer.

P11: Ultra-wide Bandwidth Electromagnetic Wave Absorbers with Multilayered Frequency Selective Surfaces

Tian Liu, Sung-Soo Kim
Chungbuk National University (Korea)

A high-capacitive frequency selective surface (FSS) with a new structure of folded spiral conductors has been proposed as the small-array periodicity and low-frequency resonance FSS for the aim of ultra-wide bandwidth absorbers in multilayer structure. Through a combination of the high capacitive spiral FSS with other conventional FSS (square loop, square patch) with a medium- and high-frequency resonance, an ultra-wide absorption bandwidth (4.7-50.0 GHz for -10 dB reflection loss) can be designed with a small total thickness close to the theoretical limit.

P12: Engineering spontaneous valley coherence in two dimensional heterostructures

Anshuman Kumar
Indian Institute of Technology Bombay (India)

In order to harness the valley degree of freedom in TMDCs, it is critical to be able to actively control the coherence between excitons in the two valleys. Here we demonstrate how spontaneous valley coherence (SVC) can be achieved by creating a heterostructure of the TMDC with other 2D materials. Subsequently we will present our recent results to show tunability of SVC using certain commonly available 2D semiconductor heterostructures.

P13: High-efficient phase modulator based on all dielectric metasurface electrically tunable by thin layer liquid crystal for visible light modulation

Mingyu Sun
University of Shanghai for Science and Technology (China)

We propose phase modulator by LC composited TiO2 metasurface. Under effect of Huygens' condition, obvious binary phase shift with high transmittance about 80 % is obtained with small driving voltage of 4∼8 V, and a large dipole resonance extension above 150 nm to be expected. The convolutional neural network based inverse design setup helps to anticipate the proper LC layout with respect to the measured optical output. Such LC composited metasurface device could be a solution to the high-efficient phase modulator.

P14: Sorting full angular momentum states with all-dielectric Pancharatnam-Berry spiral transformation metasurfaces

Baiming Wang[1], Yuanhui Wen[1], Jiangbo Zhu[2], Yujie Chen[1], Siyuan Yu[3]
[1]Sun Yat-sen University (China), [2]Northumbria University (United Kingdom), [3]University of Bristol (United Kingdom)

Spin and orbital angular momenta (SAM and OAM), constitute a complete and higher state space of light. Here we propose a scheme that combines the spiral coordinate transformation with all-dielectric Pancharatnam-Berry metasurfaces for high-resolution simultaneous sorting SAM and OAM states of light. Simulations and experiments are demonstrated sorting 7 OAM states and 2 SAM states. This compact, high-resolution, and high-efficiency full angular momentum state sorter could have applications in both classical and quantum information systems.

P15: Influence of ordering of gold nanohole arrays on plasmonic resonances

Brindhu Malani S.[1], P. Viswanath[2]

[1] *Mangalore University (India),* [2] *Centre for Nano and Soft Matter Sciences (India)*

Gold nanoholes of varying hole sizes and ordering were fabricated using colloidal lithography. The degree of ordering was quantified using pair-correlation function and bond-orientational order parameters. Reflectance studies from experiments and simulations of these samples shows that it supports both localized surface plasmon resonance and propagating surface plasmon polaritons. We found that spectral resolution improves for sample with long range order and higher bond-orientational order parameter. Based on plasmonic responses and order quantification optimum sample is chosen for refractive index sensing.

P16: Realization of photonic time crystal in a trapped exciton-polariton condensate
Ting-Wei Chen[1], Shih-Da Jheng[2], Szu-Cheng Cheng[2]
[1] *National Chiayi University (Taiwan),* [2] *Chinese Culture University (Taiwan)*

A photonic time crystal in a trapped polariton condensate is theoretically realized. Numerical modeling based on the open-dissipative Gross-Pitaevskii equation suggests the formation of a quantized vortex surrounded by azimuthal superflows within the annular excitation area.

P17: Optomagnetic field in nonmagnetic plasmonic nanostructures
Vage Karakhanyan, Clement Eustache, Yannick Lefier, Thierry Grosjean
University of Bourgogne - Franche-Comté (France)

Using simplified hydrodynamic model, we theoretically investigate resonant inverse Faraday effect within individual plasmonic nanostructures. Upon illumination with circularly polarized light, resonant nanostructures are shown to develop an optomagnetic field that is controllable by the helicity of the light. Given their submicron footprint, individual plasmonic nanostructures open new prospects towards ultrafast and polarization-controlled tunable magnetism on the nanoscale, thus potentially impacting large panel of application and techniques including all optical magnetization switching, spin-wave excitation and optomagnetic tweezing of nano-objects.

10:20 - 12:40 — Victor Veselago Room

Session 1A3

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

10:20 : Invited talk
Nanophotonic systems for image processing
Lukas Wesemann, Timothy Davis, Ann Roberts
The University of Melbourne (Australia)

Conventional all-optical image processing requires relatively bulky optics limiting its potential use in mobile electronic systems. Here, the use of nanoscale resonant gratings and other thin film structures for image processing of both amplitude and phase objects is presented.

10:40 : Invited talk
Spatial and dynamical multi-level control over thermal emission
Ziquan Xu[1], Huanzheng Zhu[1], Min Qiu[2], Qiang Li[1]
[1] *Zhejiang University (China),* [2] *Westlake University (China)*

We demonstrate a thermal emitter with spatial and dynamic tunability by using phase-transition material vanadium dioxide. Emissivity varies from 0.19 to 0.91 during the insulator-to-metal transition. Laser-induced phase transition and its application in multi-level spatial control of thermal emission are also demonstrated.

11:00 : Invited talk
High refractive index contrast meta-surfaces for sensing and emitting devices
Yuusuke Takashima, Masanobu Haraguchi, Yoshiki Naoi
Tokushima University (Japan)

High contrast meta-surfaces support several optical eigenmodes, and the interference of the excited modes provides the extraordinary optical properties. We experimentally have demonstrated unique ultraviolet and blue-violet devices with high contrast meta-surface, such as a highly polarized ultraviolet light-emitting diode with very low loss and highly sensitive refractive index sensor with very simple optical system operating blue-violet wavelength.

11:20 : Invited talk
Synchronously wired infrared antennas for resonant single-quantum-well photodetection up to room temperature
Hideki T. Miyazaki[1], Takaaki Mano[1], Takeshi Kasaya[1], Hirotaka Osato[1], Kazuhiro Watanabe[1], Yoshimasa Sugimoto[1], Takuya Kawazu[1], Yukinaga Arai[1], Akitsu Shigetou[1], Tetsuyuki Ochiai[1], Mel F. Hainey Jr.[1], Yoji Jimba[2], Hiroshi Miyazaki[3]
[1] *National Institute for Materials Science (Japan),* [2] *Nihon University (Japan),* [3] *Tohoku University (Japan)*

To apply optical patch antennas sandwiching dielectrics between metal layers for optoelectronic devices, wiring to each electrically isolated antenna is indispensable. We show that geometrically engineered metallic wires interconnecting the antennas can function to synchronize the optical phases for promoting coherent resonance, not only as electrical conductors. Antennas connected with optimally folded wires are applied to quantum well infrared photodetectors, and a polarization-independent quantum efficiency as high as 61 % at 78 K, even extending to room temperature, is demonstrated.

11:40 : Invited talk
Bloch surface wave platform in the near- and mid-infrared regions
Chih-Zong Deng[1], Ya-Lun Ho[1], Yang-Chun Lee[2], Zhiyu Wang[1], Yi-Hsin Tai[1], Hirofumi Daiguji[1], Jean-Jacques Delaunay[1]
[1] *The University of Tokyo (Japan),* [2] *National Taiwan University (Taiwan)*

Bloch surface wave (BSW) platform opens up new possibilities in the design of sensors and components for photonic circuits owing to its superior properties such as low propagation losses that enable long optical communication length and large surface sensing area. Here, we report a BSW platform realizing well-coupled BSW in a wide spectral range from the NIR to the MIR with possible applications in light guiding and sensing.

12:00 : Invited talk
The Wonderful World of Flat Bands
Sergej Flach
Institute for Basic Science (Korea)

Certain lattice wave systems in translationally invariant settings have spectral bands that are strictly flat or independent of momentum, arising from either internal symmetries or fine-tuned coupling. These flat bands display remarkable strongly interacting phases of matter. Flat bands have now been observed in a variety of settings, ranging from electronic systems to ultracold atomic gases and photonic devices. I will review the design and implementation of flat bands and chart future directions of this exciting field.

12:20 : Invited talk
Acoustic metamaterial beam with a perfect bandgap based on a quadruple-mode resonator array
Motonobu Tomoda, Kentaro Fujita, Osamu Matsuda, Oliver B. Wright
Hokkaido University (Japan)

We introduce a metamaterial in the form of a rectangular cross-section beam made of a single isotropic material that can simultaneously suppress all elastic-wave polarizations,i.e. compressional, in-plane shear, flexural and torsional waves, over a range of frequencies around 1 kHz. This is experimentally achieved by machining replicas of a unit cell based on a planar resonator with interconnected ribs in analuminum beam. Our method opens the way to various applications in easily-manufacturable vibration isolators and novel acoustic wave control.

10:20 - 12:30 — Allan Boardman Room

Session 1A4

Symposium I: Hybrid Nanomaterials and Metastructures for Photonics, Sensing and Energy

Organized by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

Chaired by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

10:20 : Keynote talk
Semiconductor Nanocrystal Optoelectronics: Pushing the Limits
Volkan Demir Hilmi
Bilkent University (Turkey)

In this talk, we will introduce the emerging field of semiconductor nanocrystal optoelectronics, with most recent examples of their photonic structures and optoelectronic devices employing such atomically flat, tightly confined, quasi 2 dimensional CQWs, also popularly nick named "nanoplatelets".

10:50 : Invited talk
Metamaterial Absorber-enhanced Light-harvesting and Light-energy conversion
Peng Yu[1], Wenhao Wang[1], Zhiming Wang[1], Alexander Govorov[2]
[1] *University of Electronic Science and Technology (China),* [2] *Ohio University (USA)*

In this talk, we will present an overview of metamaterial absorber-enhanced light-harvestings and their use in the light-energy conversion devices, such as hot electron generation for photochemistry and photothermal for bolometry.

11:10 : Invited talk
Plasmonic nanostructures for solar fuels generation
Alberto Naldoni
Palacky University (Czech Republic)

The development of large-scale solar energy conversion technologies for fuels and chemicals is currently hindered by low yields and scarce product selectivity. Plasmonic nanostructures have emerged as a promising building block to enhance light-matter interaction in solar fuel devices and to trigger alternative reaction pathways. In this talk, I will summarize our recent results about the integration of plasmonic nanoantennas and nanoparticles in systems for solar fuels generation, discussing the fundamental mechanisms underlying the observed enhanced reactivity.

11:30 : Invited talk
Optically Active Nanostructures
Yurii K Gun'ko, Fearghal C. Donnelly, finn Purcell-Milton, Vera A. Kuznetsova
Trinity College Dublin (Ireland)

We present advances in the development of various optically active nanomaterials. We discuss the main approaches to induce optical activity in nanomaterials, including: the synthesis of nanomaterials in the presence of chiral ligands, post-synthetic capping of achiral nanostructures with chiral molecules, presence of chiral defects and even simple stirring of achiral anisotropic colloidal nanostructures. Most of the optically active nanostructures demonstrate strong unique circular and linear dichroism responses and very interesting structural morphologies.

11:50 : Invited talk
Measuring the magnetic dipole transition of single nanorods by Fourier microscopy
Reinaldo Chacon[1], Aymeric Leray[1], Jeongmo Kim[2], Khalid Lahlil[2], Sanro Mathew[1], Alexandre Bouhelier[1], Jong-Wook Kim[2], Thierry Gacoin[2], Gérard Colas des Francs[1]
[1] *Université Bourgogne Franche-Comté (France),* [2] *Ecole Polytechnique (France)*

Rare-earth ions can present optical transitions with significant magnetic dipole (MD) character that can be manipulated by the crystalline or molecular hosting environment. They are of strong interest for engineering light-matter interaction at the nanoscale with numerous applications in nanophotonics. We analyze in details the optical transition in individual and single cristalline rare-earth doped nanocrystals. We measure the MD orientation and demonstratea 100 % magnetic transition in our homemade synthesized single cristalline

nanorods.

12:10 : Invited talk
Photonic flat-band lattices and unconventional light localization
Zhigang Chen
Nankai University (China)

In this talk, we briefly summarize developments on the flat-band localization and the associated phenomena in photonic lattices, including unconventional line states and noncontractable loop states. We show that such photonic lattices offer a convenient platform for probing the underlying physics of flat-band systems, which may provide inspiration for exploring fundamentals and applications of flat-band physics in other structured media from metamaterials to other nanophotonic materials.

10:20 - 12:30 — Tatsuo Itho Room

Session 1A5

Bottom-up approaches, new fabrication routes and ENSEMBLE3

Organized by: Dorota Pawlak and Virginie Ponsinet

Chaired by: Dorota Pawlak and Virginie Ponsinet

10:20 : Invited talk
Planar nanooptics in anisotropic van der Waals crystals
Pablo Alonso-Gonzalez
University of Oviedo (Spain)

Highly anisotropic crystals have recently attracted considerable attention because of their ability to support polaritons with a variety of unique properties, such as hyperbolic dispersion, negative phase velocity, or extreme confinement. Here, we will show experimental demonstrations of the unique behaviour of PhPs in these crystals including highly directional propagation and ultra-low losses.

10:40 : Invited talk
Nanostructured optical fibers
Rafal Kasztelanic[1], Dariusz Pysz[1], Adam filipkowski[1], Alicja Anuszkiewicz[2], Marcin Franczyk[1], Ryszard Buczynski[1]
[1] *University of Warsaw (Poland),* [2] *Lukasiewicz Research Network - Institute of Microelectronics and Photonics (Poland)*

The nanostructuring technique allows to fabrication of all-glass optical fibers with properties not differing from the existing solutions. Moreover, nanostructuring makes it possible to break the circular symmetry of the fiber structure and fabricate new fibers, impossible to manufacture with other methods, as well as to optimize the fiber optical parameters more extensively.

11:00 : Keynote talk
Publishing in Nature Journals
Rachel Won
Nature Photonics (United Kingdom)

This talk, although with an emphasis on Nature Photonics, will introduce you to all the Nature journals, and cover the detailed information and guidelines on scientific manuscript preparation and submission. Also presented is an overview on the editorial and peer-review processes in all Nature journals. For those who are interested in being an editor, you will get to know the selection criteria and process of Nature journals.

11:30 : Invited talk
Self-assembled chiral plasmonic metasurfaces
Matthias Pauly, Vincent Lemaire, Sribharani Sekar, Wenbing Wu, Gero Decher
Université de Strasbourg (France)

Chiral plasmonic metasurfaces are self-assembled from oriented non-chiral metallic nanowires and nanorods using Grazing Incidence Spraying combined to the Layer-by-Layer assembly approach. The resulting thin films display a very high circular dichroism over the whole visible and near-infrared wavelength range, and the optical properties are highly dependent on the superstructure which can be easily tuned by this approach.

11:50 : Invited talk
Optical Properties of Artificial Chiral Metasurfaces
Emiljia Petronijevic[1], Grigore Leahu[1], Alessandro Belardini[1], Roberto Roberto Li Voti[1], Concita Sibilia[1], Tiziana Cesca[2], Giovanni Mattei[2]
[1] *Universita di Roma La Sapienza (Italy),* [2] *University of Padova (Italy)*

Here we investigate optical chiral properties of metasurfaces fabricated by means of nanosphere lithography. This low-cost and simple technique combined with angled evaporation of a plasmonic layer was employed to produce arrays of tilted elliptical nanoholes in Au or Ag. The elliptical shape and the in-plane tilt lead to the symmetry breaking, which further enables different coupling with circularly polarized light of opposite handedness. We investigate intrinsic and extrinsic chiral behavior in the visible and near infrared range.

12:10 : Invited talk
Scattering electromagnetic eigenstates of a two-constituent composite and their exploitation for calculating a physical field
David J Bergman, Parry Chen, Asaf Farhi
Tel Aviv University (Israel)

The spectral representation of an electric field in a two-constituent composite medium is revisited. A theory is developed for calculating the electromagnetic (EM) eigenstates of Maxwell's equations for such a composite where the magnetic permeability as well as the electric permittivity have different uniform values in the two constituents.

10:20 - 12:20 — Christian Huygens Room

Session 1A6

Symposium III: Advanced passive and active metasurfaces and zero-index optics

Organized by: Howard Lee, Yu-Jung (Yuri) Lu and Zi Jing Wong

Chaired by: Howard Lee, Yu-Jung (Yuri) Lu and Zi Jing Wong

10:20 : Invited talk
Metasurface enhanced high-sensitive IR spectroscopy
Takuo Tanaka
RIKEN and Tokushima University (Japan)

Metasurfaces consist of metal-insulator-metal structure were developed for a versatile platform of high-sensitive IR spectroscopy. A device with nano-fluidic channel allows the introduction and precise control of number of analyte molecules into the intense electromagnetic field of metamaterials, resulting in the improvement of sensitivity up to 2 orders compared to state-of-the-art plasmonic enhanced IR spectroscopies. High sensitive gas spectroscopy has also demonstrated by the use of vertically aligned MIM metasurface device.

10:40 : Invited talk
Generation of high-efficiency light sheets by dielectric metasurfaces
Dangyuan Lei
City University of Hong Kong (Hong Kong)

In this talk, I will present a few analytical and intelligent approaches for designing high-efficiency light sheets with dielectric metasurfaces, including realization of multiple light sheets by metasurface-based Fourier transformation, structured light sheets by aperture-like metasurface arrays, large-area light sheet by phase-controlled intelligent metasurface. I will also discuss the possibility of using phase-changing materials to achieve switchable metasurfaces.

11:00 : Invited talk
Metasurface design and application for compact AR device
Byoungho Lee, Jangwoon Sung, Gun-Yeal Lee
Seoul National University (Korea)

The principles and applications of metasurface will be given with detailed examples. Three metasurface designs that can exceed the conventional optical modulation will be given, which are complex-amplitude modulation, full-space visible light modulation, and phase-change material-based metasurface. Then, metalens eyepiece for augmented reality will be discussed.

11:20 : Invited talk
Active Metasurfaces based on Phase-Change Materials
Min Qiu
Westlake University (China)

Metasurfaces, incorporated with phase-change materials, show extraordinary tunability and reconfigurability with a simple design. We explore their possible applications in dynamic light manipulation, emissivity control and thermal management and camouflage, etc., which hold high promise for uncovering novel physical phenomena and settling practical problems.

11:40 : Invited talk
Near-infrared Active Metasurfaces for Tunable Beam Diffraction and Dynamic Polarization Conversion
Pin Chieh Wu[1], Ruzan Sokhoyan[2], Ghazaleh Kafaie Shirmanesh[2], Wen-Hui Cheng[2], Ragip A. Pala[2], Meir Grajower[2], Harry Atwater[2]
[1] *National Cheng Kung University (Taiwan),* [2] *California Institute of Technology (USA)*

In this talk, I will firstly discuss an all-dielectric active metasurface platform based on electro-optically tunable III-V multiple-quantum-well (MQW) resonators. By selectively applying an electrical bias to metasurface elements, we experimentally realize a dynamically switchable diffraction grating and beam steering. Subsequently, I will report a scheme of active polarization modulation by using indium tin oxide (ITO)-based tunable metasurfaces. By suitably biasing the metasurface structure, the polarization of reflected light can be converted to versatile states.

12:00 : Invited talk
Generating High Resolution Accelerating Optical Beams and Beam Array Based on All-dielectric metasurfaces
Binbin Yu, Lei Chen, Xu Chen, Dawei Zhang, Jing Wen
University of Shanghai for Science and Technology (China)

We experimentally realize high-resolution Airy optical beams and beam array with long working and non-diffraction propagation distances based on our proposed highly compact all-dielectric synthetic metasurface, that integrate a cubic phase and the phase of a Fresnel holographic lens. In addition, we demonstrate that imposing the phase of a Dammann grating to the above synthetic metasurface produces an array of Airy optical beams.

10:20 - 12:30 — Augustin Fresnel Room

Session 1A7

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii

Chaired by: Eugene Kamenetskii

10:20 : Invited talk
Interaction of chiral light with topological singularities in plasmonic metasurfaces
Eliav D. Epstein, Leeju Singh, Maayan Fox, Shmuel Sternklar, Yuri Gorodetski

Ariel University (Israel)

We present simple metasurfaces with different topologies supporting plasmonic edge states at the boundary between them. Preliminary experiments and numerical simulations show the achieved mode localization in line defects and point singularities. Line singularities are shown to support dark and bright modes. Point singularities show strong localization of light which can be further modified by the varying topological order of the structure.

10:40 : Invited talk
Theory of Photoinduced Spin Polarization in Spin-Orbit-Coupled Systems
Masahito Mochizuki, Takashi Inoue, Yasuhiro Tanaka
Waseda University (Japan)

We theoretically study the photo-induction of spin polarization in electron systems with spin-orbit interactions irradiated with circularly polarized light. It is demonstrated that the rotating electric field of CPL is converted to an effective static field and induces the spin polarization perpendicular to the polarization plane. We find that the magnitude and sign of the induced spin polarization are governed by the electron filling and the Fermi-surface geometry.

11:00 : Invited talk
Time-resolving surface plasmon orbital angular momentum from pure geometric chirality
Chen-Bin Huang[1], **Yanan Dai**[2], **Hrvoje Petek**[2]
[1] *National Tsing Hua University (Taiwan),* [2] *University of Pittsburgh (USA)*

We demonstrate the creation of plasmonic OAM contributed purely through the geometrical chirality of the spiral. The experiments are carried out through time-resolved two-photon photoemission electron microscopy, where the recorded movies reveal the orbiting trajectories of surface plasmon polaritons coupled by the spiral under linearly-polarized excitations.

11:20 : Invited talk
Theory of Single Molecular Near field Circular Dichroism by Photo-induce Force Microscopy
Hajime Ishihara, Hidemasa Yamane, Nobuhiko Yokoshi
Osaka Prefecture University (Japan)

We theoretically propose the near field circular dichroism (CD) of single molecules by photo-induced force microscopy (PiFM). Based on the extended discrete dipole approximation (e-DDA) incorporating the nonlocal optical response, we calculate PiFM CD map. The result indicates a greatly enhanced near field CD of single molecules.

11:40 : Invited talk
Universal energy barriers of large magnetic skyrmions
Jan Masell
RIKEN Center for Emergent Matter Science (Japan)

Magnetic skyrmions are whirls in the magnetization for which a topological winding number can be defined. Because of this topology, skyrmions are often believed to gain some superior topological protection, in particular close to the continuum limit. However, even in this limit their energy barriers remain finite for a large class of systems. Moreover, the height of the barrier is determined by higher order gradients of the continuum theory which arise, e.g., from higher order interactions.

12:00 : Keynote talk
A new spin for acoustics
Konstantin Bliokh
RIKEN (Japan)

I will show theoretical and experimental results proving that water waves possess nontrivial spin and momentum densities, which can be described within a universal relativistic field theory construction. These results provide a new twist for sound and water-surface waves, and offer new fields for applications of various vector-wave phenomena, so far mostly restricted to photonic and quantum-electron systems.

10:20 - 12:30 — Ibn Al-Haytham Room

Session 1A8

Symposium V: Phononics and acoustic metamaterials

Organized by: Jensen Li and Guoliang Huang

Chaired by: Jensen Li and Guoliang Huang

10:20 : Invited talk
Asymmetric Elastic-wave Transmission in a Lossless Metasurface
Bing Li[1], Yabin Hu[1], Yongquan Liu[2], Meiying Zhao[1], Zheng Li[3]
[1] Northwestern Polytechnical University (China), [2] Xi'an Jiaotong University (China), [3] Peking University (China)

Our research presents theoretical, numerical and experimental investigations of asymmetric elastic-wave transmission in a thin plate with a lossless elastic metasurface. A theoretical framework is developed to control the asymmetric elastic-wave transmission without tailoring losses. We numerically and experimentally demonstrate that the asymmetric behavior can be realized based on higher order diffraction in a lossless structural waveguide. We further experimentally show that the novel phenomenon can be obtained within a relatively broad range of incident angles and frequency band.

10:40 : Invited talk
Giant extraordinary transmission of longitudinal acoustic waves
Oliver B. Wright[1], Thibaut Devaux[1], Hiroya Tozawa[1], Paul H. Otsuka[1], Sylvain Mezil[1], Motonobu Tomoda[1], Osamu Matsuda[1], Eun Bok[2], Sam Hyeon Lee[2]
[1] Hokkaido University (Japan), [2] Yonsei University (Korea)

We demonstrate extraordinary longitudinal bulk-wave acoustic transmission inside a solid structure, acting as an acoustic meta-atom, that is connected between two tungsten blocks. By including concentric grooves of optimal dimensions, we show how the extraordinary acoustic transmission efficiency can be increased to a value exceeding 500, and how directed output beams inside solids can be produced. Applications include acoustic imaging and sensing.

11:00 : Invited talk
Self-synchronization of Thermal phonons in a Charged Silicon Resonator System
Zhongwei Zhang[1], Yangyu Guo[1], Marc Bescond[1], Jie Chen[2], Sebastian Volz[1], Masahiro Nomura[1]
[1] The University of Tokyo (Japan), [2] Tongji University (China)

Self-synchronization is an important collective behavior, in which oscillators are dynamic in a coherent state. In this work, we demonstrate that the Coulombic force coupled thermal phonons can be spontaneously synchronized, without any external driving, which is well understood from the synchronization of frequency and phase. By generating coherent thermal phonons, self-synchronization also significantly enhances thermal transport. Our findings might promote physical understanding of the emergence of coherent phonons, and also the engineering of nanoscale thermal transport.

11:20 : Spatiotemporal effective media for acoustic waves
Xinhua Wen[1], Xinghong Zhu[1], Hong Wei Wu[2], Jensen Li[1]
[1] Hong Kong University of Science and Technology (Hong Kong), [2] Anhui University of Science and Technology (China)

Based on an approach of virtualized metamaterials with software-defined impulse response, we experimentally realize an acoustic spatiotemporal effective medium in dynamically switching between two resonating configurations with a modulation frequency at least 5 times higher than the signal frequency. We also establish the effective medium formula.

11:35 : Invited talk
Experimental investigation of defect modes in tubular phononic crystals
Frieder Lucklum
Technical University of Denmark (Denmark)

In this contribution the use of defect modes in phononic crystals for sensing applications will be discussed on the basis of different practical realizations. As a specific example, experimental results of wave transmission through tubular phononic crystals will be compared for different materials and in the presence of different geometric defects to the ideal crystal as well as to reference measurements through a corresponding hollow tube and solid cylinder.

11:55 : Invited talk
On the use of a Helmholtz resonator to acoustically dope a Plate-type metamaterial
Matthieu Malléjac[1], Aurélien Merkel[2], Vincent Tournat[1], Vicent Romero-Garcia[1], Jean-Philippe Groby[1]
[1] *Le Mans Université (France),* [2] *Universite de Lorraine (France)*

In this work, we analytically, numerically, and experimentally investigate the feasibility of an acoustic analogue of the photonic doping effect, i.e., the ability of changing the effective properties of a medium by embedding a dopant. We show that a one dimensional Plate-type Acoustic Metamaterial (PAM) can be efficiently doped using a single doping impurity, e.g., a tuned Helmholtz resonator. The influence of both the location of the dopant and the losses are studied.

12:15 : Reminiscence of edge states in 1-dimensional hyperuniform acoustic materials
Svetlana Kuznetsova[1], Jean-Philippe Groby[1], Lluis M. Garcia-Raffi[2], Vicent Romero-Garcia[1]
[1] *Université du Mans (France),* [2] *Universitat Politecnica de Valencia (Spain)*

Hyperuniform materials are systems made from point distributions that suppress density fluctuations on large length scales. They present wide and isotropic bandgaps despite being highly disordered and degenerate. Here, we report the localization of acoustic waves at the interface between two 1-dimensional hyperuniform materials yielding in different states. Both materials represent an air-filled acoustic waveguide with rigid diaphragms acting as scatterers. Tunability of the band structure and emergence of the edge modes provide promising applications in wave control devices.

10:20 - 12:20 — Gaston Floquet Room

Session 1A9
Acoustic and seismic metamaterials

10:20 : A homogenization model for acoustic metasurfaces and design sensitivity analysis for topology optimization
Yuki Noguchi[1], Takayuki Yamada[2]
[1] *Tokyo Institute of Technology (Japan),* [2] *Kyoto University (Japan)*

In this paper, an efficient numerical analysis model for acoustic metasurfaces is provided based on a homogenization method. Considering its application to the optimal design of acoustic metasurfaces by topology optimization, we discuss the design sensitivity called the topological derivative. Numerical examples are provided to confirm the validity of the proposed model and sensitivity.

10:35 : Fluid-like Elastic Reflective Metasurface
JooHwan Oh, YeJeong Shin
Ulsan National Institute of Science and Technology (Korea)

Elastic mode conversion has been considered as a unique characteristic of elastic waves that cannot be avoided. In this paper, a fluid-like elastic reflective metasurface that can break this coupling is proposed with numerical and experimental supports. In other word, only longitudinal wave is reflected for the obliquely incident longitudinal wave, i.e., the surface behaves as fluid boundary. We believe that our research may provide a new way in elastic metasurface technologies.

10:50 : Deep-subwavelength holey acoustic second-order topological insulators for spoof surface wave
Zhiwang Zhang[1], Ying Cheng[1], Dajian Wu[2], Desheng Ding[3], Xiaojun Liu[1]
[1] *Nanjing University (China),* [2] *Nanjing Normal University (China),* [3] *Southeast University (China)*

We illustrate a holey HOTI capable to sustain deeply confined corner states fifty times smaller than the

wavelength. Not only do we experimentally observe a remarkable resilience of these surface confined acoustic states against defects, but do also demonstrate topologically protected sound in three different frequency regimes. Concerning this matter, our findings will thus have the capability to push forward exciting applications for robust acoustic imaging way beyond the diffraction limit.

11:05 : Design and Manufacturing of Monolithic Mechanical Metastructure with Ultrawide Bandgap for Low Frequency Vibration and Noise Control
F. Muhammad, C. W. Lim
City University of Hong Kong (Hong Kong)

The present study proposes a novel 3-D monolithic mechanical metastructure with capability to induce ultrawide three-dimensional bandgap with relative bandwidth or gap-to-mid-gap ratio 171.5 %. The bandgap is induced and discussed by principle of mode separation that utilizes the locally resonant global and local modes to open ultrawide bandgap. The wave attenuation inside the bandgap frequencies are demonstrated by developing finite array model and performing numerical frequency response study. The numerical findings are corroborated through experiment test on 3-D printed prototype.

11:20 : Sonic semimetals with intersecting nodal rings
Liyang Zheng, Johan Christensen
University Carlos III de Madrid (Spain)

Nodal rings, protected by bulk topology and symmetries, arise from the crossing of the valance and conduction bands. In this work, we experimentally demonstrate three-dimensional sonic semimetals that exhibit intersecting nodal rings, and further investigate their topological original and the corresponding exciting wave properties. The nontrivial topology characterized by winding number due to nonsymmorphic symmetry guarantees the appearance of zero-energy surface waves. Novel transport phenomena, such as negative reflection and focusing, are also discussed.

11:35 : Coupled Scholte modes supported by soft elastic plates in water
Bethany Staples, Thomas Graham, Alastair Hibbins, Roy Sambles
University of Exeter (United Kingdom)

Unlike many materials, such as aluminium, the transverse wave speed in soft solids are less than that of longitudinal sound in water. This leads to a localized surface wave, the Scholte wave, having a speed well below that of sound in water. Here we use a thin acrylic plate and demonstrate that the two Scholte waves couple across the plate by using pulsed ultrasound excitation to record the dispersion of both the slow antisymmetric and faster symmetric coupled waves.

11:50 : Numerical and conceptual design of vibroacoustic metamaterial solutions for structural vibration reduction in launcher components
Daria Manushyna[1], Heiko Atzrodt[1], Marvin Droste[1], Niels Deschauer[2]
[1] *Fraunhofer Institute for Structural Durability and System Reliability LBF (Germany),* [2] *MT Aerospace AG (Germany)*

This work deals with numerical and conceptual design of vibroacoustic metamaterial solutions for structural vibration reduction in launcher components. The adjustable and compact design of vibroacoustic metamaterials based on a local resonance effect leads to an attractive and flexible solution especially for lightweight thin-walled structures in space industry. An inverse unit cell modelling approach is used to for the numerical design of a demonstrator including multiple tuned vibration absorbers (TVA).

12:05 : Multiple Scattering Theory in the study of Non-Hermitian Sonic Second Order Topological Insulators
Maria Rosendo Lopez[1], Zhiwang Zhang[1], Daniel Torrent[2], Johan Chistensen[1]
[1] *Universidad Carlos III de Madrid (Spain),* [2] *Universitat Jaume I (Spain)*

Here, we make use of the Multiple Scattering Theory to calculate the topological corner states of both Hermitian and Non Hermitian Sonic Second Order Topological Insulators. Our findings reveal that the sound is trapped in the corners of the Concentric Square Crystal considered, based on an inner SC made up of a topological non-trivial region enclosed by a topological trivial region. This approach allows us to compute the spectral dependence of corner states with defects, showing its robustness.

10:20 - 12:35 — Lawrence Bragg Room

Session 1A10

Plasmonics: Fundamentals and Applications

Organized by: Hong Wei

Chaired by: Hong Wei

10:20 : Invited talk
From passive to active manipulation of the polarization states of electromagnetic waves by plasmonic metastructures
Ruwen Peng, Xiang Xiong, Ren-Hao Fan, Mu Wang
Nanjing University (China)

In this talk, we focus on both passive and active manipulation of the polarization states of light with 2D/3D plasmonic metastructures.

10:40 : Invited talk
Colloidal self-assembly route towards efficient designing of nanophotonic architectures
Swagato Sarkar[1], Joby Joseph[1], Tobias A.F. Koenig[2]
[1] *Indian Institute of Technology Delhi (India),* [2] *Leibniz Institute of Polymer Research Dresden e. V. (Germany)*

We report a plasmonic grating of Au nanoparticle chains on a TiO2 layer to study the dispersion relation through simple spectroscopic methods. Compared to Au nanobars, the experimentally observed range of hybridized guided-modes can now be extended to modes along the nanoparticle chain lines. Fabrication of such hybrid-architectures over macroscopic areas through successful confluence of top-down and bottom up approaches like interference lithography and colloidal self-assembly respectively has resulted in polarization-dependent sensitivity enhancement.

11:00 : Invited talk
Multipole Engineering in Silicon Mie Resonator with Cap Layer
Junichi Takahara, Ikuto Hotta
Osaka University (Japan)

We study the mechanism of spectral narrowing of resonant scattering from a silicon Mie resonator by adding a cap layer. Multipole decomposition analysis reveals that lossy materials cause spectral red-shift of electric dipole only and induces the narrowing of Mie resonance.

11:20 : Invited talk
Nanoantennas Made of Gold and Silver Nanowires
Jianfang Wang, Xiaolu Zhuo
The Chinese University of Hong Kong (Hong Kong)

Wet-chemistry methods are developed to grow high-aspect-ratio gold and silver nanorods in high purity. These nanorods possess higher-order plasmon modes. Moreover, their longitudinal dipolar plasmon mode can be synthetically varied from the visible to the mid-infrared region. The broadside-antenna and color-routing functions are demonstrated with these nanorods, where light of different colors is directed to different directions. Moreover, these nanorods ate used to enhance the vibrational signals of organic molecules in the mid-infrared region with remarkable enhancement factors.

11:40 : Invited talk
Plasmonic chirality of one-dimensional nanostructures: the role of lattice resonance
Wei Zhang
Institue of Applied Physics and Computational Mathematics (China)

We perform systematic studies of one-dimensional (1D) chains of twisted nanorod dimers, focusing on the collective effect. Our studies reveal that the interplay between local structure/near field interaction and collective effect/far field interaction leads to quite different optical activity than that of the local nanostructures. In particular, it is found that the one-dimensional arrays of achiral objects show chiral responses due to the collective effect. Our studies provide useful guidance for the design of sensors based on optical activity.

12:00 : Invited talk
Plasmonic colour printing for information encryption
Zhang-Kai Zhou, Jiancai Xue
Sun Yat-sen University (China)

Plasmonic structures can selectively absorb or reflect light, making them can provide on-demand structural colours for building image devices. Based on our studies about plasmonic printing of interference colours , herein we introduce a new nano-steganography technique which is based on the optical inference of a plasmonic system. By carefully controlling the structural perturbation in such system, information encryption with near-perfect hiding and the property of countersurveillance can be obtained. Also, Information encryption based switchable metasurface imaging will be introduced.

12:20 : Electron Dynamics in Plasmons
Hue T. B. Do[1], Wen Jun Ding[2], Zackaria Mahfoud[2], Lin Wu[2], Michel Bosman[1]
[1] *National University of Singapore (Singapore),* [2] *A*STAR (Singapore)*

We show that the Particle-in-Cell (PIC) simulation method can be used to robustly describe plasmon resonances, with a unique emphasis on the motion of the electrons in the time domain. Laser-excited and electron-beam-excited plasmons are studied to obtain the femtosecond time-scale dynamics of electrons in plasmons, including the plasmon dephasing, the electron kinetics during damping and the evolution of plasmons and electrons during interaction with an electron beam.

10:20 - 12:20 — Rene Descartes Room

Session 1A11

Novel Topological Photonic Materials

Organized by: Matthias Saba and Sang Soon Oh

Chaired by: Matthias Saba and Sang Soon Oh

10:20 : Invited talk
Topological Singular Points in Photonic Crystals with Broken Symmetry
Masaya Notomi
Tokyo Institute of Technology (Japan)

We demonstrate that it is possible to deterministically generate topologically-protected bound states in the continuum (BIC) by breaking C6 symmetry of triangular-lattice photonic crystals. Furthermore, we found a variety of pair-creation and annihilation processes of circularly-polarized states, which are another type of singular points, by symmetry breaking. We also clarify that there is an intriguing conservation rule of two different topological charges, which account for vectorial nature of these singularities.

10:40 : Invited talk
Hidden symmetry enforced nexus points of nodal lines in layer-stacked dielectric photonic crystals
Ruo-Yang Zhang[1], Zhongfei Xiong[2], Yuntian Chen[2], Che Ting Chan[1]
[1] *Hong Kong University of Science and Technology (Hong Kong),* [2] *Huazhong University of Science and Technology (China)*

In an AB-layer-stacked photonic crystal consisting of anisotropic dielectrics, we discover that the unique photonic band connectivity leads to triply degenerate nexus points of two nodal rings and a Kramers-like nodal line. The emergence and intersection of the line nodes are guaranteed by a hidden symmetry of Maxwell's equations. The bands with a constant kz and the iso-frequency surfaces nearby the nexus point both disperse as a spin-1 Dirac-like cone, indicating exotic transport features of light at nexus point.

11:00 : Invited talk
Three-dimensional metamaterials and two-dimensional photonic crystals for topological photonic phase
Minkyung Kim, Junsuk Rho

Pohang University of Science and Technology (Korea)

My recent work on 3D topological semimetals based on metamaterials and 2D topological insulators based on photonic crystals will be presented in this talk. In the first part, topological semimetals whose topological phases arising from effective optical properties, hyperbolicity and chirality, will be covered. In the latter part, exploration of 2D nontrivial topology characterized by quantum Hall phase and Zak phase will be presented.

11:20 : Invited talk

Nodal link in double diamond photonic crystal

Haedong Park[1], Stephan Wong[1], Xiao Zhang[2], Sang Soon Oh[1]
[1] *Cardiff University (United Kingdom),* [2] *Sun Yat-sen University (China)*

We demonstrate nodal links in momentum space using a dielectric double diamond structure. We also characterize the topological natures of the nodal links. These topological natures are summarized into non-Abelian charges.

11:40 : Invited talk

Moiré superlattice induced giant gauge field and Landau levels in bilayer Metacrystal

Wenhui Wang[1], Wenlong Gao[2], Yuanjiang Xiang[3], Shuang Zhang[2]
[1] *University of Fribourg (Switzerland),* [2] *University of Birmingham (United Kingdom),* [3] *Hunan University (China)*

We report the first experimental observations of the Landau level flat bands and the associated eigen states in photonics bi-layer metacrystals. The moiré pattern formed by the lattice constant mis-match in the metacrystals is shown to create huge effective gauge field resulting in the photonic flat-band Landau levels. The photonic Landau levels are measured by the microwave near field scanning system and agrees with the theoretical and numerical predictions excellently.

12:00 : Invited talk

Topological photonics: Mistaken paradigms and new opportunities

Aitzol Garcia-Etxarri[1], Maria Blanco de Paz[1], Chiara Devescovi[1], Matt Proctor[2], Paloma Arroyo Huidobro[3], Barry Bradlyn[4], Maia Garcia Vergniory[1], Dario Bercioux[1]
[1] *Donostia International Physics Center (Spain),* [2] *Imperial College London (United Kingdom),* [3] *Instituto Superior Tecnico (Portugal),* [4] *University of Illinois at Urbana-Champaign (USA)*

In this work, through the application of the method of "Topological Quantum Chemistry"(TQC) to photonic crystals and the numerical calculation of Wilson loops and different topological invariants we will introduce a variety of novel topological effects in 2D and 3D photonic crystals. For instance, we will present the first instance of fragile topology in a photonic system, higher order photonic TI sustaining topologically protected corner states and our latest advances in the design of 3D topological photonic crystals.

Lunch

12:30 - 14:00

14:00 - 15:25 — Victor Veselago Room

Session 1A12

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

14:00 : Invited talk

Tailoring the emission and the photodynamics of quantum emitters with high index dielectric nanostructures

Peter Wiecha[1], Mélodie Humbert[1], Clément Majorel[1], Nicolas Mallet[1], Bruno Masenelli[2], Gérard Colas des Francs[3], Franck Fournel[4], Vincent Larrey[4], Aurélie Lecestre[1], Guilhem Larrieu[1], Arnaud Arbouet[1], Christian Girard[1], Vincent Paillard[1], Aurelien Cuche[1]
[1] *Université de Toulouse (France),* [2] *Université de Lyon (France),* [3] *Université Bourgogne-Franche Comté (Fran-*

ce), [4] *Université Grenoble Alpes (France)*

We show both experimentally and theoretically that the photodynamics of several electric and/or magnetic quantum emitters can be controlled by high index dielectric nanostructures made of Silicon.

14:20 : Tailoring the plasmonic properties of metals: The case of substoichiometric titanium nitride
A. Catellani, A. Calzolari
CNR-NANO Istituto Nanoscienze (Italy)

We present a first principles study of the composition-plasmonic properties interplay in sub-stoichiometric TiNx crystals, which conjugate superior structural properties and tunable optical response. We investigate the stability of defective TiNx over a large range of vacancy concentrations, and we describe the microscopic character and the plasmonic properties of these systems. Our results indicate a clear trend in the modification of the plasmonic activity of TiNx as a function of nitrogen concentration.

14:35 : Invited talk
Ultrafast all-optical magnetic writing in transparent dielectrics
Andrzej Stupakiewicz
University of Bialystok (Poland)

We demonstrated the all-optical photo-magnetic recording in Co-ions doped iron garnet films using a time-resolved magneto-optical spectroscopy and single-shot ultrafast imaging of magnetic domains. Ultrashort laser pulses at near-infrared range it is possible to write and rewrite magnetic bits with a frequency of up to 20 GHz, with the maximum repetition rate being defined by the frequency of ferromagnetic resonance in the field of photoinduced magnetic anisotropy.

14:55 : Keynote talk
Strainoptronics: A New Degree of Freedom for 2D Material Device Engineering
Rishi Maiti, Hamed Dalir, Volker J. Sorger
George Washington University (USA)

Here we introduce "strainoptronics the local strain engineering of 2D materials for novel optoelectronic components. We exemplary demonstrate heterogeneously integrating 2D materials in photonic circuits thus realizing a photodetector featuring a strong photoresponse (responsivity 0.5 A/W) operating at 1550 nm in silicon photonics.

14:00 - 15:20 — Allan Boardman Room

Session 1A13

Symposium I: Hybrid Nanomaterials and Metastructures for Photonics, Sensing and Energy

Organized by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

Chaired by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

14:00 : Invited talk
Broadband light beaming from a helical traveling-wave nanoantenna
Mengjia Wang, Roland Salut, Miguel Suarez, Nicolas Martin, Thierry Grosjean
FEMTO-ST Institute (France)

Nanoantennas have attracted much interest for their ability to directionally radiate light, with important implications in the optical detection of nanoscale objects. Based on the control of the resonant or dispersive properties of nanostructures, nanoantenna directivity is strongly wavelength-dependent. Here, we show that invariant light beaming can be obtained over a broad spectral range from an individual helical traveling-wave nanoantenna. This plasmonic antenna results from the extension to optics of the low-frequency helical antenna operating in the .ªxial mode".

14:20 : Invited talk

Active optical antennas driven by hexagonal boron nitride tunnel junctions

Kai Braun, Lukas Jakob, Frank Wackenhut, Florian Laible, Monika Fleischer, Alfred J. Meixner
University of Tuebingen (Germany)

The conversion of an electrical signal to an optical signal with maximum bandwidth and practical on-chip integration is of fundamental interest. Here we present active optical antennas driven by inelastic electron tunneling. We have fabricated arrays of vertical coupled antennas in metal-insulator-metal arrangements based on electrically connected gold nano rods(GNR) and hexagonal boron nitride as insulating layer. By tuning the aspect ratio of the GNRs we shift the localized plasmon resonance of the antennas and adjust the emission wavelength

14:40 : Invited talk

Plasmonic and Photonic Catalysis

Emiliano Cortes
Ludwig-Maximilians-Universitat (Germany)

Optical modes engineering in metallic and dielectric nanoparticles could open new paths for assisting chemical transformations using sunlight. In recent years, we have investigated these phenomena at the single nanoparticle level in order to unravel the mechanisms inducing catalytic transformations at these illuminated interfaces. Gaining a nanoscopic insight of these processes and their interplay could aid in the rational design of novel plasmonic and photonic photocatalysts.

15:00 : Invited talk

Modeling plasmonic hot-electron generation and their role in photocatalysis

Lucas Vazquez Besteiro[1], Zhiming M. Wang[2], Alexander O. Govorov[3]
[1] *Universidade de Vigo (Spain),* [2] *University of Electronic Science and Technology of China (China),* [3] *Ohio University (USA)*

Plasmonic nanoparticles can excite high-energy electrons capable of traversing into neighboring materials and driving secondary processes in photosensing and photocalytic applications. In this talk we will describe strategies to enhance the excitation of these high-energy carriers, and discuss their utility in several technological contexts. Our discussion will be supported by results from a hybrid theoretical model combining a quantum-mechanical description of the electronic states and a classical electrodynamic calculation of the collective plasmonic modes of large plasmonic nanocrystals.

14:00 - 15:20 — Tatsuo Itho Room

Session 1A14

Bottom-up approaches, new fabrication routes and ENSEMBLE3

Organized by: Dorota Pawlak and Virginie Ponsinet

Chaired by: Dorota Pawlak and Virginie Ponsinet

14:00 : Invited talk

Block copolymer directed nanoarchitectures for the design of novel optical materials

Alberto Alvarez Fernandez[1], Barry Reid[1], Guillaume Fleury[2], Virginie Ponsinet[2], Stefan Guldin[1]
[1] *University College London (United Kingdom),* [2] *Université de Bordeaux (France)*

Several types of block copolymers have been used as templates to produce well-defined dielectric and metallic nanostructures in 3D or 2D, with high degree of order and tunability. Resulting structures have shown interesting optical properties such as high-index metasurfaces or antireflective coatings.

14:20 : Invited talk

Photonic nanomaterials by self-assembly of block copolymers

Tapio Niemi
Tampere University (finland)

Both the scientific community and the industry are actively investigating innovative means to overcome

the fundamental limitations of conventional nanolithography. One emerging technique is based on directed self-assembly of block copolymers. Besides the possibility to realize extremely small feature sizes, the self-assembled polymers enable fabrication of exotic nanostructures, which are challenging or even impossible to fabricate by other methods. I shall demonstrate few applications for etch masks, refractive index tuning and preparation of multi-material nanostructures.

14:40 : Invited talk
Non-fading Plasmonic Color Printing through Laser Processing of Semicontinuous Metal films
Piotr Nyga[1], Sarah N. Chowdhury[2], Zhaxylyk Kudyshev[2], Esteban Garcia[2], Alexei S. Lagutchev[2], Alexander V. Kildishev[2], Vladimir M. Shalaev[2], Alexandra Boltasseva[2]
[1] *Military University of Technology (Poland),* [2] *Purdue University (USA)*

We report non-fading generation of vibrant colors through a femtosecond laser post-fabrication processing of a plasmonic semicontinuous metal film deposited on a metallic mirror coated with a sub-wavelength-thick dielectric spacer. Long term stability of color is obtained through structures' overcoating with a dielectric layer. Local changes induced to nanostructures of semicontinuous film are controlled by the femtosecond laser parameters, especially fluence. Wide range of vibrant colors in reflection mode from blue to green, to red can be easily obtained.

15:00 : Invited talk
Fabrication of amorphous photonic materials by colloidal self-assembly
Joshua Ricouvier, Romain Pierrat, Remi Carminati, Patrick Tabeling, Pavel Yazhgur
ESPCI Paris (France)

Recently discovered well-engineered disordered photonic band gap materials can potentially enable the production of energy-efficient displays or freeform wave-guides. In our research, we propose a colloidal self-assembly approach to produce such amorphous materials. By drying bidispese 2D emulsions, we produce a foam-like material with extremely low long-range density fluctuations (hyperuniformity) and strong short-range order, which open a disordered PBG. The obtained results suggest that photonic foams are potentially excellent candidate for disordered 3D PBG materials.

14:00 - 15:20 — Christian Huygens Room

Session 1A15

Symposium III: Advanced passive and active metasurfaces and zero-index optics

Organized by: Howard Lee, Yu-Jung (Yuri) Lu and Zi Jing Wong

Chaired by: Howard Lee, Yu-Jung (Yuri) Lu and Zi Jing Wong

14:00 : Invited talk
Bound states in the continuum in metasurfaces with dipolar meta-atoms
Diego R. Abujetas[1], Juan J. Saenz[2], Jose A. Sanchez-Gil[1]
[1] *Instituto de Estructura de la Materia (CSIC) (Spain),* [2] *Donostia International Physics Center (Spain)*

We explore the emergence of bound states in the continuum (BICs) in metasurfaces consisting of dipolar meta-atoms. We derive a coupled dipole theoretical formulation to describe the optical properties of a periodic array consisting of several electric/magnetic dipoles per unit cell, thereby investigating robust symmetry-protected BICs through different mechanisms in various kinds of arrays of interest throughout the electromagnetic spectrum: high-refractive-index disks in the GHz, metallic rod dimers in the THz, and silicon nanodisks in the visible.

14:20 : Invited talk
Nonlinear interactions of guided plasmons in graphene metasurfaces
Joel Douglas Cox
University of Southern Denmark (Denmark)

We explore nonlocal and quantum finite-size effects in the propagating plasmons supported by 1D graphene

nanoribbons and their associated nonlinear response, revealing a strong dependence on such phenomena for narrow ribbons excited by optical fields carrying large in-plane momenta. Our findings suggest new possibilities to engineer nonlinear interactions among guided plasmons in graphene-based nonlinear metasurfaces.

14:40 : Invited talk
Silicon based metastructures and metasurfaces
Ahmed Mahmoud
American University in Cairo (Egypt)

Throughout the past two decades, the concept of metamaterials introduced itself as a powerful tool for achieving non-conventional light-matter interaction in numerous scenarios. Despite the research efforts and the concurrent discoveries, the difficulty of fabrication and the incompatibility of the structures to conventional CMOS environments limit the influence of such efforts. In this work we explore various tunable metastructures and metasurfaces within our research efforts towards achieving the functionalities and phenomena of metamaterials within conventional environments and materials.

15:00 : Invited talk
Single-Emitter Near-Field Excited Quantum Dynamics in Near-Zero-Index Materials
Frank Bello[1], Nuttawut Kongsuwan[2], John F. Donegan[1], Ortwin Hess[1]
[1] *Trinity College Dublin (Ireland),* [2] *Quantum Technology Foundation (Thailand)*

We investigate the quantum dynamics from single quantum emitters (QE) excited using near-field light from a plasmonic transducer. Results show the ability to strongly drive a QE using a plasmonic near field with an ultrafast single-photon emission rate of 101-102 fs-1 for emitters embedded in nearzero index (NZI) media. QEs embedded in NZI media also demonstrate excellent enhancement of spontaneous emission compared to those in free space (≈ 107). Comparisons are made using QEs embedded in other common materials such as Silicon.

14:00 - 15:15 — Augustin Fresnel Room

Session 1A16

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii

Chaired by: Eugene Kamenetskii

14:00 : Invited talk
3D FDTD-LLG modelling of magnetisation dynamics in thin film ferromagnetic structures
Feodor Ogrin
University of Exeter (United Kingdom)

Here I propose a model which uses 3D finite-difference-time-domain (FDTD) approach together with Landau-Lifshits-Gilbert (LLG) formalism to find the exact solutions for magnetisation dynamics in thin film ferromagnetic structures. Two case studies are demonstrated, in which the model is validated against analytical and experimental methods.

14:20 : Invited talk
Realization of Dynamic Electromagnonic Microwave Crystal via Magnon-Photon Coupling in Artificial Multiferroic Heterostructure
Alexander A. Serga[1], Alexey B. Ustinov[2], Andrey A. Nikitin[2], Andrei V. Drozdovskii[2], Alexander A. Semenov[2], Dmytro A. Bozhko[3], Burkard Hillebrands[1], Erkki Lähderanta[4], Boris A. Kalinikos[2]
[1] *Technische Universitaet Kaiserslautern (Germany),* [2] *St. Petersburg Electrotechnical University (Russia),* [3] *University of Colorado at Colorado Springs (USA),* [4] *LUT-University (finland)*

Magnon transport in time-dependent periodic spatial potentials-dynamic magnonic crystals-paves a way to energy-efficient data transfer and information proceeding. Voltage control of magnon currents promises to be

fast and low energy-consuming. It can be achieved in artificial multiferroic heterostructures, where the strong coupling of magnons and microwave photons constitutes new quasiparticles called electromagnons. Here, we report on the experimental realization of a voltage-controlled dynamic electromagnonic crystal operating at microwave frequencies.

14:40 : Invited talk
Geometrical symmetry breaking in nanomagnets
Oleksandr V. Pylypovskyi
Helmholtz-Zentrum Dresden (Germany)

Three-dimensional ferro- and antiferromagnetic nanoarchitectures possess a special interplay between their geometrical (topological) properties and the magnetic order parameter. The emergent chiral and anisotropic responses extend the intrinsic material properties and pave the way to novel functionalities of spintronic and spin-orbitronic devices.

15:00 : The role of plasmonic excitations in the far-field configurational chirality
Ieeju Singh[1], Shumuel Sternklar[2], Yuri Gorodestki[1]
[1] *Ariel University (Israel),* [2] *Ariel Univerity (Israel)*

Broken mirror symmetry of chiral structures imposes a lack of mirror symmetry in the scattering profile. When an energy dissipation channel is introduced in the system, an overall optical activity arises. Plasmonic nanostructures, therefore, are ideal platform to induce optical activity by means of consitutional or configurational chirality. We experimentally investigate mechanism of the plasmonically-induced configurational chirality in a periodic monoclinic hole array with a broken mirror symmetry.

14:00 - 15:20 — Ibn Al-Haytham Room

Session 1A17

Symposium V: Phononics and acoustic metamaterials

Organized by: Jensen Li and Guoliang Huang

Chaired by: Jensen Li and Guoliang Huang

14:00 : Invited talk
Taking inspiration from polymer chemistry: Tacticity in chiral phononic crystals
Andrea E. Bergamini[1], Marco Miniaci[2], Domenico Tallarico[1], Gwenael Hannema[1], Bart Van Damme[1], Armin Zemp[1]
[1] *Empa, Materials Science and Technology (Switzerland),* [2] *IEMN (France)*

In this contribution, we will discuss a more complete picture of the constraints imposed by engineering considerations to the design of phononic materials, how the exploitation of chirality and tacticity as design feature is helping us tack- ling some of these issues, as well as answering some of the interesting physical questions that we encountered along the way.

14:20 : Invited talk
Valley-protected Topological Lamb Waves in Asymmetric Pillared Metamaterials
Bernard Bonello[1], Wei Wang[1], Bahram Djafari-Rouhani[2], Yan Pennec[2], Yabin Jin[3]
[1] *Sorbonne Université (France),* [2] *Université de Lille - IEMN (France),* [3] *Tongji University (China)*

We present a numerical study of the valley-protected topological propagation of zero-order antisymmetric (A0), symmetric (S0), and shear horizontal (SH0) Lamb waves at different domain walls between topologically distinct asymmetric double-sided pillared phononic crystals. The topological phase transition is obtained by imposing two large space inversion symmetry breaking perturbations on the height of some pillars in the unit cell. We demonstrate the unidirectional transport of A0, S0, and SH0 modes at different domain walls in straight or Z-shaped guides.

14:40 : Invited talk

fiber-integrated microcavities for efficient generation of coherent acoustic phonons
Martin Esmann[1], Omar Ortiz[2], Florian Pastier[3], Anne Rodriguez[2], Priya Priya[2], Aristide Lemaître[2], Carmen Gomez-Carbonell[2], Isabelle Sagnes[2], Abdelmounaim Harouri[2], Pascale Senellart[2], Valérian Giesz[3], Norberto Daniel Lanzillotti-Kimura[2]
[1] *Université Paris-Saclay (Germany),* [2] *Université Paris-Saclay (France),* [3] *Quandela SAS (France)*

Coherent phonon generation by picosecond optical pump-probe spectroscopy is an important experimental tool for studying acoustic properties at the nanoscale. In this work, we integrate semiconductor micropillar cavities confining near-infrared light and 18 GHz acoustic phonons with single-mode fibers. This approach solves a major challenge of existing pump-probe experiments using mechanical delay lines: maintaining the spatiotemporal overlap of pump and probe beams on a micro-object to achieve well-controlled, reproducible mode matching conditions.

15:00 : Invited talk
Lightweight three-dimensional metamaterials for omnidirectional attenuation of mechanical waves and vibrations
Anastasiia O. Krushynska, Monica Acuautla
University of Groningen (The Netherlands)

Tailored composites with frequency band gaps are promising for mechanical wave control and vibration mitigation. Despite advances in their developments, the generation of omni-directional broadband band gaps remains challenging. We propose a class of lightweight phononic structures addressing this challenge. Omnidirectional performance is achieved by simultaneously activating several wave scattering mechanisms. Numerically estimated strong attenuation at ultrasound frequencies is validated in transmission experiments on polymeric 3D-printed samples.

14:00 - 15:30 — Gaston Floquet Room

Session 1A18
Plasmonics and nano-optics

14:00 : CdZnO nanoparticle coating on GaAs for IR field enhancement
Eduardo Martinez Castellano[1], Julen Tamayo-Arriola[1], Miguel Montes Bajo[1], Oleksii Klymov[2], Carmen Martinez-Tomas[2], Said Agouram[2], Elias Munoz[1], Vicente Munoz-Sanjosé[2], Adrian Hierro[1]
[1] *Universidad Politécnica de Madrid (Spain),* [2] *Universitat de València (Spain)*

In this work, we study the plasmonic response of CdZnO nanoparticles grown on GaAs in the mid-IR range of the spectrum. We measured the transmittance of the system and evaluated the field-enhancement profile of the system, identifying two plasmonic modes. finally, we briefly discussed the potential applicability of this NP coating in photonic devices, once demonstrated the penetration of the electrical field within the substrate supporting the NPs.

14:15 : Demonstration and Tuning of Tamm Plasmons at the Interface with Metasurfaces
Oleksandr Buchnev[1], Alexandr Belosludtsev[2], Victor Reshetnyak[3], Dean R. Evans[4], Vassili A. Fedotov[1]
[1] *University of Southampton (United Kingdom),* [2] *Center for Physical Sciences and Technology (Lituania),* [3] *Taras Shevchenko National University of Kyiv (Ukraine),* [4] *Air Force Research Laboratory (USA)*

We demonstrate experimentally that Tamm plasmons can be supported by a dielectric mirror interfaced with a metasurface, a discontinuous metal film patterned on the sub-wavelength scale. Not only do Tamm plasmons survive the nano-patterning of the metal film, but they also become sensitive to external perturbations as a result. In particular, by depositing a nematic liquid crystal on the outer side of the metasurface we were able to red-shift a Tamm plasmon by 35 nm.

14:30 : Low-melting-point borophosphate glass as a matrix for NP-doped, luminescent composites produced using the NPDD method
Rafal Nowaczynski[1], Marcin Gajc[2], Hancza Surma[2], Piotr Paszke[3], Kamil Szlachetko[3], Piotr Piotrowski[3], Dorota Anna Pawlak[2]
[1] *Warsaw University of Technology (Poland),* [2] *Institute of Electronic Materials Technology (Poland),* [3] *University*

of Warsaw (Poland)

NanoParticle Direct Doping is a method developed in the Institute of Electronic Materials Technology in Warsaw that allows fabrication of volumetric composites based on glass matrices doped with various kinds of nanoparticles, including metallic plasmonic NPs, Quantum Dots and rare-earth ions. It allows us to obtain photoluminescent materials co-doped with different types of NPs, varying in size and composition, in which it is possible to observe effects such as plasmonic enhancement of the excitonic emission or radiative energy transfer.

14:45 : Optical Probing of Plasmonic Hot Electron Occupancies
Zsuzsanna Papa[1], **Judit Budai**[2], **Shirly Espinoza**[3], **Mateusz Rebarz**[3], **Martin Zahradnik**[3], **Péter Dombi**[1]
[1] *Wigner Research Center for Physics (Hungary),* [2] *ELI-ALPS (Hungary),* [3] *ELI Beamlines (Czech Republic)*

We discuss the in-depth distribution and time evolution of hot electrons generated upon the excitation of surface plasmon polaritons. We applied ellipsometry to measure the dielectric function of plasmonic systems and to determine their electron distribution. Applying cw illumination, the spatial location of hot electrons can be deduced. Pump-probe approach with $<$100fs resolution enabled us to measure electron distributions belonging to stages of plasmon decay when energetic electrons are generated, scattered among each other and interact with the lattice.

15:00 : Plasmons in nanostructured and corrugated 2D materials
Bruno Majérus[1], **Peter Vancso**[2], **Levente Tapaszto**[2], **Luc Henrard**[1]
[1] *University of Namur (Belgium),* [2] *Hungarian Academy of Sciences (Hungary)*

In this work we theoretically investigate plasmonic excitations in 2D materials. We suggest that localized plasmons in corrugated graphene increase the surface enhanced Raman spectroscopy (SERS) response of given molecules. We also show that mirror twin boundaries (MTB) in transition metal dichalcogenides (TMDs) can sustain plasmon due to their local metallic behavior as recently experimentally highlighted.

15:15 : Quantum Dot Photoluminescence Enhancement in GaAs Nanopillar Oligomers Driven by Collective Magnetic Modes
Damir Yagudin[1], **Maria Kroychuk**[1], **Maxim Rakhlin**[2], **Aidar Galimov**[2], **Alexey Toropov**[2], **Tatiana Shubina**[2], **Grigorii Klimko**[2], **Alexander Shorokhov**[1], **Andrey Fedyanin**[1]
[1] *Lomonosov Moscow State University (Russia),* [2] *Ioffe Institute (Russia)*

Resonant nanostructures made of high-index dielectrics are an auspicious platform for controlling of light at the nanoscale. In this paper, we study a GaAs nanopillar oligomer system with embedded InAs quantum dots. Our experiments and calculations show that excitation of Mie type resonances in such structures leads to the enhancement of the photoluminescence from quantum emitters due to a spectral overlap of the emitter absorption or emission spectra with the collective magnetic resonance of the cluster.

14:00 - 15:20 — Lawrence Bragg Room

Session 1A19

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

14:00 : Invited talk
Latent symmetries and their application in Physics
Malte Rontgen
University of Hamburg (Germany)

I will give an overview on latent symmetries, a new class of symmetries in systems described by matrix equations. Although these symmetries are not apparent from a geometric inspection of the system, they have powerful effects such as inducing symmetries of the eigenstates' components or even degeneracies in the eigenvalue spectrum. Their study thus allows to gain knowledge about the system's structure that remains hidden from a direct observation.

14:20 : Invited talk

Mimicking Magnetic Localized Surface Plasmons With High-Index Dielectrics: Enhancing Magnetic Resonance Imaging Signal-To-Noise Ratio

Carlo Rizza, Elia Palange, Angelo Galante, Marcello Alecci
University of L'Aquila (Italy)

We show that surface waves supported by a negative permeability sphere (magnetic localized surface plasmons, MLSPs) can be well reproduced by the electromagnetic field scattered by a low-loss high-index dielectric sphere. In the magnetic resonance imaging (MRI) context, we suggest the use of these spoof MLSPs to increase MRI efficiency. More precisely, we show that the MLSPs, coupled to a standard radio-frequency surface coil, are able to enhance the MRI signal-to-noise ratio with respect to standard setups.

14:40 : Invited talk

Full-Wave Formalism for Soliton Propagation in Nonlinear Photonic Crystals

Vakhtang Jandieri[1], Ramaz Khomeriki[2], Douglas Werner[3], Jamal Berakdar[4], Daniel Erni[1]
[1] *University of Duisburg-Essen (Germany),* [2] *Tbilisi State University (Georgia),* [3] *The Pennsylvania State University (USA),* [4] *Martin-Luther Universitat (Germany)*

The propagation of the temporal solitons in Kerr-type photonic crystal waveguides is investigated theoretically and numerically. An expression describing the evolution of the envelope of the soliton, which is based on full-wave modal analysis taking into account all space-harmonics, is rigorously obtained. The nonlinear coefficient is derived, for the first time, based on a modification of the refractive indices for each space-harmonic due to the Kerr-type nonlinearity.

15:00 : Invited talk

All dielectric 3D periodic nanoresonators for phase and polarization control of SH light

Giuseppe Marino[1], Carlo Gigli[1], Davide Rocco[2], Luca Carletti[2], Isabelle Sagne[3], Stephan Suffit[1], Costantino De Angelis[2], Giuseppe Leo[1]
[1] *Université de Paris (France),* [2] *University of Brescia (Italy),* [3] *Universite Paris-Saclay (France)*

We demonstrate numerically and experimentally enhanced efficiency and polarization control of nonlinear mixing via 3D all-dielectric periodic nanostructures. The 3D spatial periodicity allows diffractive interferences of SH light for the phase control, while the meta-atom geometry allows the excitation of Mie-modes for polarization control.

14:00 - 15:15 — Rene Descartes Room

Session 1A20

Novel Topological Photonic Materials

Organized by: Matthias Saba and Sang Soon Oh

Chaired by: Matthias Saba and Sang Soon Oh

14:00 : Topological scattering in Photonic Weyl metamaterial

Wenlong Gao[1], Hua Cheng[1], Yangang Bi[2], Hongbo Sun[3], Jianguo Tian[4], Shuqi Chen[4], Shuang Zhang[1]
[1] *University of Birmingham (Germany),* [2] *University of Birmingham (United Kingdom),* [3] *Jilin University (China),* [4] *Nankai University (China)*

Weyl points are the sources or drains of Berry flux. Here we experimentally observe the topological signature in the scattering of the photonic Weyl points. Specifically, we discover a helical phase distribution in the angled-resolved reflected waves, representing a winding phase in the momentum space, which leads to an angular momentum beam in the reflection. Our findings pave way for potential device level applications to angular momentum beams with photonic Weyl systems.

14:15 : Topological Kagome Lattice Laser

Yongkang Gong, Stephan Wong, Anthony J. Bennett, Diana L. Huffaker, Sang Soon Oh
Cardiff University (United Kingdom)

Discovery of new types of photonic topological platforms facilitates the development of novel topological lasers that are potentially immune to cavity defects with high lasing efficiency. We propose a topologically protected laser cavity based on broadband nontrivial edge states in semiconductor photonic crystals with Kagome lattice, and investigate the robustness and dynamics of the lasing cavity.

14:30 : Topological nanophotonics with time-reversal-invariant plasmonic lattices
Paloma A. Huidobro
University of Lisbon (Portugal)

Topological nanophotonics offers a promising path towards the robust control of photons at the nanoscale by exploiting topologically protected boundary modes that are immune to a range of defects and imperfections. I will focus on 1D and 2D realisations of topological boundary modes in arrays of plasmonic nanoparticles.

14:45 : Transport and localization of polaritons in Semi-Dirac honeycomb lattices
Bastian Real[1], Omar Jamadi[1], Marijana Milicevic[2], Nicolas Pernet[2], Tomoki Ozawa[3], Gilles Montambaux[2], Isabel Sagnes[2], Aristide Lamaitre[2], Luc Le Gratiet[2], Abdelmounaim Harouri[2], Sylvain Ravets[2], Jacqueline Bloch[2], Alberto Amo[1]
[1] *Université de Lille (France),* [2] *Université Paris-Saclay (France),* [3] *Tohoku University (Japan)*

Strain strongly affects the transport and localisation properties of graphene. For a critical uniaxial compression, graphene shows a semi-Dirac cone with massless and massive dispersions along perpendicular directions. Here we implement strained polariton honeycomb lattices to evidence the highly anisotropic transport of polaritons and to observe directional vacancy states with chiral symmetry. Our work paves the way for the study of transport and localisation in chiral lattices with exotic Dirac dispersions.

15:00 : Vorticial Phase Mirror in Photonic Weyl metamaterial
Wenlong Gao[1], Hua Cheng[1], Yangang Bi[1], Wenwei Liu[2], Zhancheng Li[2], Qinghua Guo[1], Yang Yang[1], Oubo You[1], Jing Feng[3], Hongbo Sun[3], Jianguo Tian[2], Shuqi Chen[2], Shuang Zhang[1]
[1] *University of Birmingham (United Kingdom),* [2] *Nankai University (China),* [3] *Jilin University (China)*

Weyl points are the sources or drains of Berry flux. Here we experimentally observe the topological signature in the scattering of the photonic Weyl points. Specifically, we discover a helical phase distribution in the angled-resolved reflected waves, representing a winding phase in the momentum space, which leads to an angular momentum beam in the reflection. Our findings pave way for potential device level applications to angular momentum beams with photonic Weyl systems.

Coffee Break and Exhibit Inspection

Session 1P2

Poster session II

15:20 - 16:00

P1: THz Metamaterial Device Design with SRRs
Brinta Chowdhury, Abdullah Eroglu
(USA)

THz device design method for periodic structures using single and double gap split ring resonators (SRRs) is introduced. The method involves implementation of split ring resonators with application of network parameters. The closed form relations are developed and verified with electromagnetic and circuit simulators. The prototype then has been built and measured. The results are compared, and agreement has been observed between analytical, simulation and measurement results.

P2: Design, Simulation and Fabrication of Ultra Wide Band Microstrip Patch Antenna for Wireless Application
Suleiman Babani, Zainab Yunusa, Umar Musa, Abubakar Sani Ali
Bayero University Kano (Nigeria)

Ultra wideband (UWB) technology is one of the most widely technologies used in wireless communication system to support the application that required high data rate and high speed. The purpose of this work

is to design and fabricate ultra-wideband microstrip patch antenna for wireless application with optimum performance such as wide bandwidth, good matching impedance, small antenna size exhibits and its E and H-plane radiation patterns are stable over the UWB frequency range.

P3: Focus Beam System Biaxial Cross-Polarization Approximation Technique
Nicholass Alan O'Gorman
Air Force Institute of Technology (USA)

When testing non-isotropic metamaterials, the axes of the sample being measured, and the antenna being used need to align in order to calculate the material parameters. If the axes of the sample are unknown or the sample was not aligned properly, the resulting data will not result in accurate measurements. This paper discusses a method for the focus beam system to calculate the material parameters for a biaxial sample without knowing the axis orientation.

P4: Spherical symmetric pure and hybrid electromagnetic anapoles based on cartesian electric-current multipole expansion
Vishal Vashistha[1], Andriy Serebryannikov[1], Matti Kaivola[1], Maciej Krawczyk[2]
[1] *Aalto University (finland),* [2] *Adam Mickiewicz University (Poland)*

In this work, we have proposed a plasmonic realization of fundamental anapole using three nanorods structure and studied its properties. With our design, we are able to suppress the far-field radiation by a factor of 1000 compared to a dipole source with the same integrated amplitude of the electric current density.

P5: Broadband vectorial ultra-flat optics with up to 99 % experimental efficiency in the visible
Arturo Burguete-Lopez, Fedor Getman, Makarenko Maksim, Andrea Fratalocchi
KAUST (Saudi Arabia)

We propose a methodology that allows the production of high efficiency (up to 99 % in the visible) ultra-flat (down to 50 nm thick) optics for vectorial light control and for arbitrarily defined broadband input-output responses of a desired wavefront shape. Experimetally, we show basic transmission/reflection components such as polarizer beam splitters and dichroic mirrors can be manufactured with over 90 % efficiency across the visible and present the basis for a two sub-pixel flat optics display.

P6: Ultra-flat optics design platform for a high-efficient wavefront engineering
Maksim Makarenko, Fedor Getman, Arturo Burguete-Lopez, Andrea Fratalocchi
KAUST (Saudi Arabia)

In this work we propose a universal design platform for the development of high-efficient wavefront engineering structures. We demonstrate the efficiency of this approach by designing a series of common optical devices with an efficiency exceeding 99 %.

P7: Chiral Nanophotonics with Atomically Thin Semiconductors
T. V. Raziman, Rasmus H. Godiksen, Shaojun Wang, Moos Muller, Jaime Gomez Rivas, Alberto G. Curto
Eindhoven University of Technology (The Netherlands)

Spin-valley polarization in atomically thin semiconductors opens a new perspective to explore optical chirality. Here we summarize our progress on the exploitation of 2D semiconductors as sources and probes for chiral nano-optics. We show how competing optical transitions in few-layer materials allow a high degree of circular polarization. Second, in order to enhance polarization, we design achiral nanophotonic resonators that satisfy the conditions needed for improving chiral light emission as a path towards efficient sources of spin-valley-polarized light.

P8: Fabrication and Simulation of Photonic Crystals based on Silicon Nanopillars
Elena Lopez-Aymerich, Roger Lera-Leri, Zoilo Nunez-Lasus, Maria Dimaki, Winnie E. Svendsen, Sergi Hernandez, Daniel Navarro-Urrios, Mauricio Moreno, Florenci Serras, Albert Romano-Rodriguez
University of Barcelona (Spain)

In this paper we show successful nanofabrication of photonic crystals based on up to 3 μm long silicon nanopillars. Different nanopillars with 60 to 100 nm radius, a triangular distribution and pitch of 500 nm have been fabricated on silicon or Silicon-On-Insulator substrates. Simulations of the electromagnetic field distribution inside these devices have been carried out to ensure the correct behaviour of the samples as photonic crystals, waveguides and resonators for their use in sensing applications.

P9: Thermally tunable invisibility at terahertz: different mechanisms in one structure
Andriy E. Serebryannikov
Adam Mickiewicz University (Poland)

Thermally tunable invisibility at terahertz frequencies is revisited with the focus on the contribution of different mechanisms achievable in different frequency and permittivity ranges. The mechanisms based on localized surface plasmon resonances and volume-mode resonances in high-index dielectric shells and others may co-exist for one scatter, enabling on-off switchable functionality.

P10: field characterization of nanometric gap-antennas for strong coupling
Maria Monserrat Alvarez Ortiz, Pawel Wozniak, Niek F. van Hulst
The Institute of Photonic Sciences (ICFO) (Spain)

The field enhancement at the nanoscale is a powerful tool to achieve the strong coupling regime to control and maximize the emission of single-photon sources. Nanoantennas show strong optical response due to the excitation of localized surface plasmon resonances. Particularly strong resonances can be achieved by exploiting coupled resonators forming gap nanoantennas. Here, we investigate the properties of plasmonic dimer antennas of sub 10 nm separation.

P11: Surface plasmon-polariton in a hybrid structure of hyperbolic metasurface and phase-changing material
Olga Kharitonova[1], Igor Bychkov[1], Vladimir Shavrov[2], Dmitry Kuzmin[1]
[1] *Chelyabinsk State University (Russia),* [2] *Kotelnikov Institute of Radio-engeneering and Electronics of RAS (Russia)*

In this work we theoretically investigate surface plasmon-polariton (SPP) in a hybrid structure of hyperbolic metasurface based on graphene and phase-changing material (VO2). Introducing the PCM into hyperbolic metasurface leads to additional tunability of optical properties of the structure, which may be of great interest for numerous practical applications.

P12: Optical and photocatalytic properties of rare earth doped ZnS Nanocrystalline
Amel Tounsi, Djahida Talantikite-Touati, Roumaissa Khalfi, Hamid Merzouk
University of Bejaia (Algeria)

New nanosized materials play a fundamental role in various industrial applications thanks their unique and functional properties. Moreover, in recent years, a great effort has been made to the design and control fabrication of nanostructured semiconductors such as zinc sulphide. So, much attention has been according in research to co-doped ZnS for improve the quality of ZnS thin films. We present in this work the preparation and characterization of ZnS and lanthanides doped ZnS prepared by co-precipitation method.

P13: Phase-shifted ellipsometric surface plasmon resonance sensor
Ibrahim Watad, Ibrahim Abdulhalim
Ben Gurion University of the Negev (Israel)

We have demonstrated both experimentally and theoretically simple approaches to extract the light polarization changes induced by surface plasmon resonance [1-6]. Here, we present an ellipsometric approach based on phase-shifted ellipsometry with a design based on Kretschmann-Raether configuration both in the angular and spectral modes [5-6].

P14: Plasmonic Nanocavity Metasurface Based on Laser-Structured Silver Surface and Silver Nanoprisms for the Enhancement of Adenosine Nucleotide Photoluminescence
Oleg Yeshchenko[1], Vladislav Kudrya[1], Anastasiia Tomchuk[1], Igor Dmitruk[1], Nataliya Berezovska[1], Petro Teselko[1], Sergii Golovynskyi[2], Bin Xue[2], Junle Qu[2]
[1] *Taras Shevchenko National University of Kyiv (Ukraine),* [2] *Shenzhen University (China)*

A photoluminescence spectroscopy and imaging of biomolecules at room temperature realized in the plasmonic cavity metasurface based on the Ag laser-induced periodic surface structure (LIPSS) and Ag triangular nanoprisms studied in the present work. The strong plasmon enhancement of photoluminescence of dAMP deposited on such metasurfaces observed. The plasmonic cavity metasurfaces consisting of metal LIPSS and metal nonspherical nanoparticles showned to be crucial for the highly sensitive detection and imaging of biomolecules at room temperature without any dye labels.

P15: Enhanced Electromagnetic Properties of Golden nanoparticle by hybrid film of Graphene in visi-

ble Frequency
Mohammad A. Abdollahi, Golamreza Moradi, Amir Nader Askarpour
Amirkabir University of Technology (Iran)

This paper want to consider of Golden nanoparticle (NP) that covered by graphene layer. This made that NP excited in lower frequency. This excitation express in Surface Plasmon. So it should considered the properties of SPP resonance. Scattering Cross Section and Absorption Cross Section examined by FEM method in Comsol and results compared with calculation of Mie Expansion in Matlab application. At least the losses of the proposed structure checked

P16: Simulation of plasmon enhanced electric field and its impact on vibrational spectra
Tanguy Colleu-Banse, Vincent Liégeois, Luc Henrard
University of Namur (Belgium)

Raman and infrared spectroscopy allow for an unambiguous identification of microscopic objects. Surface-Enhanced Spectroscopies improves its cross section by a coupling with plasmon excitations. However, the interpretation of resulting spectra is challenging. This works focuses on the enhancement of the local electromagnetic field associated with metallic nanodisks plasmon excitation. Simulation are obtained by Discrete Dipole Approximation (DDA). This local response is then combined with Time Dependent DFT (TD-DFT) to investigate its effect on the vibrational spectrum of hydrogen cyanide.

P17: Two-Directional Optical Binding Near One-Dimensional Photonic Crystal
Nataliia Kostina, Alexander S. Shalin
ITMO University (Russia)

Here we consider optical forces acting on a pair of particles near 1D photonic crystal. The surface wave of such structure (BSW) provides stable optical binding for both polarizations of incident light. The distances between the stable positions of the particles are shown to be less than incident wavelength due to Bloch surface wave dispersion. These results demonstrate possibility of flexible optical manipulation of the arrays of nanoparticles.

P18: Gold nanostructures devices on flexible substrate for strain optical monitoring
Florian Lamaze[1], Abdelhamid Hmima[1], Nicolas Bercu[2], Thomas Maurer[1], Louis Giraudet[2], Julien Proust[1]
[1] *University of Technology of Troyes (France),* [2] *University of Reims Champagne-Ardennes (France)*

Gold nanoparticles dimers (GNDs) can be used as sensitive optical sensors for the detection of local nano-deformation. There is a growing interest for sensor technologies based on polydimethylsiloxane (PDMS) as flexible substrate, since it allows reversible strain. In this context, the present work tackles the development of organized gold nanopatterns on PDMS to improve the sensitivity of strain monitoring at nanoscale.

P19: Design of Ultra-Broadband and Compact Beamsplitter using Subwavelength Grating-based Multimode Interference Coupler
Kamalodin Arik, Mahmood Akbari, Amin Khavasi
Sharif University of Technology (Iran)

An ultra-broadband and compact beam splitter is proposed using inherent anisotropy and dispersion property of a subwavelength grating (SWG)-based all dielectric metamaterial. These properties are used for designing a multimode interference (MMI) splitter. The designed 3dB SWG MMI splitter possess a bandwidth of more than 800nm, maintaining insertion loss below 1dB and a zero power imbalance. The overall footprint of the proposed device is highly small.

16:00 - 17:10 — Victor Veselago Room

Session 1A21
Plenary Session II

16:00 : Plenary talk
Metasurfaces for Light Management in Semiconductor Thin films

Deirdre M. O'Carroll
Rutgers University (USA)

In this talk, recent work on improving light trapping and light extraction in organic semiconductor thin films using plasmonic metasurfaces will be presented. Numerous optical phenomena, such as absorption induced scattering, out-of-plane waveguiding and morphology-dependent surface plasmon outcoupling, are identified due to exciton-plasmon coupling between the organic semiconductor and the metasurface.

16:35 : Plenary talk
Structuring Light and Dark with Metaoptics
Federico Capasso
Harvard University (USA)

Metasurfaces can generate arbitrary vector beams. I will discuss devices that enable light's spin and orbital angular momentum (OAM) to evolve, simultaneously, from one state to another along the propagation direction and polarizing elements that virtually rotate their orientation as a function of the propagation distance. Advances in high OAM lasing will be reported along with the design and realization of two-dimensional phase and polarization singularities.

Break

17:10 - 17:30

17:30 - 19:05 — Victor Veselago Room

Session 1A22

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

17:30 : Invited talk
Plasmon dephasing and macroscopic polarization conversion in single nanoporous particles
Pritam Khan, Grace Brennan, Syed A. M. Tofail, Ning Liu, Christophe Silien
University of Limerick (Ireland)

Plasmon damping strongly affects their temporal and spectral behaviour. Coupled and mesoscopic plasmonic systems having complex spectra generally impede damping analysis. As such, we report that polarimetric dark-field microscopy with an incident circular polarized laser is sensitive to the plasmon dephasing and unambiguously records the change in damping induced upon molecule adsorption. These results offer new perspectives in molecule sensing and materials tunability for light polarization conversion at sub-microscopic scale.

17:50 : Invited talk
Metasurface enabled ultrafast polarization and on-chip light shaping
Amit Agrawal
National Institute of Standards and Technology (USA)

We demonstrate the versatility of dielectric metasurfaces to (i) shape the temporal evolution of ultrafast optical pulses, and (ii) discuss their applications towards creating integrated photonic interfaces with quantum systems.

18:10 : Invited talk
Low-Loss On-Chip Surface Grating Couplers Engineered Using Subwavelength-Structured Metamaterials
Daniel Benedikovic[1], Xavier Le Roux[1], Carlos Alonso-Ramos[1], Cécilia Dupré[2], Bertrand Szelag[2], Pavel Cheben[3], Daivid Fowler[2], Sylvain Guerber[2], Eric Cassan[1], Delphine Marris-Morini[1], Frédéric Boeuf[4], Laurent Vivien[1]
[1] *Université Paris-Saclay (France),* [2] *University Grenoble Alpes (France),* [3] *National Research Council Canada*

(Canada), [4]*STMicroelectronics (France)*

The presence of low-loss optical interfaces is arguably one of the key factors to succeed for silicon photonics. Here, we report on our latest advances in subwavelength-structured and metamaterial-engineered fiber-chip grating couplers with a L-shaped waveguide profiles. Grating couplers are made in silicon-on-insulator platform and facilitate robust sub-decibel coupling of light with device features lying well in the range of available fabrication technologies.

18:30 : Invited talk

Enhanced forward scattering from magnetic scatterers: design and synthesis of resonant Huygens' sources

Philippe Barois, Ashod Aradian, Alexandre Baron, Maria Letizia De Marco, Romain Dezert, Glenna Drisko, Etienne Duguet, Rajam Elancheliyan, Tom Jatteau, Laurent Lermusiaux, Olivier Mondain-Monval, Virginie Ponsinet, Serge Ravaine, Philippe Richetti, Mona Treguer-Delapierre
Université de Bordeaux (France)

We present optical studies of nano-resonators (meta-atoms) designed for a specific control of their angular scattering in visible light. Directional scattering is obtained by adjusting the series of odd and even scattering modes. The architecture of the meta-atoms is designed to enhance the magnetic dipolar scattering which appears as the major contribution to the odd modes. Several types of meta-atoms are investigated. We show that the bottom-up approach enables multiple synthetic strategies and we compare their optical efficiencies.

18:50 : Photon bunching and antibunching of two quantum emitters near a coated sphere

Tiago J. Arruda[1]**, Romain Bachelard**[2]**, John Weiner**[3]**, Sebastian Slama**[4]**, Philippe W. Courteille**[3]
[1]*Federal University of Alfenas (Brazil),* [2]*Federal University of São Carlos (Brazil),* [3]*University of São Paulo (Brazil),* [4]*University of Tübingen (Germany)*

We theoretically study the cooperative decay rate and the dipole-dipole interaction associated with two dipole emitters close to a coated nanosphere. Considering a plasmonic nanoshell containing a gain medium inside the core, the second-order correlation function for the two emitters shows the possibility of tuning the photon emission, selecting either photon bunching or antibunching as a function of the polarization and position of the sphere. This result opens vistas to applications involving tunable single-photon sources in engineered artificial media.

17:30 - 18:50 — Allan Boardman Room

Session 1A23

Symposium I: Hybrid Nanomaterials and Metastructures for Photonics, Sensing and Energy

Organized by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

Chaired by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

17:30 : Invited talk

Plasmonics of thermoresponsive nanocomposite metasurfaces

Michele Magnozzi[1]**, Yannic Brasse**[2]**, Tobias A. F. Koenig**[2]**, Francesco Bisio**[3]**, Eva Bittrich**[2]**, Andreas Fery**[2]**, Maurizio Canepa**[1]
[1]*Universita di Genova (Italy),* [2]*Leibniz-Institut fur Polymerforschung Dresden e.V. (Germany),* [3]*CNR-SPIN (Italy)*

Gold/PNIPAM core-shell nanoparticles (NPs) possess proven photothermal and sensing capabilities. In this contribution we report in situ spectroscopic ellipsometry(SE) measurements to determine the complex, temperature dependent properties of ordered lattices of such NPs. The approach proposed here is instrumental to the analysis and design of functional hybrid metasurfaces with plasmonic functionalities, including particle-to-film coupled systems.

17:50 : Invited talk

Ultrafast Spectroscopy and Imaging of Quantum Optical and Plasmonic Processes

Gary Wiederrecht
Argonne National Laboratory (USA)

There is a strong need for the ability to spatially resolve photoinduced processes in nanoscale structures, and to temporally resolve the evolution of energy flow in these structures. These materials can be particularly challenging for imaging due to issues with scattering and small sample volumes. Novel approaches to the time-resolved spectroscopy and imaging of quantum optical and plasmonic processes are described here.

18:10 : Invited talk

Temporal Plasmonics of metallic nanoparticle dimers: The Fano and Rabi regimes

Oscar Rodrigo Avalos-Ovando[1], Lucas V. Besteiro[2], Zhiming Wang[3], Alexander O. Govorov[1]
[1] *Ohio University (USA),* [2] *Universidade de Vigo (Spain),* [3] *University of Electronic Science and Technology of China (China)*

We study signature temporal responses of the Fano and Rabi regimes in dimers of plasmonic nanoparticles. In their optical spectra, the Fano system possesses a peculiar line-shape, while the Rabi system exhibits a characteristic splitting. We find a difference in temporal dynamics as well: Fano systems show at most one temporal beat after a pulsed excitation, whereas Rabi systems have a significant number of beats. Remarkably, both regimes show coherent time dynamics with non-trivial and characteristic relaxation behaviors.

18:30 : Invited talk

Photon Down-Conversion via Nonadiabatic Dynamics in Molecular Polaritons

Juan B. Perez-Sanchez, Joel Yuen-Zhou
University of California San Diego (USA)

We theoretically studied the photoisomerization of thiacynine iodide molecule embedded in an optical microcavity. Our model consisted of the reaction coordinate and two electronic states coupled to a single cavity mode. We showed that an electronic excitation at cis configuration is followed by the generation of two photons upon isomerization. Our finding suggests a new mechanism to achieve photon down-conversion by exploiting the emergent molecular dynamics in polaritonic architectures.

17:30 - 18:55 — Tatsuo Itho Room

Session 1A24

Bottom-up approaches, new fabrication routes and ENSEMBLE3

Organized by: Dorota Pawlak and Virginie Ponsinet

Chaired by: Dorota Pawlak and Virginie Ponsinet

17:30 : Keynote talk

Metamaterials that travel faster than light: putting the squeeze on photons

John B. Pendry[1], Paloma Huidobro[2], Emanuele Galiffi[1]
[1] *Imperial College London (United Kingdom),* [2] *Instituto Superior Tecnico-University of Lisbon (Portugal)*

'Nothing can travel faster than light' is not a correct statement. Many things can and do. Think of a wave breaking at an angle on the sea shore. The point of impact travels along the beach very fast if the angle is a shallow one and can travel infinitely quickly as the angle tends to zero. I shall speak about metamaterials in which the structure moves with a velocity close to or faster than light giving rise to phenomena not seen in static structures. The structures naturally break time reversal invariance giving rise to effects for photons that resemble electrons in a magnetic field. In another realisation the metamaterial grabs hold of the field lines of incident radiation and squeezes then into a tightly formed pulse forming a supercontinuum of intense radiation.

18:00 : Invited talk

Combining top-down and bottom-up techniques to fabricate metamaterials

Kay Dietrich[1], Matthias Zilk[2], Martin Steglich[2], Thomas Siefke[2], Uwe Hübner[1], Andreas Tünnermann[3],

Ernst-Bernhard Kley[2], **Carsten Rockstuhl**[4], **Thomas Pertsch**[2]
[1] *Leibniz Institute of Photonic Technology (Germany),* [2] *Friedrich Schiller University Jena (Germany),* [3] *Fraunhofer Institute for Applied Optics and Precision Engineering (Germany),* [4] *Karlsruhe Institute of Technology (Germany)*

By combining top-down and bottom-up nanotechnologies, we fabricate an isotropic metamaterial with resonant electric and magnetic response. Our approach is based on realizing a large number of nano-scatterers by fast character projection electron-beam lithography and their subsequent randomized embedding into a liquid matrix, which can later be applied to any other surface and solidified. Our approach unlocks novel opportunities to fabricate nanomaterials with a complex optical response in the bulk but also on top of arbitrarily shaped optical elements.

18:20 : Directed assembly of hybrid colloids for optics
Maeva Lafitte[1], **Rajam Elancheliyan**[1], **Romain Dezert**[1], **Quentin Flamant**[1], **Oren Regev**[2], **Philippe Barois**[1], **Alexandre Baron**[1], **Olivier Mondain Monval**[1], **Virginie Ponsinet**[1]
[1] *Université de Bordeaux (France),* [2] *Ben Gurion Univ Negev (Israel)*

Colloidal assemblies of gold nanoparticles were synthesized using an emulsion-based formulation route. The synthesis technique involved emulsification followed by controlled ripening of an aqueous suspension of gold nanoparticles in an oil phase. The structural control of the as-synthesized clusters is demonstrated using different techniques. Their optical resonant properties are determined by spectroscopic polarized multi-angle static light scattering. The study evidences strong optical magnetic dipolar resonances and strongly forward scattering patterns, both being tunable by monitoring the cluster inner structure.

18:35 : Invited talk
Dispersion, tunability and active properties of chosen structures of hyperbolic metamaterials
Janusz Parka, Alessandro Pianelli, Karol Sielezin, Rafał Kowerdziej, Michał Dudek, Marek Olifierczuk
Military University of Technology (Poland)

Numerical simulations of hyperbolic metamaterial properties metal-dielectric type structures ware described. Propagation of electromagnetic wave from VIS and NIR range through hyperbolic metamaterial structure have been analyzed. The characteristics describing components of permittivity tensor in these materials ware presented. Relations between properties of different type of hyperbolic metamaterial are discussed.

17:30 - 18:50 — Christian Huygens Room

Session 1A25

Symposium III: Advanced passive and active metasurfaces and zero-index optics

Organized by: Howard Lee, Yu-Jung (Yuri) Lu and Zi Jing Wong

Chaired by: Howard Lee, Yu-Jung (Yuri) Lu and Zi Jing Wong

17:30 : Invited talk
Enhanced Hot Carrier Effects Using Ultra-Thin Metal films, Alloys, And Index Near-Zero Substrates
Jeremy Munday
University of California, Davis (USA)

Bulk metals are good reflectors of light, however, ultra-thin films and nanostructures composed of these same materials can create highly absorptive systems. Here we show that $\sim$100 % absorption is achievable provided that the ultra-thin metals are deposited on an index near zero substrate. We further demonstrate that this absorption can be used to generate photocurrent through the transfer of energy from the photons to the free electrons in the metal, enabling new designs for efficiency hot carrier optoelectronic devices.

17:50 : Invited talk
Nonlinear Doping of Epsilon-Near-Zero Media
Ehsan Nahvi[1], **Inigo Liberal**[2], **Nader Engheta**[1]
[1] *University of Pennsylvania (USA),* [2] *Public University of Navarra (Spain)*

We theoretically explore the possibility of obtaining enhanced magnetic nonlinearity by doping a linear epsilon near-zero (ENZ) host with a nonlinear dielectric inclusion. As an application of this concept, we exploit the enhanced nonlinearity in the context of a nonlinear absorber where we deploy a nonlinear doped ENZ slab as the spacer layer in a Salisbury screen. In addition to the enhanced nonlinearity, such absorbers are shown to exhibit highly tunable characteristics, such as bandwidth control.

18:10 : Invited talk
A new approach to meter-scale and durable all-dielectric meta-optics: gains and challenges
Eyal Feigenbaum, J. H. Yoo, N. J. Ray, H. T. Nguyen, M. A. Johnson, S. Baxamusa, S. Elhadj
Lawrence Livermore National Laboratory (USA)

We present an alternative approach to dielectric meta-surfaces based on resonant elements which has far less limitations on scalability and durability. The process is based on laser raster-scan of a thin metal film on a glass, followed by dry-etching and removal of the metal mask. Since the air-glass volumetric ratio mixing approach is limited by the depth of the layer, we have developed approaches to "boost"the attainable phase response, to be discussed here.

18:30 : Invited talk
Metaphotonic Computational Image Sensors
Arka Majumdar
University of Washington (USA)

We demonstrated full color imaging using metasurface and computational imaging techniques.

17:30 - 18:40 — Augustin Fresnel Room

Session 1A26

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii

Chaired by: Eugene Kamenetskii

17:30 : Invited talk
Chiral Flat Optics: from chiral photonic crystals to spin-selective metasurfaces
Behrooz Semnani, Jeremy Flannery, Rubayet Al Maruf, Michal Bajcsy
University of Waterloo (Canada)

This work presents the design, fabrication and characterization of a chiral photonic crystal structure which exhibits extreme optical activity around the high-symmetry points in k-space. We also extend the design to chiral focusing metasurfaces with unique functionalities. The underlying physics is guided-mode-resonance combined via weakly completed resonators to introduce both a desired phase profile and reflectivity in a monolithic dielectric structure.

17:50 : Invited talk
Shaping Optical Chirality on the Nanoscale with Photonic Molecules from High Refractive Index Building Blocks
Bjoern Reinhard
Boston University (USA)

Nanostructures, including nanowires, nanodisks and nanoparticles from high refractive index materials can support both magnetic and electric resonances. Combination of these basic building blocks into oligomers or clusters, so called photonic molecules, facilitates an engineering of electromagnetic fields with unique properties. In this presentation, we will discuss design criteria for generating enhanced optical chirality in high refractive index photonic molecules assembled from structurally well-defined silicon nanodisks. Experimental evidence for switchable chiroptical hot spot formation is presented.

18:10 : Keynote talk
Optical and photochemical properties of chiral plasmonic nanostructures
Alexander Govorov[1], **Lucas V. Besteiro**[2]
[1] *Ohio University (USA),* [2] *UESTC and INRS (China)*

Chiral photochemical reactions at the molecular level have proven to be a challenging task since chiral molecule species possess tiny chiroptical signals. In contrast, plasmonic nanocrystals offer very strong circular dichroism. We propose taking advantage of this property, introducing a novel mechanism driving surface photochemistry in a chiral plasmonic nanocrystal. This mechanism is based on the generation of hot electrons and leads to plasmon-assisted chiral growth.

17:30 - 18:55 — Ibn Al-Haytham Room

Session 1A27

Symposium V: Phononics and acoustic metamaterials

Organized by: Jensen Li and Guoliang Huang

Chaired by: Jensen Li and Guoliang Huang

17:30 : Invited talk
Diffraction-free propagation of Gaussian sound beam through layered water-steel structure
Arkadii Krokhin[1], **Yurii Zubov**[1], **Bahram Djafari-Rouhani**[2], **Yuqi Jin**[1], **Mathew Sofiel**[1], **Ezekiel Walker**[3], **Arup Neogi**[1]
[1] *University of North Texas (USA),* [2] *Institut d'Electronique, de Microelectronique et Nanotechnologie (France),* [3] *Echonovus Inc. (USA)*

A finite-width acoustic bean propagating in a homogeneous medium spreads with distance. The spreading occurs due to the Fourier components which make nonzero angles with the direction of propagation. The rate of spreading is defined by the diffraction coefficient. We consider propagation of Gaussian sound beam through a periodic steel-water layered structure and demonstrate that for certain frequencies the diffraction coefficient vanishes. In the experiment the nonspreading propagation of sound was observed at distances about 1 m.

17:50 : Invited talk
Double negativity in bubble metamaterials
Maxime Lanoy[1], **Geoffroy Lerosey**[1], **Fabrice Lemoult**[1], **Valentin Leroy**[2], **Arnaud Tourin**[1], **John Page**[3]
[1] *Institut Langevin, ESPCI Paris, Université PSL (France),* [2] *Université de Paris (France),* [3] *University of Manitoba (Canada)*

I will show how double negativity can be achieved in a metamaterial populated solely with monopolar subwavelength resonators, such as air bubbles in water. A disordered set of identical bubbles in water is known to exhibit a gap above their individual resonance in the frequency range of which only the effective compressibility is negative. But introducing pair-wise spatial correlations leads to the formation of a transparency window, which is associated with negative values of both compressibility and density.

18:10 : Higher-order topological sound transport in synthetic dimensions
Hui Chen[1], **Hongkuan Zhang**[2], **Qian Wu**[1], **Yu Huang**[2], **Huy Nguyen**[1], **Emil Prodan**[3], **Xiaoming Zhou**[2], **Guoliang Huang**[1]
[1] *University of Missouri (USA),* [2] *Beijing Institute of Technology (China),* [3] *Yeshiva University (USA)*

We formulate the theoretical principles and for the first time manufacture acoustic crystals composed of arrays of acoustic cavities strongly coupled through modulated channels to evidence two-dimensional (2D) dynamic topological pumping. We delineate the generated four-dimensional (4D) quantum Hall effects by calculating second Chern numbers and physically demonstrate robustness against the imperfections. Synthetic dimensions could open up a new platform to explore any continuous orbit in higher-order topological matter in dimensions four and higher.

18:25 : Active Metamaterials with Odd Micropolar Elasticity
Yangyang Chen[1], Xiaopeng Li[1], Colin Scheibner[2], Vincenzo Vitelli[2], Guoliang Huang[1]
[1] *University of Missouri (USA),* [2] *The University of Chicago (USA)*

Materials made from active, living, or robotic components can display emergent properties arising from local sensing and computation. Here, we realize a freestanding active metabeam with piezoelectric elements and electronic feed-forward control that gives rise to an odd micropolar elasticity absent in energy-conserving media. Our continuum approach, built on symmetries and conservation laws, could be exploited to design others systems such as synthetic biofilaments and membranes with feed-forward control loops.

18:40 : Microtwist homogenization of 3D Pyrochlore lattices on Mechanical Polarization
Rongyu Xia[1], Hui Chen[1], Zheng Li[2], Guoliang Huang[1]
[1] *University of Missouri (USA),* [2] *Peking University (China)*

We develop a 3D microtwist effective theory of Pyrochlore lattices to capture the Parity (P) asymmetric zero modes by which polarization emerges or fades on a macroscopic scale. By mapping three periodic zero modes to macroscopic degrees of freedom, the 3D microtwist theory ends up being a kinematically enriched theory. The 3D microtwist elasticity is formulated by using two-scale asymptotic approach and its constitutive and balance equations are derived for a fairly generic isostatic lattice: the 3D Pyrochlore lattice.

17:30 - 18:45 — Gaston Floquet Room

Session 1A28
Metamaterials and metasurfaces

17:30 : Ulta-wideband waveguide embedded graphene-based terahertz absorber
James Campion[1], Nikolaos Xenidis[1], Roman Ivanov[2], Joachim Oberhammer[1], Irina Hussainova[2], Dmitry Lioubtchenko[3]
[1] *KTH Royal Institute of Technology (Sweden),* [2] *Tallinn University of Technology (Estonia),* [3] *KTH Royal Institute of Technology (Sweden) and Institute of High-Pressure Physics, PAS (Poland)*

A novel type of absorber material is developed for the frequency range of 67-500 GHz. The absorber is based on graphene augmented inorganic nanofibers deposited inside a metallic waveguide cassette, allowing them to be utilised in standard waveguide systems. The material's microstructures result in a low level of reflectance ($<$ -15 dB) and good absorbance ($textgreater$ 20 dB) from 110-500 GHz, making them highly suited for wideband terahertz applications.

17:45 : Multipolar analysis of random all-dielectric nanoresonator arrays
Maria Bancerek, Krzysztof M. Czajkowski, Olga Kochanowska, Tomasz J. Antosiewicz
University of Warsaw (Poland)

The optical properties of bottom-up amorphous arrays with stochastic distribution of high-index dielectric antennas stem from an interplay of the single-particle response, mutual coupling and substrate-mediated effects. We develop a theoretical framework that incorporates electric and magnetic dipolar interactions to prove that interparticle coupling even in random arrays is important. Our results show how to utilize intra-array coupling to maximize array sensitivity for refractometric sensing purposes.

18:00 : Ge2Sb2Te5-based, ultrathin, all-dielectric tunable mid-wavelength infrared perfect absorber
Roy Avrahamy, Amiel Avraham Ishaaya, Mark Auslender
Ben-Gurion University of the Negev (Israel)

GST-225 (Ge2Sb2Te5) phase change material was recently experimentally reported to exhibit measurable photoconductivity, a well-defined bandgap, and reconfigurable continuous partial crystallization. Sequentially, here we propose an ultrathin, all-dielectric, metamaterial-design based on an asymmetrical optical micro-/nanocavity, enclosing a 10nm thick GST-225 photoactive layer, inversely optimized for perfect tunable absorption in the mid-wavelength infrared. The perfect absorption, solely in GST-225, can be spectrally-tuned actively (thermally/electrically/optically) by varying the crystallinity, and geometrically using the design parameters, which is highly application beneficial.

18:15 : Linear-to-circular polarization conversion using time-dependent metamaterials
Victor Pacheco Peña[1], **Nader Engheta**[2]
[1] *Newcastle University (United Kingdom),* [2] *University of Pennsylvania (USA)*

In this communication we explore a mechanism to achieve an arbitrary conversion of the polarization of electromagnetic waves by using time-dependent metamaterials for real-time polarization rotation and frequency conversion.

18:30 : Symbolic regression in nano-optics: characterization of dispersive materials as a case study
Claudio Canales[1], **Alexandre Vial**[2], **Demetrio Macias**[2]
[1] *Universidad de Santiago de Chile (Chile),* [2] *University of Technology of Troyes (France)*

In this contribution we propose a Symbolic Regression (SR) scheme, based on Genetic Programming (GP), to retrieve the closed expression that represents the dispersion model of a given material. As starting point, we consider an isotropic, homogeneous, dispersive dielectric material to illustrate the operational principles of our approach. Then, we discuss its possibilities and limitations when used to solve this kind of inverse problem.

17:30 - 19:00 — Lawrence Bragg Room

Session 1A29

Plasmonics: Fundamentals and Applications

Organized by: Hong Wei

Chaired by: Hong Wei

17:30 : Invited talk
Plasmon-Exciton Coupling: Light-forbidden Transitions and Quasichiral Interactions
Antonio I. Fernandez-Dominguez
Universidad Autonoma de Madrid (Spain)

We present two plasmon-exciton coupling phenomena emerging due to the confined nature of surface plasmon (SP) resonances in nanocavities. first, we will investigate the impact of light-forbidden transitions have in the population dynamics and far-field spectrum of nanoparticle-on-a-mirror SPs and three-level quantum emitters (QEs). Second, we will present a combined classical and quantum electrodynamics description of the interactions between two circularly-polarized QEs held above a SP waveguide. We will establish the conditions for non-reciprocal, chiral, coupling between them.

17:50 : Invited talk
Observing strong coupling in individual plasmonic cavities
Gilad Haran
Weizmann Institute of Science (Israel)

We utilize individual plasmonic bowties as cavities to couple to a small number of quantum emitters. Devices with one to several semiconductor quantum dots demonstrate vacuum Rabi splitting in light scattering spectra and in electron energy loss spectra. Data analysis shows that our systems are within or at the onset of the strong coupling regime. Photoluminescence studies demonstrate antibunching from single quantum dots within plasmonic cavities, paving the way to cavity QED studies at room temperature.

18:10 : Invited talk
Quantitative characterization of second order nonlinear light conversion from inorganic and organic nano(micro)-structures
Ning Liu[1], **Matthew Gleeson**[1], **Zhe Li**[1], **Sarah Guerin**[1], **Syed A. M. Tofail**[1], **Pritam Khan**[1], **Hongxing Xu**[2], **christophe Silien**[1]
[1] *University of Limerick (Ireland),* [2] *Wuhan University (China)*

Second harmonic generation and sum frequency generation are the nonlinear optical processes of doubling or summing the frequency of input light by passing it through non-centrosymmetric crystalline materials.

Quantitative modelling of their nonlinear processes is of great importance for optimizing nano(micro)crystal based nonlinear photonic devices for applications in frequency conversion, multiplexed signal transmission and noninvasive sensing. Here we demonstrate the quantitative analyses of optical nonlinear conversion in inorganic and organic nano(micro)structures with known and unknown second order susceptibility tensor.

18:30 : THz plasmons in AlGaN/GaN grating gate structures at 4K and 300K
Pavlo Sai, Maciej Sakowicz, Kamil Stelmaszczyk, Dmytro B. But, Mateusz Słowikowski, Maciej filipiak, Maksym Dub, Pawel Prystawko, Grzegorz Cywinski, Sergey Rumyantsev, Wojciech Knap
CENTERA Laboratories (Poland)

Terahertz plasmon resonances were studied at 4.2K and 300K in GaN-based grating gate structures using two THz spectroscopy techniques: Fourier-Transform Infrared Spectroscopy and Time Domain Spectroscopy. Gratings of different periods were coupled to the two-dimensional electron gas in AlGaN/GaN in order to investigate the dispersion law of 2D-plasmons. The plasmon frequency was tuned by the gate voltage both, at 4.2K and 300K. Observation of the tunable plasmons at room temperatures opens the way for high temperature THz plasmonic devices.

18:45 : Deciphering Mode-Coupling Mechanism in Extraordinary Optical Transmission via Signature Fano Resonance for Active Tuning
Meng-Ju Yu, Jimmy Xu
Brown University (USA)

We report on an investigation that aims at deciphering the mode-coupling mechanisms in extraordinary optical transmission (EOT). The EOT phenomenon, being extraordinary, is also intriguing in the interplays between its modes or mode-couplings. Understanding the coupling mechanism would pave the way to the next advances such as active- or on-command tunable EOT. We conduct computational experiments to decipher the coupling mechanism through the Fano resonance signature.

17:30 - 18:50 — Rene Descartes Room

Session 1A30

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

17:30 : Invited talk
Sparse Array as Metamaterial for Higher-Order Modes Suppression in an Accelerator Cavity
Ning Zhou[1], Terry Smith[2], Geoff Waldschmidt[2], Alireza Nassiri[2], Thomas T. Y. Wong[1]
[1] *Illinois Institute of Technology (USA),* [2] *Argonne National Laboratory (USA)*

A metamaterial formed by sparsely populated array of metallic rods exhibiting photonic bandgap (PBG) properties is employed to fill a cavity resonator for future particle accelerator applications. Beginning with an array on a triangular lattice, the optimization process leads to a star-shape array. The cavity-waveguide assembly was fabricated with copper and cold tested for resonance characteristics. A return loss of over 20 dB at the designed resonance frequency of 11.41 GHz was measured.

17:50 : Invited talk
Acoustic Graphene Plasmons under a DC bias
Michael Sammon, Tony Low
University of Minnesota (USA)

It has been shown that in a graphene/insulator/metal structure, the plasmons acquire a linear dispersion whose sound velocity is very near the Fermi velocity in graphene. I show that a DC current causes a redshift of the acoustic plasmons travelling upstream of the direction in which electrons flow. As the redshift of the upstream branch causes acoustic plasmon to approach the particle-hole continuum, the spectral weight of this plasmon branch is substantially reduced, resulting in a near unidirectional plasmon.

18:10 : Invited talk

Nanostructured Complex Metal Oxides for Infrared Plasmonics

Nicholas Charipar, Raymond Auyeung, Heungsoo Kim, Kristin Charipar, Alberto Piqué
U.S. Naval Research Laboratory (USA)

Complex metal oxides, such as indium tin oxide (ITO) and vanadium dioxide (VO2), are of interest for plasmonics because ITO is an optically transparent electrical conductor while VO2 exhibits a metal-insulator transition. The growth of ITO and VO2 thin films via pulsed laser deposition is discussed. Laser processing techniques are investigated as a means to produce ordered nanostructures in these thin films. The infrared properties of both the as-grown thin films and resulting nanostructured complex metal oxides are characterized.

18:30 : Invited talk

field-Ready Quantum Technologies based on Nanowire Sources

Khaled Mnaymneh[1], Robin L Williams[1], David B Northeast[1], Jeongwan Jin[1], Sofiane Haffouz[1], Patrick Laferrière[2], Edith Yeung[2], Lambert Giner[2], Henri Morin[2], Jean Lapointe[3], Geofrey C Aers[3], Philip J Poole[3], Dan Dalacu[3]
[1] *Emerging Technologies, National Research Council Canada (Canada),* [2] *University of Ottawa (Canada),* [3] *National Research Council Canada (Canada)*

Quantum technologies based on semiconductor quantum dots placed in photonic nanowires are discussed. Epitaxial growth strategies of the embedded dots targeting field-appropriate wavelengths are presented. The tapered shape of the nanowires allows for direct and evanescent coupling to bulk and integrated optics, respectively. This enables a high degree of photonic integration aimed at deploying plug-and-play quantum systems to the field for applications in secure communications, sensing and metrology.

18:00 - 19:00 — Tutorial Room

Session 1A31

Conference Tutorials I

Organized by: Ishwar Aggarwal

18:00 : Tutorial

Metasurface Flat Optics: from components to mass manufacturing to systems

Federico Capasso
Harvard University (USA)

Flat optics based on metasurfaces has emerged in recent years as a promising alternative to refractive and Fresnel optics in many applications, due to the smaller footprint, mass-manufacturing using the same technology of semiconductor chips, easier control of aberrations and multifunctionality. I will cover recent advances in components and show how they have led to breakthroughs in cameras and other systems such as ultra compact spectrometers.

Wednesday 21st July, 2021

09:00 - 11:00 — Victor Veselago Room

Session 2A1

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

09:00 : Invited talk

Nanophotonics and femtosecond magnetism in all-dielectric metasurfaces

Alexander Chernov[1], Mikhail Kozhaev[1], Daria Ignatyeva[1], Andrey Voronov[1], Dolendra Karki[2], Miguel Levy[2], Vladimir Belotelov[1]

[1] *Russian Quantum Center (Russia),* [2] *Michigan Technological University (USA)*

Light manipulation in magnetic nanostructured materials attracts much attention in the context of data processing, spintronic and light modulation applications. In this work we demonstrate a subwavelength light localization within the magnetic dielectric metasurface made of bismuth-substituted iron garnet leading to light intensity modulation and an efficient magnon excitation. The advanced light control and selective spin manipulation are achieved due to appearance of various types of excited modes in the nanostructured surfaces.

09:20 : Invited talk

Free-carriers nonlinearities in semiconductor plasmonics

Federico De Luca[1], Michele Ortolani[2], Cristian Ciraci[1]

[1] *Istituto Italiano di Tecnologia (IIT) (Italy),* [2] *Sapienza University of Rome (Italy)*

We study free-carriers nonlinearities in highly doped semiconductors. We develop a theoretical model based on the hydrodynamic description of free-electrons expanding nonlinear terms up to the third-order. Because of small carrier densities in semiconductors compared to noble metals, hydrodynamic effects result strongly amplified. We show that contrarily to noble metals, in fact, free-electron nonlinearities in doped semicoductors can be several orders of magnitude larger than crystalline lattice nonlinearities.

09:40 : Invited talk

Surface waves from flexural and compressional resonances of beams

Agnes Maurel[1], Kim Pham[2], Sébastien Guenneau[3], Jean-Jacques Marigo[4]

[1] *Institut Langevin/ESPCI (France),* [2] *Institut Polytechnique de Paris (France),* [3] *Imperial College (United Kingdom),* [4] *Ecole Polytechnique (France)*

We present a model describing the propagation of elastic waves in a soil substrate supporting an array of cylindrical beams experiencing flexural and compressional resonances. The resulting surface waves are of two types: in the sagittal plane, hybridized Rayleigh waves which can propagate except within bandgaps resulting from a complex interplay between flexural and compressional resonances. anti-plane shear wave, decoupled from the hybridized Rayleigh wave, which is the elastic analogue of electromagnetic spoof plasmon polaritons.

10:00 : Invited talk

A computational technique for the scattering problem of inhomogeneous metasurfaces

Bo O. Zhu

Nanjing University (China)

Metasurfaces have attracted much attentions recently because of the enriched electromagnetic wave control abilities. So far, the full wave analysis of metasurfaces, especially that of inhomogeneous ones, is not well supported by the popular commercial softwares. In this paper, a computational technique is proposed for the scattering problems of metasurfaces. Compared with the popular numerical methods, the finite element method, the proposed approach is easy to implement since it does not need meshing and basis functions.

10:20 : Invited talk

Optical Chirality Generation and Amplification in Biomolecule-Assembled Plasmonic Nanostructures

Dangyuan Lei
City University of Hong Kong (Hong Kong)

I will discuss the generation and amplification of optical chirality in achiral metal nanostructures assembled with chiral biomolecules. The first part of this talk focuses on how an individual plasmonic nanostructure interacts with chiral biomolecules, enabling switching the molecular chirality and probing the molecular conformation evolution. The second part presents how to assemble one-dimensional plasmonic nanoparticle chains with chiral biomolecules to induce plasmonic circular dichroism response in the NIR-UV region and their assembly configuration dependence.

10:40 : Invited talk

Characterization of mid-IR photonic crystal slabs using angle-resolved FT-IR spectroscopy

Takashi Kuroda[1], Siti Chalimah[1], Yuanzhao Yao[1], Naoki Ikeda[1], Yoshimasa Sugimoto[1], Rei Hashimoto[2], Tsutomu Kakuno[2], Kei Kaneko[2], Shinji Saito[2], Kazuaki Sakoda[1]
[1] *National Institute for Materials Science (Japan),* [2] *Toshiba Corp. (Japan)*

Fourier transform (FT) spectroscopy is a versatile technique to study the infrared (IR) optical response of solid-, liquid-, and gas-phase samples. Here we design and construct a high- precision angle-resolved reflectance setup compatible with a commercial FT-IR spectrometer. As a demonstration of the capability of the reflectance setup, we measure the angle- dependent mid-infrared spectra of two-dimensional photonic crystal slabs, and determine the in-plane photonic band dispersion in the vicinity of gamma point in momentum space.

09:00 - 11:00 — Allan Boardman Room

Session 2A2

Symposium I: Hybrid Nanomaterials and Metastructures for Photonics, Sensing and Energy

Organized by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

Chaired by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

09:00 : Keynote talk

Dielectric metasurfaces for flat optics: wavefront engineering and future applications

Junsuk Rho
Pohang University of Science and Technology (POSTECH) (Korea)

Miniaturization is a main stream in modern technology, but reduction of conventional optical components accompanies performance degradation that limits the minimum feature size of optical devices. Metasurfaces that consist of ultrathin subwavelength antenna arrays can be a promising solution because metasurfaces provide an effective way of wavefront engineering without constraints on the device size. Electromagnetic responses of individual building blocks are determined by its geometric configurations, and many kinds of antennas have been explored to clarify the capability of metasurfaces, thereby, it has been verified that dielectric antennas can control amplitude, phase, and even both of them simultaneously.

09:30 : Invited talk

Microscopic Study on Circular Dichroism Localized in Materials to Analyze Hierarchical Chirality in Various Scales

Tetsuya Narushima
Institute for Molecular Science (Japan)

Circular dichroism (CD) has been used to analyze chirality in molecules. These years, it has been reported that spatially extended chiral systems, such as crystals, molecular assemblies and nanostructures, also show CD activity. In order to explore properties of the CD activity and its physical origin, we developed a CD microscope and visualized spatial CD distribution observed in the chiral systems of metallic nanostructures,

biological cells, and so forth.

09:50 : Invited talk
Gap-SPPs of Closely Coupled Nanowire Dimers Visualized by SERS Imaging
Sang-Min Park, Zee Hwan Kim
Seoul National University (Korea)

We report a visualization of gap-SPPs of a AgNW dimer. A dimer loaded with a monolayer of molecules is locally excited to launch the SPPs, and the SERS maps of the molecules are acquired to visualize gap-SPPs. The SPP maps reveal that the dimers with a few nm of gap can propagate up to $\sim$8 μm. They also show oscillating components with periods of 400 $\sim$ 800 nm, arising from the beating between a monopole-monopole and a dipole-dipole gap-SPPs.

10:10 : Invited talk
Luminescence Manipulation from Upconversion Nanorods via Plasmonic Nanogratings and Shear-Induced Alignment
Huilin He, Anshi Chu, Zhen Yin, Jianxun Liu, Ke Li, Jiawei Wang, Dan Luo, Yanjun Liu
Southern University of Science and Technology (China)

Greatly enhanced upconversion luminescence was demonstrated by integrating the core-shell upconversion nanorods with the Ag nanogratings. We also demonstrated a facile polypropylene-aided shear-driven method to obtain large-scale orientationally ordered upconversion nanorods, showing a liquid crystalline nematic phase.

10:30 : Aluminum fractal nanoantennas based on Cayley trees
Thomas Simon[1], Xiaoyan Li[2], Dmitry Kholpin[1], Jérome Martin[1], Mathieu Kociak[2], Davy Gerard[1]
[1] *Universite de Technologie de Troyes (France),* [2] *Université Paris Sud (France)*

We propose and demonstrate optical antennas based on the Cayley tree branching geometry. Using electron energy loss spectroscopy, we unveil the complex mode structure associated with these antennas. A broadband optical response, spanning from the UV to the mid-IR, is evidenced.

10:45 : Strong Coupling in Metallo-dielectric Hybrid Metasurfaces
Ajith Padyana Ravishankar, Srinivasan Anand
KTH Royal Institute of Technology (Sweden)

The presented work involves designing a hybrid metasurfaces by incorporating merits of two different types of resonator system (metal and dielectric) and investigating novel optical features emerging from the metasurface. The metasurface design consists of a high-index resonator array on top of thick metal film with a spacer layer. Simulation studies show that a strong coupling can be achieved between the anapole mode in the disk and a surface plasmon polariton (SPP) mode at metal dielectric interface.

09:00 - 10:55 — Tatsuo Itho Room

Session 2A3

Bottom-up approaches, new fabrication routes and ENSEMBLE3

Organized by: Dorota Pawlak and Virginie Ponsinet

Chaired by: Dorota Pawlak and Virginie Ponsinet

09:00 : Reversible strain-tuning of quantum optical emission in WSe2 monolayers
Javier Martin-Sanchez[1], Oliver Iff[2], Davide Tedeschi[3], Magdalena Moczala-Dusanowska[2], Sefaattin Tongay[4], Kentaro Yumigeta[4], Javier Taboada-Gutiérrez[1], Matteo Savaresi[3], Armando Rastelli[5], Pablo Alonso-Gonzalez[1], Sven Höfling[2], Rinaldo Trotta[3], Christian Schneider[2]
[1] *University of Oviedo (Spain),* [2] *Universität Würzburg (Germany),* [3] *Sapienza University of Rome (Italy),* [4] *Arizona State University (USA),* [5] *Johannes Kepler University Linz (Austria)*

The future development of ultra-compact two-dimensional (2D) photonic technologies for quantum information

processing relies on our ability to tailor the optical properties of single photon sources in 2D nanomaterials. In this talk, we will present hybrid 2D-piezoelectric devices for the reversible manipulation of the emission energy of quantum emitters in wrinkled WSe2 semiconductor monolayers. Our results show a record tuning range of about 15 meV while preserving a high single photon purity.

09:15 : Invited talk
Mid-submicrometre pixelation of InGaN micro-LED displays with high integration capabilities for AR-glasses
Jun Hee Choi, Jinjoo Park, Kiho Kong, Joo Hun Han, Jung Hun Park, Nakhyun Kim, Eunsung Lee, Joosung Kim, Dong Chul Shin, Younghwan Park, Jaikwang Shin
Samsung Advanced Institute of Technology (Korea)

InGaN-based blue light-emitting diodes (LEDs), with their high efficiency and brightness, are entering the display industry. However, a significant gap remains between the expectation of highly efficient light sources and their experimental realization into tiny pixels for ultrahigh-density displays for augmented reality (AR). Here, we report using tailored ion implantation (TIIP) to fabricate highly-efficient, electrically-driven pixelated InGaN microLEDs (μLEDs) at the mid-submicron scale (line/space of 0.5/0.5 μm. Moreover, we demonstrate high-density TFT and QD C/F integration technologies.

09:35 : Keynote talk
Nanophotonics with Two-Dimensional Materials
Javier Garcia de Abajo
ICFO – Institut de Ciencies Fotoniques (Spain)

In this presentation, we will overview the general characteristics of the optical response of these materials, which can be understood in terms of simple theoretical models. We will also cover more sophisticated descriptions, aiming at exploring genuinely quantum-mechanical effects. We will further overview recent advances in the fields of ultrafast optical response and nonlinear optics, as well as the potential application of these materials in light modulation, quantum-optics, and optical sensing.

10:05 : Keynote talk
3D Laser Nanoprinting of 3D Metamaterials
Martin Wegener
Karlsruhe Institute of Technology (KIT) (Germany)

We review our recent progress concerning 3D laser nanoprinting of 3D metamaterials. In the context of this special session, we emphasize advances in 3D additive manufacturing with respect to printing speed.

10:35 : Invited talk
Self-Organized Metamaterials and Nanoparticles for Nonlinear Optics and Hot Electron Processes
Luke H. Nicholls, Francesco Lotti, Yunlu Jiang, Mazhar E. Nasir, Anatoly V. Zayats
King's College London (United Kingdom)

Metamaterials offer a way to control and utilize light on the nanoscale, which cannot be achieved with conventional materials. However, many metamaterial constructions require time consuming fabrication methods that result in small active area arrays. The metallic nanorod metamaterial, with its self-organised fabrication method, allows 2-inch wafer size metamaterial arrays to be constructed both quickly and cheaply. In this talk the applications of this metamaterial will be discussed from chemical sensing to nonlinear optics and intensity dependent filters.

09:00 - 10:00 — Christian Huygens Room

Session 2A4

Symposium III: Advanced passive and active metasurfaces and zero-index optics

Organized by: Howard Lee, Yu-Jung (Yuri) Lu and Zi Jing Wong

Chaired by: Howard Lee, Yu-Jung (Yuri) Lu and Zi Jing Wong

09:00 : Invited talk
Electrically Tunable Metasurface for Complex Amplitude Modulation
Sangjun Han[1], Seyoon Kim[2], Shinho Kim[1], Tony Low[3], Victor Brar[2], Min Seok Jang[1]
[1]Korea Advanced Institute of Science and Technology (KAIST) (Korea), [2]University of Wisconsin-Madison (USA), [3]University of Minnesota (USA)

Tunable plasmonic modes offered by graphene provide new opportunities to create electo-optically active devices with novel characteristics that have thus far been impossible to be realized by using conventional media. In this talk, we introduce dynamic complex amplitude modulation with graphene-based metasurfaces.

09:20 : Invited talk
Plasmon-assisted multipolar terahertz absorption spectroscopy in graphene
Andrea Marini[1], Alessandro Ciattoni[2], Claudio Conti[3]
[1]University of L'Aquila (Italy), [2]CNR-SPIN (Italy), [3]Consiglio Nazionale delle Ricerche (Italy)

We explore plasmon-enhanced absorption spectroscopy showing that multipolar rotational transitions of molecules in proximity of localized graphene structures can be accessed thanks to terahertz plasmons. In particular we consider H2+, demonstrating that graphene micro-rings provide a giant field localization enabling the enhancement of the absorption cross-section by 8 orders of magnitude.

09:40 : Invited talk
Metaphotonics meet fibers: a novel pathway towards boosting in-coupling efficiencies and single-fiber optical trapping
Markus A. Schmidt[1], Henrik Schneidewind[1], Uwe Huebner[2], Matthias Zeisberger[3], Malte Plidschun[3], Jisoo Kim[3], Oleh Yermakov[4], Yuri Kivshar[4], Andrey Bogdanov[4], Haoran Ren[5], Stefan A. Maier[6]
[1]Leibniz Institute of Photonic Technology (Germany), [2]Leibniz Institute of Photonic Techology (Germany), [3]Leibniz Institute of Photonics Technology (Germany), [4]ITMO University (Russia), [5]Macquarie University (Australia), [6]Ludwig-Maximilian University of Munich (Germany)

Here we present that interfacing optical fiber with nanostructures defines a novel class of fiber-integrated devices - nanostructure-interfaced fiber - allowing to reach new domains of applications for Fiber Optics research. Through 3D nanoprinting and modified electron-beam lithography, we integrate high NA-meta-lenses and dielectric ring gratings onto the end faces of single mode fibers. These devices allows for efficient light incoupling at angles as large as 80° and for trapping polymer microbeads with one single-mode fiber device.

10:00 - 11:00 — Christian Huygens Room

Session 2A5

Non-Hermitian Photonics: From Plasmonics, and Metamaterials, to Topological and Quantum systems

Organized by: Konstantinos Makris, Manas Kulkarni, Ramy El-Ganainy and Sahin Ozdemir

Chaired by: Konstantinos Makris, Manas Kulkarni, Ramy El-Ganainy and Sahin Ozdemir

10:00 : Invited talk
Nonequilibrium dynamics and thermalization in open quantum many-body systems
Yuto Ashida, Masahito Ueda
The University of Tokyo (Japan)

I will present two distinct theoretical formalisms to analyze out-of-equilibrium open many-body dynamics with an arbitrary number of quantum jumps. first, I discuss propagation of correlations beyond the Lieb-Robinson bound, which originates from the nonorghotonality of non-Hermitian eigenstates. Second, I show that a generic nonintegrable many-body system subject to continuous observation thermalizes itself at a single-trajectory level. This finding provides a way to efficiently solve a many-body Lindblad master equation.

10:20 : Invited talk
Localization and universality in non-Hermitian many-body systems

Ryusuke Hamazaki[1], **Kohei Kawabata**[2], **Naoto Kura**[2], **Masahito Ueda**[2]
[1] *RIKEN (Japan),* [2] *University of Tokyo (Japan)*

We show that novel and rich physics concerning localization and universality appears in non-Hermitian quantum many-body systems. As a first topic, we analyze non-Hermitian systems with asymmetric hopping in the presence of interaction and disorder. We demonstrate that a novel real-complex transition occurs upon many-body localization. As a second topic, we discuss universality classes of spectral statistics in non-Hermitian random matrices. We find two new universality classes characterized by transposition symmetry, which is distinct from time-reversal symmetry.

10:40 : Invited talk
Inversely Designed Clustering in Non-Hermitian Disorder for Controlled Wave Delocalization
Sunkyu Yu, Xianji Piao, Namkyoo Park
Seoul National University (Korea)

Here we explore wave localization in non-Hermitian disordered potentials. By employing the inversely designed optical platform having the target nearest-neighbor correlation, we investigate the effect of clustering on localization. At the specific level of gain or loss, anomalous delocalization of light is observed for highly disordered patterns, which originates from the clustering-induced alteration of the parity-time symmetry breaking condition. The comparison with other delocalization processes in non-Hermitian systems will also be discussed.

09:00 - 11:00 — Augustin Fresnel Room

Session 2A6

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii

Chaired by: Eugene Kamenetskii

09:00 : Invited talk
Generation of superconducting vortices by angular momentum of light
Takehito Yokoyama
Tokyo Institute of Technology (Japan)

We investigate a superconducting state irradiated by a laser beam with spin and orbital angular momentum. It is shown that superconducting vortices are generated by the laser beam due to heating effect and transfer of angular momentum of light. Possible experiments to verify our prediction are also discussed.

09:20 : Invited talk
Chirality of Multipolar Lattice Resonances in Plasmonic Crystal Excited by Vortex Beams
Keiji Sasaki, Hiroki Kitajim, Kyosuke Sakai
Hokkaido University (Japan)

We demonstrate that dipolar and quadrupolar lattice resonances in finite-sized, square-lattice arrays of metal nanodisks can be excited by circularly polarized vortex beams carrying spin and orbital angular momenta. The simulation results show that spatial distributions of the lattice resonances in the plasmonic crystals exhibit characteristic patterns with the chirality that conserve the chirality of the incident light and the excited plasmonic fields of individual nanodisks.

09:40 : Invited talk
Optical vortex induced structured materials via two-photon-absorption
Takashige Omatsu
Chiba University (Japan)

We report on that irradiation of picosecond optical vortex pulses with orbital angular momentum allows us to form unique helical or flower-shaped structures via two photon absorption. Such structures reflect not only the

spatial intensity profile, wavefront and polarization of the irradiated optical vortex field but also the nonlinear spatial modulational instability of optical vortex in materials.

10:00 : Invited talk
High Harmonic Generation in Quantum Spin Liquids: Analogy to Graphene, Semiconductors, and Superconductors
Minoru Kanega[1], Tatsuhiko N. Ikeda[2], Masahiro Sato[1]
[1] *Ibaraki University (Japan),* [2] *University of Tokyo (Japan)*

High harmonic generation (HHG) in matter has been extensively studied, and metallic systems have long been its central target in solids. Recently, researchers have begun to extend the targets of HHG to other materials. We theoretically study HHG in magnetic insulators, especially, focusing on quantum spin liquids (QSLs). We show that HHG in QSLs may exhibit their characteristics and the emergence of their even-order harmonics is controlled with a static external field in a class of magnets.

10:20 : Invited talk
Evolution of the Hybridization Processes in Heavy Fermion CeCoIn5
Zhengxing Wei, Yupeng Liu, Jingbo Qi
University of Electronic Science and Technology of China (China)

We investigate the quasiparticle dynamics in the heavy fermion CeCoIn5 using ultrafast pump-probe spectroscopy. Our results indicate that this material system undergoes hybridization fluctuations before the establishment of heavy electron coherence, as the temperature decreases from ∼120 K (T†) to ∼55 K (T*). Such observation urges to develop new microscopic theory different from the conventional single impurity Kondo model for understanding the hybridization process.

10:40 : Invited talk
Spin current generation due to Stern-Gerlach¬-like effects
Mamoru Matsuo
University of Chinese Academy of Sciences (China)

Spin current is a key concept in spintronics. It is known that the spin current is generated in media with the presence pf spin dependent potentials, such as a strong spin-orbit coupling and spin-vorticity coupling. In this talk, we focus on the Stern-Gerlach-like spin transport phenomena driven by spin-vorticity coupling in elastic materials as well as by the transverse spin of the surface plasmon polariton.

09:00 - 10:40 — Ibn Al-Haytham Room

Session 2A7
Symposium II: New trends in nanophotonics and advanced materials
Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

09:00 : Invited talk
Plasmonic Probe for Electrochemical Reaction at Metal Nanostructures
Kei Murakoshi
Hokkaido University (Japan)

Single layer graphene can used as to determine the electronic structures of plasmonic nano-electrodes for photoelectrochemical energy conversions. We have revealed the relationship between the photoenergy conversion ability and electrochemical potential of the Fermi level of the plasmonic structure. The present electrochemical Raman measurements was proved to provide detailed understanding on the plasmon-induced charge transfer process for further developments on the ability.

09:20 : Invited talk
Directional emission from colloidal quantum dots using dielectric metasurfaces
Yeonsang Park, Hyochul Kim, Jeong Yub Lee, Woong Ko, Kideok Bae, Kyung-Sang Cho
Samsung Advanced Institute of Technology (Korea)

We present a dielectric metasurface deflector composed of two TiO2 nanoposts whose design was adapted from the optical Yagi-Uda nanoantenna. The deflector array was formed and integrated with a colloidal quantum-dot resonant cavity using a dry etching method. To demonstrate the deflection performance, we measured the far-field image of the photoluminescence from colloidal quantum dots. We have demonstrated that the quantum dot emission transmitted through deflector arrays was deflected by 20°.

09:40 : Invited talk
Metasurface-Enabled 3-Dimensional Structured-Light Imaging
Seunghoon Han, Jang-Woo You, Byunghoon Na, Jeong Yub Lee, Namseop Kwon, Jaekwan Kim, Hyeonsoo Park, Narae Han, Yongsung Kim, Hyuck Choo
Samsung Electronics (Korea)

We have demonstrated compact structured-light projectors for 3D-depth imaging. The projectors are made by integrating metastructures directly on a DFB LD and a VCSEL array. The metastructures are subwavelength dielectric nanostructures that allow very precise, versatile wavefront manipulation. They serve as a single-element solution that provides precise control of phases and amplitudes, and the nanoscale size allows a wide field-of-view in a smallest form-factor possible.

10:00 : Invited talk
Phase Mapping of the SPP-Coupled Nanoparticles by Angle-Resolved Cathodoluminescence
Takumi Sannomiya[1], Andrea Konecna[2], Taeko Matsukata[1], Zac Thollar[1], Takayuki Okamoto[3], F. Javier Garcia de Abajo[2], Naoki Yamamoto[1]
[1] *Tokyo Institute of Technology (Japan),* [2] *ICFO-Institut de Ciencies Fotoniques (Spain),* [3] *RIKEN (Japan)*

Nanoscale gaps between metals can strongly confine electromagnetic fields that enable efficient electromagnetic energy conversion and coupling to nanophotonic structures. In particular, the gap formed by depositing a metallic particle on a metallic substrate produces coupling of localized particle plasmons to propagating surface plasmon polaritons. Here we demonstrate the experimental visualization of the phase associated with the plasmonic field of metallic particle-surface composites through nanoscopically and spectroscopically resolved cathodoluminescence using a scanning transmission electron microscope.

10:20 : Invited talk
On-chip super-compact photonic quantum CNOT gate
Xifeng Ren[1], Ming Zhang[2], Lantian Feng[1], Daoxin Dai[2]
[1] *University of Science and Technology of China (China),* [2] *Centre for Optical and Electromagnetic Research (China)*

We demonstrate a super-compact integrated quantum CNOT gate on a silicon chip by using the idea of symmetry breaking of a 6-channel waveguide superlattice. The present path-encoded quantum CNOT gate is implemented with a footprint of 4.8x4.45 μm2 as well as a high process fidelity of $\sim$0.925 and a low excess loss of $<$0.2 dB. The footprint is shrunk very significantly by $\sim$10,000 times compared to those previous integrated quantum CNOT gates based on dielectric waveguides.

09:00 - 10:55 — Gaston Floquet Room

Session 2A8

Parity-Time and quasi-normal modes in Photonics, Plasmonics, Acoustics

Organized by: Anatole Lupu and Henri Benisty

Chaired by: Anatole Lupu and Henri Benisty

09:00 : Invited talk
Non-conservative optics with dielectric metasurfaces
Andrey A. Sukhorukov
The Australian National University (Australia)

We introduce a general approach for tailored non-conservative transformations of polarization states of light

based on scattering and interference from specially engineered nano-resonators in ultra-thin dielectric metasurfaces. We present theoretical and experimental results demonstrating the fundamentals aspects and potential applications of such metasurfaces. These include an optimal monitoring of deviations from a selected polarization, transformation of any input two-photon quantum polarization-entangled state to an arbitrary target state, and discrimination between a set of objects with different polarization characteristics.

09:20 : Invited talk
Revealing the missing dimension at an exceptional point
Renmin Ma
Peking University (China)

The radiation of electromagnetic and mechanical waves depends not only on the intrinsic properties of the emitter but also on the surrounding environment. We show experimentally that this scenario breaks down at a non-Hermitian degeneracy known as an exceptional point. We find a chirality-reversal phenomenon in a ring cavity where the radiation field reveals the missing dimension of the Hilbert space, known as the Jordan vector.

09:40 : Hiding Parity-time Symmetry by Transformation Optics
Xinghong Zhu[1], Hongfei Wang[2], Dangyuan Lei[2], John Brian Pendry[3], Jensen Li[1]
[1] *The Hong Kong University of Science and Technology (Hong Kong),* [2] *City University of Hong Kong (Hong Kong),* [3] *Imperial College London (United Kingdom)*

We investigate how exceptional points can be constructed by using transformation optics (TO). By transforming a seed structure with conventional PT symmetry, we theoretically generate non-Hermitian daughter systems which do not possess PT symmetry in the usual sense but with inherited exceptional points and PT-phase transitions.

09:55 : Invited talk
Restricted Hilbert transform for a non-Hermitian management of electromagnetic fields
Waqas Ahmed[1], Muriel Botey[2], Ramon Herrero[2], Ying Wu[1], Kestutis Staliunas[2]
[1] *King Abdullah University of Science and Technology (KAUST) (Saudi Arabia),* [2] *Universitat Politecnica de Catalunya (UPC) (Spain)*

Spatial symmetry breaking in non-Hermitian systems allows tailoring wave propagation. Inspired by such property, we propose a local Hilbert Transform to control the field flows in non-Hermitian systems, restricting the complex refractive index within practical limits. We propose an iterative procedure, and show, how such procedure limits the space of complex refractive index within desired ranges. The proposed method provides a flexible way to systematically design locally PT-symmetric systems realizable with a limited collection of realistic materials.

10:15 : Invited talk
Control of Light Reflection and Transmission with Active Metasurface
Vasily V. Klimov
Lebedev Physical Institute (Russia)

New approach to all-optical control of light propagation with active metasurfaces is suggested. This approach is based on modification of losses in meta-atoms with an external light beam. The efficiency and quickness of the response of our metasurface are achieved by using complicated structures of eigen-oscillations in meta-atoms consisting of lossy and gain nanoparticles of an identical shape. The approach suggested paves the way for developing new active metasurfaces with a fast and substantial response to control light beam.

10:35 : Invited talk
A universal form of one-dimensional complex potentials featuring spectral singularities
Vladimir Konotop, Dmitry A. Zezyulin
Universidade de Lisboa (Portugal)

A one-dimensional complex potential in the Schrodinger equation features spectral singularities if and only if it has a universal form. Respective solutions have a universal form too. This allows one to construct complex potentials enabling either coherent perfect absorption or to lasing, or to both, at any prescribed wavelength. The described potentials allow for deformations leading to bound states in continuum or to exceptional points. We also describe potentials resulting in two or in three spectral singularities at desirable wavelengths.

09:00 - 10:45 — Lawrence Bragg Room

Session 2A9

Plasmonics: Fundamentals and Applications

Organized by: Hong Wei

Chaired by: Hong Wei

09:00 : Invited talk
Light Assisted Synthesis of Novel Plasmonic Nanostructures for Single-molecule Surface-enhanced Raman Scattering and Nanofocusing
Zhipeng Li
Capital Normal University (China)

The introduce of light during the synthesis process brings additional controllable freedom that enables new possibility to tailor the physical parameters of nanomaterials. We have developed a two-step photo-reduction approach to generate highly reproducible single-molecule Surface-enhanced Raman Scattering (SM-SERS) materials. We also shown that photochemical synthesis can create silver nano-needles with high aspect rate and ultra-smooth surface. These nano-needles are excellent nanofocusing waveguides with divergent effective refractive index for plasmon propagating modes.

09:20 : Invited talk
CQED in hybrid nanophotonic structures
Ying Gu, Zhiyuan Qian, Fan Zhang, Zhichao Li, Qi Zhang, Qihuang Gong
Peking University (China)

We first propose an approach that combines a photonic crystal and metallic nanoparticle structure to create nanocavities with both strong local-field intensity and high helicity, where both strong and weak couplings with unidirectional propagation are obtained. Then, we propose the mechanism of edge state-led mode coupling under topological protection. Based on this mechanism, in topological photonic structure containing a resonant plasmon nanoantenna, an obvious absorption reduction in the spontaneous emission spectra appears.

09:40 : Plasmonics in near-zero-index media
Ben Johns, Joy Mitra
Indian Institute of Science Education and Research (India)

We investigate surface plasmon polaritons (SPPs) at the interface of a metal and a near-zero index (NZI) medium. Interestingly, these SPPs can be excited directly by free-space radiation as their dispersion lies above the free-space light line, in contrast to the case of conventional metal-dielectric interfaces. We explore unusual phenomena such as impedance matching of a NZI medium with free space and perfect electromagnetic absorption, and present designs for active and passive plasmonic waveguides incorporating NZI media.

09:55 : Invited talk
The Coulomb Blockade in Plasmonics and How to Optically Lift it
Thomas A Klar, Dmitry Sivun
Johannes Kepler University Linz (Austria)

We propose that a Coulomb blockade can suppress the tunneling current in quantum plasmonics in case of very small nanoparticles. Hence, a redshift is sustained even for sub-nanometer approach. This holds up to moderate fields that do not surpass the Coulomb blockade. Only for stronger optical fields, the Coulomb blockade is lifted and a charge transfer plasmon can be formed.

10:15 : Measuring the temperature of plasmonic systems in ultrafast pump-probe experiments
Maria Sygletou[1], Marzia Ferrera[1], Giuseppe Della Valle[2], Michele Magnozzi[1], Daniele Catone[3], Patrick O'Keeffe[3], Alessandra Paladini[3], Francesco Toschi[3], Stefania Benedetti[4], Piero Torelli[4], Lorenzo Mattera[1], Maurizio Canepa[1], Francesco Bisio[5]
[1] University di Genova (Italy), [2] IFN-CNR - Politecnico di Milano (Italy), [3] CNR-ISM (Italy), [4] CNR-Istituto Officina dei Materiali (Italy), [5] CNR-SPIN (Italy)

After light-metallic nanoparticles (NPs) interaction, the system subcomponents, such as electron gas, lattice

and environment, gradually return to equilibrium by means of complex dynamic relaxation processes. Up to now, the absence of direct experimental method for measuring the dynamic temperature evolution of each system subcomponents was a major hurdle in understanding such processes.In this work, we discuss different methods for directly measuring the ultrafast evolution of the electronic temperature in metallic NPs, impulsively excited by ultrafast radiation pulses.

10:30 : Tunable Optical Response of Plasmonic Au Nanoparticles Embedded in Ta-doped TiO2 Transparent Conductive films
Cristina Mancarella[1], Maria Sygletou[2], Beatrice Roberta Bricchi[1], Francesco Bisio[3], Andrea Li Bassi[1]
[1] *Politecnico di Milano (Italy),* [2] *University of Genova (Italy),* [3] *Consiglio Nazionale delle Ricerche-CNR-SPIN (Italy)*

Localized Surface Plasmon Resonances (LSPR) of Au nanoparticles can be tailored in the visible range through nanoparticle geometry. However modulation is limited by the fixed carrier density of metals. Embedding Au nanoparticles in Transparent Conductive Oxides (TCOs) is an original approach to widen LSPR tunability by acting directly on the surrounding host. In this contribution we show that the easily modifiable permittivity of the TCO matrix succeeds as an additional degree of freedom in tuning properties.

09:00 - 10:45 — Rene Descartes Room

Session 2A10

Metamaterial enabled new devices and applications

Organized by: Weiren Zhu, Ciyuan Qiu and Fajun Xiao

Chaired by: Weiren Zhu, Ciyuan Qiu and Fajun Xiao

09:00 : Invited talk
Metamirror for generation and control of Airy beams
Rui Feng[1], Badreddine Ratni[2], Jianjia Yi[3], André de Lustrac[4], Hailin Zhang[1], Shah Nawaz Burokur[2]
[1] *Xidian University (China),* [2] *Université Paris Nanterre (France),* [3] *Xi'an Jiaotong University (China),* [4] *Université Paris-Saclay (France)*

Due to their intriguing diffraction-free, self-bending, and self-healing properties, Airy beams have attracted enormous research interests. An electronically reconfigurable metamirror is proposed to generate Airy beams on a wide frequency range by designing two distinct coding states with opposite reflective phase of 0° and 180° as digital bits of "0."and "1"states. Both numerical simulations and experimental measurements are performed to verify the Airy beam properties from 9 GHz to 12 GHz.

09:20 : Invited talk
Planar Vortex Beam Generator for Circularly Polarized Incidence Based on FSS
Yuxiang Wang[1], Kuang Zhang[1], Yueyi Yuan[1], Badreddine Ratni[2], Shah Nawaz Burokur[2], Qun Wu[1]
[1] *Harbin Institute of Technology (China),* [2] *Université de Paris Nanterre (France)*

A new technique to design a low-profile planar vortex beam generator is proposed based on microwave frequency selective surface (FSS). Each unit cell is composed of a stack of patches and grids separated by thin dielectric substrates. A simple equivalent circuit model, composed of transmission lines coupled together with shunt capacitors and inductors, is presented to analyze this structure. The prototype of the proposed planar OAM generator operating in X-band is designed, fabricated and experimentally characterized.

09:40 : Invited talk
Plasmon Nano-tweezers towards sub 10 nm particles trapping
Fajun Xiao, Jianlin Zhao
Northwestern Polytechnical University (China)

In this work, we demonstrate the radially polarized beam can excited an annular potential well in a plasmonic coaxial aperture for stably trapping the 5 nm particles under a relatively low optical power. Furthermore, we demonstrate the plasmon mode residing in the closely spaced silver coated fiber tip and gold film can

produces a sharp quasi-harmonic potential well, capable of stably trapping 2 nm quantum dot beneath the tip apex with the laser power as low as 3.7 mW.

10:00 : Programmable absorbing metasurface for active scattering manipulation
Linda Shao, Weiren Zhu
Shanghai Jiao Tong University (China)

We present a programmable absorbing metasurface for active scattering manipulation. A metasurface unit with switchable perfect absorption and perfect reflection is achieved by incorporating a PIN diode into a typical metamaterial absorber, where the absorption and reflection functions can be switched by biased voltages. The simulated field results shows that the scattering properties can be controlled by changing the voltage distribution on PIN diodes on the metasurface.

10:15 : Metamaterial Absorbers for Infrared Stealth Applications
Jinglan Zou, Cong Quan, Zhihong Zhu, Xiaodong Yuan, Jianfa Zhang
National University of Defense Technology (China)

We explore selective metamaterial absorbers for infrared stealth applications. Several different designs will be discussed. We show that with multi-band absorption, the designed metamaterials can suppress the scattering near infrared signals used by laser-guided missiles, and the mid-infrared emission by matching the atmospheric absorption band. High-temperature metals for metamaterial designs, such as tungsten and molybdenum, will be discussed.

10:30 : Superscattering and superdirective emission via mode stacking in subwavelength meta-atoms
Alex W. Powell, Alastair Hibbins, John Roy Sambles
University of Exeter (United Kingdom)

Designing a subwavelength meta-atom so that multiple resonances occur at the same frequency can vastly enhance its interaction with electromagnetic radiation, as well as its directivity. However, experimentally demonstrating this effect has previously proven difficult. We demonstrate that such mode stacking, leading to superscattering and superdirectivity of emission, can be readily achieved through the careful structuring and arrangement of core-shell dielectric spheres. This work has applications in diverse fields such as antenna design, imaging and optoelectronics.

Coffee Break and Exhibit Inspection

Session 2P1

Poster session III

11:00 - 11:40

P1: Single-walled carbon nanotube phase shifters for low THz frequencies
Aleksandra Przewłoka[1], Serguei Smirnov[2], Aleksandra Krajewska[1], Joachim Oberhammer[2], Mikhail Khodzitsky[3], Dmitri Lioubtchenko[1]
[1] *CENTERA Laboratories (Poland),* [2] *KTH Royal Institute of Technology (Sweden),* [3] *ITMO University (Russia)*

In this work single-walled carbon nanotube length dependence on phase tuning properties of dielectric rod waveguide is experimentally studied in ultra-wide frequency band of 0.1-0.5 THz.

P2: Structural Morphological and Optical Studies Of La-doped ZnS Thin films synthesized by Chemical Bath Deposition Technique in Acidic medium.
Hamid Merzouk, Djahida Talantikit
Algeria University (Algeria)

La-doped ZnS thin films have been produced on glass substrates using a chemical bath deposition route. X ray diffraction, atomic force microscopy, scanning electronic Microscopy, spectrophotometer and photoluminescence characterizations are used to study structural, morphological and optical properties of our samples. The lanthanum concentration was varied from 0 % to 10 % Spectroscopic analyses have shown significant improvement of optical transmittance reaching 90 % for films doped at 1 % in the visible but For all others the transmission do not exceed 80 %

P3: Gold Nanoparticle Arrays on Flexible Substrate for Stress Measurements
William d'Orsonnens[1], Florian Lamaze[1], Abdelhamid Hmima[1], Julien Proust[1], Aymeric Leray[2], Thomas Maurer[1], Eric finot[2]
[1] *University of Technology of Troyes (France),* [2] *University of Burgundy (France)*

Gold nanoparticles, and gold nanoparticles arrays, have widely been used as sensors, especially in the biology field due to their plasmonic properties. They present strong coupling in the visible range which makes them easy to observe. We therefore aim to use nanoparticles arrays to create a mechanical strain test sensor based on Fano effect. To do so we developed techniques to deposit gold nanoparticles on flexible substrates.

P4: Scattering properties of non-reciprocal systems with gain/loss
Hamed Ghaemidizicheh
Lancaster University (United Kingdom)

We develop a transfer matrix description for non-reciprocal media with gain and loss, and show how topological signatures in these systems can be detected in transport experiments. This includes signatures of the non-Hermitian skin effect, for which we clarify the role of scattering boundary conditions.

P5: Exciton diffusion and annihilation in nanophotonic landscapes
T. V. Raziman, C. Peter Visser, Alberto G. Curto
TU/e - Eindhoven University of Technology (The Netherlands)

Excitonic emitters in semiconductors exhibit diffusion and annihilation. Conventional nanophotonics improves light emission by providing enhancements of excitation, emission efficiency, and collection, but neglects exciton dynamics. We exploit exciton dynamics for improving emission, going beyond the localized Purcell effect. We present guidelines to benefit from diffusion and to ameliorate the effects of annihilation. We identify the dominant mechanisms for enhancement for limits of diffusion and annihilation. Controlling exciton dynamics has direct implications for light-emitting devices based on excitonic nanomaterials.

P6: Tunable and robust long-range coherent dipole interactions mediated by Weyl bound states
Inaki Garcia-Elcano[1], Alejandro Gonzalez-Tudela[2], Jorge Bravo-Abad[1]
[1] *Universidad Autonoma de Madrid (UAM) (Spain),* [2] *Instituto de fisica Fundamental (IFF-CSIC) (Spain)*

The interaction between a quantum emitter and a Weyl pho- tonic environment is investigated. We show that a photon-atom bound state is formed at the proximities of the Weyl frequency. Remarkably, the photonic part of such light-matter hybrid state features a tunable and robust power law spatial confinement. When considering more than one emitter couple to the bath we demonstrate that the emergent Weyl bound state can be harnessed to mediate long-range interactions between emitters.

P7: Accurate Circuit Model for Periodic Array of Square Patches
Saeed Zolfaghary, Amin Khavasi, Behzad Rejaei
Sharif University of Technology (Iran)

A novel circuit model for the grid impedance of electrically dense arrays of subwavelength metallic square patches is derived using analytical formulas for arrays of metallic square holes. By comparison with full-wave simulations, we show that the model can predict the reflection and transmission of frequency selective surface with high accuracy.

P8: Designing Scattering Properties of Metasurfaces
James Capers, Simon Horsley, Alastair Hibbins
University of Exeter (United Kingdom)

Metasurfaces have been shown to enhance the Local Density of Optical States (LDOS), providing large improvements in the power emission of dipole emitters. Many experimental works have focused on the properties of metasurfaces composed of square arrays of scatterers. In this work, we develop a method of designing metasurfaces to produce the desired scattering properties, focusing on the application to antenna design. Using this method, we demonstrate a three-fold improvement in the LDOS compared to a square array.

P9: Equivalent Circuit Model for Charactering Hysteresis of Perovskite Solar Cells
Ting Xu[1], Zishuai Wang[2], Wei E. I. Sha[1]
[1] *Zhejiang University (China),* [2] *The University of Hong Kong (China)*

Equivalent circuit model is a useful tool to characterize device physics of perovskite solar cells (PVSCs). Based on detailed balance theory and dynamics of carriers and ions, an equivalent circuit model is proposed

for modeling current-density voltage characteristics of PVSCs. The dynamic hysteresis phenomena are reproduced and the connections between the device properties and circuit elements are established. Evidently, the circuit model offers systematic descriptions to the working mechanisms of PVSCs, which is beneficial to design and performance optimization.

P10: New Plasmonic System for Visible Light-Driven Hydrogen Evolution Reaction
Hiro Minamimoto, Daiki Sato, Kei Murakoshi
Hokkaido University (Japan)

Excitation of the localized surface plasmon resonance leads to the generation of the reaction active species. The excited species makes it possible to trigger the efficient multi electron transfer reactions. In this study, plasmon-induced hydrogen evolution reactions have been achieved by the introduction of the the plasmonic metal nanostructures intothe p-type GaP semiconductor electrode. Through the photoelectrochemical measurements, the unique molecular process has been confirmed at the present plasmonic photoconversion electrode, resulting in the unique reaction selectivity.

P11: Enhanced light generation due to hybridization of lattice and gap plasmon modes in periodic MIM tunnel junction
Saurabh Kishen, Jinal Tapar, Naresh Kumar Emani
Indian Institute of Technology Hyderabad (India)

A promising approach to realize electrically excited on-chip nanoscale optical sources is through inelastic electron tunneling. Its practical implementation, however, suffers from low electron-to-photon transduction efficiencies. Here, we investigate the enhancement of light generation in a periodic Ag-SiO2-Ag tunnel junction due to inelastic electron tunneling. By efficiently coupling lattice resonance with gap plasmon mode, we achieve an enhancement in the local density of optical states by three orders of magnitude and a radiative efficiency 30 $\%$ higher than the uncoupled structure.

P12: Large area fabrication of plasmonic nanostructures using nanoimprint lithography with contact transfer
Jun Hyun Kim, Doo-In Kim, Myung Yung Jeong
Pusan National University (Korea)

In this study, the nanoimprint lithography (NIL) process was proposed and demonstrated to fabricate the plasmonic nanostructures. An embossing of a PMMA substrate and the transfer of a deposited metallic nanostructures were implemented simultaneously using a thermal-NIL for the cost-effective large area fabrication of the plasmonic nanostructures.

P13: Fabrication of 1-D Photonic crystals to enhance thermochromic properties of VO2 nanostructures
Dipti Umed Singh[1], **Omkar Bohite**[1], **Remya Naryanan**[2]
[1] *Indian Institute of Science Education and Research (India),* [2] *Savitribai Phule Pune University (India)*

Effect of 1-D photonic crystals on optical transmission of VO2 is studied by depositing VO2 thin films on Distributed Bragg Reflectors (DBR) in the infrared (IR) spectrum. Monoclinc VO2 nanoparticles were first synthesized by solution processed method. By combining VO2 films on DBR structure, the average optical transmission approaches to zero in the IR region in and above the critical temperature. which could be the positional design for VO2 nanoparticles based hybrid Photonic absorbers for various smart window applications

P14: Spectral singularities and non-reciprocal light scattering in 2D PT-symmetric metamaterials
Jinal Kiran Tapar, Saurabh Kishen, Saurabh Kishen, Naresh Kumar Emani
Indian Institute of Technology (India)

We consider vertically stacked GaInP PT-symmetric resonators that constitute meta-atoms for the 2D active metamaterial. From numerical simulations and scattering theory formalism, we show that these metasurfaces support zero-width resonances, i.e. spectral singularities (SS). By tuning the coupling between gain and loss resonators, we demonstrate the spectral singularities are robust over a wide range of parameter variations. We also show that vertically stacked GaInP resonators can exhibit broadband unidirectional invisibility and strong directional scattering.

P15: Small signal Frequency Response of a slotted photonic crystal based Raman laser

Akash Kumar Pradhan, Mrinal Sen
Indian Institute of Technology (ISM) (India)

Small signal frequency response of a silicon naocrystal based slotted photonic crystal Raman laser has been evaluated theoretically by solving the coupled mode equations for laser in steady state. Modulation bandwidth in the order of $\sim$ 144 GHz has been achieved in this type of laser due to the high Raman gain coefficient of silicon nanocrystal.

P16: Fluorescent Microdiamonds Conjugated with Hollow Gold Nanoparticles as Photothermal fiducial Markers

Shan-Jen Kuo[1], Sih-Wei Chang[1], Yuen-Yung Hui[2], Oliver Y. Chen[2], Yen-Wei Chen[2], Ching-Che Lin[1], Dehui Wan[3], Huan-Cheng Chang[2], Hsuen-Li Chen[1]
[1] *National Taiwan University (Taiwan),* [2] *Academia Sinica (Taiwan),* [3] *National Tsing Hua University (Taiwan)*

In this study, we characterized fluorescent microdiamonds (FMDs) and explored their potential use as fiducial markers for image guided photothermal therapy. To exploit the excellent thermal conductivity of diamonds, we decorated the surface functionalized FMDs with hollow gold nanoparticles (HGNs). The dual functions fluorescent and thermal imaging of the HGN-FMDs were performed when applying the distinct excitation laser wavelengths of the HGNs and the FMDs, respectively.

P17: Sub-wavelength imaging of few-cycle nanoplasmonic near-fields using interferometric time-resolved photoemission electron microscopy

Alexander Gliserin[1], Soo Hoon Chew[1], Sungho Choi[2], Dong Eon Kim[2], Seungchul Kim[1]
[1] *Pusan National University (Korea),* [2] *Pohang University of Science and Technology (Korea)*

We present a first implementation of a novel perturbative autocorrelation technique for direct sampling of ultrafast electric fields with a photoemission electron microscope. Unlike conventional nonlinear autocorrelation, this method preserves the phase, providing a full characterization of the electric field without additional spectral information. This allows direct observation of sub-wavelength electric near-fields at plasmonic nanostructures on the shortest time scales, which we demonstrate at a monolayer of self-assembled 40-nm gold nanospheres with sub-100-nm spatial resolution.

P18: 3D Metastructure Design for Noise Suppression of Audible Frequency Band

Sung-Sil Cho, Ic-Pyo Hong
Kongju National University (Korea)

We fabricated a simple acoustic spectrum measurement system for measuring acoustic transmission loss and proposed a new acoustic metastructure that can reduce noise.To validate the performance of the designed system, the previously studied acoustic metastructure was generated and the acoustic transmission loss was measured and compared. In addition, the novel acoustic metastructure was proposed for noise reduction. The simulation results show that the proposed acoustic metastructure has a loss of 67dB at 478Hz and a bandgap of 448-546Hz.

P19: Synthesis of gold nanoparticles using α-amino acids

Aleksandra Maria Figat, Bartosz Bartosewicz, Malwina Liszewska, Bartłomiej J. Jankiewicz
Military University of Technology (Poland)

Various α-amino acids have been used as reducing and stabilizing agents in the synthesis of gold nanoparticles following the Turkevich protocol. The shape, size distribution, stability and optical properties of synthesized nanoparticles were characterized by SEM, DCS, PALS technique and UV-vis spectroscopy. The differences in chemical structure of α-amino acids strongly affect their reactivity and influence the shape, size distribution and stability of synthesized gold nanoparticles.

11:40 - 12:30 — Victor Veselago Room

Session 2A11

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

11:40 : Keynote talk
Commercializing Metaphotonics
Hyuck Choo
Samsung Electronics Co., Ltd. (Korea)

According to a market research organization, the metaphotonics market is expected to exceed $10B in 10 years, and its growth be fueled by the rapidly spreading IoT and related services powered by the 5G network. But, what are the successful commercialization examples of metamaterials that we know? In this presentation, I will share some of our recent results and on-going commercialization efforts for metaphotonics utilizing Si-based IC-processing technologies. A few areas of metamaterial applications include safer autonomous driving; custom-tailored point-of-care health monitoring and diagnosis; and improving light-capturing efficiency of sub-micron-pixel CMOS imagers. I look forward to share and discuss our findings and vision for the coming years.

12:10 : Invited talk
Bi-physical stealth metamaterials for waterborne objects
Yi Zhou[1], Jian Chen[1], Rui Chen[1], Wenjie Chen[1], Liu Liu[2], Zheng Fan[3], Yungui Ma[1]
[1] *Zhejiang University (China),* [2] *South China Normal University (China),* [3] *Nanyang Technological University (Singapore)*

In this work, a bi-physical ultrathin metamaterial that could simultaneously make underwater objects invisible for magnetic field and acoustic wave is demonstrated and validated. This coat could shield the magnetic field with the field disturbance ratio less than 0.5 % over a broad frequency range (10-250 kHz) and strongly attenuate ultrasonic waves with a nearly unity absorptivity meanwhile. This metamaterial may shed light on building multifunctional devices for various waterborne applications.

11:40 - 12:40 — Allan Boardman Room

Session 2A12

Symposium I: Hybrid Nanomaterials and Metastructures for Photonics, Sensing and Energy

Organized by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

Chaired by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

11:40 : Invited talk
Polarization state generator obtained by self-assembled plasmonic nanoparticles
Yann Battie[1], Jie Gao[2], Emilie Pouget[2], Reiko Oda[2], Laurent Broch[1], Matthias Pauly[3], Aotmane En Naciri[1]
[1] *Université de Lorraine (France),* [2] *Université de Bordeaux (France),* [3] *ICS (UPR22-CNRS) (France)*

In this work, we explore the optical properties of gold nanoparticles assembled into chiral structure. This structure exhibits a complex multianisotropy which comes from the dipolar interaction between NPs. We show that these nanostructures are good candidates for new polarization devices.

12:00 : Invited talk
Precisely positioned atomistic quantum emitters in monolayer MoS2
Alexander Holleitner
Technische Universitat Munchen (Germany)

For photonic and plasmonic hybrid circuits, it is essential to place single photon emitters with the highest lateral position possible to allow for a controlled exploitation of the local electromagnetic fields. We demonstrate the deterministic generation of single defect emitters in a monolayer MoS2 van der Waals heterostructure with a lateral creation accuracy of $\sim$9 nm. Our work paves way towards the controlled generation of atomistic single photon emitters in monolayer 2D materials embedded in optoelectronic quantum devices.

12:20 : Invited talk

Overcoming Limits in Nano-Optical Simulations, Design and Experiments Using Deep Learning

Peter R. Wiecha, Guilhem Larrieu, Aurélie Lecestre, Otto L. Muskens
LAAS-CNRS Toulouse France (France)

Tremendous research efforts have been put into the field of nano-optics, leading to applications like flat optics or negative index metamaterials. However, there are physical and/or methodological constraints, hard to overcome. For instance, the optical diffraction limit is a difficult obstacle in microscopy or optical information storage. Inverse design of nanostructures is another example for a difficult tasks. We show how very hard to solve problems can be tackled efficiently using methods of artificial intelligence and specifically deep learning.

11:40 - 12:20 — Tatsuo Itho Room

Session 2A13

Bottom-up approaches, new fabrication routes and ENSEMBLE3

Organized by: Dorota Pawlak and Virginie Ponsinet

Chaired by: Dorota Pawlak and Virginie Ponsinet

11:40 : Invited talk

Organic Polymeric-carbon-nitride-based Metamaterials: A Novel Platform for Nano-optical Device Innovation

Daniel Clarke[1], Julya Siena[2], Corinna Kaspar[3], Wolfram Pernice[3], Markus Antonietti[2], Ortwin Hess[1]
[1] *Trinity College Dublin (United Kingdom),* [2] *Max Planck Institute of Colloids and Interfaces (Germany),* [3] *University of Munster (Germany)*

In this contribution, we present a combined theoretical and experimental investigation of pCN-coated, gold double-fishnet metamaterials. Our full-dimensionality, finite-difference time-domain calculations are complemented with state-of-the-art device fabrication procedures which make possible the realization of such pCN-based metamaterials, and we compare our theoretical predictions directly with experimental measurements.

12:00 : Invited talk

Gold nanoparticles: from plasmonic field enhancement and luminescence to nanofabrication

Céline Molinaro[1], Sylvie Marguet[1], Ludovic Douillard[1], Fabrice Charra[1], Farid Kameche[2], Olivier Soppera[2], Dandan Ge[3], Renaud Bachelot[3], Céline Fiorini-Debuisschert[1]
[1] *Université Paris-Saclay (France),* [2] *Université de Haute-Alsace (France),* [3] *Université de Technologie de Troyes (France)*

The two-photon-excited luminescence of gold nanoparticules is studied in detail. A phenomenological model is proposed which reveals the importance of field enhancement at the plasmonic NP resonances for both plasmon enhanced absorption and plasmon enhanced emission, with surface effects also playing an important role. Beyond these fundamental aspects, we show that plasmonic hot spots can also interestingly be taken into profit for the realization of advanced hybrid nanostructures for photonics

11:40 - 12:40 — Christian Huygens Room

Session 2A14

Non-Hermitian Photonics: From Plasmonics, and Metamaterials, to Topological and Quantum systems

Organized by: Konstantinos Makris, Manas Kulkarni, Ramy El-Ganainy and Sahin Ozdemir

Chaired by: Konstantinos Makris, Manas Kulkarni, Ramy El-Ganainy and Sahin Ozdemir

11:40 : Invited talk
Stability optimization of random networks with added non-Hermitian nodes from a parity-time symmetry perspective
Henri Benisty
Institut d'Optique Graduate School (France)

A network being described by a real symmetric coupling matrix between its elements, we look at the addition of gain and loss elements coupled to the network, to maximize the so-called unbroken phase of the parity-time symmetry approach now familiar in optics: we minimize imaginary parts of eigenvalues. We explore with Fourier tool how coupling should be arranged and attempt to find rules similar to those established for "stability-optimized-circuitsïn the context of neural networks.

12:00 : Invited talk
Non-Hermitian media with global and local unidirectionality: theory and applications
Muriel Botey, Waqas W. Ahmed, Zeki Hyaran, Judith Medina, Hamza Kurt, Ramon Herrero, Kestutis Staliunas
Universitat Politècnica de Catalunya (UPC) (Spain)

Structured media provide the momentum compensation for the scattering of waves, shaping the the propagation of light. Yet only the interplay between both the real and imaginary modulations introduces unidirectionality in the light management. A generalized Hilbert transform allows tailoring the two quadratures of the complex permittivity to design periodic or disordered non-Hermitian media, holding either global or local unidirectionality following arbitrary vector fields. Moreover, the method allows restricting the permittivity within realistic values rendering it suitable for applications.

12:20 : Invited talk
Ultrathin Acoustic Parity-Time Symmetric Metasurface Cloak
Johan Christensen[1], María Rosendo-López[1], Hao-Xiang Li[2], Yi-fan Zhu[2], Xu-dong Fan[2], Daniel Torrent[3], Bin Liang[2], Jian-chun Cheng[2], Johan Christensen[1]
[1] *Universidad Carlos III de Madrid (Spain),* [2] *Nanjing University (China),* [3] *Universitat Jaume (Spain)*

By using an elaborate arrangement of gain and lossy acoustic media respecting parity-time symmetry, we built a one-way unhearability cloak able to hide objects seven times larger than the acoustic wavelength. Generally speaking, our approach has no limits in terms of working frequency, shape, or size, specifically though we demonstrate how, in principle, an object of the size of a human can be hidden from audible sound.

11:40 - 12:30 — Augustin Fresnel Room

Session 2A15

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii

Chaired by: Eugene Kamenetskii

11:40 : Bi-hyperbolic Isofrequency Topologies in a Gyroelectromagnetic Medium
Vladimir Tuz[1], Volodymyr Fesenko[2]
[1] *Jilin University (China),* [2] *National Academy of Sciences of Ukraine (Ukraine)*

Isofrequency topologies are studied for a gyroelectromagnetic medium. This medium is obtained by stacking optically thin magnetized ferrite and semiconductor layers into a unified structure. In such a structure, a bi-hyperbolic isofrequency contour appears as a simultaneous effect of both periodic arrangement of constitutive layers and external magnetic field influence. It is proposed to consider the obtained bi-hyperbolic isofrequency contour as a new topology class of the wave dispersion.

11:55 : Invited talk
Antiferromagnetism, chirality, and magneto-optical effects

Jonathan Kipp[1], **Fabian Lux**[1], **Kartik Samanta**[1], **Maximilian Merte**[1], **O. Gomonay**[2], **Frank Freimuth**[1], **Marjana Lezaic**[1], **Stefan Blugel**[1], **Yuriy Mokrousov**[2]
[1] *Peter Grunberg Institut (Germany),* [2] *University of Mainz (Germany)*

We study the influence of chirality on magneto-optical phenomena in frustrated magnets. By referring to models and microscopic calculations we suggest a way to identify the sense of crystal and magnetic chirality of two-dimensional magnets from the behavior of the Hall and magneto-optical effects that they exhibit, promoting new protocols for probing these fundamental properties of matter.

12:15 : Full Manipulation of Circular Polarizations for Multiple Vortex Beams Generation based on Phase-Engineered Metasurface
Kuang Zhang[1], **Yueyi Yuan**[1], **Badreddine Ratni**[2], **Shah Nawaz Burokur**[2], **Qun Wu**[1], **Patrice Genevet**[3]
[1] *Harbin Institute of Technology (China),* [2] *Université Paris Nanterre (France),* [3] *Université Côte d'Azur (France)*

In this paper, a phase-engineered non-interleaved metasurfaces is proposed for multiple vortex beam generation, which is combining versatile phase modulation methods. Different from traditional scheme based on phase interleaving for multiple functionalities, four vortex beam wavefronts carrying independent orbital angular momentum (OAM) can be created through all four circular polarization (CP) transmission channels. Theoretical simulations are conducted and effectively verified the feasibility of the proposed theory for artificial manipulation of CP manipulation in microwave region.

11:40 - 12:45 — Ibn Al-Haytham Room

Session 2A16

Exotic Meta-media - Time-dependent, Nonlocal and Other Novel Responses

Organized by: Martin McCall, Jonathan Gratus and Paul Kinsler

Chaired by: Martin McCall, Jonathan Gratus and Paul Kinsler

11:40 : Asymmetric frequency conversion with acoustic non-Hermitian space-time varying metamaterial
Xinhua Wen[1], **Xinghong Zhu**[1], **Alvin Fan**[1], **Wing Yim Tam**[1], **Jie Zhu**[2], **Fabrice Lemoult**[3], **Mathias fink**[3], **Jensen Li**[1]
[1] *Hong Kong University of Science and Technology (China),* [2] *Hong Kong Polytechnic University (China),* [3] *PSL University (France)*

We experimentally realize an acoustic non-Hermitian space-time varying metamaterial using digital virtualized resonating meta-atoms. By temporally modulating the material gain and loss, we can diminish the main band and achieve high efficiency frequency conversion at the same time due to the gain-loss balance in time domain. We also experimentally demonstrate the asymmetric amplification with such an acoustic metamaterial.

11:55 : Invited talk
Analysis of nonlocal constitutive relations to homogenize metamaterials
Fatima Zohra Goffi[1], **Karim Mnasri**[1], **Michael Plum**[1], **Carsten Rockstuhl**[1], **Andrii Khrabustovskyi**[2]
[1] *Karlsruhe Institute of Technology (Germany),* [2] *University of Hradec Kralové (Czech Republic)*

It has been appreciated that nonlocal constitutive relations are more performant to homogenize metamaterials, which are obtained by approximating a general response function of the electric field describing the response of the metamaterial. In this research, a second order Padé approximation of the response function is adopted that leads to several formulations. To decide which formulation is consistent for the homogenization, we present a checklist each constitutive relation has to pass to be admissible.

12:15 : Wave scattering by layered structures in critical condtions
Kim Pham[1], **Agnès Maurel**[2]
[1] *IMSIA - ENSTA Paris (France),* [2] *Institut Langevin (France)*

We derive an effective model governing the light scattering in structures alternating metal/dielectric layers

of subwavelength thicknesses. The homogenization procedure is conducted on the Maxwell equations in three dimensions, the resulting model involves effective constitutive relations which link the electric field and electric displacement as well as non-intuitive transmission conditions at the extremities of the substructure. In transverse electric polarization, the model reduces to a fully local model while in transverse magnetic polarization, classical non local terms appear.

12:30 : 4-dimensional covariant helicity states in vacuum and linear media
Robert Thompson[1], **Ivan Fernandez-Corbaton**[1], **Martin McCall**[2]
[1] *Karlsruhe Institute of Technology (Germany),* [2] *Imperial College London (United Kingdom)*

The notion of helicity in solutions to Maxwell's vacuum equations in standard 3 + 1 notation is extended to media expressed in 4-D coordinate-free notation. This allows us to significantly generalise the definition of helicity that is associated with the (anti-)self-duality of solutions to Maxwell, a generalization that permits easy extension to media in curved spacetimes.

11:40 - 12:40 — Gaston Floquet Room

Session 2A17

Advanced modeling techniques for the design of metasurface devices

Organized by: Patrice Genevet and Stéphane Lanteri

Chaired by: Patrice Genevet and Stéphane Lanteri

11:40 : Invited talk
Metasurfaces for Divergent Beams and Large-Area Metasurfaces
Daniel Andrén, Jade Martinez-Llinas, Ruggero Verre, Mikael Kall, Philippe Tassin
Chalmers University of Technology (Sweden)

We will give an overview of our recent work on the design and fabrication of metasurfaces, i.e., dense arrays of subwavelength-sized scatterers (meta-atoms) designed in shape, size, position, and orientation. first, we have developed simulation strategies for large-scale metasurfaces and metasurfaces for strongly divergent beams. Second, we have developed a facile fabrication technique based on an exposed resist to build large-scale metasurfaces. These novel computational and fabrication techniques allow us to achieve metasurfaces with unprecedented functionality.

12:00 : Invited talk
Fundamental limitations of ultra-flat Huygens metasurfaces
Carlo Gigli[1], **Pierre Chavel**[2], **Philippe Lalanne**[3]
[1] *Université de Paris (France),* [2] *Université de Lyon (France),* [3] *Université de Bordeaux (France)*

There are two physical effects that are exploited nowadays to implement flat metalenses, either subwavelength guidance implementing varying propagation delays, or resonant confinement combining two resonances. We compare both approaches and identify possible FUNDAMENTAL limitations with the second approach.

12:20 : Invited talk
Contour integral methods for resonance phenomena in nano-optics
Felix Binkowski[1], **Fridtjof Betz**[1], **Remi Colom**[1], **Martin Hammerschmidt**[2], **Philipp-Immanuel Schneider**[2], **Lin Zschiedrich**[2], **Sven Burger**[1]
[1] *Zuse Institute Berlin (Germany),* [2] *JCMwave GmbH (Germany)*

We review contour integral methods for the solution of nonlinear eigenvalue problems resulting from Maxwell's equations. Numerical realizations of the methods are applied to compute and analyze resonances in nano-optical systems with material dispersion.

11:40 - 12:40 — Lawrence Bragg Room

Session 2A18

Machine learning for metamaterials and metasurfaces

Organized by: Mohamed Bakr and Willie Padilla

Chaired by: Mohamed Bakr and Willie Padilla

11:40 : Invited talk
Inverse design in nanophotonics using deep-learning
Junsuk Rho
Pohang University of Science and Technology (POSTECH) (Korea)

Recent introduction of deep learning into nanophotonics has enabled efficient inverse design process. Once the deep learning network is trained, it allows fast inverse design for multiple design tasks. In this talk, we show several inverse designing nanophotonic structures using deep learning. We firstly discuss inverse design methods that increase the degree of freedom of design possibilities.

12:00 : Invited talk
Deep Learning Approach for the Enhanced Light-Matter Interactions in Dielectric Nanostructures
Lei Xu[1], Mohsen Rahmani[2], Yixuan Ma[1], Daria A. Smirnova[2], Khosro Zangeneh Kamali[2], Fu Deng[1], Yan Kei Chiang[1], Lujun Huang[1], Haoyang Zhang[3], Stephen Gould[2], Dragomir N. Neshev[1], Andrey E Miroshnichenko[1]
[1] UNSW Canberra (Australia), [2] The Australian National University (Australia), [3] The Queensland University of Technology (Australia)

In this paper, we utilize a deep-learning approach for obtaining high-quality factor (high-Q) resonances with desired characteristics, such as linewidth, amplitude and spectral position. We exploit such high-Q resonances for the enhanced light-matter interaction in nonlinear optical metasurfaces and optomechanical vibrations, simultaneously.

12:20 : Invited talk
A generalized accurate predictor of nano-optical near fields and far-fields using a deep learning neural network
Otto L. Muskens, Peter R. Wiecha
University of Southampton (United Kingdom)

We present a deep learning artificial neural network (ANN) capable of predicting the full near-fields and far-fields of nanostructures. The ANN captures the direct relationship between the geometry and the internal fields. It successfully addresses plasmonic antenna modes, magneto-electric resonances of high-index dielectrics, electromagnetic anapole states, Kerker effects, near-field particle interactions and chiral hot spots. This new data-driven ANN approach to nano-optical modelling enables very fast evaluations and opens new routes to inverse design of nano-optical structures and metasurfaces.

11:40 - 12:40 — Rene Descartes Room

Session 2A19

Plasmonics for single molecule detection and manipulation

Organized by: Denis Garoli

Chaired by: Denis Garoli

11:40 : Invited talk
Light-Induced Particle Binding Assisted by Metamaterial Substrates

Alexander Shalin[1], **Natalia Kostina**[1], **Pavel Ginzburg**[2]
[1] *ITMO University (Russia),* [2] *Tel Aviv University (Israel)*

Here we study light-induced interaction of several dielectric particles above a hyperbolic metamaterial. It is shown, that both surface and volumetric modes of the substrate define distances between interacting particles, beyond the diffraction limit. Moreover, by varying the thickness of the metamaterial substrate it is possible to tune magnitude of the optical force and distances between the particles.

12:00 : Invited talk

Protein-Tailored Plasmonic Silver Nanorings over Graphene-Coated Nanopores for Localized Enhanced Fluorescence

Matteo Ardini[1], **Giorgia Giovannini**[2], **Nicolo Maccaferri**[3], **Xavier Zambrana-Puyalto**[2], **Gloria Panella**[1], **Francesco Angelucci**[1], **Rodolfo Ippoliti**[1], **Denis Garoli**[2], **Francesco De Angelis**[2]
[1] *University of L'Aquila (Italy),* [2] *Istituto Italiano di Tecnologia (Italy),* [3] *University of Luxembourg (Luxembourg)*

Engineering electromagnetic fields through plasmons provides advances in several applications. Nanodevices with improved optical properties, for instance, are obtained using the architecture of proteins and their affinity towards nanomaterials. Here, silver nanorings are synthesized on the ring protein Prx and arranged over graphene-coated nanohole arrays achieving improved and localized fluorescence. This approach represents a proof-of-concept for future nanopore-based technologies, e.g. next-generation sequencing and single-molecule detection.

12:20 : Invited talk

Plasmonic Sensing by Gold Nano-Mushroom Arrays Fabricated using a Novel Anisotropic Etching Regime

Daniel Darvill[1], **Marzia Iarossi**[1], **Ricardo M. Abraham Ekeroth**[2], **Aliaksandr Hubarevich**[1], **Francesco De Angelis**[1]
[1] *Istituto Italiano di Tecnologia (Italy),* [2] *Universidad Nacional del Centro de la Provincia de Buenos Aires (Argentina)*

We report a novel fabrication route for creating a plasmonic sensing platform based upon arrays of gold nano-mushrooms. This technique allows for a single processing step to create polystyrene mushrooms from colloidal masks produced using colloidal lithography prior to metal deposition. We show the potential of this plasmonic nanostructure as a biosensor tuned to the near infra-red with efficacy similar to those found in literature.

Lunch

12:40 - 14:00

14:00 - 15:10 — Victor Veselago Room

Session 2A20

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

14:00 : Keynote talk

Prineha Narang
Harvard University (USA)

Keynote

14:30 : Invited talk

Few-femtosecond plasmon transients probed with nm-scale sensitivity

Peter Dombi
Wigner Research Centre for Physics (Hungary)

Photoelectron probing of few-femtosecond plasmon transients on nanostructures reveals the ultrafast dynamics of localized plasmon oscillation decay with nm-scale sensitivity at plasmonic hot spots.

14:50 : Invited talk
Hyperuniform and Local Self-Uniform Solar Light Absorbers
Marian Florescu[1], Nasim Tavakoli[2], Richard Spalding[1], G. Gkantzounis[1], Chenglong Wan[1], Ruslan Röhrich[2], Evgenia Kontoleta[2], Femius Koenderink[2], Riccardo Sapienza[3], Esther Alarcon Llado[2]
[1] *University of Surrey (United Kingdom),* [2] *NWO-I Amolf (The Netherlands),* [3] *Imperial College London (United Kingdom)*

We explore the ability of hyperuniform disordered structures to improve light absorption in thin-film architectures and show that hyperuniform and local self-uniform correlations may be designed to enhance the coupling to quasi-guided modes supported by the thin film. We report a theoretical solar energy absorption of 84 % in a broadband spectral range (400-1050 nm), in a one micron-thick Si membrane, which is, to the best of our knowledge, the best value achieved in ultra-thin Si membranes.

14:00 - 15:20 — Allan Boardman Room

Session 2A21

Symposium I: Hybrid Nanomaterials and Metastructures for Photonics, Sensing and Energy

Organized by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

Chaired by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

14:00 : Invited talk
Degenerate ZnO nanocrystals and nanowires for Mid IR plasmonics
Bruno Masenelli[1], Mohamed K. H. Taha[1], Olivier Boisron[1], Patrice Mélinon[1], K. Masenelli-Varlot[1], Vincent Sallet[2], Isabelle Lefebvre[3], Christophe Delerue[3]
[1] *Université de Lyon (France),* [2] *Université de Versailles- St Quentin (France),* [3] *Université de Lille-ISEN (France)*

We investigate Ga doped degenerate ZnO nanocrystals and nanowires. We show that tunable mid IR plasmons are achieved in both cases. The dopant location and activation within the nanostructures have to be carefully controlled in order to induce efficient plasmons.

14:20 : Invited talk
Dynamic Polarization Control Using Temperature Driven Nonlinearities in Anisotropic Metamaterials
Luke H. Nicholls, Jingyi Wu, Anastasiia Zaleska, Mazhar Nasir, Anatoly V. Zayats
King's College London (United Kingdom)

By altering the permittivity of an anisotropic metamaterial, achieved by exploiting the Kerr-type nonlinearity of metals, we demonstrate control over the polarization of light. This is accomplished in a reflection configuration, allowing higher signal intensities. Moving away from femtosecond pulse control illumination, we also investigate the effect of using CW control light. This is made possible by the designed epsilon near zero (ENZ) region of the nanorod metamaterial and its related nonlocal properties.

14:40 : Invited talk
Large scale fabrication of silicon Mie nanoresonators: an alternative to gold ?
Julien Proust[1], Pierre Michel Adam[1], Redha Abdeddaim[2], Anne Laure Baudrion[1], Jeremie Beal[1], Frederic Bedu[2], Thomas Begou[2], Johann Berthelot[2], Sebastien Bidault[3], Nicolas Bonod[2], Wajdi Chaabani[4], Abdallah Chehaidar[4], Stephane Chenot[5], Anne Laure Fehrembach[2], Bruno Gallas[5], Maria F. Garcia Parajo[6], Julien Lumeau[2], Artur Movsesyan[1], Mathieu Mivelle[7], Igor Ozerov[2], Jerome Plain[1], Raju Regmi[2], Herve Rigneault[2], Jerome Wenger[2], Pamina M. Winkler[2]
[1] *University of Technology of Troyes (France),* [2] *Aix-Marseille University (France),* [3] *ESPCI (France),* [4] *SFAX University (Tunisia),* [5] *Sorbone University (France),* [6] *ICFO Institut de Ciencies Fotoniques (Spain),* [7] *Universite*

Pierre et Marie Curie (France)

High index dielectric nanoparticles have been proposed for many different applications. The multiples optical properties of such called Mie resonators allowed us to question there use as an alternative to gold. Actually, the optical resonnances, coupled with a strong nearfield can open perspective in plasmonic uses. Widespread utilization in practice also requires largescale production methods for crystalline silicon nanoparticles. We demonstrate a lowcost, and largescale fabrication method of crystalline spherical silicon colloidal Mie resonators in water, using a blender.

15:00 : Invited talk
A bottom-up approach to the fabrication of optical metamaterials utilizing the self-assembly of silver dodecahedral clusters
Lucien Roach, Laurent Lermusiaux, Véronique Many, Alexandre Baron, Romain Dezert, Etienne Duguet, Virginie Ponsinet, Serge Ravaine, Philippe Richetti, Philippe Barois, Mona Tréguer-Delapierre
CNRS-Université de Bordeaux (France)

A key requirement on 'meta-atoms' comprising optical metamaterials, is a light-induced magnetic response of similar magnitude to the electric response. It is desirable to assemble such materials through bottom-up approaches, requiring the production of colloidally dispersed 'meta-atoms'. However, many of the currently realizable candidate colloidal particles present too weaker magnetic response. Hence, there is a need for novel magnetically-polarizable meta-atoms. We present silver dodecapods as a strong candidate for such a role.

14:00 - 15:25 — Tatsuo Itho Room

Session 2A22

Symposium III: Advanced passive and active metasurfaces and zero-index optics

Organized by: Howard Lee, Yu-Jung (Yuri) Lu and Zi Jing Wong

Chaired by: Howard Lee, Yu-Jung (Yuri) Lu and Zi Jing Wong

14:00 : Invited talk
Materials for nonlinear optical metasurfaces
Augustine Urbas
Air Force Research Lab (USA)

We will explore recent work in linear and nonlinear metasurfaces for optical applications incluing novel materials exploration.

14:20 : Invited talk
Low-loss zero-index metamaterials based on a bound state in the continuum (BiC)
Haoning Tang[1], Clayton DeVault[1], Phil Camayd-Munoz[1], Danchen Jia[2], Yueyang Liu[3], Fan Du[4], Olivia Mello[1], Yang Li[3], Eric Mazur[1]
[1]*Harvard University (USA),* [2]*Zhejiang University (China),* [3]*Tsinghua University (China),* [4]*Nankai University (China)*

On-chip metamaterials with a refractive index of zero can achieve perfect spatial coherence, leading to various applications in nonlinear and quantum optics. Those applications are severely hampered by the out-of-plane radiation losses as a result of the small amplitude momentum of zero-index metamaterial. Here we eliminate the out-of-plane radiation losses by realizing zero index with BiC. Our experimental results show that a BiC zero-index metamaterial has a quality factor over 15000 at the zero-index wavelength.

14:40 : Keynote talk
Tunable and Time-Modulated Flat Optics
Harry A. Atwater, Ghazaleh Shirmanesh, Prachi Thureja, Jared Sisler, Ruzan Sokhoyan, Meir Grajower
California Institute of Technology (USA)

Metasurfaces offer tremendous opportunity for photonics, namely, to manipulate amplitude, phase, and po-

larization of electromagnetic waves with arrays of subwavelength nanoantennas, enabling systems with flat optical components featuring dramatically reduced size, weight and power. Currently most metasurfaces are 'static' and have functions that are fixed at the time of fabrication. By making the system tunable or reconfigurable in its phase, amplitude and polarization response through incorporation of electro-optical effects, one can achieve real-time control of optical functions and indeed achieve multi-functional characteristics after fabrication. Despite the real-time tunability offered by the electro-optical metasurfaces, their operation thus far has been limited to the quasi-static regime, where temporal variations are slow enough that they do not result in changes in scattered beam frequency. By contrast, time modulated metasurfaces are temporally at rates high enough to generate new frequencies. Introducing time modulation to these metasurfaces opens a four-dimensional design space which can be used to overcome several fundamental limitations associated with static and quasi-static metasurfaces.

15:10 : Transdimensional photonic lattices with van der Waals metasurfaces and strong coupling to high-index thin layers
Viktoriia Babicheva
University of New Mexico (USA)

Transition metal dichalcogenides (TMDCs) from the family of van der Waals layered materials have been shown to exhibit tailorable optical properties along with strong nonlinearity, high refractive index, and anisotropy. We envision that TMDCs is a promising material platform for designing ultra-thin optical elements. We investigate a van der Waals metasurface that consist of disk-shaped nanoantennas made of TMDC material placed on top of a thin intermediate layer of high-index material such as silicon and low-index oxide substrate.

14:00 - 15:20 — Christian Huygens Room

Session 2A23

Non-Hermitian Photonics: From Plasmonics, and Metamaterials, to Topological and Quantum systems

Organized by: Konstantinos Makris, Manas Kulkarni, Ramy El-Ganainy and Sahin Ozdemir

Chaired by: Konstantinos Makris, Manas Kulkarni, Ramy El-Ganainy and Sahin Ozdemir

14:00 : Invited talk
Quantum correlations in PT-symmetric systems
Francesco Ciccarello
University of Palermo (Italy)

We study the dynamics of correlations in a paradigmatic setup to observe PT-symmetric physics: a pair of coupled oscillators, one subject to a gain one to a loss. Quantum correlations (QCs) are created, despite the system being driven only incoherently, and can survive indefinitely. We link PT-symmetry breaking to the long-time behavior of QCs, which display different scalings in the PT-broken/unbroken phase and at the exceptional point (EP). The EP in particular stands out as the most classical configuration.

14:20 : Invited talk
On the connection between parity-time symmetry and time-variant wave media
Theodoros T. Koutserimpas, Romain Fleury
Swiss Federal Institute of Technology Lausanne (Switzerland)

Parity-time symmetry can allow non-Hermitian Hamiltonians to exhibit real eigenvalues. This interesting condition of symmetries has enabled numerous studies in the fields of quantum mechanics and optics. Such theoretical and experimental studies involve a combination of material gain and loss. In this talk, we connect the phenomena that are related to parity-time symmetry with the wave phenomena that are related to temporal changes of the wave parameters of the medium, by introducing a time-transitioning matrix.

14:40 : Invited talk
Nonlinear mode competition and symmetric protected power oscillations in topological lasers

Simon Malzard[1], **Henning Schomerus**[2]
[1] *Imperial College London (United Kingdom),* [2] *Lancaster University (United Kingdom)*

Topological lasing in non Hermitian systems offers a new interpretations of topological states as they can be selectively amplified by distributed gain and loss. A key question is whether such topological mode selection persists when nonlinearities that stabilise these systems at their working point are included. Here we show that topological defect lasers can operate in genuinely topological states with analogues of zero modes from the linear setting, as well as a novel states displaying symmetry protected power oscillations.

15:00 : Invited talk
Emergent PT symmetry and quantum fluctuations in a double-quantum-dot circuit QED set-up
Archak Purkayastha[1], **Manas Kulkarni**[2], **Yogesh Joglekar**[3]
[1] *The University of Dublin (Ireland),* [2] *Tata Institute of Fundamental Research (India),* [3] *Indiana University Purdue University Indianapolis (IUPUI) (USA)*

Open classical and quantum systems with effective parity-time (PT) symmetry have shown tremendous promise for advances in lasers, sensing, and non-reciprocal devices. However, the microscopic origin of such effective, non-Hermitian models is not well under-stood. In this work, by microscopically modelling a double-quantum-dot-circuit-QED set-up that is realizable in state-of-the-art experiments, we show that a non-Hermitian Hamiltonian emerges naturally, which can be controllably tuned to observe both PT-transition, as well as the effect of quantum fluctuations.

14:00 - 15:20 — Augustin Fresnel Room

Session 2A24

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii

Chaired by: Eugene Kamenetskii

14:00 : Invited talk
The influence of the internal domain wall structure and chirality on spin wave dynamics in periodic magnetic stripe domain patterns
Pawel Gruszecki[1], **Jan Kisielewski**[2], **Andrzej Maziewski**[2], **Maciej Krawczyk**[1]
[1] *Adam Mickiewicz University (Poland),* [2] *University of Bialystok (Poland)*

The study of the Dzyaloshinskii-Moriya interaction together with perpendicular magnetocrystalline anisotropy and film's thickness influence on both the static magnetic configuration and the dynamics of spin waves in periodic aligned stripe domain patterns is provided. We analyze the sensitivity of excitation of resonant modes on polarization of the microwave field. Subsequently, we demonstrate in micromagnetic simulations the unidirectionality of spin-wave propagation along the domain walls and define the conditions for its occurrence.

14:20 : Invited talk
Synthetic chiral light for efficient control of chiral light matter interaction
David Ayuso, Ofer Neufeld, Andres Felipe Ordonez, Piero Decleva, Gavriel Lerner, Oren Cohen, Misha Ivanov, Olga Smirnova
Max-Born-Institut Berlin (Germany)

I will talk about synthetic chiral light, a new type of freely propagating optical fields that we have recently introduced. Synthetic chiral light enables the highest possible degree of control over chiral light-matter interaction. It allows us to drive a strong nonlinear response in chiral molecules of a selected handedness. As a result, we can force a particular molecular enantiomer to emit bright harmonic light while its mirror twin remains dark, reaching the ultimate efficiency limit in chiral discrimination.

14:40 : Invited talk
Superparamagnetic nanoparticles with deep UV plasmonic response

Vladimir P. Drachev[1], **Ali Aliev**[2]
[1] *Skolkovo Institute of Science and Technology (Russia),* [2] *University of Texas at Dallas (USA)*

Structural and magnetic characterizations prove that the single-domain and superparamagnetic properties of nanoparticles required for spin dependent plasmon oscillations. Good quality plasmon resonance in absorption is proven to be a property of isolated Co nanoparticles. The magnetic field induced aggregation of nanoparticles results in a suppression of the resonance quality. The measured magnetic moment above blocking temperature is about 0.69 of Bohr magnetons per atom in a 8.8 nm nanoparticle, which is much lower than in bulk cobalt, 1.73.

15:00 : Invited talk
Magnon-polaritons condensates with superfluidity and vortex formation
Eugene Kamenetskii
Ben Gurion University of the Negev (Israel)

We show that magnon-polaritons can be realized due to magnon condensation caused by magnetic dipole-dipole interaction. We study quantized vortices in magnon-polariton condensates arising from magnetic-dipolar-mode (MDM) oscillations in a quasi-2D ferrite disk placed in a microwave cavity. We show that is possible to trap a magnon Bose-Einstein condensate in a ring geometry and induce rotational superflow in this system. We consider torque transfer induced by MDM oscillations.

14:00 - 15:20 — Ibn Al-Haytham Room

Session 2A25

Exotic Meta-media - Time-dependent, Nonlocal and Other Novel Responses

Organized by: Martin McCall, Jonathan Gratus and Paul Kinsler

Chaired by: Martin McCall, Jonathan Gratus and Paul Kinsler

14:00 : Invited talk
Quantum spill-out induced enhancement in surface nonlinear plasmonic response
Muhammad Khalid, Cristian Ciraci
Italian Institute of Technology (Italy)

We develop a theoretical model based on the quantum hydrodynamic description of free-electrons and present its numerical implementation to investigate surface second-order nonlinearities. The presented method is capable of dealing with realistic profiles of equilibrium density of a metal. In the spectral analysis of Na and Ag thick slabs, we observe strong resonances induced by the electron spill-out from the metal surface. These resonances can be exploited to enhance the second-harmonic conversion efficiency by several orders of magnitude.

14:20 : Invited talk
A (re-)introduction to spatial dispersion
Paul Kinsler
Lancaster University (United Kingdom)

I examine the traditional approach to spatial dispersion, and contrast this with an alternative based on a fundamental re-examination of the basic principles. I emphasise the key role of the spatial properties which generate spatially dispersive behaviour: geometry, structure, and dynamics.

14:40 : Invited talk
D and H cannot exist: Axions, topology and global charge conservation
Jonathan Gratus[1], **Paul Kinsler**[1], **Martin W McCall**[2]
[1] *Lancaster University (United Kingdom),* [2] *Imperial College London (United Kingdom)*

The excitation fields D and H cannot be directly measured and have a gauge freedom. Admitting this freedom opens many possibilities, concerning the axionic response, which have direct application. We show a simple scenario which due to topological reasons is impossible using D and H. It can be used to model periodic latti-

ces which have non zero total charge and show that an evaporated black hold can break charge conservation. We reflect on the nature of a homogeneous axionic response.

15:00 : Invited talk
Surface waves with mixed exponential and linear localization characteristics
Tom Mackay[1], **Chenzhang Zhou**[2], **Akhlesh Lakhtakia**[2]
[1] *University of Edinburgh (United Kingdom),* [2] *Pennsylvania State University (USA)*

A theory underpinning new types of surface waves, guided by the planar interface of an anisotropic material and an isotropic material, has been developed. These new surface waves propagate only in one direction for each quadrant of the interface plane and their decay in the direction normal to the interface in the anisotropic partnering material is given by the product of an exponential and a linear function of distance from the interface plane.

14:00 - 15:15 — Gaston Floquet Room

Session 2A26

Parity-Time and quasi-normal modes in Photonics, Plasmonics, Acoustics

Organized by: Anatole Lupu and Henri Benisty

Chaired by: Anatole Lupu and Henri Benisty

14:00 : Invited talk
Nonorthogonality constraints in open quantum systems
Jan Wiersig
Otto-von-Guericke-Universitat (Germany)

The nonorthogonality of quasi-normal modes plays an important role in the physics of non-Hermitian systems. We demonstrate that the known nonorthogonality bound for effective Hamiltonians describing decaying systems may not be valid in quantum and wave systems with radiation due to quantum backflow. A geometric interpretation of the nonorthogonality bound is given which reveals that in this context the complex energy (or frequency) space can be seen as a surface of constant negative curvature.

14:20 : High-Q modes, quasi-modes, and pseudo-modes in dielectric nanoparticles of different shapes
Vasily V. Klimov
Lebedev Physical Institute (Russia)

Optical properties of dielectric nanoparticles of different shapes are investigated. Continuous distributions of Q factor as a function of frequency and permittivity are found, and modes, quasi-modes, and pseudo-modes of NP are extracted. The pseudo-modes are characterized by small stored energy and scattered power. Our results show that among nanoparticles of different shapes but of the same volume nanospheres have the highest Q factor in the limit of high permittivity.

14:35 : Invited talk
Optical mode transfer by encircling fixed and moving exceptional points
Pierre Berini
University of Ottawa (Canada)

We discuss recent progress on optical mode transfer in parity-time symmetric systems. We discuss structures where modes evolve in parameter space such that an exceptional point is encircled, and consider cases where the exceptional point is fixed or mobile. We also discus prospects for realizing non-linear or active structures.

14:55 : Invited talk
Nanoantennas with Balanced Gain and Loss
Alejandro Manjavacas
University of New Mexico (USA)

We will discuss how the addition of plasmonic elements with gain to conventional metallic nanoantennas can

serve to achieve directional optical responses.

14:00 - 15:20 — Lawrence Bragg Room

Session 2A27

Machine learning for metamaterials and metasurfaces

Organized by: Mohamed Bakr and Willie Padilla

Chaired by: Mohamed Bakr and Willie Padilla

14:00 : Invited talk
Deep-Neural-Network Enabled Metasurface Designs
Sensong An, Clayton Fowler, Bowen Zheng, Hong Tang, Hang Li, Hualiang Zhang
University of Massachusetts Lowel (USA)

Metasurfaces are being widely investigated and adopted for their potential for integrating multiple functionalities into a single, flat optical device. A key challenge in this field is the non-intuitive design process that produces designs based on specific electromagnetic requirements. Meanwhile, deep neural network (DNN) has been proven to be an effective solution to non-intuitive design tasks. In this paper, we detail a novel approach to design metasurfaces using DNNs and demonstrate some devices achieved based on this approach.

14:20 : Invited talk
Deep learning the electromagnetic properties of metamaterials with neural networks
Omar Khatib, Simiao Ren, Jordan Malof, Willie Padilla
Duke University (USA)

We demonstrate use of machine learning to explore the fundamental electromagnetic properties of all-dielectric metasurfaces. Our neural network architecture enables a machine learning based approach for discovering new physical insights from data - automating the traditional ways by which physicists develop models of nature from experimental and numerical observations. Our approach is Kramers-Kronig compliant, and is not limited to the case demonstrated, but is compatible with many characterization techniques including Fourier transform spectroscopy, ellipsometry, and terahertz time domain spectroscopy.

14:40 : Invited talk
Accelerating the Design of Photonic Metamaterials by Artificial Intelligence
Yongmin Liu
Northeastern University (USA)

In this talk, I will discuss how to accelerate the design of novel metamaterials by deep learning, a subset of artificial intelligence (AI) that learns multilevel abstraction of data using hierarchically structured layers. Different from the conventional approaches, deep learning can produce fast and accurate designs without the need of case-by-case and time-consuming numerical calculations. The results show many exciting opportunities in the areas of optical design, integration and measurements when interfacing photonics with deep learning.

15:00 : Invited talk
Symphotic Metamaterials for Photonic Computing and Machine Learning Applications
David R. Smith, Patrick Bowen, Daniel Marks, Roberto Zecca, Divya Pande
Duke University (USA)

Symphotic metamaterials are volumetric metamaterials that multiplex large numbers of optical functions with high efficiency. Provided enough functionality can be integrated into a symphotic device, a variety of computing algorithms can be implemented photonically, vastly reducing latency and with orders of magnitude less energy consumption. Here we introduce the symphotic concept and describe a device that can compute a convolution optically-a critical step in many neuromorphic architectures.

14:00 - 15:20 — Rene Descartes Room

Session 2A28

Plasmonics for single molecule detection and manipulation

Organized by: Denis Garoli

Chaired by: Denis Garoli

14:00 : Invited talk

Surface-enhanced Raman scattering signal intensity as a function of the plasmon resonance and the excitation wavelength

Sylwester Gawinkowski
Polish Academy of Sciences (Poland)

We report on single-molecule surface-enhanced Raman spectroscopy of porphyrins, porphycenes, and phthalocyanines. Using the tunable wavelength laser and tuning it around the local plasmon resonance and electronic resonance of the molecule, we are showing the influence of that parameter on the single-molecule SERS signal strength and its detectability. The results show that steric factors play a crucial role in the detectability of single-molecules.

14:20 : Invited talk

Single-Molecule SERS Detection of DNA Bases in Oligonucleotides by Controllable Electro-plasmonic Trapping of Single Nanoparticles in Plasmonic Nanoholes

Jianan Huang, Mansoureh Z. Mousavi, Yingqi Zhao, Aliaksandr Hubarevich, Fatima Omeis, Giorgia Giovannini, Denis Garoli, Francesco De Angelis
Italian Institute of Technology (Italy)

DNA molecules flow through nanopores too fast to allow Surface-enhanced Raman spectroscopy (SERS) detection of single bases. Here, we report an approach to control the residence time of molecules in a hot spot by an electro-plasmonic trapping effect. By directly adsorbing molecules onto a gold nanoparticle and trapping the single nanoparticle in a plasmonic nanohole up to minutes, we demonstrate single-molecule SERS detection of all four DNA bases as well as discrimination of single nucleobases in a single oligonucleotide.

14:40 : Invited talk

Transferred Nanopores Array from Nanosphere Lithography onto a Holey Membrane for Biosensing Applications

Marzia Iarossi[1], Daniel Darvill[2], Jian-An Huang[2], Ricardo M. Abraham Ekeroth[3], Francesco De Angelis[2]
[1] *Universita degli Studi di Genova (Italy),* [2] *Istituto Italiano di Tecnologia (Italy),* [3] *Universidad Nacional del Centro de la Provincia de Buenos Aires (Argentina)*

We report on an easy and low-cost strategy that combines the fabrication of an ordered array of nanopores by performing thermal annealing on a hexagonally close-packed monolayer of nanospheres and the transfer of the colloidal array onto a holey membrane. Adjusting the duration of the annealing process it is possible to control both size and shape of the interstices in the nanospheres arrays. Both optical and electrical measurements have been performed to evaluate the properties of the nanopores array.

15:00 : Invited talk

Time- and field-Resolved Response of Plasmonic Nanostructures and Their Applications to Single-Molecule Detection and Manipulation

Nicolo Maccaferri
University of Luxembourg (Luxembourg)

Plasmonics enables a plenty of novel optical effects and functionalities. In the first part of the talk we will show that, by combining femtosecond time-domain spectroscopy and high-resolution confocal microscopy, it is possible to measure full time- and field-resolved response of single plasmonic nanoantennas. In the second part of the talk, we will show practical applications of plasmonic nanostructures to single-molecule detection, enhanced spectroscopies, nanoparticle trapping and beaming, and resonant energy transfer.

Coffee Break and Exhibit Inspection

Session 2P2

Poster session IV

15:20 - 16:00

P1: Simulation of Large Metasurfaces through Transfer Function Mask
Chenglin Xu, Mayank Bahl, Evan Heller
Synopsys, Inc. (USA)

A more efficient and accurate approach is demonstrated to simulate metasurfaces. The new approach employs FFT-BPM to propagate the transmitted field through a transfer function mask, which is formed by using rigorous FDTD or RCWA algorithm on local nano-cells. Larger grid and step sizes can be used and the new approach is more efficient and requires less RAM, hence it can be applied to larger metasurfaces. Validations against FDTD and FD-BPM shows it remains accurate, within a reasonable approximation.

P2: Strongly Extended Many-Body Enhancement in Diamond Epsilon Near-Zero Metamaterials
Olivia L. Mello[1], Yang Li[2], Philip Camayd-Munoz[3], Marki Loncar[1], Eric Mazur[1]
[1] *Harvard University (USA),* [2] *Tsinghua University (China),* [3] *California Institute of Technology (USA)*

We demonstrate analytically and numerically that with a diamond epsilon near-zero (ENZ) metamaterial with design we experience an ultra-high cooperative enhancement over distances greater than 10 microns for both two emitters and many-body ensembles of dipoles.

P3: Dynamic plasmonic nanorod pixels
Nicholas J. Greybush[1], Kristin Charipar[1], Paul Johns[1], Stephen J. Bauman[2], Dennis Doyle[3], Jeffrey A. Geldmeier[1], Jawad Naciri[1], Nicholas Charipar[1], Jake Fontana[1]
[1] *U.S. Naval Research Laboratory (USA),* [2] *University of Arkansas Fayetteville (USA),* [3] *University of Pittsburgh (USA)*

Plasmonic metamaterials present a new paradigm for color generation, but their properties are often either static in time or suffer from slow switching speeds. However, by reversibly aligning colloidal plasmonic nanorods using electric fields, we demonstrate rapid modulation of light on microsecond time scales. Tailoring nanorod aspect ratio and composition facilitates operation across the visible through short-wave-infrared spectra. We characterize plasmonic nanorod pixels' chromaticity and luminance, and showcase spatial, spectral, and temporal control of light in exemplary display devices.

P4: Metamaterial-assisted Inductive Power Transferusing Transmission-Line Mode
Jorge V. de Almeida[1], Eduardo Costa da Silva[1], Marbey Manhaes Mosso[1], Carlos A. F. Sartori[2]
[1] *Pontifical Catholic University of Rio de Janeiro (Brazil),* [2] *Polytechnic School of USP (Brazil)*

In this paper, a metamaterial-assisted coil for inductive power transfer system is presented. The proposed prototype exploits the transmission-line mode instead of the usual antenna one in order to minimize radiation at the resonance. By judiciously choosing the operating mode of the circuit's driver, the driver losses are reduced and the focusing mechanism of the metamaterial-based lens is improved. The theoretical results are supported by analytical and numerical evidence.

P5: Design Strategies for Highly Integrated and Efficient Metasurfaces enabling advanced Terahertz Imaging
Thomas S. Nowack, Yash D. Shah, Mitchell G. Kenney, Ivonne Escorcia Carranza, James Grant, David Cumming
University of Glasgow (United Kingdom)

To advance Terahertz imaging towards its unique applications, drastic improvement of the optical setups in terms of efficiency and number of required components is imperative. We present our approach to design large-area, all-dielectric metasurfaces for ultra-compact, efficient imaging optics at THz frequencies, which significantly reduce reflective and alignment losses by multiplexing and superposition of optical responses. We exemplify this with two metalenses based on geometric phase that exhibit two multiplexed focal points for orthogonal polarizations and a superimposed Q-plate.

P6: Gain Properties of Axially Slotted Antenna Coated by Inhomogeneous Materials Embedded in Different Materials and Metamaterials

Saddia Ilyas[1], **M. Farooq Nasir**[1], **Shakeel Ahmed**[2]
[1] *Riphah International University (Pakistan),* [2] *Quaid-i-Azam University (Pakistan)*

The properties of axially slotted cylindrical antenna coated with inhomogeneous material placed in various metamaterials have been studied. The semi analytical technique is employed to reveal the effects of different coating layers and host medium on the gain properties of the slotted antenna. The relationship of coating thickness, inhomogeneity profile and nature of the host medium with characteristics of the slotted antenna have been discussed.

P7: Single-molecule and single-nanoparticle spectroscopy of porphycene derivatives

Abdolvahab Amirsalari[1], **Katarzyna Tarnowska**[1], **Yoshio Hisaeda**[2], **Sylwester Gawinkowski**[1]
[1] *Polish Academy of Sciences (Poland),* [2] *Kyushu University (Japan)*

Here we have studied the SERS signal intensity as a function of concentration, temperature, and excitation wavelength for a series of porphycene derivatives. The SERS spectra were averaged over a large area of uniformly distributed gold nanorods deposited on the glass substrate. In the case of the very low concentration samples also temporal evolution of SERS signal on hot-spots was registered. Temporal evolution combined with bianalytical method proved single-molecule detection.

P8: Effect of deposition angle on fabrication of plasmonic metal nanocones

Jiri Liska[1], **filip Ligmajer**[1], **Pedro V. Pinho**[2], **Lukas Kejik**[1], **Michal Kvapil**[1], **Petr Dvorak**[1], **Nikolaus S. Leitner**[3], **Erik Reimhult**[3], **Tomas Sikola**[1]
[1] *Brno University of Technology (Czech Republic),* [2] *University of Campinas (Brazil),* [3] *University of Natural Resources and Life Sciences (Austria)*

Metal nanocones can be used to enhance light-matter interactions or for location-specific plasmonic sensing. Their fabrication often utilizes self-shading effect, which occurs during metal film evaporation into circular nanowells. We present a view on the fabrication of ordered arrays of gold nanocones using electron-beam lithography/evaporation. Lateral position of the substrate during the evaporation influences the symmetry of the fabricated nanocones and that off-axis deposition forms asymmetric structures. Our findings help to identify limits for production of wafer-scale arrays.

P9: Agile Metamaterial Absorber at W-bande

Khedidja Bouras, Abdelhadi Labiad, Mouloud Bouzouad
Laghouat University (Algeria)

In this work we propose an SRR type absorption cell with a negative refractive index which exhibit both negative permittivity and permeability around its resonance. The agile SRR is circular shape with four branches which has switches installed. The proposed structure is a matrix 3 X 3 unit cell controllable with an external system like MEMS, where it subject boundary condition. We get the agility feature if we change the type of one or many cells in the matrix structure.

P10: Nonlinear Properties of Magnetic Metasurfaces

Anastasia Bir, Dmitriy Romanenko, Sergey Odintsov, Sergey Nikitov, Sergey Grishin
Saratov State University (Russia)

In a paper, the experimental results of the amplitude-frequency and power characteristics of two-dimensional ferromagnetic structures are demonstrated in microwave range. It is established that the presence of a periodic structure makes it possible to control the power thresholds of nonlinear processes of spin waves.

P11: Monochromatic THz radiation of relativistic electrons from a metasurface

Daria Sergeeva[1], **Alexey Tishchenko**[1], **Alexander Aryshev**[2]
[1] *National Research Nuclear University "MEPhI"(Russia),* [2] *KEK: High Energy Accelerator Research Organization (Japan)*

We report on experimental and theoretical studies of coherent THz Smith-Purcell radiation and grating transition radiation generated by an electron bunch from a metasurface. The results are compared, and agreement is found to be marvelous for spectra, while angular distributions show discrepancy. We show that, qualitatively, the difference in angular distributions can be caused by contribution of such processes as coupling between particles or excitation of surface plasmon-polaritons.

P12: Integrated All Optical Passive Neural Network Using Silicon Metalines
Sanaz Zarei, Mahmood R. Marzban, Amin Khavasi
Sharif University of Technology (Iran)

We propose a fully optical architecture for implementing deep neural network using nano-photonic integrated circuits. Fully optical matrix multiplications are performed using silicon-based metalines. The proposed whole-passive optical neural network is very compact and works at the speed of light, with less energy consumption than state of the art electronic counterparts. Various complex functions that is performed by digital neural networks can be implemented by our proposal at the wavelength of 1.55μm.

P13: Three-Dimensional Photonic Crystal Composites with High Refractive Index Thin films
Mike P. C. Taverne[1], Xu Zheng[1], Yushao Chen[1], Katrina A. Morgan[2], Lifeng Chen[1], Ghadah Alzaidy[2], Chung-Che Huang[2], Ying -Lung Daniel Ho[1], Daniel W. Hewak[2], John G. Rarity[1]
[1] *University of Bristol (United Kingdom),* [2] *University of Southampton (United Kingdom)*

We study polymer photonic crystals coated with varying thickness of high refractive index material aiming to make functional photonic devices capable of controlling light through band structure and dispersion. We observed red shifts of partial bandgaps in the near infrared region when the thickness of deposited MoS2 films increases. A $\sim$150 nm red shift of the fundamental and high order bandgaps is measured after a $\sim$15nm thick MoS2 coating.

P14: Enhancement of Antenna Radiation through Control of the Local Environment
Leanne D. Stanfield, Alastair Hibbins, Roy Sambles
University of Exeter (United Kingdom)

The radiated power of a dipole antenna off resonance can be enhanced by employing an iterative design process derived from the Purcell effect. The local electromagnetic environment about an emitter can by engineered by controlling the local physical environment. For a 1 cm dipole antenna radiating at 2 GHz, embedded in a dielectric structure, radiated power enhancement rates of up to 5280 times have been predicted by computational models.

P15: Anisotropic Electromagnetic Wave Propagation in Two Dimensional Ferromagnetic Metamaterials
Maria Amelchenko[1], Feodor Ogrin[2], Aleksey Titov[1], Sergey Grishin[1]
[1] *Saratov State University (Russia),* [2] *University of Exeter (United Kingdom)*

It is well known that metamaterials are artificial structures providing electromagnetic properties that natural materials do not have. There is a class of metamaterials called ferromagnetic metamaterials possessing a negative permeability in microwave range and a permittivity that can changes its sign in terahertz range. In this paper, both the anisotropic properties and dispersion characteristics of fast and slow electromagnetic waves (EMWs) propagating in two-dimensional ferromagnetic metamaterials (metasurfaces) with finite wire conductivity are studied.

P16: Chemically Modulated Hyperbolic Metamaterials
Jose L. Ocana-Pujol, Ralph Spolenak, Henning Galinski
ETH Zurich (Switzerland)

Hyperbolic Metamaterials are multilayered optical nanomaterials that exhibit, due to their intrinsic anisotropy, optical topological transitions. Here, we propose and experimentally demonstrate an all zirconium-based hyperbolic metamaterial. We have selected ZrN/ZrO2 as specific example, as these earth-abundant refractory materials offer unique mechanical and thermal stability in extreme environments, such as high temperatures above 2000C. Alternating the reactive gases, oxygen and nitrogen during reactive sputtering, enables continuous growth of a chemically modulated nanomaterial.

P17: Phononic band gap of longitudinal acoustic waves in one-dimensional crystal for ultrasonic applications
Ahmed Kahlouche, Mounir Bouras, Nassim Dermeche, Abdesselam Hocini
University of Mohamed Boudiaf of M'sila (Algeria)

Nowadays, sensor technology has attracted great interest in various domains. In this work, we have analyzed phononic band gaps of one-dimensional phononic crystal made by a stack of N bi-layers of LiNbO3/SiO2. The transmission spectrum of acoustic waves is calculated by using the transfer matrix method (TMM). The results clearly demonstrate the existence of phononic band gap of which the position and the width are strongly

affected by many physical parameters. Our results are useful in various applications such as acoustic barriers and sensor materials

P18: Toward investigation of reactive intermediates via Surface-enhanced Raman Spectroscopy (SERS)
Łukasz Gutowski[1], **Malwina Liszewska**[1], **Bartosz Bartosewicz**[1], **Bogusław Budner**[1], **Jan L. Weyher**[2], **Bartłomiej J. Jankiewicz**[1]
[1] *Military University of Technology (Poland),* [2] *Polish Academy of Sciences (Poland)*

The Surface-enhanced Raman Spectroscopy (SERS) has been used to investigate the possibility of aryl monoradicals generation from thiophenols and phenylmethanethiols substituted with iodine or bromine atoms. The monolayers of radical precursors were deposited on SERS substrates, which were then immersed in methanol and irradiated for six hours with a UVC lamp. Pre- and post-reaction SERS spectra were obtained by using a portable Raman spectrometer and compared with the spectra of expected products of radicals reaction with methanol.

16:00 - 17:10 — Victor Veselago Room

Session 2A29

Plenary Session II

16:00 : Plenary talk
How Light Behaves when the Refractive Index Vanishes
Robert W. Boyd
University of Ottawa (Canada)

We describe some of the properties of light propagation through material for which the dielectric permittivity and hence the refractive index is nearly vanishing. Among other unusual optical properties, we find that such epsilon-nearzero (ENZ) materials display an extremely large nonlinear optical response, with important implications for the field of photonics.

16:35 : Plenary talk
Empowering Quantum Photonics with Nanoplasmonics and Machine Learning
Vladimir Shalaev
Purdue University (USA)

New approaches to address major challenges in quantum photonics by employing powerful ideas and concepts developed in the field of plasmonic metamaterials will be discussed.

Break

17:10 - 17:30

17:30 - 18:50 — Victor Veselago Room

Session 2A30

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

17:30 : Keynote talk
The Challenge of META is (Aperiodic) Inverse Electromagnetic Design
Eli Yablonovitch
UC Berkeley (USA)

Meta-Materials were inspired by the idea of periodic sub-wavelength geometrical units that produce an effective permittivity and permeability. Inevitably, in human affairs, there is a goal, and it may be that the goal is best achieved by an aperiodic rather than a periodic design. This is a universal problem in electromagnetics: What is the best design to achieve a specific goal? I will introduce the .Adjoint Method", a combination of calculus and linear algebra that generates optimal electromagnetic designs.

18:00 : Keynote talk
Wavelength conversion through plasmonic photoconductive nanostructures
Mona Jarrah
University of California Los Angeles (USA)

In this presentation, I will briefly overview the physics and possible macroporous, inch-scale nanostructures with submicron lattice parameter and discuss strategies for potential extension of more complex and functionally optimized hierarchical nanostructures.

18:30 : Invited talk
Nonlinear and electro-optic nanostructured metal-oxides
Felix Richter, Viola Valentina Vogler-Neuling, Helena Weigand, Flavia Timpu, Artemios Karvounis, Rachel Grange
ETH Zurich (Switzerland)

Non-centrosymmetric metal-oxide media possess a plethora of functional optoelectronic properties like second harmonic generation, electro-optic and electro-mechanical response. We present a variety of approaches to exploit these mechanisms at the nanoscale with the use of all-dielectric metasurfaces and photonic crystals based on barium titanate as well as plasmonic metasurfaces based on gold-barium titanate nanostructures.

17:30 - 18:50 — Allan Boardman Room

Session 2A31

Symposium I: Hybrid Nanomaterials and Metastructures for Photonics, Sensing and Energy

Organized by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

Chaired by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

17:30 : Invited talk
Enhancing second-harmonic generation using dipolar-parity modes in non-planar plasmonic nanocavities
Feng Wang, Hayk Harutyunyan
Emory University (USA)

Efficient optical nonlinear sources at the nanoscale are important for the development of photonic circuitry, quantum optics, and biosensing. In this work, we use metal-insulator-metal nanocavities to demonstrate strong second harmonic generation in nanoscale plasmonic cavities. We show that in contrary to the common belief, double-resonant cavities can designed with dipolar-type modes for both fundamental and emission resonances.

17:50 : Invited talk
Theory of hot-carrier generation and relaxation in plasmonic nanoparticles
Yu Zhang
Los Alamos National Laboratory (USA)

A quantum-mechanical model for hot-carrier generation, relaxation, and extraction is developed. The plasmon excitation and hot-carrier generation from the plasmon decay are derived from the linear-response time-dependent density functional theory. And its connection to the semiclassical model is discussed. Relaxation due to electron-electron and electron-phonon scatterings are treated on equal footing. With this development,

the initial distribution of hot-carriers and lifetimes of hot-carriers induced by different excitation are investigated.

18:10 : Invited talk
Manipulating Plasmonic Excitonic Nanomaterials with Coherent Phonons
Matthew S. Kirschner, Wendu Ding, Craig T. Chapman, Xiao-Min Lin, Lin X. Chen, George C. Schatz, Richard D. Schaller
Northwestern University (USA)

Coherent acoustic phonons can modulate electronic interactions with proximal excitonic molecular species. Gold bipyramids with systematically altered aspect ratios and corresponding localized surface plasmon resonance energies, functionalized with an excitonic, J-aggregated dye molecule, produce two hybridized states that exhibit anti-crossing behavior with a Rabi splitting energy of 120 meV. Such oscillatory plasmonic-excitonic nanomaterials offer a route to manipulate and dynamically-tune the interactions of plasmonic/excitonic systems and unlock a range of potential applications.

18:30 : Invited talk
Plasmon-Induced Resonance Energy Transfer for Photocatalysis, Biosensing and Photodynamic Therapy
Nianqiang Wu
University of Massachusetts Amherst (USA)

This talk presents a new energy transfer mechanism from metal to semiconductor, that is, plasmon-induced resonance energy transfer (PIRET). This talk will demonstrate the use of PIRET mechanism to design new materials and devices for solar energy conversion, photocatalysis, biosensing and photodynamic therapy.

17:30 - 19:05 — Tatsuo Itho Room

Session 2A32

Advanced modeling techniques for the design of metasurface devices

Organized by: Patrice Genevet and Stéphane Lanteri

Chaired by: Patrice Genevet and Stéphane Lanteri

17:30 : Invited talk
T-operator limits on electromagnetic power transfer: nanophotonic upper bounds on far-field cross sections and Purcell enhancement
Sean Molesky, Prashanth S. Venkataram, Weiliang Jin, Pengning Chao, Alejandro Rodriguez
Princeton University (USA)

We present a scheme based on the scattering T operator to set physical bounds on any single electromagnetic design problem that can be framed as a net power process. The technique is found to predictively quantify and differentiate the relative performance of dielectric and metallic devices for both far and near-field sources (e.g. Purcell enhancement). The resulting framework, which relies on Lagrange duality, has immediate applications for guiding, understanding, and improving inverse design.

17:50 : Invited talk
Optimization Paradigms for Metasurface Inverse-design
Eric B. Whiting, Sawyer D. Campbell, Ronald P. Jenkins, Pingjuan L. Werner, Douglas H. Werner
The Pennsylvania State University (USA)

Metasurfaces with high efficiency and broadband performance hold the potential to revolutionize optical system design. However, advanced optimization methods and design techniques must be exploited to achieve performances that surpass conventional optical systems. In this paper, two metasurface design strategies are presented and their advantages and challenges discussed. The first strategy is based on topology optimization while the second is based on deep learning. finally, we discuss how hybridizing these techniques could surpass the state-of-the-art for metasurface optimization.

18:10 : Invited talk
Metasurface optimization based on coupled mode theory
Zongfu Yu
University of Wisconsin Madison (USA)

We develop a coupled mode theory to model metasurfaces. It is much faster than full-wave solvers. Combined with the adjoint method, we show that the CMT approach can be used to efficiently design complex metasurfaces for a variety of functions. As an example, we also demonstrate thermal holograms based on metasurfaces.

18:30 : Invited talk
Bounds on achievable performance via Lagrange duality
Guillermo Angeris, Jelena Vuckovic, Stephen Boyd
Stanford University (USA)

While the problem of designing physical devices is computationally hard, heuristics such as inverse design are often successful in finding designs with very good performance. A natural question to ask is: how does the performance of these designs compare to the best possible performance? We show how to construct a convex (and therefore easily solvable) problem whose optimal value bounds the best achievable performance, for a given objective. We also provide a proof of the NP-hardness of physical design.

18:50 : An efficient global optimization technique based on statistical learning for highly efficient metasurface designs at visible regime
Mahmoud M. R. Elsawy, Patrice Genevet, Régis Duvigneau, Stéphane Lanteri
Université Cote d'Azur (France)

The object of this contribution is twofold. first, we present a brief review of the common inverse design techniques in the field of metasurfaces. Second, we present a global optimization technique based on statistical learning for optimizing highly efficient metasurface devices. Using our method, a light deflection metasurface with efficiency reaching 85 $\%$ for both TM and TE polarizations has been realized at the visible regime.

17:30 - 19:05 — Christian Huygens Room

Session 2A33

Non-Hermitian Photonics: From Plasmonics, and Metamaterials, to Topological and Quantum systems

Organized by: Konstantinos Makris, Manas Kulkarni, Ramy El-Ganainy and Sahin Ozdemir

Chaired by: Konstantinos Makris, Manas Kulkarni, Ramy El-Ganainy and Sahin Ozdemir

17:30 : Invited talk
Encircling exceptional points as a non-Hermitian extension of rapid adiabatic passage
Alexander Schumer[1], Juraj Feilhauer[2], Jorg Doppler[1], Alexei A. Mailybaev[3], Julian Bohm[4], Ulrich Kuhl[4], Nimrod Moiseyev[5], Stefan Rotter[1]
[1] *Vienna University of Technology (Austria),* [2] *Slovak Academy of Sciences (Slovak Republic),* [3] *Instituto Nacional de Matematica Pura e Aplicada - IMPA (Brazil),* [4] *Université côte d'Azur (France),* [5] *Technion-Israel Institute of Technology (Israel)*

Coherent transfer of population between different energy levels is a key task in quantum mechanical applications with rapid adiabatic passage (RAP) being one of the most prominent protocols. By reframing the underlying process in the domain of non-Hermitian physics through adding a variable amount of loss we theoretically and experimentally disclose a fundamental connection between the symmetric state flip of RAP and the asymmetric state transfer when encircling an exceptional point (EP).

17:50 : Correlations of indistinguishable photons in quantum walks under broken PT-symmetry
Friederike U. J. Klauck[1], Markus Grafe[2], Matthias Heinrich[1], Alexander Szameit[1]
[1] *University of Rostock (Germany),* [2] *Fraunhofer-Institut fur Angewandte Optik und Feinmechanik (Germany)*

We experimentally study the correlations of indistinguishable photons in a one-dimensional Parity-Time (PT) symmetric quantum walk. Introducing a symmetric loss distribution in a homogeneous waveguide system gives rise to PT-symmetry, which drastically alters the correlations of indistinguishable photons, giving rise to e.g. correlations similar to distinguishable classical particles in a random walk.

18:05 : Invited talk
Optical thermodynamics in topological Haldane lattices
Pawel Jung[1], **Midya Parto**[1], **Fan Wu**[1], **Yuzhou Liu**[2], **Mercedeh Khajavikhan**[2], **Demetrios Christodoulides**[1]
[1] *University of Central Florida (USA),* [2] *University of Southern California (USA)*

In this work we show that a nonlinear topological Haldane lattice exhibits a number of interesting optical thermodynamic properties such a heat capacity function with the Schottky anomaly effect or a metastable responses leading to different final temperatures and chemical potentials at equilibrium condition.

18:25 : Invited talk
Topological band theory for dissipative quantum and classical systems
Simon Lieu
University of Maryland (USA)

I will present a topological classification applicable to dissipative systems governed by a general class of Lindblad master equations. The dynamical matrix governing the equations of motion for "quadratic Lindbladians"must belong to one of ten non-Hermitian Bernard-LeClair symmetry classes which reduce to the Altland-Zirnbauer classes in the closed limit. These symmetries protect edge modes in a dissipative environment. I will discuss current efforts to extend the formalism to bosonic systems, with relevant implications for topological photonics.

18:45 : Invited talk
Non-Hermitian Constant Intensity Waves
Ziad H. Musslimani
Florida State University (USA)

In this talk, we will discuss recent progress related to linear and nonlinear wave propagation in non Hermitian media. We shall show that under certain circumstances, a constant intensity waves can propagate in non-homogeneous media with imposed parity-time symmetry. Such waves can even exists in a complex non-hermitian random media.

17:30 - 19:00 — Augustin Fresnel Room

Session 2A34

Light-matter interactions in new materials and meta-architectures

Organized by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

Chaired by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

17:30 : Invited talk
Gyrotropic responses mediated by Jahn-Teller and spin-orbit interactions
Blai Casals, Gervasi Herranz
Institute for Materials Science of Barcelona ICMAB-CSIC (Spain)

We report on gyrotropic responses mediated by Jahn-Teller polarons and spin-orbit coupling, whereby a spin-reversal is induced by photons and can be selectively detected by circularly polarized light. We show that spin-reversal requires the concurrent action of orthorhombic and tetragonal Jahn-Teller modes, which opens up a pathway to explore quantum effects that involve spin and orbital degrees of freedom. Additionally, our results provide an original, general pathway towards the generation of magnetic-responsive gyrotropic responses.

17:50 : Invited talk

Conformable metasurfaces for linear and nonlinear applications

Jialing Xiao, Usenobong Akpan, Sebastian A. Schulz, Andrea Di Falco
University of St Andrews (United Kingdom)

Conformable metasurfaces retain all the properties of their rigid counterparts, while presenting unique opportunities both in terms of optical properties and applications. Here we discuss our most recent results in imaging, antenna design and nonlinear optics based on them.

18:10 : Invited talk

Interplay of Absorption and Scattering in Metal-Dielectric Cylinders: Extreme Refractive Index Limits and Response Sensitivities

Nasim Mohammadi Estakhri[1], Nooshin M. Estakhri[2]
[1] *Chapman University (USA),* [2] *University of Michigan, Ann Arbor (USA)*

Structural singularities such as sharp corners are linked to extreme field concentration and presence of hotspots in small particles, typically resulting in enhanced absorption efficiency. In this work we analytically investigate the interplay of absorption and scattering in a class of singular metal-dielectric particles in the shape of joined half-cylinders. We will discuss the role of refractive indices and material loss in the response of these geometries and pinpoint several phenomena including resonant scattering/absorption, sharp absorption response, and invisibility.

18:30 : Keynote talk

Tunable Light-Matter Coupling in Low-Dimensional Excitonic Semiconductors

Deep Jariwala
University of Pennsylvania (USA)

The focus of this talk will be light-matter interactions in excitonic semiconductors such as 2D transition metal dichalcogenides, carbon nanotubes as well as hybrid perovskites. Results on exciton-plasmon coupling and exciton-polariton formation under reflectance and emission spectroscopy will be presented.

17:30 - 18:45 — Ibn Al-Haytham Room

Session 2A35

Exotic Meta-media - Time-dependent, Nonlocal and Other Novel Responses

Organized by: Martin McCall, Jonathan Gratus and Paul Kinsler

Chaired by: Martin McCall, Jonathan Gratus and Paul Kinsler

17:30 : Invited talk

Boundary Conditions in Time Dependent Materials

Rebecca Seviour[1], Johnathan Gratus[2], Paul Kinsler[2]
[1] *University of Huddersfield (United Kingdom),* [2] *Lancaster University (United Kingdom)*

Currently there is growing interest in time dependent media, materials whose constitutive relations change with time. Most models assume the permittivity and permeability are constant. This approach works if both permittivity and permeability are real. However to model lossy materials it is natural to consider complex constitutive relations. In this paper we demonstrate with a simple example that such a model is unphysical in a time dependent media. Furthermore we derive the correct boundary conditions necessary dependent media.

17:50 : Invited talk

Twisted light in metamaterials with spatial dispersion

Alexey Tishchenko
National Research Nuclear University "MEPhI"(Russia)

We report on the theoretical studies of generation of non-classical light carrying orbital angular momentum and its propagation in metamaterials with spatial dispersion. The distinctive feature of such a light is a longitudinal component of the field, the effect of which increases the degree of its twisting. As a mechanism of

generation of such waves we consider Cherenkov radiation. We also discuss the role of relativistic effects and causality principle in terms of the phenomena considered.

18:10 : Invited talk
Refraction and Impedance Patterns in Moving Media
Zoe-Lise Deck-Leger[1], **Christophe Caloz**[2]
[1] *Polytechnique Montréal (Canada),* [2] *Katholieke Universiteit Leuven (Canada)*

To study wave propagation in moving media, a common graphical tool is the isofrequency diagram, or refractive index pattern, which provides the direction and the velocity of a wave. Here, we complement this tool with the impedance pattern, which provides information on the wave amplitude. We argue that the two tools should be used on an equal footing when solving problems involving moving media.

18:30 : Nonlocal and Soft Plasmonics in Ion Particle Chains
Christin David
Friedrich-Schiller-University Jena (Germany)

Plasmonic properties of charged fluids are discussed via a two-fluid model. Additional degrees of freedom (ion mass, ion charge, concentration) allow a wide range of bulk resonance frequencies. In analogy to metal nanoparticles, I include commonly neglected charge interactions thus deriving analytic expressions for nonlocal Mie coefficients for coupled charge carriers. Plasmonic ionic response is studied in microspheres and chains and compared to metal systems.

17:30 - 18:25 — Gaston Floquet Room

Session 2A36

Parity-Time and quasi-normal modes in Photonics, Plasmonics, Acoustics

Organized by: Anatole Lupu and Henri Benisty

Chaired by: Anatole Lupu and Henri Benisty

17:30 : Invited talk
Non-Hermitian Properties of Photonic and Plasmonic Nanocavities
Christophe Sauvan
Institut d'Optique - CNRS (France)

Photonic and plasmonic nanocavities confine light at a deep subwavelength scale but generally suffer from large radiative leakage and absorption losses. As a consequence, nanocavities are inherently non-Hermitian systems. The non-Hermitian character provides them peculiar properties, especially regarding the control of spontaneous emission. Quasinormal modes, i.e., natural eigenmodes of a non-Hermitian system, are the adequate tools for describing light-matter interactions in photonic and plasmonic nanocavities.

17:50 : Invited talk
Supersymmetric signatures of topological states
Henning Schomerus
Lancaster University (United Kingdom)

By contrasting settings of photonic graphene, topological CROWs, quantum walks, and mesoscopic devices, I clarify the physical consequences of supersymmetry, which is hidden behind the mathematical description of topological effects in chiral systems but leaves concrete signatures in experimentally observable states.

18:10 : Observation of exceptional arcs and cusp singularities in acoustics
Kun Ding[1], **Weiyuan Tang**[1], **Xue Jiang**[1], **Yi-Xin Xiao**[2], **Zhao-Qing Zhang**[2], **C. T. Chan**[2], **Guancong Ma**[1]
[1] *Imperial College London (United Kingdom),* [2] *Hong Kong University of Science and Technology (China)*

The known fact that two singularities can be connected by geometric arcs reveals fundamental excitations of materials, such as Fermi arc and the associated interface modes. However, it is still an open question that which geometric structure connects two higher-order exceptional points (EPs). In this work, by using the

ternary acoustic cavity system we demonstrate both theoretically and experimentally that it is the exceptional arc that bridges two order-3 EPs and produces the cusp singularity at the order-3 EP.

17:30 - 18:15 — Lawrence Bragg Room

Session 2A37

Machine learning for metamaterials and metasurfaces

Organized by: Mohamed Bakr and Willie Padilla

Chaired by: Mohamed Bakr and Willie Padilla

17:30 : Nanostructured Materials for artificial neural computing
Zongfu Yu
University of Wisconsin Madison (USA)

We show that optical waves passing through a nanophotonic medium can perform artificial neural computing. Complex information, such as an image, is encoded in the wave front of in-put light. The medium continuously transforms the wave front to realize highly sophisticated computing tasks such as image recognition.

17:45 : Unidirectional non-Hermitian structures on demand by genetic optimization
Waqas W. Ahmed[1], Ramon Herrero[2], Muriel Botey[2], Ying Wu[1], Kestutis Staliunas[2]
[1] *King Abdullah University of Science and Technology (Saudi Arabia),* [2] *Universitat Politècnica de Catalunya (UPC) (Spain)*

We propose a general approach based on genetic optimization to achieve 'on demand' asymmetric light transport in non-Hermitian structures. The procedure allows designing the imaginary part of permittivity distribution from a given (arbitrary) real part of permittivity distribution for asymmetric reflection in a broad range of frequencies. We demonstrate a selective spectral unidirectional light reflection control, in such a way that it switches from left to right (or vice versa) with varying operating frequency.

18:00 : Inverse design of one-dimensional multilayer structure by artificial neural network
Kirill Safronov, Vladimir Bessonov, Andrey Fedyanin
Lomonosov Moscow State University (Russia)

We propose new method of artificial neural network (ANN) training for inverse design of multilayer structures. The ANN directly learns to predict parameters of structures by target reflection spectrum. The transfer matrix method is employed during ANN training to overcome the issue of non-unique inverse problem solution. We compare the target spectrum with spectrum of structure predicted by ANN during the training process. Our ANN is able to design structures with a target spectrum with high fidelity.

18:15 - 18:55 — Lawrence Bragg Room

Session 2A38

Opto-mechanical metasurfaces and metamaterials

Organized by: Dibakar Roy Chowdhury, Jayasri Dontabhaktuni and Harshavardhan Kalathur

Chaired by: Dibakar Roy Chowdhury, Jayasri Dontabhaktuni and Harshavardhan Kalathur

18:15 : Invited talk
Extreme Nonreciprocity in Spatio-Temporally Modulated Metasurfaces
Andrew E. Cardin, Sinhara R. Silva, Shai. R. Vardeny, Wilton J. M. Kort-Kamp, Hou-Tong Chen, Diego A. R. Dalvit, Abul K. Azad

Los Alamos National Laboratory (USA)

In this work, we experimentally demonstrate a spatio-temporal modulated reflectarray metasurface that is capable of dynamical wave-front shaping and nonreciprocal propagation of free space electromagnetic radiation. Arbitrary space-time phase distributions in reflection are achieved by embedding electronically modulated varactors into the resonators of our metasurface. Our experimental measurements reveal on-demand wave-front control of frequency conversion processes. We also demonstrate maximum violation of Lorentz reciprocity in both beam steering due to nonreciprocal excitation of surface waves along the metasurface.

18:35 : Invited talk
Applications of metasurface optics in atom-based sensors
Jennifer T. Choy
University of Wisconsin - Madison (USA)

The discrete energies of atomic electrons and the ability to probe and control them with light have enabled a host of precision measurements. In this talk, I will describe the benefits and challenges of state-of-the-art atomic sensors via examples of atom-based inertial sensors and magnetometers. I will discuss critical developments in nanophotonic engineering that are needed to improve the utility and performance of these sensors and our progress towards developing a photonic-integrated atomic magnetometer using metasurface polarization optics.

17:30 - 18:30 — Rene Descartes Room

Session 2A39

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

17:30 : Invited talk
Strong light-matter coupling: new trends in plexitonics
Yury P. Rakovich
CSIC-UPV/EHU (Spain)

We report our recent results of research of plasmon-exciton interactions in Au and Au@Ag nanorods integrated with J-aggregates of cyanine dyes is presented. In all developed hybrid nanostructures, the anti-crossing behavior of the hybridized modes can be tracked using a number of spectroscopic techniques such as absorption, photoluminescence (PL) and magnetic circular dichroism (MCD).

17:50 : Invited talk
In situ electron energy-loss spectroscopy for nanoscale optical devices
Soren Raza
Technical University of Denmark (Denmark)

We demonstrate dynamic electromechanical control over the coupling of a gold nanodisk dimer all the way to sub-nanometer-sized gaps. By combining EELS with in situ electrical actuation, we can follow the evolution of the gap size and optical properties with unprecedented spatial and spectral resolution. We show that our electromechanical device can be used as light modulator with low power consumption and high speed.

18:10 : Invited talk
Plasmochromic dynamic color modulation
Eric Hopmann, Abdulhakem Y. Elezzabi
University of Alberta (Canada)

Plasmonic-electrochromic ("plasmochromic") devices have recently gained significant interest in the research community, due to the dynamic optical properties of the electrochromic material and the high sensitivity of the plasmon to its dielectric environment. Here, plasmochromic resonance modulation is used to create a dynamic reflective display with a wavelength modulation of over 64 nm in the visible range. The results are verified via FDTD analysis, which projects a maximum wavelength shift of over 100 nm.

18:00 - 19:00 — Tutorial Room

Session 2A40

Conference Tutorials II

Organized by: Ishwar Aggarwal

18:00 : Tutorial
Design of Active and Reconfigurable Metasurfaces
Harry A. Atwater
California Institute of Technology (USA)

A grand challenge for nanophotonics is the realization of comprehensively tunable metasurface nanoantenna arrays enabling dynamic, active control of the key constitutive properties of light – amplitude, phase, wavevector and polarization. Achieving this will open new photonics applications in phased-array optical beam steering, visible light modulation for communications and thermal radiation management. This tutorial will discuss design approaches for active and reconfigurable metasurfaces including selection of active materials, electromagnetic design and time-modulation. We will also survey status and outlook for electronically tunable and reconfigurable plasmonic and all-dielectric metasurfaces, whose elements are arbitrarily reprogrammable, enabling a wide array of functions, including steering, focusing, and frequency multiplexing of scattered radiation.

Thursday 22nd July, 2021

09:00 - 11:00 — Victor Veselago Room

Session 3A1

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

09:00 : Invited talk

Enhancing the second harmonic generation from nonlinear crystals by plasmonic nanostructures

Emre Gurdal, Anke Horneber, Nadim Shaqqura, Alfred J. Meixner, Dieter P. Kern, Dai Zhang, Monika Fleischer

Eberhard Karls Universitat Tubingen (Germany)

Frequency conversion plays an important role in non-linear optics, and nonlinear crystals are frequently employed as optical elements. However, processes such as frequency doubling by second harmonic generation (SHG) still suffer from limited conversion efficiency. Here we combine commercial LiNbO3 crystals with plasmonic nanoparticles in order to boost SHG from the crystal surface. The interaction is fundamentally investigated for a single nanodisc, and maximized by a dense array of particles.

09:20 : Invited talk

Hybrid metal/organics in strong coupling for switchable fluorescence

Joel Bellessa, Jean-Michel Benoit, Clementine Symonds, Kevin Chevrier

University Lyon 1 (France)

In this paper we evidence bifunctionality properties, photochromaticity and luminescence, in strongly coupled optical system. Strong coupling has been achieved between an electromagnetic mode, the surface plasmon, and two organic emitters: a J-aggregate, known for its high absorption properties and a photochromic material which absorption can be optically switched on and off. We show that the emission of the aggregated dye can be reversibly shifted between the activated and desactivated form of the photochromic material.

09:40 : Invited talk

Sensing Spatial Coherence of Light with Planar Metallic Metamaterials

Thomas Frank, Oleksandr Buchnev, Tamsin Cookson, Malgosia Kaczmarek, Pavlos Lagoudakis, Vassili A. Fedotov

University of Southampton (United Kingdom)

We report on a discovery that homogeneous metallic non-diffracting metamaterials of a certain type respond differently to spatially coherent and incoherent light, enabling robust speckle-free discrimination between different degrees of coherence. The effect has no direct analogue in natural optical materials and may find applications in compact metadevices enhancing imaging, vision, detection, communication and metrology.

10:00 : Invited talk

Measurement of the quantum geometric tensor and of the anomalous Hall drift in a continuous medium

Antonio Gianfrate[1], Olivier Bleu[2], Lorenzo Dominici[1], Vincenzo Ardizzone[1], Milena De Giorgi[1], Dario Ballarini[1], Giovanni Lerario[1], Kenneth West[3], Loren N. Pfeiffer[3], Dmitry Solnyshkov[2], Daniele Sanvitto[1], Guillaume Malpuech[2]

[1] *CNR NANOTEC (Italy),* [2] *Université Clermont Auvergne (France),* [3] *Princeton University (USA)*

We report a direct measurement of the Berry curvature and of the quantum metric in a 2D continuous photonic medium. The measured components of the quantum geometric tensor are used for a quantitative prediction of the anomalous Hall effect, which is then confirmed by experiment.

10:20 : Invited talk

Chiroptically Active Metal Nanoparticles Inherently composed of Atomic Chirality

Zhifeng Huang
Hong Kong Baptist University (Hong Kong)

Chiral nanoparticles (CNPs), fabricated by glancing angle deposition with fast substrate rotation, are composed of chiral lattices at the atomic scale and bear optical activity (OA). The chiral lattices at their surfaces give rise to enantiospecific adsorption of molecules, resulting in enantioselective amplification of molecular OA and asymmetric photocatalysis. These results provide an insight into developing potential applications of functional CNPs in the practically vital fields of enantiodifferentiation, bio-detection, bio-imaging and asymmetric catalysis.

10:40 : Invited talk
Measurement of saturable absorption behavior of CNT/PDMS coated high-Q microcavity towards mode-locking of Er-doped laser
Riku Imamura, Keigo Nagashima, Takasumi Tanabe
Keio University (Japan)

We developed a method for coating CNT/PDMS on a high-Q silica microcavity that allows us to obtain saturable absorption that is needed for building a microresonator based Er-doped mode-locked laser.

09:00 - 11:00 — Allan Boardman Room

Session 3A2

Symposium I: Hybrid Nanomaterials and Metastructures for Photonics, Sensing and Energy

Organized by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

Chaired by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

09:00 : Invited talk
Photo-thermoelectric Conversion of Plasmonic Nanohole Array
Wakana Kubo
Tokyo University of Agriculture and Technology (Japan)

We report a plasmonic photodetector consisting of an ultra-thin silver film with nanohole array, whose photodetection mechanism is based on thermoelectric conversion triggered by plasmonic local heating. The contribution of plasmonic local heating to thermoelectric conversion is verified experimentally and numerically, in order to discuss the mechanisms governing light detection. This plasmonic photo-thermoelectric conversion will be available for improving the power conversion of thermoelectric device by creating thermal gradients across the device.

09:20 : Invited talk
Accelerated Foerster-Type Nonradiative Energy Transfer of Semiconductor Nanocrystals
Pedro Ludwig Hernandez Martinez[1], **Hilmi Volkan Demir**[2]
[1]*Nanyang Technological University Singapore (Singapore),* [2]*Nanyang Technological University (Singapore)*

We present a review of accelerated nonradiative energy transfer employing semiconductor nanocrystals by using either the plasmonic effect or the dimensionality effect. We start with enhanced Foerster-type resonance energy transfer (FRET) accelerated via selective plasmon mediation between NCs. Next, we present FRET accelerated via dimensionality and show the ultrafast exciton transfer from a thin film of CdSe/CdS nanoplatelets to a MoS2 monolayer. Our findings indicate that such accelerated FRET of NCs holds great promise for optical sensing and photodetection

09:40 : Keynote talk
Chiral Near-field Properties of Plasmonic Nanomaterials: Imaging and Functions
Hiromi Okamoto
Institute for Molecular Science (Japan)

Based on near-field and far-field optical activity microscopic methods, we showed gold nanostructures give

highly enhanced optical activity in the local sites near the nanostructures (∼102 times enhancement as compared with macroscopic optical activity), even in achiral nanostructures, suggesting strong chiral near-field interaction. The strong chiral near-field interaction gives highly circularly polarized luminescence from achiral dye molecules adsorbed on chiral gold nanostructures. We also demonstrate dissymmetry of optical trapping behavior of chiral gold nanoparticles.

10:10 : Invited talk
Novel nonlinear chiroptical effects
Ventsislav K. Valev
University of Bath (United Kingdom)

Following our recent discovery of the Hyper Rayleigh Scattering Optical Activity (HRS OA), further developments and related, new nonlinear chiroptical effects are reported. The new effects enable chiroptical characterization in tiny volumes of illumination.

10:30 : Up- and Down-Conversions Coupled to Surface Lattice Resonances in Aluminum Periodic Arrays
Shunsuke Murai, Yuan Gao, Katsuhisa Tanaka
Kyoto University (Japan)

Aluminum is known to plasmonic up to ultraviolet frequencies, while its plasmonic performance in near infrared is less explored. In this study, for the purpose of verifying that aluminum is working effectively from ultraviolet to near infrared regions, we fabricate arrays of aluminum nanocylinders with the lattice periodicity ranging from 150 to 980 nm. Amplified up- and down-conversion are exhibited by coupling emitters on top of the lattice that resonates at their excitation wavelengths.

10:45 : Nanoscale ZnO growth via localized photothermal energy conversion in plasmonic nanoantennas
Christophe Pin[1], Hideki Fujiwara[2], Tatsuro Suzuki[1], Keiji Sasaki[1]
[1] *Hokkaido University (Japan),* [2] *Hokkai-Gakuen University (Japan)*

In this work, a new bottom-up nanofabrication method based on plasmon-assisted hydrothermal synthesis (PAHS) is demonstrated. By engineering the polarization-dependent optical and thermal properties of a gold nanogap antenna, we achieve localized growth of a few-nm-thick zinc oxide (ZnO) layer at the targeted central position of the antenna. It is numerically shown that the back-action of the material synthesis on the plasmonic resonance can be used to achieve self-limited material growth.

09:00 - 11:00 — Tatsuo Itho Room

Session 3A3
Thermal Plasmonics and Metamaterials for Environment and Energy Application

Organized by: Junichi Takahara and Kotaro Kajikawa

Chaired by: Junichi Takahara

09:00 : Invited talk
Thermophotovoltaic system using a photonic crystal emitter operating above 1300K
Masahiro Suemitsu, Takashi Asano, Susumu Noda
Kyoto University (Japan)

We demonstrate a thermophotovoltaic system comprising a selective thermal emitters based on Si rod-type photonic crystal and InGaAs photovoltaic cells. A high heat to electricity conversion efficiency of 11.2 % is obtained, which is 1.65 times higher than the previously reported record value(6.8 %).

09:20 : Invited talk
Development of Surface Plasmon Resonance Enhanced Photo-electric Conversion Devices
Akira Baba, Chutiparn Lertvachirapaiboon, Kazunari Shinbo, Keizo Kato

Niigata University (Japan)

Surface plasmon resonance (SPR) phenomena have attracted considerable attention since many years because of the extremely strong enhancement and confinement of electric fields near metal surfaces. Recently, we have studied grating-coupled surface plasmon-based multiple plasmonic structures for electric-field enhanced organic device applications such as biosensors and photo-electric conversion devices. In this presentation, we will introduce our recent progress on surface plasmon enhanced photo-electric conversion systems.

09:40 : Invited talk

Thermal Emissions by Tamm Plasmon Polaritons

Kuo-Ping Chen[1], Zih-Ying Yang[2], Satoshi Ishii[2], Takahiro Yokoyama[2], Thang Duy Dao[2], Mao-Guo Sun[1], Pavel S. Pankin[3], Ivan V. Timofeev[3], Tadaaki Nagao[2]

[1]National Chiao Tung University (Taiwan), [2]National Institute for Materials Science (NIMS) (Japan), [3]Siberian Federal University (Russia)

Infrared wavelength selective thermal emission based on Tamm plasmon is experimentally demonstrated with ultra-sharp resonance. The excitation of Tamm plasmon polaritons (TPPs) occurs between a distributed Bragg reflector (DBR) and a metal film. The proposed structure could achieve twice higher Q-factor for the measured emissivity comparing to typical plasmonic thermal emitters.

10:00 : Invited talk

Titanium nitride for light-to-heat and heat-to-light conversions

Satoshi Ishii[1], Manpreet Kaur[1], Shunsuke Murai[2], Shinya Goya[2], Makoto Higashino[2], Katsuhisa Tanaka[2], Zih-Ying Yang[3], Kuo-Ping Chen[3], Tadaaki Nagao[1]

[1]National Institute for Materials Science (NIMS) (Japan), [2]Kyoto University (Japan), [3]National Chiao Tung University (Taiwan)

Metallic properties of titanium nitride (TiN) can be used to enhance non-radiative decay processes in the nanoscale. In the current paper, our recent works using TiN nanostructures for photothermal heating and wavelength-selective thermal emissions are reviewed.

10:20 : Invited talk

Waveguiding of Radiation from Silica Plates

Kotaro Kajikawa

School of Engineering, Tokyo Institute of Technology (Japan)

Passive radiative cooling (RC) refrigerates objects, such as solar panels, without using electricity. In this paper, improvement of RC ability of a silica plate with silica particles is demonstrated. This is due to the decrease in the reflectivity at the flat surface of a silica plate at the mid-infrared wavelength range. It is also shown that handling of RC is possible using aluminum waveguide. This expands the possibilities of the method for various applications.

10:40 : Invited talk

Metasurfaces for Heat-Shield Windows and Their Near-Infrared Reflectance Control using Movable Thin-films

Yoshiaki Kanamori

Tohoku University (Japan)

Metasurfaces for heat-shield windows which transmit visible wavelengths and reflect near-infrared (NIR) wavelengths for sun light were designed and fabricated. Moreover, by combining the metasurfaces with movable thin-films, reflectance switchable filters that could change reflectance at NIR wavelengths whereas there was little change in visible wavelengths were designed. It can be expected to be used as smart glasses that control transmittance of the thermal wavelengths in summer and winter.

09:00 - 10:50 — Christian Huygens Room

Session 3A4

Non-Hermitian Photonics: From Plasmonics, and Metamaterials, to Topological and Quantum systems

Organized by: Konstantinos Makris, Manas Kulkarni, Ramy El-Ganainy and Sahin Ozdemir

Chaired by: Konstantinos Makris, Manas Kulkarni, Ramy El-Ganainy and Sahin Ozdemir

09:00 : Invited talk
Topological field Theory far from Equilibrium
Federico Tonielli[1], Jan C. Budich[2], Alex Altland[1], Sebastian Diehl[1]
[1] *University of Cologne (Germany),* [2] *Technische Universitat Dresden (Germany)*

Observable properties of topological quantum matter are often described by topological field theories. We extend this principle beyond thermal equilibrium by studying the response to an external gauge field of a driven-dissipative system with a Chern insulator stationary state. We show that, if the particle number is conserved, such response is described at late times by the same abelian Chern-Simons theory valid at thermal equilibrium. As a corollary, we pre- dict chiral edge modes stabilized by a dissipative bulk.

09:20 : Instability of nonreciprocal non-Hermitian media
Henning Schomerus
Lancaster University (United Kingdom)

I develop a general response theory for non-conserving optical, mechanical or acoustic media in which Hermiticity is broken due to nonreciprocal effects. I show that these media undergo an instability phase transition when they display the non-Hermitian skin effect. This makes these media ideally suited as sensors and amplifiers.

09:35 : Hamiltonian and Liouvillian exceptional points in noisy non-Hermitian systems
Jan Wiersig
Otto-von-Guericke-Universitaet (Germany)

We discuss the relation between Hamiltonian and Liouvillian exceptional points (EPs) in non-Hermitian systems with parametric noise. Conclusions for the performance of EP-based sensors are drawn.

09:50 : Topological bulk lasing mode in non-Hermitian kagome lattices
Stephan Wong, Sang Soon Oh
Cardiff University (United Kingdom)

Due its robustness against disorders, topological edge modes have been used to enhance the performances of lasers. The quality of topological lasers can be further improved using novel topological phases in one-dimensional non-Hermitian photonic topological insulators. Here, we demonstrate topologically protected mode extended over the bulk of a two-dimensional kagome lattice with rhombus geometry by introducing an imaginary gauge field. This show the possibility to achieve a phase-locked broad-area topological lasers in two-dimensional lattices.

10:05 : Quantum interference with bianisotropic metasurface
Hong Liang[1], Kai Ming Lau[1], Wai Chun Wong[1], Shengwang Du[2], Wing Yim Tam[1], Jensen Li[1]
[1] *The Hong Kong University of Science and Technology (Hong Kong),* [2] *The University of Texas at Dallas (USA)*

We investigate how quantum interference can be controlled by using bianisotropic metasurfaces. By considering a bianisotropic metasurface with material loss from metal, we numerically demonstrate an asymmetric control of quantum interference with an origin from an exceptional point of the metasurface in the classical regime.

10:20 : Keynote talk
Rigorous modal analysis of micro and nanoresonators
Philippe Lalanne
Université de Bordeaux (France)

Microcavities and nanoresonators are characterized by their modes, called quasinormal modes because they are the eigensolutions of non-Hermitian operators. In contrast to waveguide and free space modes,

quasinormal modes are not well documented in the literature, although nanoresonances play an essential role in current developments in nanophotonics. The reason is due to mathematical difficulties, see details in the recent review article [LPR 12, 1700113 (2018)], and especially to the fact that quasinormal modes cannot be normalized by their energy.

09:00 - 11:00 — Augustin Fresnel Room

Session 3A5

Light-matter interactions in new materials and meta-architectures

Organized by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

Chaired by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

09:00 : Invited talk

Near-field spectroscopy of Photonic Crystal Cavities characterized by Fano Local Density of States

Francesca Intonti[1], Nicoletta Granchi[1], Matteo Ciardi[2], Dario Balestri[1], Daniele Pellegrino[3], Francesco Pagliano[4], Andrei Silov[4], Frank van Otten[4], Tong Wu[5], Kevin Vynck[5], Philippe Lalanne[5], Andrea fiore[4], Massimo Gurioli[1]

[1] *University of Florence - LENS (Italy),* [2] *University of Florence (Italy),* [3] *Eindhoven University of Technology (The Netherlands),* [4] *Eindhoven University of Technology and nanoPHAB (The Netherlands),* [5] *LP2N-Institut d'Optique (France)*

Microcavities and nanoresonators are characterized by their quality factors and mode volumes. While Q is unambiguously defined, there are questions on V and, in particular, on its complex-valued character, whose imaginary part is linked to the non-Hermitian nature of open systems. The complex modal volume implies a deep revision of the Purcell factor expression, with counterintuitive effects, such as non-Lorentzian local density of states. We experimentally demonstrate these predictions in coupled photonic crystal cavities with low optical losses.

09:20 : Invited talk

Enhanced light coupling into nanostructured arrays as an enabler for advanced Raman-based metrology

Thomas Nuytten[1], Janusz Bogdanowicz[1], Andrzej Gawlik[1], Yusuke Oniki[1], Karine Kenis[1], Yusuke Muraki[2], Anne L. Charley[1], Claudia Fleischmann[1], Ingrid De Wolf[1], Paul van der Heide[1]

[1] *IMEC (Belgium),* [2] *Tokyo Electron Technology Solutions (Japan)*

Recently it was found that when coherent polarized light impinges on nanoscale grating-like structures, the coupling of light is exceptionally sensitive to the parameters that define the periodicity, i.e. the pitch and CD. This effect re-opens the possibility for Raman spectroscopy to excel as a non-contact probe for phase, stress but also CD of nanostructured devices far beyond the diffraction limit. We will show how Raman spectroscopy is able to probe stress, composition, critical dimension, etc. at the nanoscale.

09:40 : Invited talk

Adaptive Photonic Metamaterials by Self-Assembly of Liquid Crystals in Nanoporous Solids

Kathrin Sentker[1], Mark Busch[1], Andriy V. Kityk[2], Patrick Huber[1]

[1] *Hamburg University of Technology (Germany),* [2] *Czestochowa University of Technology (Poland)*

Self-organized multiscale porosity in terms of precise pore size, shape, and orientation has been achieved in many base materials. Here we exemplify that in combination with self-assembly of liquid crystals in pore space this provides particularly versatile pathways for the engineering of photonic metamaterials. We present temperature-dependent structural characterizations of the thermodynamic and structural self-assembly behavior of the liquid crystals confined in nanoporous solids in combination with experiments on the resulting effective optics of the hybrid materials.

10:00 : Invited talk

Exciton Resonance Tuning in Atomically-Thin Optical Elements

Jorik van de Groep[1], **Jung-Hwan Song**[2], **Qitong Li**[2], **Umberto Celano**[3], **Pieter G. Kik**[4], **Mark L. Brongersma**[2]
[1] *University of Amsterdam (The Netherlands),* [2] *Stanford University (USA),* [3] *IMEC Leuven (Belgium),* [4] *University of Central Florida (USA)*

Next-generation flat optics require dynamic control over optical functionalities. We demonstrate accurate control over light scattering by exciton resonances in monolayer WS2 by controlling the dielectric environment of the monolayer. Next, we demonstrate actively-tunable and atomically-thin optical lenses by carving them directly out of monolayer WS2. Using ion-liquid gating to dynamically manipulate the material's exciton resonance we show active modulation of the focal intensity.

10:20 : Invited talk
Frequency tripling via sum-frequency generation by single AlGaAs nanocylinders
Attilio Zilli[1], **Davide Rocco**[2], **Marco finazzi**[1], **Lamberto Duò**[1], **Carlo Gigli**[3], **Giuseppe Marino**[3], **Giuseppe Leo**[3], **Costantino De Angelis**[2], **Michele Celebrano**[1]
[1] *Politecnico di Milano (Italy),* [2] *University of Brescia (Italy),* [3] *Université de Paris (France)*

Dielectric nano-antennas of III-V semiconductor materials offer a strong nonlinear response governed by the electro-magnetic resonances of the system. We investigate individual AlGaAs cylinders and observe efficient sum-frequency generation by mixing an input beam of telecom frequency with its second harmonic. Our work highlights a convenient frequency-tripling pathway at the nanoscale based on the second-order nonlinearity of the material.

10:40 : Invited talk
Linear and Nonlinear Interactions with Epsilon-Near-Zero Metamaterials
Humeyra Caglayan
Tampere University (finland)

We have investigated both the linear and nonlinear effects of a multilayer epsilon-near-zero metamaterial.

09:00 - 10:45 — Ibn Al-Haytham Room

Session 3A6

Metasurfaces, flat optics, FSS and HIS

09:00 : Double caustic beams generation based on metasurface
Rui Chen[1], **Yi Zhou**[1], **Wenjie Chen**[1], **Ruipin Chen**[2], **Naeem Iqbal**[1], **Yungui Ma**[1]
[1] *Zhejiang University (China),* [2] *Zhejiang Sci-Tech University (China)*

Metasurfaces provide a powerful tool to manipulate electromagnetic waves in multidimensions and can easily integrate multiple functions into a single device. Here, we propose a compact method to generate double caustic beams by polarization multiplexing. The output can be dynamically tuned by changing the incident polarization. The research result has potential applications in dynamic beam shaping, biosensing and microparticle manipulation.

09:15 : Ultra-Broadband Blackbody-Like Perfect Absorber
Ze-An Chen[1], **Yu-Jung Lu**[2], **Ta-Jen Yen**[1]
[1] *National Tsing Hua University (Taiwan),* [2] *Academia Sinica (Taiwan)*

We propose a multilayer perfect absorber with omnidirectional independence, polarization independence and broadband response simultaneously. The proposed perfect absorber possesses higher than 80 % absorption within 900-1900 nm wavelength range and incidence angle independent in both s- and p-polarization which are consistence in both simulation and experiment. Most importantly, we can easily fabricate large area sample due to the lithography-free fabrication process which is more practical in real application.

09:30 : Broadband Metasurfaces through first Order Approximation of Surface Impedances
Ashif Aminulloh Fathnan, Andreas E. Olk, David A. Powell
University of New South Wales (Australia)

We introduce a procedure to realize a broadband metasurface based on inductance-capacitance (LC) reso-

nators in series and parallel configurations. To broaden the operational bandwidth, the L and C values must be obtained by a first order approximation method considering the equivalent surface impedance and its derivative in the center frequency. We verified our method using experiment in millimeter-wave frequencies and show that the broadband metasurface achieves a significant increase of bandwidth (more than 80 % increase) compared to a single-frequency design.

09:45 : Transparent Metamaterial Absorber with Broadband RCS Reduction for Solar Arrays
Shunliu Jiang, Xiangkun Kong, Lingqi Kong, Qi Wang
Nanjing University of Aeronautics and Astronautics (China)

In this paper, a metamaterial absorber with simultaneous high optical transparency and broadband microwave absorption is presented. By tailoring the reflection response of meta-atoms, 80 % absorption performance from 6.8GHz to 18GHz. In the meantime, by employing transparent substrates, including indium tin oxide and anti-reflection glass, good optical transmittance are obtained. The absorptivity of the proposed metamaterial absorber is simulated and measured experimentally. Both results demonstrate highly consistence which verify the reliability of our design for use in solar arrays.

10:00 : High-efficiency anomalous reflection with acoustic metasurfaces
Xing-Feng Zhu, Jie Yao, Qi Wei, Da-Jian Wu, Xiao-Jun Liu
Nanjing Normal University (China)

We present the theoretical, numerical and experimental investigations on the high-efficiency anomalous reflection (AR) by acoustic metasurfaces (AMs). Closed-end tubes are designed to realize the passive-lossless AM. A considerable improvement of 31 % in the overall efficiency is confirmed in the AM compared to that based on generalized reflection law when the incident and reflected angles are 0° and 75° respectively. Experimental results are in accord with finite element simulations and theoretical analyses.

10:15 : Influence on wide-angle metasurface doublet due to different types of all-dielectric metasurface
Hidemitsu Toba, Hidetsugu Takagi, Michio Ohashi, Katsura Otaki
Nikon Corporation (Japan)

We compare the incidence angle dependence among three types of subwavelength structures in all-dielectric polarization-insensitive metasurfaces through electromagnetic simulations. As a result, the waveguide-type metasurface was found to be most suitable for wide-angle metalenses. Therefore, we performed full-wave electromagnetic simulations of cylindrical doublet metalenses to compare the influence on lens performance between micropostttype metasurfaces and waveguide-type metasurfaces. These results indicate that the waveguide-type metasurface improves the lens performance of the doublet lens previously introduced.

10:30 : Polarization-reconfigurable Water-based Frequency Selective Rasorber With Four Operating Modes
Ling Qi Kong, Xiang Kun Kong, Shun Liu Jiang, Xiang Xi Yan, Lei Xing
Nanjing University of Aeronautics and Astronautics (China)

A multifunctional polarization-reconfigurable water-based frequency-selective rasorber (FSR) was presented in this communication. The proposed structure is composed of a cross-gap FSS and two layers of parallel water channels fixed on the opposite sides of a dielectric substrate, where the layers are arranged in orthogonal polarization with independent control of the top and bottom channels. The novelty of the design lies in its reconfigurability between four different operating modes by injecting water or not in the top and bottom channels.

09:00 - 11:00 — Gaston Floquet Room

Session 3A7

Topology in photonic crystals, metamaterials, and metasurfaces: physics and design

Organized by: Yang Li and Benfeng Bai

Chaired by: Yang Li and Benfeng Bai

09:00 : Invited talk
Broadband Optical Modulation via Dual Epsilon-Near-Zero Modes
Qin Chen, Long Wen
Jinan University (China)

Epsilon-near-zero (ENZ) modes have attracted extensive interests due to its ultrasmall mode volume resulting in extremely strong light-matter interaction. However, the operation bandwidth is usually limited by the ENZ wavelength range. In this paper, broadband optical modulation is demonstrated by dual ENZ modes in a TCOs/dielectric/silicon nanotrench configuration. Different types of carrier accumulations in both silicon and TCOs give rise to the ENZ states at two wavelengths determined by the carrier densities.

09:20 : Invited talk
Discovering Topological Surface States of Dirac Points In An Acoustic Crystal
Hengbin Cheng[1], Yixin Sha[2], Rongjuan Liu[1], Chen Fang[1], Ling Lu[1]
[1] *Chinese Academy of Sciences (China),* [2] *Peking University (China)*

Dirac materials, unlike the Weyl materials, have not been found in experiments to support intrinsic topological surface states, as the surface arcs in existing systems are unstable against symmetry-preserving perturbations. Utilizing the proposed glide and time-reversal symmetries, we theoretically design and experimentally verify an acoustic crystal of two frequency-isolated three-dimensional Dirac points with four branched gapless helicoid surface states.

09:40 : Invited talk
Active optical metasurfaces based on VO2 phase change materials
Tongtong Kang, Zheng Peng, Min Xiao, Jun Qin, Longjiang Deng, Lei Bi
University of Electronic Science and Technology (China)

We report several active metasurface devices based on VO2 hybrid metaatoms. We show several prototype devices for ultrafast optical modulation, optical switch and flexible active photonic device applications.

10:00 : Invited talk
Observation of a Topological Edge State in the X-ray Band
Zhiwei Guo, Haitao Jiang, Yong Sun, Yunhui Li, Hong Chen
Tongji University (China)

In this work, the topological edge state is theoretically proposed and experimentally demonstrated at the interface of two kinds of photonic crystals having different bandgap topological characteristics in the X-ray regime. Remarkably, this topologically protected edge state is immune to the thickness disorder as long as the zero-average-effective-mass condition is satisfied. The results extend the topological photonics to the X-ray regime and paves the way for the development of novel X-ray optics such as high-resolution X-ray filters/monochromators.

10:20 : Invited talk
Realization of Photonic Charge-2 Dirac Point by Engineering Super-modes in Topological Superlattices
Mengying Hu[1], Kun Ding[2], Tong Qiao[1], Xi Jiang[1], Qiang Wang[1], Shining Zhu[1], Hui Liu[1]
[1] *Nanjing University (China),* [2] *Imperial College London (United Kingdom)*

We report on the first experimental realization of the charge-2 Dirac point in the visible region by deliberately engineering hybrid topological states called super-modes in a 1-D optical superlattice system with two additional synthetic dimensions. Utilizing direct reflection and transmission measurements, we also show the approach to manipulating two spawned Weyl points that are identically charged in synthetic space. Moreover, topological end modes uniquely resulting from the charge-2 Dirac point can be delicately controlled within

truncated superlattice samples.

10:40 : Invited talk
Generation of optical phase vortex beams by momentum-space polarization vortices around BIC
Lei Shi
Fudan University (China)

An optical phase vortex (OV) is a beam with spiral wave front and screw phase dislocation. Here we theoretically and experimentally realized a novel but easy approach to generate OVs. This new class of OV generators operates in the momentum space, meaning that there is no real-space center of structure. Any even order of OV, which is actually a quasi-non-diffractive high-order quasi-Bessel beam, at any desired working wavelength could be achieved in principle.

09:00 - 09:40 — Lawrence Bragg Room

Session 3A8

Opto-mechanical metasurfaces and metamaterials

Organized by: Dibakar Roy Chowdhury, Jayasri Dontabhaktuni and Harshavardhan Kalathur

Chaired by: Dibakar Roy Chowdhury, Jayasri Dontabhaktuni and Harshavardhan Kalathur

09:00 : Invited talk
Nanophotonic platforms for light emitting metasurfaces
Naresh Kumar Emani, Saurabh Kishen, Jinal Tapar
Indian Institute of Technology Hyderabad (India)

In this talk we focus on two major research themes (a) Two-dimensional PT (parity-time-reversal) symmetric metamaterials and (b) Improvement of light emission efficiency in electrically driven MIM tunnel junctions. We will briefly discuss our key findings given below.

09:20 : Invited talk
Concept of mechanically tunable terahertz circular polarizer
Xiaolong You, Christophe Fumeaux, Withawat Withayachumnankul
The University of Adelaide (Australia)

A terahertz circular polarizer is developed based on an extended analytical method incorporating network analysis and genetic algorithm. Simulations reveal that the design enables a 15-dB extinction ratio relative bandwidth of 14.3 %. The center operation frequency can be tuned by design from 220 to 330 GHz through varying the spacer thicknesses. The performance suggests the potential of the structure to function as a mechanically tunable terahertz circular polarizer, provided that air gaps are included in between the dielectric spacers.

09:40 - 11:00 — Lawrence Bragg Room

Session 3A9

Integrated lithium-niobate photonics: structures, devices, systems and applications

Organized by: Xianfeng Chen and Yang Li

Chaired by: Xianfeng Chen and Yang Li

09:40 : Invited talk

Spectral engineering of LNOI waveguides: from ultranarrow to broadband
Katia Gallo, Alessandro Prencipe, Halvor Fergestad
KTH - Royal Institute of Technology (Sweden)

The development of advanced nano-structuring capabilities on LNOI is paving the way towards low-footprint photonic circuits leveraging appealing functionalities of LiNbO3 for ultrafast signal processing and wavelength conversion. In the talk we shall present ultra-narrow bandpass and multi-resonance filters, implemented with phase-shifted Bragg gratings in LNOI photonic wires. We shall also discuss designs of dispersion engineered waveguides for broadband second harmonic generation, appealing for wavelength multicasting, ultrashort pulse frequency doubling and enhanced quadratic cascading in the telecom band.

10:00 : Invited talk
Periodically poled lithium niobate microdisk resonators on insulator
Zhenzhong Hao, Li Zhang, Qiang Luo, Xiaomei Gao, Wenbo Mao, Feng Gao, Fang Bo, Guoquan Zhang, Jingjun Xu
Nankai University (China)

We developed a fabrication process of periodically poledlithium niobate (PPLN) photonic devices on insulator with the assistance of piezo response force microscopy(PFM), providing us the abilities to fabricate micro-domain structures down to the scale of several tens of nm. The efficient harmonic generation with d33, the largest nonlinear coefficient of LN, utilized in the whole microcavity and high-order harmonic generations were demonstrated in PPLN microcavities with single and double spacial periods, respectively. The work paves the way to achieve efficient frequency conversion in on-chip LN photonic devices.

10:20 : Invited talk
Lithium niobate thin films for integrated optics
Hui Hu
Shandong University (China)

Lithium niobate (LN) thin film on a low refractive index silica (SiO2) cladding layer (LN on insulator, LNOI) has been fabricated by using ion implantation and wafer bonding technologies. The LN thin film has the excellent physical properties. The high refractive index contrast can enable ultra-small waveguides, facilitating the development of ultra-compact photonic integrated devices and circuits. The progress of LNOI material is reviewed.

10:40 : Invited talk
Fabrication of lithium niobate on insulator device for nonlinear frequency conversion
Shijie Liu, Yuanlin Zheng, Xianfeng Chen
Shanghai Jiaotong University (China)

We have done a lot of work on the lithium niobate microdisk, including fabrication, second harmonic generation, cascading quadratic processes and high-Q exterior WGM. We will also present an on-chip Solctype device based on transverse electro-optic effect at the telecommunication wavelengths in a periodically poled lithium niobate on insulator ridge waveguide. Cascaded sum-frequency generation and electro-optic polarization coupling is also observed in this device.

09:00 - 09:55 — Rene Descartes Room

Session 3A10

Topology in photonic crystals, metamaterials, and metasurfaces: physics and design

Organized by: Yang Li and Benfeng Bai

Chaired by: Yang Li and Benfeng Bai

09:00 : Invited talk
Unidirectional Radiation Enabled by Topological Charge Evolution

Xuefan Yin[1], **Jicheng Jin**[2], **Marin Soljacic**[3], **Chao Peng**[1], **Bo Zhen**[2]
[1] *Peking University (China),* [2] *University of Pennsylvania (USA),* [3] *MIT (USA)*

In this work, it is demonstrated that the unidirectional emission can be realized even without mirrors on the bottom, by manipulating the evolution of topological charges in the polarization field. The observed up-down asymmetry ratio is up to 27.7 dB. Our work provides an effective approach to achieve unidirectional radiation without the need for mirrors and represents a vivid example of applying topological principles to design and optimize the photonic devices.

09:20 : Invited talk
Recent experimental and theoretical developments in synthetic dimensions including the frequency axis of light
Luqi Yuan[1], **Avik Dutt**[2], **Qian Lin**[2], **Momchil Minkov**[2], **Meng Xiao**[3], **Mingpu Qin**[1], **Xianfeng Chen**[1], **Shanhui Fan**[2]
[1] *Shanghai Jiao Tong University (China),* [2] *Stanford University (USA),* [3] *Wuhan University (China)*

The field of synthetic dimensions in photonics is under rapid development and is interesting to the broad community. Recent efforts on the synthetic space including the frequency axis of light have been largely explored with their linear properties. Moreover, we show the possibility of creating an effective nonlinear Bose-Hubbard Hamiltonian with local interactions along the frequency dimension. Our works trigger further interests in synthetic dimensions and point towards potential possibilities for manipulating internal degrees freedom of light.

09:40 : Discovery of topological metamaterials by symmetry relaxation and smooth topological indicators
Cyrill Bösch[1], **Tena Dubcek**[1], **Frank Schindler**[2], **Andreas fichtner**[1], **Marc Serra-Garcia**[1]
[1] *ETH Zurich (Switzerland),* [2] *Princeton University (USA)*

Topological metamaterials have emerged, both, to realize and study topological physics, as well as in the search of practical applications. However, systematically designing topological metamaterials has remained a challenge due to the very nature of topology, its robustness. Here we present a novel approach, based on symmetry relaxation and gradient methods that, for the first time, tunes the topological index directly. We have successfully applied the method to design both conventional and higher-order topological systems.

09:55 - 11:10 — Rene Descartes Room

Session 3A11
Plasmonics and nano-optics

09:55 : Self-assembly of Cubic Plasmonic Nanoparticles for Unnaturally High Refractive Index at Optical Frequency
Ji-Hyeok Huh, Jaewon Lee, Seungwoo Lee
Korea University (Korea)

In this work, we demonstrate self-assembly of the cubic plasmonic nanoparticles superlattice to achieve unnaturally high refractive index (n) at optical frequencies (i.e., near infrared (NIR)). first, we (i) synthesize highly uniform gold nanocubes (Au NCs) and then, (ii) self-assemble them into 2D superlattice. Through this self-assembly approach, Au NC superlattices are successfully obtained over the large area, exhibiting n of 6.4 at the resonant (NIR), which were not reached thus far.

10:10 : Conformal Symmetry and its Application to Plasmon Localization
Lizhen Lu[1], **Emanuele Galiffi**[2], **Kun Ding**[2], **Tianyu Dong**[1], **Xikui Ma**[1], **John Pendry**[2]
[1] *Xi'an Jiaotong University (China),* [2] *Imperial College London (United Kingdom)*

Transformation optics provides us an elegant and insightful way to harness symmetry. By leveraging the conformal symmetry, we propose a general strategy for the design of light-stopping plasmonic metasurfaces, which is able to localize surface plasmon polaritons in space longer than their plasmon lifetime. Furthermore, by investigating the properties of conformal symmetry, we stress its significance in tuning the band struc-

tures of subwavelength plasmonic systems, which can be extended to a variety of applications via different conformal transformations.

10:25 : High-Performance Transparent Conducting Electrodes (TCEs) Using Plasmonic Wires
Chin-Chien Chung[1], Rober J. Visser[2], B.Leo Kwak[2], Hyunsung Bang[2], Chung-Chia Chen[2], Wan-Yu Lin[2], Ta-Jen Yen[1]
[1] *National Tsing-Hua University (Taiwan),* [2] *Corporate CTO Office (USA)*

We design the structure of metal to control the plasma frequency at near infrared region. We obtain highly transparent metal within visible regime. Accompanied by the intrinsically low resistivity, we achieve high performance transparent conducting electrode based on the structure-designed metal. We integrate the TCE with OLED. Our device demonstrates high current density and luminance.

10:40 : In-situ imaging the Hygroscopic Growth of Individual Aerosol Nanoparticles using a Surface-Sensitive Photonic Microscope
Yan Kuai, D. G. Zhang
University of Science and Technology of China (China)

The water uptake of ultrafine atmospheric aerosols affect public health, atmospheric chemistry and the Earth's climate. In this paper we present a surface-sensitive photonic microscope that was proposed to measure the hygroscopic growth of single aerosol nanoparticle, and for the first time recorded the phase change process with the good time resolution. These time-resolved measurements will be critical for understanding of the interactions between water vapor and aerosols that significantly affect chemical reactivity, aging, and atmospheric composition.

10:55 : Anapole-assisted Dark Plasmon Excitation in Hollow Silicon Disk
Kang Du[1], Pei Li[1], Heng Wang[2], Kun Gao[1], Ting Mei[1]
[1] *Northwestern Polytechnical University (China),* [2] *School of Physical Science and Technology, Northwestern Polytechnical University, Xi'an, China (China)*

The anapole mode excited by silicon nanodisk provides a mildly enhanced and low loss field while exhibiting non-radiating property. Due to the special nature of anapole mode, much research has focused on the light-matter interaction engineered by the anapole-assisted enhanced field. Here, based on the anapole mode in hollow silicon disk, we proposed a new method for exciting dark plasmon mode.

Coffee Break and Exhibit Inspection

Session 3P1

Poster session V

11:00 - 11:40

P1: Temperature effects on the surface plasmon resonance in Bi2O3-Ag eutectic composite
Kamil Szlachetko[1], Monika Tomczyk[1], Marcin Raczkiewicz[2], Dorota Pawlak[2]
[1] *University of Warsaw (Poland),* [2] *Lukasiewicz Research Network (Poland)*

The temperature dependences of spectral position, width and intensity of the surface plasmons of metallic Ag nanoparticles in Bi2O3-Ag were studied in the temperature range from ambient conditions to 500 °C. The increase of temperature leads to nonlinear and appreciable redshift and broadening of the localized surface plasmon resonance band in Bi2O3-Ag. The observed dependences were compared with temperature dependences and simple Drude-Lorentz approximation.

P2: Optical studies of the Bi2ZnOB2O6 glass doped with silver nanoparticles and Er3+ ions
Katarzyna Sadecka[1], Andrzej Klos[1], Barbara Surma[1], Ryszard Piramidowicz[2], Anna Jusza[2], Krzysztof Anders[2], Dorota A. Pawlak[1]
[1] *Institute of Electronic Materials Technology (Poland),* [2] *Warsaw University of Technology (Poland)*

This work reports the optical studies of the Bi2ZnOB2O6 (BZB) glass doped with silver nanoparticles (nAg) and Er3+ ions. The material was obtained by modified micropulling down method. LSPR of nAg resonance in BZB glass occurs at 620 nm. Annealing of BZB:nAg:Er3+ material at 450 °C caused two fold increase of the

luminescence at 1532 nm.

P3: Linear and nonlinear effects in metamaterials based on magnonic crystals and semiconductors
Oleg Matveev, Dmitrii Romanenko, Maria Morozova
Saratov State University (Russia)

We present results of theoretical and experimental investigations of propagation of spin waves in heterostructure magnonic crystal - semiconductor wafer. Direct current in semiconductor wafer allows to control of band gap characteristics in such structure. In addition, we observed propagating of soliton-like pulses and electrical control of number and velocity of such pulses.

P4: Quadriwave lateral shearing interferometry for characterization of metasurfaces
Samira Khadir[1], Daniel Andrén[2], Ruggero Verre[3], Qinghua Song[4], Serge Monneret[3], Patrice Genevet[4], Mickael Käll[2], Guillaume Baffou[3]
[1] *Centre de recherche sur l'hétéroepitaxie et ses applications (CRHEA) (France),* [2] *Chalmers University of Technology (Sweden),* [3] *Institut Fresnel (France),* [4] *Université Cote d'Azur (France)*

We report in this work a new investigation method for characterization, inspection and diagnosis of metasurface based devices. It is an optical method based on quadriwave lateral shearing interferometry (QLSI), a high-resolution, quantitative phase microscopy technique capable of mapping both the intensity and phase profiles of a light beam. In this study, we focus on conventional metalenses and linear phase-gradient metasurfaces, including resonant and geometrical Pantcharatnam-Berry phase metasurfaces.

P5: Radiative rate enhancement in spherical lead halide perovskite particle for optical cooling
Pavel Tonkaev, George Zograf, Sergey Makarov
ITMO University (Russia)

Recent studies demonstrated high interest in halide perovskite materials for different applications including solar cells, light emitting diodes and many others. Moreover, it was revealed that perovskite film can be cooled by laser irradiation due to effective up-conversion. In the other hand, particle supporting Mie-resonance can enhance spontaneous emission rate, which has crucial importance for optical cooling. In this work we theoretically reveal enhancement of radiative rate emission in single spherical lead halide perovskite particle.

P6: Boosting Faraday rotation in a one-dimensional coupled resonator magnetoplasmonic structure made by silica matrix doped with magnetic nanoparticles
Mounir Bouras, Nassim Dermeche, Ahmed Kahlouche, Abdesselam Hocini
University of Mohamed Boudiaf of M'sila (Algeria)

The present study aimed to evaluate the magneto-optic Faraday rotation of one-dimensional coupled resonator magnetoplasmonic structure by metallic cover layer in each resonator. To this purpose, transfer matrix method was used where crystals made by SiO2/ZrO2 or SiO2/TiO2 doped with magnetic nanoparticles using sol-gel process in different configurations and use and 10-nm thick gold or silver layer for the excitation of the surface plasmon polaritons (SPPs).

P7: Doping an Eutectic 3D Material to get Plasmonics Effects
Miguel Cuerva[1], Marcin Raczkiewicz2[2], Dorota A. Pawlak[2]
[1] *University of Warsaw (Poland),* [2] *Institute of Electronic Materials Technology (Poland)*

Due to the development of new manufacturing technologies and the increasing availability of nanomaterials, plasmonic has become an emerging field of photonic research. Although the fabrication of metal elements has already been widely demonstrated, the development of three-dimensional plasmonic materials progresses slowly. Hence, we report the development of a eutectic compound that incorporates nanometric silver to provide surface plasmonic resonance around 600 nm

P8: Competing Interactions in Doped Rare-earth Manganites nanostructural system
Wiqar Hussain Shah
International Islamic University (Pakistan)

The Structural, magnetic and transport behavior of La1-xCaxMnO3+(x=0.48, 0.50, 0.52 and 0.55 and =0.015) compositions close to charge ordering, was studied through XRD, resistivity, DC magnetization and AC susceptibility measurements. With time and thermal cycling (T<300 K) there is an irreversible transformation of the low-temperature phase from a partially ferromagnetic and metallic to one that is less ferromagnetic and highly resistive.

P9: Underground Wireless Communication based on Metamaterial enhanced Magnetic Induction for Smart Irrigation
B. Raagavi, Sugumar Swathi, S. Sakthivel M.
Anna university (India)

An appropriate communication strategy for transmitting underground information to achieve agricultural automation is based on magnetic induction techniques. To increase the transmission distance range, metamaterial is introduced in-between the magnetic induction coils. The proposed Permeability Negative Metamaterial is placed between the magnetic induction coils to increase the received power strength. In future, metamaterial enhanced magnetic induction based underground wireless communication system can be used effectively to transmit the sensor data to the farmer's mobile app using cloud.

P10: Quantum Dot Enhanced Performance of Plasmonic Refractive Index sensor for Cancer Detection
Simitha S.[1], Jesly Jacob[2], Vibin Ipe Thomas[1]
[1] *CMS college, Kottayam (India),* [2] *Assumption College, Changanacherry (India)*

This paper proposes a novel biosensor based on quantum dots for detection of diseased cells. We aim to report a simple, label-free and enhanced figure of merit (FOM) plasmonic cavity model which has potential to exhibit sensitivity and selectivity for detecting cancer cells. Proposed structure is studied using finite Element Method. The structure with and without quantum dot is optimized to make biosensor with better performance. The proposed sensor with dot shows improved sensitivity and FOM.

P11: Modelling Nanostructures for Application in Plasmonically Enhanced Hot-Electron Devices
Noushin Dolati, Kylie Catchpole, Thomas White, Fiona J. Beck
Australian National University (ANU) (Australia)

Here we design nanostructures to have strong, tunable absorption in Au nanoparticles (NPs) for application in hot electron devices. Using 2D optical modelling, we show the tunability in small NPs absorption in the infrared spectral region by mounting NPs on grating structures. We demonstrate that introducing a thin dielectric layer between the NPs and the gratings can increase the absorption in the NPs up to 3.8-fold.

P12: Spectroscopic properties of freshwater diatoms frustules: a type of self-assembled nanoporous silica structures
Ankur Gogoi[1], Jayur Tisso[1], Partha P. Nath[2], Gazi A. Ahmed[2]
[1] *Jagannath Barooah College (India),* [2] *Tezpur University (India)*

Fourier Transform Infrared (FTIR) and photoluminescence (PL) spectroscopy of nanoporous silica frustules of various fresh water diatoms were conducted to investigate their potential as unique silica structures for photonic and luminescent device applications. The internal chemical structure of the frustules was revealed by the FTIR spectra which showed characteristic peaks for diatom biosilica, such as bending of siloxane (Si-O-Si) and stretching of silanol (Si-OH) groups.

P13: Spatial filtering Enabled Spectral Characterization of a Photonic Crystal Cavity
Shilpi Gupta, Naresh Sharma, Govind Kumar, R. Vijaya
IIT Kanpur (India)

We experimentally demonstrate a technique to estimate resonance wavelength of a photonic crystal cavity by spatially filtering a laser beam incident at different angles and imaging the transmitted beam profile. The transmitted beam exhibits two features: an annular beam and a central spot. Under the resonance condition, the two features overlap spatially. We develop calibration curves for the spectral characterization using transfer matrix method. The estimates from our cost-efficient technique match well with measurements obtained using a spectrophotometer.

P14: A Double layer SRR Meta- material Absorber for C band applications
Shubhangi Mahendra Palekar, Neeraj Rao
VNIT Nagpur (India)

Metamaterials have great applications in microwave circuits. They are used to improve antenna parameters. Metamaterial absorber absorb maximum of incident radiation in certain frequency band. Here, a circular and a square split ring resonator are individually designed. Then a circular split ring is placed over a square ring resonator and the combined structure is simulated. Simulation results shows that the obtained structure is a double layer meta material absorber for C band applications.

P15: Acousto-Optic Coupling in a fishbone Phoxonic Nanobeam Cavity
Jin-Chen Hsu[1], Chieh-Chun Chang[2], Tzy-Rong Lin[2]
[1] *National Yunlin University of Science and Technology (Taiwan),* [2] *National Taiwan Ocean University (Taiwan)*

Acousto-optic (AO) coupling in a fishbone phoxonic nanobeam cavity is studied. Because of the dual photonic and phononic bandgaps in the structure, optical and acoustic modes can be confined in the gradient phoxonic cavity. with the spatial overlap between the modes, AO coupling can be enhanced. Boosting of the interface effect mainly contributes to the AO coupling enhancement. Here we calculate the phoxonic band structures, cavity modes, and coupling rates to discuss the AO coupling in the proposed system.

P16: Acoustic Imaging by an Three-dimensional Acoustic Meta-lens
Sang-Hoon Kim, Jung-Woo Kim
Mokpo National Maritime University (Korea)

A 3D acoustic Luneburg lens or an acoustic Luneburg ball of the radius of 60 mm was manufactured by a 3D printer. The focusing ability was simulated by the commercial FEM analysis program, COMSOL Multiphysics simulator and measured in experiment, too. Acoustic plane wave of5 15 kHz were applied to the lens and the acoustic gain was obtained. The 3D imaging by the Luneburg ball is presented.

P17: The power law behaviors of Q factor for impedance matched zero index media
Liangsheng Li, Yong Zhu, Jie Gao, Hongcheng Yin, Yansong Wang
Science and Technology on Electromagnetic Scattering Laboratory (China)

The reflectivity, resonance width and eigen-frequency have been investigated for a single slab with the impedance matched zero index models. Moreover, we found that the resonance widths exhibit the power law behaviors in the vicinity of BICs. Typically, for the IMZI model, the resonance widths are proportional to theta. finally, the power law behaviors of real frequency are the sub-leading term, and the exponent values are dependent on the model.

P18: Active photo-tuning of resonances in symmetric THz Fano Metasurfaces
Subhajit Karmakar[1], Ravendra Kumar Varshney[1], Dibakar Roy Chowdhury[2]
[1] *Indian Institute of Technology (IIT) (India),* [2] *Mahindra Ecole Centrale (India)*

We theoretically propose active photo tuning of different resonances in symmetric terahertz (THz) Fanometasurfaces. With the increase of substrate conductivity,dipole dip and transparency peak get depleted keeping Fanodip intact. The relative effect of photo-tuning also depends on lattice periodicity. Such results can be extremely beneficial to several futuristic metaphotonics applications inTHz regime.

P19: A transparent fluoropolymer for daytime radiative cooling
Hoang ThiThanhTam[1], Mana Toma[1], Takayuki Okamoto[1], Mio Hidaka[2], Kensuke Fujii[3], Yasuhiro Kuwana[3], Kotaro Kajikawa[1]
[1] *Tokyo Institute of Technology (Japan),* [2] *AGC Inc. (Japan),* [3] *AGC Inc., Marunouchi (Japan)*

We introduce the fluoropolymer film that is transparent 98 % of incident sunlight and emitting 97 % in the atmospheric transparency window. By the indoor experiment, the 50 μm-thick fluoropolymer film cools to 7.6 °C below ambient air temperature. Moreover, the paint-ability and the weather-resistant allow to apply the fluoropolymer film in the wide range of human life.

P20: Towards Spiral-Like Cold Atom States
Vasileios E. Lembessis, Anwar Al Rsheed, Andreas Lyras, Omar M. Aldossary
King Saud University (Saudi Arabia)

We solve the Schroedinger equation and calculate the wave functions and corresponding energies for a Rb atom trapped by the optical dipole potential created by the interaction of the atom and a Helical Optical Tube (HOT) light field. The wave functions have a twisted spiral-like spatial structure. Our work paves the way for the generation of twisted atom laser beams.

P21: Polarization-insensitive broadband achromatic metalens from ultraviolet to near-infrared regions
Yue Li, Zheng Peng, Lei Bi, Longjiang Deng, Jianliang Xie, Bo Peng
University of Electronic Science and Technology of China (China)

Metalenses have presented extraordinary abilities in compact optical devices. However, there still remains a challenge of achromatic aberration, which limits the usefulness for broadband applications. Here, we propose a polarization-insensitive metalens made of multi-layer metasurfaces to achieve a broadband achromatic

focusing from ultraviolet to near-infrared regions. A wavelength-independent focal length is achieved at 355, 450 and 785 nm with focusing efficiencies of 12 %, 30 % and 58 %. Our work provides a general approach in applications of various flat achromatic devices.

11:40 - 12:40 — Victor Veselago Room

Session 3A12

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

11:40 : Invited talk
High-performance Ultraviolet Metasurfaces using Wide-bandgap Dielectrics
Cheng Zhang[1], Wenqi Zhu[2], Junyeob Song[2], Qingbin Fan[3], Lu Chen[2], Jinghui Yang[2], Ting Xu[3], Amit Agrawal[2], Henri J. Lezec[2]
[1] *Huazhong University of Science and Technology (China),* [2] *National Institute of Standards and Technology (USA),* [3] *Nanjing University (China)*

I will present our recent efforts of achieving low-loss ultraviolet metasurfaces using wide-bandgap dielectric materials. The demonstrated devices perform an array of representative wave-front shaping functionalities and operate down to the deep-UV regime, with efficiencies up to 72 %.

12:00 : Invited talk
Suppressing Exciton Interaction in 2D Semiconductors
Jeongyong Kim
Sungkyunkwan University (Korea)

We investigated the effect of metal screening of exciton interaction in 1L-WS2 by using Au film substrate spaced by hBN layer. We found that PL lifetime and QY can be greatly enhanced at high exciton density, which we attributed to the suppressed exciton-exciton annihilation due to screened exciton interaction.

12:20 : Invited talk
Flat Nonlinear Optics with Intersubband Polaritonic Metasurfaces
Daeik Kim[1], Jaeyeon Yu[1], Inyong Hwang[1], Seongjin Park[1], Hyeongju Chung[1], Frederic Demmerle[2], Gerhard Boehm[2], Mikhail A. Belkin[2], Jongwon Lee[1]
[1] *Ulsan National Institute of Science and Technology (Korea),* [2] *Technische Universitat Munchen (Germany)*

In this work we report electrically tunable nonlinear response and giant nonlinear circular dichroisms based on intersubband polaritonic nonlinear metasurfaces. Experimentally we achieved 0.75 μm of the second harmonic generation spectral peak tuning and over 86 % of nonlinear circular dichroisms around 10 μm wavelength.

11:40 - 12:45 — Allan Boardman Room

Session 3A13

Symposium I: Hybrid Nanomaterials and Metastructures for Photonics, Sensing and Energy

Organized by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

Chaired by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

11:40 : Keynote talk
Photophysical Effects behind the Efficiency of Hot Electron Injection in Plasmon-Assisted Catalysis
Miguel A. Correa-Duarte

Universidade de Vigo (Spain)

The present study examines the joint role played by the morphology and composition of plasmonic nanoparticles in their photosensitizing capabilities. The critical influence of these parameters is evidenced by the effect of Au and core-shell Au@Ag nanorods on a TiO2-driven photochemical probe reaction. In this case, the use of the bimetallic composites leads to a remarkable increase in the photocatalytic activity of the semiconductor compared to that found for the monometallic Au sensitizers.

12:10 : Invited talk
Excitons in nanophotonic landscapes: fluctuating, diffusing, annihilating
Alberto G. Curto
Eindhoven University of Technology (The Netherlands)

Excitons in atomically thin semiconductors are sensitive to their electronic and photonic environments. Here we present our experimental and theoretical results on the fluctuation, diffusion, and annihilation of excitons near nanostructures. Our results have implications for exciton-based sensors, single-photon sources based on 2D materials, and efficient and high-power light-emitting devices.

12:30 : New Synthesis Approach of Aluminum Nanoparticles for UV- Plasmonics
Marion Castilla[1], Silvère Schuermans[1], Florian Lamaze[1], Thomas Maurer[1], Gil Markovich[2], Uri Hananel[2], Davy Gérard[1], Jérome Martin[1], Jérome Plain[1], Julien Proust[1]
[1] *University of Technology of Troyes (UTT) (France),* [2] *Tel-Aviv University (Israel)*

Aluminum nanostructures appear to be a good alternative to gold or silver because of the broad range of their plasmonic resonances (UV to NIR) and their reduced cost. In this paper, we present a new way of synthesis of Al nanoparticles based on sonochemistry and solvothermal reaction. By tuning the solvothermal reaction time, we are able to control the size of the nanoparticles between 10 to 100nm. finally, we will present some applications of such nanoparticles.

11:40 - 12:50 — Tatsuo Itho Room

Session 3A14

Thermal Plasmonics and Metamaterials for Environment and Energy Application

Organized by: Junichi Takahara and Kotaro Kajikawa

Chaired by: Kotaro Kajikawa

11:40 : Invited talk
A Suspended TiN film for Thermal Plasmonics Platform
Kentaro Iwami, Yuta Otome, Azusa Tahara, Satoshi Ikezawa
Tokyo University of Agriculture and Technology (Japan)

In this study, A suspended TiN film on a silicon substrate is studied and fabricated through sputter deposition and sacrificial layer etching. The balance of the internal stresses between TiN and sacrificial layers are found to be important to release suspended film structures. Modification of spectral reflectance was demonstrated by introducing hole array structure to the suspended film.

12:00 : Omnidirectional Narrow-band Thermal Radiation by Mie Resonator on Refractory Metal
Junichi Takahara, Akihiro Kawano
Osaka University (Japan)

We propose a narrow-band thermal radiation emitter based on a refractory metasurface composed of Germanium Mie resonators on Tungsten substrate. The metasurface radiates omnidirectional thermal radiation with a quality-value Q of 132 and an emissivity of 0.96 at mid-IR range in simulation. We fabricated the device and demonstrated Q∼34 at 7.8micron in experiment.

12:15 : Invited talk
New polaritonic materials for radiative cooling

Juliana Jaramillo[1], G. L. Whitworth[2], A. Francone[2], N. Kehagias[2], P. D. Garcia[2], C. M. Sotomayor-Torres[2]
[1] *Universitat Autonoma de Barcelona (Spain),* [2] *Catalan Institute of Nanoscience and Nanotechnolog (Spain)*

Implementing sustainable methods for cooling is urgent, due to global warming and the high energy consumption associated to modern cooling technologies. In this work, we propose novel polaritonic materials as an energy-efficient solution for above-ambient radiative cooling.

12:35 : Heat transfer regulation for textiles using tailorable metallic wires
Muluneh G. Abebe[1], Eric Khousakoun[2], Jeremy Odent[1], Jean-Marie Raquez[1], Sylvain Desprez[2], Bjorn Maes[1]
[1] *University of Mons (Belgium),* [2] *Materia Nova (Belgium)*

We numerically explore the concept of dynamic, switchable infrared transmittance using electromagnetic and thermal calculations, for the use of smart, temperature regulating textiles. We discuss the photonic effects of metallic and shape-memory-polymer coated mono-filaments on the temperature dependent transmittance of the textile fabric.

11:40 - 12:25 — Christian Huygens Room

Session 3A15

Non-Hermitian Photonics: From Plasmonics, and Metamaterials, to Topological and Quantum systems

Organized by: Konstantinos Makris, Manas Kulkarni, Ramy El-Ganainy and Sahin Ozdemir

Chaired by: Konstantinos Makris, Manas Kulkarni, Ramy El-Ganainy and Sahin Ozdemir

11:40 : Nonlinear spectral singularities and tunable laser with 2D material coating
Hamed Ghaemidizicheh
Lancaster University (United Kingdom)

We investigate the application of nonlinear spectral singularity in a nonlinear non-Hermitian optical system consisting of an infinite planar slab that is coated with a two-dimensional (2D) material in arbitrary transverse electric TE and transverse magnetic TM modes. Here, we explore the effects of placing the slab between Graphene and 2D Weyl semimetal sheets. We show that the 2D material introduces additional physical parameters for tuning the output intensity of the laser.

11:55 : Quantum correlations in PT-symmetric systems
Federico Roccati[1], Salvatore Lorenzo[1], Gioacchino Massimo Palma[1], Gabriel Landi[2], Matteo Brunelli[3], Francesco Ciccarello[1]
[1] *Università degli Studi di Palermo (Italy),* [2] *Universidade de Sao Paulo (Brazil),* [3] *(United Kingdom)*

We study the dynamics of correlations in a paradigmatic setup to observe PT-symmetric physics: a pair of coupled oscillators, one subject to a gain one to a loss. Quantum correlations (QCs) are created, despite the system being driven only incoherently, and can survive indefinitely. We link PT-symmetry breaking to the long-time behavior of QCs, which display different scalings in the PT-broken/unbroken phase and at the exceptional point (EP). The EP in particular stands out as the most classical configuration.

12:10 : Exotic atom-photon interactions in a non-Hermitian photonic lattice
Federico Roccati[1], Salvatore Lorenzo[1], Giuseppe Calajò[2], Gioacchino Massimo Palma[1], Angelo Carollo[1], Francesco Ciccarello[1]
[1] *Università degli Studi di Palermo (Italy),* [2] *CFO-Institut de Ciencies Fotoniques (Spain)*

We study emission properties and dipole-dipole interactions for a set of quantum emitters (atoms) coupled to a photonic lattice with engineered losses which exhibits the non-Hermitian skin effect. A number of exotic quantum optics effects occur such as loss-induced chiral emission, exactly localized metastable dressed states, chiral photon-mediated atom-atom interactions. At a lattice exceptional point, the effective couplings between the emitters are exactly non-reciprocal and short-range.

11:40 - 12:40 — Augustin Fresnel Room

Session 3A16

Light-matter interactions in new materials and meta-architectures

Organized by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

Chaired by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

11:40 : Invited talk
Switchable nanooptics with conducting polymer nanoantennas
Magnus Jonsson
Linkoping University (Sweden)

I will present our recent research on switchable nanooptical resonances in nanostructures of organic conducting polymers, and the use of such materials in display applications.

12:00 : Invited talk
Excitonic Behavior and Photo-Carriers Transport in 2D Quantum Confined Metal Organic Chalcogenides
Lorenzo Maserati, Sivan Refaely-Abramson, Christoph Kastl, Mirko Prato, Stefano Pecorario, Bianca Passarella, Andrea Perinot, Anna Anupa Thomas, filippo Melloni, Mario Caironi
Istituto Italiano di Tecnologia (Italy)

We unveil anisotropic 2D excitons in a self-assembled, layered bulk silver benzeneselenolate coordination polymer, [AgSePh]∞. This in-plane covalently bonded hybrid multiple quantum well nanostructure, resemble the 2D hybrid metal halides perovskites, but it is non-polar and air stable. We therefore investigate the charge carriers' transport across a [AgSePh]∞. The photo-response of this material suggests possible use of this materials as air-stable UV photodetector UV even on flexible substrates.

12:20 : Invited talk
Spin dynamics in thin films and nanostructures based on Fe60Al40
Anna Semisalova[1], Tanja Strusch[1], Ralf Meckenstock[1], Rantej Bali[2], Jonathan Ehrler[2], Kay Potzger[2], Kilian Lenz[2], Jürgen Lindner[2], Michael Farle[1]
[1] *University of Duisburg-Essen (Germany),* [2] *Institute of Ion Beam Physics and Materials Research (Germany)*

We report on ferromagnetic resonance detected spin pumping in Fe60Al40/Pd and Fe60Al40/permalloy bilayers, and laterally patterned Fe60Al40 nanostructures with periodical ferromagnetic/paramagnetic interfaces. Due to its magnetostructural phase transition Fe60Al40 can be utilized as a paramagnetic or ferromagnetic material at the same temperature depending on its structural order parameter. In this study we investigate the dual role of this alloy as a spin source and a spin sink.

11:40 - 12:40 — Ibn Al-Haytham Room

Session 3A17

Light-matter interactions in new materials and meta-architectures

Organized by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

Chaired by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

11:40 : Tunable and dynamic structural colors in nano-optics: toward future applications
Junsuk Rho, Jaehyuck Jang
Pohang University of Science and Technology (POSTECH) (Korea)

In this abstract, I will discuss our efforts in realizing multifunctional a-Si:H metaholograms that can encode multiple pieces of information in a monolayer device for anticounterfeiting applications.

11:55 : Redox-tunable structural colouration by UV-patterned conducting polymer nanofilms on metal surfaces
Shangzhi Chen, Magnus P. Jonsson
Linkoping University (Sweden)

In this presentation, I will introduce our latest studies on the redox state tunable structural colouration based on conducting polymers and the use of UV-patterning technique for fabricating multi-colour images within single steps.

12:10 : Plasmonic Electronic Paper
Marika Gugole, Oliver Olsson, Jolie Blake, Kunli Xiong, Andreas Dahlin
Chalmers University of Technology (Sweden)

We work on developing reflective displays (electronic paper) in color by combining plasmonic nanostructures and electrochromic materials. The main motivation is to save energy in comparison with emissive displays. (Further details in submitted file.)

12:25 : Narrow Linewidth Plasmonic Color filters for Transmission with Enhanced Out-Of-Band Suppression
Anabel De Proft[1], Kristof Lodewijks[2], Pol Van Dorpe[2], Xavier Rottenberg[2]
[1] *Katholieke Universiteit Leuven (Belgium),* [2] *IMEC (Belgium)*

We report on a novel plasmonic color filter design leveraging the interference of a dielectric post array and a metallic hole array, complemented with a metal cover on the dielectric posts to suppress out-of-band transmission. Simulations predict a combination of linewidth (down to 25 nm), transmission (45 %) and out-of-band transmission surpassing previously reported plasmonic color filters for transmission.

11:40 - 12:40 — Gaston Floquet Room

Session 3A18

Topology in photonic crystals, metamaterials, and metasurfaces: physics and design

Organized by: Yang Li and Benfeng Bai

Chaired by: Yang Li and Benfeng Bai

11:40 : Invited talk
Topological bulk laser
Renmin Ma
Peking University (China)

Here, we propose and experimentally demonstrate a topological bulk laser in a judiciously architected nanocavity array, where a bulk state is harvested for lasing in a topological way. The topological bulk laser is based on a novel band-inversion induced reflection, which provides a new lasing-mode selection mechanism and renders emission directionality.

12:00 : Invited talk
Prediction of topological transitions in photonic crystals using machine learning
Bei Wu[1], Kun Ding[2], Che Ting Chan[3], Yuntian Chen[1]
[1] *Huazhong University of Science and Technology (China),* [2] *Imperial College London (United Kingdom),* [3] *Hong Kong University of Science and Technology (China)*

We train artificial neural networks to distinguish the geometric phases of a set of bands in photonic crystals by feeding the network with the information of photonic crystals encoded with Maxwell's equations. Interestingly, we find that the trained network yields remarkably accurate predictions of the topological phases for photonic crystals, even for those geometric and material parameters that are beyond the range of the parameter space in the training dataset.

12:20 : Invited talk
Six-dimensional light-matter interaction
Ouyang Xu, Yi Xu, Yaoyu Cao, Xiangping Li
Jinan University (China)

Pursuing new physical dimensions for tailoring and manipulating light-matter interaction is valuable from fundamental science and application points of view. In general, the intrinsic disorder effect during nanofabrication is generally considered to be useless. In sharp contrast to topological photonics that is proposed to mitigate the involuntary disorder effect, we utilize the combination of intentional disorder effect in plasmonic crystal and the polychromatic and polarized vortex beam to synthesize a record high dimension for light-matter interaction.

11:40 - 12:40 — Lawrence Bragg Room

Session 3A19
Plasmonics and nano-optics

11:40 : Mimicking a Wormhole and Giant Tidal Force with Curved Optical Spaces
Runqiu He, G. H. Liang, S. N. Zhu, H. Liu
Nanjing University (China)

We apply curved optical waveguides to simulate the evolution of a beam around a wormhole and we found the huge tidal forces acting on a beam around a wormhole, which cause the wave packets deformed or even destroyed. The experimental system provides an effective method for simulating gravity and will be helpful for Astronomical observation and prediction in the future.

11:55 : Fabrication of GaN nanopillars by metal-assisted chemical etching combined with ICP etching
Xiaomeng Zhang, Hailiang Li, Changqing Xie
Institute of Microelectronics, Chinese Academy of Sciences (China)

We present a facile and effective approach for fabricating GaN nanopillar arrays, using a combination of inductively coupled plasmas(ICP) etching and Pt/Au metal assisted chemical etching (MacEtch). By introducing defects in the metal covered area before wet etching we can achieve a faster process and greater depth. Further, the effects and significances of illumination conditions on the etching process are demonstrated.

12:10 : Electron kinetics in epsilon-near-zero optical nonlinearity
Heng Wang, Kang Du, Xinhai Dai, Wending Zhang, Soo Jin Chua, Ting Mei
Northwestern Polytechnical University (China)

The physical mechanisms of epsilon-near-zero (ENZ) optical nonlinearity are modeled and the Drude model is extended to intraband transition induced optical nonlinearity by adopting the statistical parameters. The electron overall effective mass and overall scattering time are proposed, which takes into account the distribution of energy dependent electrons in the nonparabolic band.

12:25 : Enhanced circular polarization discriminative photoresponse in the metamaterial integrated anisotropic active materials
Jing Zhou, Zeshi Chu, Xu Dai, Xiaoshuang Chen, Wei Lu
Chinese Academy of Sciences (China)

Circular polarization discrimination is desired for use in many optoelectronic applications. Nevertheless, the circular polarization extinction ratio (CPER) for absorption of the active materials, typically below 2.5. Based on double polarization selection mechanism, the integration of an asymmetric metamaterial with an anisotropic material can drastically enhance CPER by 6 to 10 times and enhance photoresponse of active materials.

11:40 - 12:40 — Rene Descartes Room

Session 3A20

Structured and topological photonic fields

Organized by: Jamal Berakdar

Chaired by: Jamal Berakdar

11:40 : Invited talk
Compact Meta-Spectrometer for Mobile Applications
jaesoong lee
Samsung Advanced Institute of Technology (Korea)

We demonstrated an extremely compact and efficient meta-structure-based spectrometer for use in the near-infrared range. The spectrometer consists of a mobile-phone CMOS imager and silicon-nanoposts-embedded dielectric multilayers fabricated directly on top of the imager. The spectrometer shows good transmission and excellent spectral resolutions. In addition, the presence of the metaposts embedded in the dielectric layers greatly simplifies the fabrication process to generate individual spectral channels. It shows promise of integrating compact spectrometers in smartphones for diverse applications.

12:00 : Invited talk
Photonic nodal rings associated with electromagnetic anti-duality symmetry
Ruo-Yang Zhang, Qinghua Guo, Biao Yang, Che Ting Chan
Hong Kong University of Science and Technology (Hong Kong)

We investigate a kind of dispersive chiral media, and show that there exists a novel kind of nodal rings exising out of any high-symmetry planes in the momentum space. These nodal rings arise from the accidental electromagnetic anti-duality symmetry at a specific frequency. More interestingly, when two such materials with opposite chiralities are adjoined at an interface, the anti-duality symmetry also ensures that the bands of interface states can intersect at the anti-duality frequency, forming two-fold degenerate Fermi arcs.

12:20 : Invited talk
High harmonic generation with topological light fields
Jonas Wätzel, Jamal Berakdar
Martin-Luther-University Halle-Wittenberg (Germany)

Results of quantum mechanical calculations of an atomic gas irradiated by three-dimensional topological light fields are presented. The investigation of the high harmonic generation reveals that the generation of topologically protected and polarization-structured light fields in the X(UV) frequency regime is possible with only one driving field.

Lunch

12:40 - 14:00

14:00 - 15:15 — Victor Veselago Room

Session 3A21

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

14:00 : Invited talk
Controlling the propagation of light and sound in silicon waveguides by means of subwavelength nanostructuration
Jianhao Zhang[1], Dorian Oser[1], Thi-Thuy-Duong Dinh[1], Xavier Le Roux[1], Miguel Montesinos[1], Christian Lafforgue[1], Diego Perez-Galacho[2], Daniel Benedikovic[1], Elena Duran Valdeiglesias[1], Vladyslav

Vakarin[1], Omar Ortiz[1], A. Rodirguez[3], Olivier Alibart[3], Pavel Cheben[4], Sebastien Tanzilli[3], Laurent Labonté[3], Delphine Marris-Morini[1], Eric Cassan[1], Daniel Lanzillotti-Kimura[1], Laurent Vivien[1], Carlos Alonso-Ramos[1]
[1] *Université Paris-Saclay (France),* [2] *Universitat Politecnica de Valencia (Spain),* [3] *Université Cote d'Azur (France),* [4] *University of Ottawa (Canada)*

Periodically patterning silicon with a pitch sufficiently small to suppress diffraction effects opens new degrees of freedom to control light propagation in silicon photonic circuits with unprecedented flexibility. Concurrently, near-infrared photons and GHz phonons in nanoscale Si waveguides have comparable wavelengths. Thus, subwavelength nanostructuration has a great potential to shape light-sound interactions in silicon waveguides. Here, we present our most recent results on the subwavelength engineering of silicon for the implementation of high-performance photonic and optomechanical components.

14:20 : Invited talk
On-chip guiding of spoof terahertz surface plasmon polaritons on metasurface pathways
Sven Becker, Tassilo fip, Marco Rahm
TU Kaiserslautern (Germany)

We investigate the guiding and routing of spoof terahertz surface plasmon polaritons (terahertz SSPPs) along metasurface pathways of subwavelength width by means of numerical calculations and experimental measurement of the spatio-temporal and spectro-temporal dynamics of the electric field of the SSPPs. The SSPPs are routed along straight and curved pathways of subwavelength path width. We show that terahertz SSPPs can be tightly guided within subwavelength space on metasurfaces without loss of the out-of-plane confinement.

14:40 : Invited talk
Tailoring Nanoscale Order in Metal and Semimetal - Based Metamaterials for Enhanced Light Harvesting, Sensing, and Switching
Johann Toudert, Rosalia Serna
Instituto de Optica-CSIC (Spain)

Self-assembled metamaterials based on metal and semi-metal nanostructures are reported. Their nanoscale order is tailored to achieve enhanced optical properties, such as a broadband near-perfect absorption of light or a broad optical phase tuning. They enable an optimal sunlight harvesting, 3D-multiplexed remote sensing and synaptic optical switching.

15:00 : Experimental Probes of Thermal Transport and Lattice Stability of Important Optoelectronic Semiconductor Nanomaterials
Richard D. Schaller
Northwestern University (USA)

We performed transient X-ray diffraction experiments on semiconductor nanocrystals and lead halide perovskites. Bragg peak shifts relate heating and peak amplitude reduction confers lattice disordering. II-VI nanoparticles melt upon absorption of $\sim$0.89 excitations/nm3. Certain perovskites are found to undergo solid-solid phase transitions prior to disordering. Diffaction intensity recovery kinetics occur over hundreds of picoseconds with slower recoveries for larger particles. These findings highlight questions of physical stability of advanced materials and related electronic impacts in high intensity excitation applications.

14:00 - 15:15 — Allan Boardman Room

Session 3A22

Symposium I: Hybrid Nanomaterials and Metastructures for Photonics, Sensing and Energy

Organized by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

Chaired by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

14:00 : Invited talk
Light management at the nanoscale bioinspired by photosynthesis photonics
William P. Wardley, Johannes. W. Goessling, Miguel Castillo, Martin Lopez Garcia
International Iberian Nanotechnology Laboratory (Portugal)

Cost-effective nanofabrication methods can be used to reproduce the phenomena of enhanced absorption and structural colour found in the leaves of some plants. Such nanophotonic biomimetic approaches can work as a playground to better understand the natural system and as inspiration for new strategies on light harvesting. We will also show that the silica exoskeleton of diatom microalgae contains slab photonic crystals that can be used as a naturally produced nanophotonic material, opening the door to bioengineered nanophotonic devices.

14:20 : Invited talk
On the mechanisms of plasmon-enhanced chiroptical response
Thomas Weiss[1], Steffen Both[1], Egor A. Muljarov[2]
[1] *University of Stuttgart (Germany),* [2] *Cardiff University (United Kingdom)*

We present a rigorous theory based on the resonant state expansion that allows us to analyze all electromagnetic contributions to the plasmonic enhancement of the chiroptical response of chiral media. Potential applications are optimized optical sensors for molecular handedness detection.

14:40 : Invited talk
Optical injection of plasmonic Janus-nanoparticles into living cells
Theobal Lohmüller
LMU München (Germany)

15:00 : Doping zinc oxide nanohybrids for application in white light emitting diodes
Alexandra Apostoluk[1], Yu Zhang[1], Christophe Theron[1], Thibaut Cornier[1], Beata Derkowska[2], Malgorzata Sypniewska[2], Stéphane Danièle[1], Bruno Masenelli[1]
[1] *Université de Lyon (France),* [2] *Nicholas Copernicus University (Poland)*

We present a study concerning the effect of doping in inorganic/organic ZnO/PAAH (polyacrylic acid) nanohybrids. The doping atoms vary in their ionic size, electronic valence and concentration. Some of them have been known to provide ZnO with magnetic properties. The effect on the optical properties of the ZnO nanoparticles of three different concentrations (0.1 %, 1 % and 5 %) of dopants is compared. The luminescent properties of the undoped and doped nanohybrids are reported.

14:00 - 15:20 — Tatsuo Itho Room

Session 3A23
Thermal Plasmonics and Metamaterials for Environment and Energy Application

Organized by: Junichi Takahara and Kotaro Kajikawa

Chaired by: Junichi Takahara

14:00 : Invited talk
Complex metamaterials for energy applications
Andrea Fratalocchi
Kaust University (Italy)

In this invited talk I will summarize recent research of my group on complex metamaterials for various energy and environmental applications ranging from world record water splitting, photo-catalysis, solar desalination and structural coloration.

14:20 : Invited talk
Smart Meta-optical Solar Reflector based on Vanadium Dioxide
Kai Sun[1], Wei Xiao[1], Ioannis Zeimpekis[1], Mirko Simeoni[2], Alessandro Urbani[2], Matteo Gaspari[2], Sandro Mengali[2], Ivano Indiveri[3], Behcet Alpat[3], Lars Kildebro[4], Javier Aizpurua[5], Dan Hawak[1], C.H. (Kees)

de Groot[1], **Otto L. Muskens**[1]
[1] *University of Southampton (United Kingdom),* [2] *Consorzio C.R.E.O. (Italy),* [3] *Maprad S.r.l. (Italy),* [4] *NIL Technology (Denmark),* [5] *CSIC-UPV/EHU (Spain)*

Optical solar reflectors (OSRs) play a crucial role in the thermal control of a spacecraft. We present novel 'smart' metasurface-based OSRs using vanadium dioxide (VO2), which has its infrared emittance modulated by temperature. We have investigated the infrared property of the ALD VO2 films under different anneal conditions and found the anneal condition can optimize VO2 infrared response. We have demonstrated that a superior emittance tunability and lower solar absorption for meta-OSRs than the planar film device.

14:40 : Invited talk
Titanium nitride and silicon nanostructuresfor photothermal applications
Osamu Takayama[1], **Evgeniy Shkondin**[1], **Shinya Goya**[2], **Makoto Higashino**[2], **Shunsuke Murai**[2], **Katsuhisa Tanaka**[2], **Satoshi Ishii**[3], **Tadaaki Nagao**[3], **Andrei V. Lavrinenko**[1]
[1] *Technical University of Denmark (Denmark),* [2] *Kyoto University (Japan),* [3] *National Institute for Materials Science (Japan)*

We report photothermal conversion of high aspect ratio TiN and Si nanostructures. We fabricate two types of TiN nanostructures: trenches and tubes, and two types of Si nanostructures: trench and air hole arrays in Si. We study the photothermal properties of these nanostructures by measuring Raman shift of the materials that corresponds to the temperature in terms of laser power. These high aspect ratio nanostructures exhibit significant temperature increase, showing the potential for highly efficient photothermal converters.

15:00 : Invited talk
Metasurface thermal emitter
Ming Zhou, Zongfu Yu
Wisconsin Madison (USA)

We show metasurface emitter can exploit collective wave effects of thermal photons to realize focused thermal emission and thermal holography.

14:00 - 15:00 — Christian Huygens Room

Session 3A24

Local enhancement and control of light-matter interaction

Organized by: Antonio Ambrosio

Chaired by: Antonio Ambrosio

14:00 : Invited talk
Nanooptics in Hyperbolic Van der Waals Materials
Javier Martin-Sanchez
University of Oviedo (Spain)

Polaritons - hybrid light-matter excitations - play a crucial role in fundamental and applied sciences, as they enable nanoscale control of light. Here, we present propagation of hyperbolic polariton along the surface of the Van der Waals (vdW) material α-MoO3 with amplitude record lifetimes. Additionally, we will discuss possible applications for the in-plane manipulation of light based on the in-plane and ray-like directional propagation of polaritons. Our findings open new avenues for fully planar photonic technologies at the nanoscale.

14:20 : Invited talk
P-plates: Pure vortex generation with a single metasurface
Marco Piccardo, Antonio Ambrosio
Fondazione Istituto Italiano di Tecnologia (Italy)

Since the introduction of the concept of optical vortex in 1989 a number of methods to generate such beams have emerged. After presenting a timeline tracing the appearance of vortex generation tools in the last 30 years, we will introduce p-plates - metasurfaces enabling the creation of vortices with high purity.

14:40 : Invited talk
Flat Optics and High Quality Factor Nanoresonators with Phonon Polaritons in Van Der Waals Materials
Michele Tamagnone
Fondazione Istituto Italiano di Tecnologia (Italy)

New types of nanophotonic devices based on phonon polaritons in hexagonal boron nitride and molybdenum trioxide are demonstrated. Different substrates (metal, phase change materials or other van der Waals materials) can be used to engineer the propagation of these polaritons. High quality factor resonators using isotopically pure boron nitride are also discussed. Polaritons in van der Waals materials are an excellent mid infrared counterpart to plasmon polaritons in mobile metals.

14:00 - 15:20 — Augustin Fresnel Room

Session 3A25

Light-matter interactions in new materials and meta-architectures

Organized by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

Chaired by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

14:00 : Invited talk
Light-absorption in nano-antennas: from self-heating to reconfigurable metasurfaces
Giulia Tagliabue
EPFL (Switzerland)

By engineering light absorption in dielectric and metallic nanoantennas, we explore new opportunities for the manipulation of temperatures at the nanoscale as well as the design of reconfigurable metaurfaces.

14:20 : Invited talk
Plasmon-driven chemical reactions: photothermal effects, near-fields, and hot charge carriers
Andrea Baldi
Vrije Universiteit Amsterdam (The Netherlands)

Metal nanoparticles scatter and absorb light thanks to surface plasmon resonances. The decay of these resonances is used to drive chemical reactions via photothermal heating, electromagnetic field enhancement, and ejection of hot charge carriers. All these mechanisms typically occur on ultrafast timescales and are therefore very difficult to disentangle experimentally. In our group, we develop strategies to disentangle and quantify the relative contribution of these activation mechanisms in plasmon-driven chemical reactions, both in ensemble and at the single-particle level.

14:40 : Invited talk
Time-Resolved Cathodoluminescence in a Transmission Electron Microscope
Sophie Meuret[1], Nikolay Cherkashin[1], Luiz Tizei[2], Yves Auad[2], Robin Cours[1], Sebastien Weber[1], Florent Houdellier[1], Mathieu Kociak[2], Arnaud Arbouet[1]
[1] *CEMES/CNRS (France),* [2] *Laboratoire de Physique des Solides (France)*

Time resolved Cathodoluminescence (TR-CL) is a unique technique that allows to measure the lifetime of radiative transition down to the picosecond at the nanometer scale. In this presentation, we will discuss the first experimental demonstration of TR-CL in a transmission electron microscope. We will show its potential, and the opportunities offer by its complementarity with other electron based spectroscopies, to correlate the optical and structural properties of materials.

15:00 : Invited talk
Unlocking the far-IR potential in plasmonics with metal oxide perovskites
Nikolaos Kalfagiannis
Nottingham Trent University (United Kingdom)

Metal-oxide perovskites are important technological materials due to their excellent properties. Here we ex-

plore the optical properties of SrTiO3 and BaTiO3 in the mid- and far-infrared regime. In this spectral range, both materials demonstrate an exceptional behavior due to their combined phonon-polariton modes allowing their real permittivity to remain negative for an extended region, in contrast to other polar dielectrics. We thus present the exceptional flexibility of both materials as active nano-photonic components.

14:00 - 14:40 — Ibn Al-Haytham Room

Session 3A26

Structural Color for Displays and Imaging

Organized by: Debashis Chanda

Chaired by: Debashis Chanda

14:00 : Invited talk
Structural Blue: Journey from fundamental research to real-life application as first omnidirectional structural color pigment
Debasish Banerjee
Toyota Research Institute of North America (USA)

In this talk we will discuss optical design strategies based on multilayer stack of thin-films to maintain brilliancy, omnidirectional characteristics of structural colors as well as feasible production methods for commercialization. This work paves the way to access of durable naturally brilliant and high chroma colors to automotive market and beyond.

14:20 : Invited talk
High-purity hybrid structural colors by enhancing optical absorption of organic dyes in resonant cavity
L. Jay Guo, Zhengmei Yang, Chengang Ji
University of Michigan (USA)

We present a simple and new method of incorporating an ultrathin dye film into a planar thin-film structure to realize high-purity reflective colors with drastically increased lifetime.

14:40 - 15:25 — Ibn Al-Haytham Room

Session 3A27

Photonic bandgap structures

14:40 : Free space topological surface states at the surface of square photonic crystals
Anna Tasolamprou[1], Maria Kafesaki[1], Costas Soukoulis[2], Eleftherios Economou[1], Thomas Koschny[2]
[1] *IESL - FORTH (Greece),* [2] *Iowa State University (USA)*

We present a square photonic crystal that sustains topological surface states at the free space interface. Band structure and direct scattering simulations demonstrate the topological surface mode unidirectionalilty and immunity to defects and back-scattering.

14:55 : Characteristics of Transmission GAPS in Photonic Hypercrystals
Munazza Zulfiqar Ali
Punjab University (Pakistan)

Here we theoretically investigate the wave propagation in two different types of photonic hypercrystals. The emergence of different types of transmission gaps in frequency as well as in momentum space and some of the characteristics of these gaps such as their dependence on filling ratio of HMM and angle of incidence is

studied by curve plotting and simulations.

15:10 : Self-action of Bloch surface waves in a one-dimensional photonic crystal
Daniil A. Shilkin, Evgeny V. Lyubin, Andrey A. Fedyanin
Lomonosov Moscow State University (Russia)

Bloch surface waves (BSWs) in one-dimensional photonic crystals are considered as a promising platform for two-dimensional integrated optics and optical manipulation of particles. In this contribution, we present an experimental study of nonlinear optical effects that occur when BSWs are excited at the interface with a water suspension of dielectric nanoparticles. The results are in agreement with our theoretical predictions and highlight the potential of BSWs for use in two-dimensional devices operating in a nonlinear regime.

14:00 - 15:15 — Gaston Floquet Room

Session 3A28
Micro/Nano fabrication and characterization techniques

14:00 : Laser-Induced Metal/Polymer Composites For Flexible Electronics
Anna Lipovka[1], Raul D. Rodriguez[1], Fedor Gubarev[1], Sergey Schadenko[1], Gennadiy Murastov[1], Alexey Zinoviev[1], Ilia Petrov[1], Ammar Al-Hamry[2], Olfa Kanoun[2], Jin-Ju Chen[3], Evgeniya Sheremet[1]
[1] *Tomsk Polytechnic University (Russia),* [2] *Chemnitz University of Technology (Germany),* [3] *University of Electronic Science and Technology of China (China)*

In this work, we present a fast, inexpensive, single-step, and scalable route for metal nanoparticles (MNPs) integration to polymer structures using laser beams. We propose the formation of highly conductive and mechanically robust aluminum/polyethylene terephthalate (Al/PET) composites for flexible electronic devices fabrication. These results are in accordance with our previous research connected to the incorporation of graphene-like materials into PET which indicates the versatility and generality of the laser processing method.

14:15 : What Influences Surface Plasmon Resonance Linewidth in MIM Structures Obtained by Colloidal Self-Assembly
Ye Yu[1], Daniel Schletz[2], Johanna Reif[1], Felix Winkler[1], Matthias Albert[1], Andreas Fery[2], Robert Kirchner[1]
[1] *Technische Universität Dresden (Germany),* [2] *Leibniz-Institut für Polymerforschung Dresden e.V. (Germany)*

LSPRs have been extendedly studied in the past decades. However, they often suffer from spectral broadening, a crucial origin of which is fabrication inaccuracies. Unfortunately, there is yet an efficient way to evaluate this impact, rendering the researchers having to rely on rather intensive, time-consuming experimentations. We present an approach to evaluate various fabrication contributors to the broadening, providing a possibility of efficient optimization in lieu of experiments, shedding light to automated fabrication, optimization of integrated design.

14:30 : Development of a high throughput metalens fabrication process relying on Bosch Deep Reactive Ion Etching and UV Nano Imprint Lithorgraphy
Christopher A. Dirdal, Geir Uri Jensen, Hallvard Angelskar, Jo Gjessing, Paul C. Vaagen Thrane
SINTEF Microsystems and Nanotechnology (Norway)

Current optical components are often bulky, heavy and expensive - thereby inhibiting the application areas of optical technology. Metasurfaces are highly promising in this respect due to their potential of making optical components small, lightweight and cheap. However, virtually all diffraction limited dielectric metasurface lenses to date rely on slow and expensive direct writing methods. At SINTEF Microsystems and Nanotechnology we are developing industrially relevant Bosch Deep Reactive Ion Etching and UV Nano Imprint Lithorgraphy processes for metalens fabrication.

14:45 : Comparative study of monocrystalline and polycrystalline gold plasmonic nanorods
Lukas Kejik, Michal Horak, Tomas J. Sikola, Vlastimil Krapek
Brno University of Technology (Czech Republic)

Plasmonic antennas are often fabricated by lithographic patterning of a thin metallic film and its properties

are then intimately related to the quality of the resulting structures. Here we compare two kinds of thin gold films: polycrystalline thin film deposited by magnetron sputtering, and chemically synthesized monocrystalline gold platelet. Both metallic substrates were used to fabricate plasmonic nanorods using focused ion beam lithography. The resulting nanorods were characterized by scanning transmission electron microscopy and electron energy loss spectroscopy.

15:00 : Microstructural Properties of ZnO Powder Nanostructures and Ab Initio Study
Salah Oudjertli, Abdelkader Safou
Research Center In Industrial Technologies (Algeria)

We used X-ray diffraction (XRD). Powder X-ray diffraction data confirm the formation of a hexagonal crystal structure with space group p63mc of ZnO. The ZnO replicas was clearly observed under an optical microscope(OM). Band structure and density of states of the phase of crystal ZnO computed using Ab Initio methods, confirmed that pure ZnO is a indirect band gap semiconductor for B1 phase, whose phase B1 is of NaCl type(Rocksalt).

14:00 - 15:15 — Lawrence Bragg Room

Session 3A29
Plasmonics and nano-optics

14:00 : Electromagnetism and Plasmon-Enhanced Light-Matter Interactions at the Nanoscale
P. A. D. Goncalves[1], T. Christensen[2], N. Rivera[1], A.-P. Jauho[3], N. A. Mortensen[1], M. Soljacic[1]
[1] *University of Southern Denmark (Denmark),* [2] *MIT (USA),* [3] *Technical University of Denmark (Denmark)*

We present a theory for quantum nanoplasmonics that incorporates nonlocality and quantum effects, such as electronic spill-out and surface-enabled Landau damping Focusing on the planar and sphere geometries, we derive analytical expressions for the nonclassical scattering coefficients, from which the optical response of the systems can be unambiguously determined. We compute the systems' plasmonic excitations and investigate the role of quantum surface corrections to plasmon-emitter interactions, e.g., Purcell enhancement, dipole-forbidden transitions rates, and plasmon-mediated energy transfer.

14:15 : Influence of primary beam energy on localized surface plasmon resonances mapping by STEM-EELS
Michal Horak, Tomas Sikola
Brno University of Technology (Czech Republic)

We present an experimental study of the influence of primary beam energy on localized surface plasmon resonances mapping by scanning transmission electron microscopy combined with electron energy loss spectroscopy. The best results are obtained using a medium primary beam energy (120 keV) as the primary beam energy should be high enough to suppress the scattering in the sample and at the same time should be low enough to avoid the appearance of relativistic effects.

14:30 : Towards implantable SERS substrates: testing the fabrication approaches
Raul Rodriguez[1], Ilia Petrov[2], Elizaveta Sviridova[2], Elena Dorozhko[2], Ali Issa[3], Evgenia Sheremet[2], Pavel Postnikov[2], Safi Jradi[3]
[1] *Tomsk Polytecnhic University (Russia),* [2] *Tomsk Polytechnic University (Russia),* [3] *University of Technoogy of Troyes (France)*

The use of Surface Enhanced Raman Spectroscopy (SERS) in vivo has attracted increasing interest in biomedical applications. In this work, we demonstrate different approaches for in vivo SERS substrates fabrication and outlook on their perspectives and future applications.

14:45 : Highly Anisotropic Tungsten Oxide Nanocrystals for Tunable NIR-Plasmonic Absorption and Scattering
Yannis Cheref, Capucine Cleret de Langavant, Eric Larquet, Axel Laborieux, Thierry Gacoin, Jongwook Kim
LPMC - Ecole Polytechnique (France)

We report on the plasmonic optical properties in the near-infrared range of Hexagonal Tungsten Bronze (HTB) nanocrystals. We present full LSPR bands dynamics where particles grow from strongly colored HTB platelets to long HTB rods invisible to the eye. Furthermore, control of the particle size allowed us to measure LSPR light scattering for the first time in doped semiconductor nanoparticles, despite carrier densities in these materials being lower than in the well-studied noble metal nanoparticles.

15:00 : Embedded Annular-Hole Arrays Enabling Multiband Near-Zero-Index Transmission at Near-Infrared
Andriy E Serebryannikov[1], **Hodjat Hajian**[2], **Ekmel Ozbay**[2]
[1] *Adam Mickiewicz University (Poland),* [2] *Bilkent University (Turkey)*

Annular-hole periodic arrays enabling high-efficiency transmission in multiple bands are studied at near-infrared. Up to four subwavelength transmission bands can be obtained by placing several annular holes within each unit cell. High efficiency in transmission is achieved due to near-zero-index behavior at the cutoffs of the plasmonic modes propagating along the coaxial wave guide channel.

14:00 - 15:20 — Rene Descartes Room

Session 3A30

Structured and topological photonic fields

Organized by: Jamal Berakdar

Chaired by: Jamal Berakdar

14:00 : Invited talk
Optical super-resolution sensing of a trapped ion's wave packet size
Martin Drechsler[1], **Sebastian Wolf**[1], **Christian Tomas Schmiegelow**[2], **Ferdinand Schmidt-Kaler**[1]
[1] *Universitaet Mainz (Germany),* [2] *IFIBA, UBA CONICET (Argentina)*

In this work we demonstrate a super-resolution optical scheme to determine the size of the wave packet of a single trapped ion. Our method is inspired by the well known ground state depletion (GSD) technique. We use a hollow beam to strongly saturate a dipole-forbidden transition around a sub-diffraction limited area at its center and observe state dependent fluorescence. By spatially scanning this laser beam over a single trapped 40Ca+ ion, we are able to distinguish the wave packet sizes of ions cooled to different temperatures. Using a depletion beam waist of 4:2(1) μm we reach a spatial resolution which allows us to determine a wave packet size of 39(9) nm for a near ground state cooled ion.

14:20 : Invited talk
The physics of the magnetoelectric near fields
Eugene Kamenetskii
Ben Gurion University of the Negev (Israel)

A continuous variation of field structure across the interfaces defines the near field. In a case of near fields of dielectric materials, one observes the evanescent wave character of the fields with continuous variation of field amplitudes and energies across the interfaces. In a case of a material with magnetoelectric (ME) properties, along with the question of variation of field amplitudes, questions also arise of variation of field phases and angular-momentum conservation across the interfaces.

14:40 : Invited talk
field Distributions and Atom Trapping in Focused Axially-Shifted Counter-Propagating light Beams
Koray Koksal[1], **Vassilis E. Lembessis**[2], **Jun Yuan**[3], **Mohamed Babiker**[3]
[1] *Bitlis Eren University (Turkey),* [2] *King Saud University (Saudi Arabia),* [3] *University of York (United Kingdom)*

This talk deals with a special kind of structured light when focused optical beams interfere with their focal planes shifted axially by a finite distance d. For doughnut beams we show how these lead to finite ring lattices, Ferris-wheels and conveyor belts. Furthermore, a new all-optical atom trapping environment arises solely due to the scattering force on atoms when the beam waists are of sub-wavelength dimensions. Our

findings are discussed with reference to sodium atoms.

15:00 : Invited talk
Metasurface spin-to-orbital angular momentum converters
Antonio Ambrosio
Istituto Italiano di Tecnologia (Italy)

We demonstrate beams with independent OAM coupled to user- defined linear or circular polarisation states, all from the same laser. Our nanostructured metasurfaces are compact and power scalable, for the creation of arbitrary angular momentum states of structured light.

Coffee Break and Exhibit Inspection

Session 3P2

Poster session VI

15:20 - 16:00

P1: Tuning the decay coefficient of sound in a 2D viscous metamaterial
Jesus Arriaga[1], José Doporto[1], Martin Ibarias[1], Arkadii Krokhin[2]
[1] *Universidad Autonoma de Puebla (Mexico),* [2] *University of North Texas (USA)*

The homogenization theory developed previously for a phononic crystal of cylinders embedded in a viscous fluid is used to calculate the decay coefficient of sound due to viscosity. We consider different Bravais lattices and different cross sections of the cylinders in order to tune the decay coefficient of sound. We observe that, in the low-frequency limit a phononic crystal with asymmetric unit cell behaves like a dissipative homogeneous metafluid with anisotropic viscosity

P2: Optical Rectification in Meta-Gratings with Broken Inversion Symmetry
Petr Moroshkin, Jimmy Xu
Brown University (USA)

We report on optical rectification effect generated by infrared absorption and diffraction in a periodic 1D meta-grating with a broken inversion symmetry in its unit cell. The photon-drag enabled effect in this case is substantially enhanced by surface plasmon polaritons, resulting in infrared driven ratchet transport of electrons.

P3: Plasmonic study of FeS2/Au and FeS2/Ag nanoparticles
R. Eyi[1], S. Lee[1], O. Manasreh[1], R. Rumpf[2]
[1] *University of Arkansas (USA),* [2] *University of Texas at El Paso (USA)*

Iron pyrite (FeS2), FeS2/Au and FeS2/Ag nanoparticles were synthesized. The absorption and PL were measured before and after the coupling. No significant increase due to the plasmonic effects of the metallic particles were observed in the optical properties after coupling. finite difference frequency domain (FDFD) simulations were performed to further investigate the effects of the coupling. An increase in the optical properties was observed. Plasmonic peaks attributed to the semiconductor were also observed in the near infrared region

P4: Plasmons, Excitons, and Polaritons in Aligned Carbon Nanotubes
Weilu Gao, Junichiro Kono
Rice University (USA)

We have recently developed a controlled vacuum filtration technique to fabricate wafer-scale films of highly aligned and densely packed SWCNTs. Here, we summarize our recent accomplishments using these unique samples.

P5: Temporal Dynamics of Strongly-Coupled Epsilon Near-Zero Metasurfaces
Mehdi Haji Ebrahim[1], Andrea Marini[2], Vincenzo Bruno[1], Daniele Faccio[1], Matteo Clerici[1]
[1] *University of Glasgow (United Kingdom),* [2] *University of L'Aquila (Italy)*

We demonstrate a significant slow-light effect in a deeply subwavelength epsilon near-zero plasmonic system

with decorated gold nanoantennae. We find that the longitudinal and transverse field components dominate the temporal response at the higher and lower resonant frequencies, respectively. We show that the slow-light effect is particularly pronounced within the strong coupling region and thus such ENZ plasmonic systems can provide an alternative platform for control and manipulation of light.

P6: Novel Photonic Glasses: Potassium Fluoride with Tellurium Oxide Doped With Rare Earth
Hamed Algarni[1], Norah A. Al Saffar[1], Manuela Reben[2], Kamal Dammak[3], Mohammed Alqahtani[1], Elsayed Yousef[1]
[1] *King Khalid University (Saudi Arabia),* [2] *AGH - University of Science and Technology (Poland),* [3] *Sfax University (Tunisia)*

The glasses within composition in mol % 64TeO2- 10WO3- 10Nb2O5- 15KF- 1.0 La2O3-x Tm2O3 (where x= 0.0 (sample A), 1'104 (sample B), 2'104 (sample C), 3'104 (sample D) and 5'104ppm (sample E) were prepared. Spectroscopic properties of these glasses were estimated. The linear refractive index and third-order non-linear susceptibility increases with increase Tm3+ ions. The emission and gain cross-section increase with increasing Tm3+ ions in the host glass. These glasses can be fabricated as a promising laser material and optical devices.

P7: Luminescence and Radiation Shielding Parameters of Optical Halohalide Phosphate Glass with doping Rare Earth
Abdulrahman Hussain[1], Kamal Dammak[2], Mohammed Alqahtani[1], Hamed Algarni[1], Manuela Reben[3], Elsayed Yousef[1]
[1] *King Khalid University (Saudi Arabia),* [2] *Sfax University (Tunisia),* [3] *AGH - University of Science and Technology (Poland)*

A homogeneity Pr3+ doped glass with the composition (in mol %) 40P2O5- 30ZnO- 20LiCl-10BaF2 -3.5Pr2O3 referred as PZLBPr glass, was prepared by the melt quenching technique (see fig. 1). Herein the luminescence and shielding parameters such as radiative life time, branching ratio, magnetic dipole, mass attenuation coefficients (MAC), half-value layer (HVL), and mean free path, (MFP), were computed in range of ionizing radiation energies. These results indicate that the optical glass can be used in various diagnostic and therapy applications.

P8: Surface plasmon-assisted spin precession in Au/YIG heterostructures
Artsiom Kazlou[1], Alexander Chekhov[2], Alexander Stognij[3], Ilya Razdolski[1], Andrzej Stupakiewicz[1]
[1] *University of Bialystok (Russia),* [2] *Free University Berlin (Germany),* [3] *Scientific-Practical Materials Research Centre of the NASB (Belarus)*

We report amplification of laser-induced spin precession in Co-doped YIG employing a surface plasmon excitation in a metal-dielectric magneto-plasmonic crystal. Our results are important for non-thermal control of all-optical magnetization reversal in dielectrics and its nanoscale localization.

P9: Terahertz near-field microscopy for quantitative measurements of the conductivity and charge carrier density on the nanoscale
Matthias M. Wiecha, Rohit Kapoor, Hartmut G. Roskos
Goethe University Frankfurt (Germany)

The suitability of a terahertz near-field microscope to quantitatively determine the conductivity and the charge carrier density of semiconductors is explored. For doped and optically excited silicon, the charge carrier density is successfully extracted from the relative phase of the terahertz nearfield signals. This technology is promising for non-contact and nanoscale-resolved characterization of electronic devices and materials.

P10: Curved structured beams: towards practical manipulation of light at the nanoscale from free space to in-plane plasmonic
Igor V Minin[1], Oleg V Minin[2]
[1] *Tomsk Polytecunic Univ. (Russia),* [2] *Tomsk Polytechnic Univ. (Russia)*

Among the ways of manipulation of light propagation, the interest is directed at the implementation of curving the trajectory of localized beam at the nanoscale in near field. It was discovered that an electromagnetic field can be made to curve after propagation through a simple dielectric material with broken symmetry. Photonic hooks features the radius of curvature, which is subwavelength - this is the smallest curvature radius of electromagnetic, acoustic and plasmonic waves ever reported.

P11: Influence of the Cell Number for finite Size Artificial Magnetic Conductor
Céline Ha[1], Jean-François Pintos[1], Priscillia Daquin[2], Serge Bories[1]
[1] *Université Grenoble Alpes (France),* [2] *CNES (France)*

This paper examines the influence of the cell number for finite size AMC under normal plane wave incidence. A comparison is carried out on the operational frequency, the fractional bandwidth, and the reflection coefficient magnitude between the finite size AMC and an infinite structure, for different cell numbers and for three different finite size screens.

P12: Fabrication of SERS Substrates via Laser Induced Surface Nanostructuring of Silicon
Alp Akbıyık, Nardin Avishan, Emre Yüce, Alpan Bek
Middle East Technical University (Turkey)

In this work, we fabricate SERS substrates using laser assisted chemical etching as a surface nano structuring technique for silicon surface. On top of the etched surface, silver is thermally deposited to form hot spots with the silicon. Silver thickness on top of the silicon is shown to influence significantly to the SERS signal obtained from the substrates along with the various parameters that affect surface roughness of silicon.

P13: Purcell enhancement and photoluminescence spectra shift of the APbI3 (A=Cs, FA) Perovskite nanocrystals coupled to Hyperbolic Metamaterials
Hamid Pashaei Adl[1], Setatira Gorji[1], Mojtaba Karimi Habil[2], Isaac Suarez[1], Vladimir S. Chirvony[1], Andrés F. Gualdron-Reyes[3], Ivan Mora-Sero[3], Carlos J. Zapata-Rodriguez[4], Juan P. Martinez-Pastor[1]
[1] *Universidad de Valencia (Spain),* [2] *University of Tabriz (Iran),* [3] *Universitat Jaume I (Spain),* [4] *Universitat de València (Spain)*

Hyperbolic metamaterials are properly designed, simulated and fabricated as an outstanding photonic structure able to control the emission rate of lead halide perovskite nanocrystals (PNCs) deposited on the top. Geometrical parameters are optimized to enhance coupling between the structure and the exciton confined in the PNCs. The device is tested for CsPbI3 and FAPbI3 PNCs, and demonstrates an increase of the exciton radiative recombination rate around a factor of 2-3 together with the red shift of the emission spectra.

P14: Properties of Ni-doped ZnO thin films prepared by Sol-gel Spin Coating and Study of ZnO Powder Nanostructures.
Salah Oudjertli[1], Abdelkader Mohammedi[2], Miloud Ibrir[2]
[1] *Research Center In Industrial Technologies (Algeria),* [2] *University of M'sila (Algeria)*

Thin films of Nickel-doped ZnO are prepared by sol-gel spin coating process. The percentage concentration of dopant: Nickel, by weight, was at 0 %, 2 % and 5 %. Band structure and density of states of the phase of crystal ZnO computed using Ab Initio methods, confirmed that pure ZnO is a direct band gap semiconductor for B3 phase, whose phase B3 is of ZnS type Blende.

P15: Simulation of a Smart filter Based on Non-linear Metamaterials and Micro-plasma
Motahareh Rahmani, Saeed Hasanpour Tadi, Babak Shokri
Shahid Beheshti University (Iran)

A smart photonic device is simulated to work as a limiter. A 2D non-linear metasurface is located inside a waveguide and its interaction with microwave by different input powers is studied. It is shown that when the input power is low, there is no micro-plasma and the system is transparent and in high input power mode, the situation is vice versa.

P16: Analysis of Overcoming Independent Core Light Propagation in Multicore Photonic Crystal fibers with Non-identical Cores Coupling
Miami Mohammed Mohammed
University of Muenster (Germany)

Multicore photonic crystal fibers with non-identical cores are analyzed numerically using Comsol Multiphysics software. Anisotropy in all cores diameters of multicores photonic crystal fibers leads to different coupling behavior. Such anisotropy causes suppressed the coupling between the core modes at some wavelengths.

P17: Tunable polaritons enhanced by the spiral nanowire metamaterials
Thanos Ioannidis[1], Tatjana Gric[1], Edik Rafailov[2]
[1] *Vilnius Gediminas Technical University (Lituania),* [2] *Aston University (United Kingdom)*

The tunable spiral nanowire metamaterial design at optical frequency is presented, and the surface polaritons

are theoretically studied. It was found that the dispersions of the polaritons could be tuned by varying physical dimensions of the spiral nanowire metamaterial. This geometry is unique. Doing so, one may dynamically control the properties of surface polaritons.

P18: All dielectric Si nanoresonator based color filters
Vishal Vashistha[1], Andriy Serebryannikov[2], Maciej Krawczyk[2]
[1] *Aalto University (finland),* [2] *Adam Mickiewicz University (Poland)*

In this study, we experimentally demonstrate high-quality colors obtained by using arrays of cross-shaped Si nanoantennas. Functionality and characteristics achieved with the aid of symmetric and asymmetric nanoantennas are compared. Si nanoantennas typically show two strong resonances: electricand magnetic dipole ones. They can be tuned by adjusting the size and shape of the nanoantennas throughout the whole visible spectrum.

P19: Spoof Localized Surface Plasmons Examination Based on Effective Medium Theory in Textured Metallic Cylinders
Amirmasood Bagheri, Mohammad Reza Tavakol, Amin Khavasi
Sharif University of Technology (Iran)

Textured closed surfaces made out of perfect electric conductors (PECs) can mimic highly localized surface plasmons (LSPs). Here, we propose and scrutinize an effective medium being able to model LSP resonances in a two-dimensional periodically decorated PEC cylinder. Thanks to the incorporation of an effective surface conductivity created at the interface of the cylinder and the homogeneous medium surrounding the structure, the proposed model is accurate. Full-wave simulations verify the validity of the proposed model.

P20: Potential of pure VO2 building blocks for tunable metasurfaces in the visible
Peter Kepič, Filip Ligmajer, Katarina Rovenska, Martin Hrton, Jirı Liska, Tomas Sikola
Brno University of Technology (Czech Repub)

Metasurfaces represent a new class of optical components, which can provide optical functions far beyond the current applications. Phase-change materials can upgrade them into tunable metasurfaces. Vanadium dioxide (VO2) represents a phase-change material, which can provide such tunability and which nanostructures were barely explored for metasurfaces in the visible. Here, we focus on the investigation of VO2 nanocylinders in the visible. For that, we use FDTD simulations based on the refractive index obtained from our optimized VO2 thin film.

P21: Numerical study of the optical properties of disordered metallic grooves by a one-mode analytical model
Denis Langevin, Julien Jaeck, Eslam El Shamy, Riad Haïdar, Patrick Bouchon
DOTA, ONERA, Paris-Saclay University (France)

Metallic grooves of sub-wavelength dimensions behave like Fabry-Perot nano-cavities able to resonantly enhance the electromagnetic field. In this summary, the consequences of positional disorder on the optical behavior of groove arrays are presented. We show, with a specifically developed simulation tool, that disorder leads to a redistribution of energy compared to the periodic case. By studying arrays of variously shaped grooved, we also show that their optical response can be described by the individual sub-array responses.

16:00 - 17:10 — Victor Veselago Room

Session 3A31
Plenary Session III

16:00 : Plenary talk
Applications of metasurfaces: From multispectral imaging to optical communications and biosensing
Maiken H. Mikkelsen
Duke University (USA)

In this talk, I will present advances in plasmonic metasurfaces with examples of potential future applications

in a wide-variety of areas from multispectral imaging to optical communications and biosensing.

16:35 : Plenary talk
4D Structured Waves
Nader Engheta
University of Pennsylvania (USA)

Varying materials parameters in time, in addition to (or instead of) spatial inhomogeneities in material platforms, can provide additional degrees of freedom in structuring and sculpting waves that lead to interesting functionalities in wave-matter interaction. While the spatial and/or temporal variations of material parameters have certain analogies and similarities, they exhibit important differences. In this talk, I will present an overview of some of the ongoing research programs on this topic in my group, will discuss the salient features, and will forecast possible future directions.

Break

17:10 - 17:30

17:30 - 19:00 — Victor Veselago Room

Session 3A32

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

17:30 : Keynote talk
Design and Knowledge Discovery in Metastructures Using Manifold Learning
Ali Adibi
Georgia Institute of Technology (USA)

New techniques for design and optimization of electromagnetic nanostructures using manifold-learning techniques are discussed. Using the strong correlation among features of an electromagnetic problem, deep-learning techniques are employed to considerably reduce the dimensionality of the problem and thus, the computation complexity, without imposing considerable error. Deep-learning algorithms can be trained to relate the reduced-dimensionality design and response spaces and facilitate the solution of the inverse design problems that are complicated to solve with conventional techniques. In addition, by training manifold-learning algorithms in the reduced-dimensionality spaces, valuable insights about the feasibility of the response and the roles of design parameters can be obtained. This talk explains the importance of these approaches and their applications to high-impact photonic nanostructures.

18:00 : Keynote talk
Volumetric microscale gradient refractive index lenses and waveguides for ultra-dense 3D optics
Paul V. Braun
University of Illinois Urbana-Champaign (USA)

Here, we present Subsurface Controllable Refractive Index via Beam Exposure (SCRIBE), a lithographic approach that enables the fabrication of volumetric microscale gradient refractive index lenses and waveguides. The basis of SCRIBE is multiphoton polymerization inside monomer-filled nanoporous silicon and silica scaffolds. Adjusting the laser exposure during printing enables 3D submicron control of the polymer infilling and thus the refractive index over a range of greater than 0.3 and chromatic dispersion tuning. Combining SCRIBE's unprecedented index range and 3D writing accuracy has realized the world's smallest (15 μm diameter) spherical Luneburg lens operating at visible wavelengths.

18:30 : Keynote talk
Active Epsilon-Near-Zero Photonics
Howard Lee[1], Aleksei Anopchenko[1], Sudip Gurung[1], Khant Minn[2], Jingyi Yang[1]
[1] *University of California, Irvine (USA),* [2] *Baylor University (USA)*

This talk will review our recent development on conducting oxide and metallic nitride epsilon-near-zero optics. I will present our recent advances on the study of enhanced ultrafast nonlinearity and broadband and field-effect tunable absorption in ultrathin transparent conducting oxide ENZ materials meta-film fabricated by atomic layer deposition technique. In addition, I will discuss the photoluminescence enhancement of 2D materials on epitaxial titanium nitride thin films grown by molecular-beam-epitaxy. These studies enrich the fundamental understanding of emission and nonlinear properties on ENZ thin films that could be important for the development of advanced nanoscale lasers/light sources, optical/bio-sensors, and nano-optoelectronic devices.

17:30 - 19:00 — Allan Boardman Room

Session 3A33

Symposium I: Hybrid Nanomaterials and Metastructures for Photonics, Sensing and Energy

Organized by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

Chaired by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

17:30 : Invited talk
Photoelectrochemical Methanol Oxidation under Visible and UV Excitation of TiO2-supported TiN and ZrN Plasmonic Nanoparticles
Olga Baturina[1], Albert Epshteyn[1], Jonathan A Boltersdorf[2], Gregory T Forcherio[3], Asher C Leff[4], Andrew Purdy[1], Blake Simpkins[1], Eva Y Santiago[5], Alexander Govorov[5]
[1]US Naval Research Laboratory (USA), [2]US Army Research Laboratory (USA), [3]Naval Warfare Center (USA), [4]General Technical Services (USA), [5]Ohio University (USA)

Combined experimental and computational approaches are used to optimize the performance of TiO2-supported TiN and ZrN nanoparticles towards photoelectrochemical methanol oxidation. Issues leading to performance losses are analyzed and mitigation strategies are proposed.

17:50 : Invited talk
Non-Hermitian Approach for Modelling Hybrid Quantum Dot/Plasmon Systems
Cristian L. Cortes, Matthew Otten, Stephen K. Gray
Argonne National Laboratory (USA)

A non-Hermitian model for modelling quantum dot/plasmon interactions including dissipation and dephasing is analysed. Optical spectra in the linear regime are adequately described and the model also describes time-dependent coherences qualitatively when both dissipation and dephasing are present, and quantitatively with neglect of dephasing. Results for a large number of quantum dots allow assessing the role of coupling disorder. Interestingly, disorder can help stabilize the ensemble average towards a dark steady-state, a result of potential relevance to sensing applications.

18:10 : Invited talk
3D-Printed Terahertz Resonant Nanocones
Andrea Rovere[1], Riccardo Piccoli[1], Andrea Bertoncini[2], Young-Gyun Jeong[1], Stéphane Payeur[1], François Vidal[1], O-Pil Kwon[3], Seung-Heon Lee[3], Roberto Morandotti[1], Carlo Liberale[2], Luca Razzari[4]
[1]INRS - Énergie, Matériaux et Télécommunications (Canada), [2]KAUST (Saudi Arabia), [3]Ajou University (Korea), [4]INRS - Energie, Matériaux et Télécommunications (Canada)

Arrays of gold-coated 3D-printed nanocones resonating in the terahertz frequency range are investigated.

18:30 : DNA Based Optical Nano-sensor for Hazardous Molecules Detection
Sarabjeet Kaur, Safi Jradi, Julien Proust
Universite de Technologie de Troyes (France)

The prolonged use of toxic pesticides in agriculture lead to their introduction into the food chain which results in the interaction of these molecules with DNA and could create some mutations and induce translocation

leading to many diseases such as cancer. The aim of this research is to develop a unique Nano-biosensor which can detect chemical agents that interact and induce changes in structure of DNA. The detection is based on field enhancement from coupled gold nanoparticles (AuNPs) in solution.

18:45 : Light induced adaptation of structural colour and light absorption enhancement in photosynthetic photonic organelles
Miguel A. Palhinha Castillo, William P. Wardley, Martin Lopez-Garcia
International Iberian Nanotechnology Laboratory (Portugal)

In this work, we communicate a theoretical investigation on a naturally occurring photonic crystal: the iridoplast, an adapted photosynthetic organelle found in plants living under low light conditions. Our numerical study suggests that these structures could be controlling the absorption and the reflectance of light in order to enhance photosynthetic activity. We model purely light dependent structural changes based on experimental reports. This could therefore have potential interest in other technological areas such as coloured solar cells.

17:30 - 19:00 — Tatsuo Itho Room

Session 3A34

Plasmonics and nano-optics

17:30 : A Near-Perfect Optical Metamaterial Absorber and Its Applications
Mahdi Safari, Joel Y. Y. Loh, George V. Eleftheriades, Nazir P. Kherani
University of Toronto (Canada)

Here, we propose a metamaterial structure composed of Cu nano-cubes distributed on a Au-Cu bilayer thin film stack for near-perfect broadband optical absorption. We demonstrate $textgreater95\ \%$ absorption in this structure over wavelengths ranging from 200 to 600 nm.

17:45 : Integrated Photodetection Leveraging Plasmonic Radiation Pressure
Jared H. Strait[1], Christian Haffner[1], Junyeob Song[1], Glenn Holland[1], Wei Zhou[2], Amit Agrawal[3], Henri J. Lezec[1]
[1] *National Institute of Standards and Technology (USA),* [2] *Virginia Tech (USA),* [3] *University of Maryland (USA)*

We present novel integrated photodetectors based on the radiation pressure of a plasmonic mode. Light absorbed in a plasmonic or hybrid plasmonic/optical waveguide builds a voltage along the length of the waveguide via the photon-drag effect. We implement this device concept for the first time and investigate its potential for fast, broadband, and inexpensive optical detection in an integrated platform.

18:00 : Photoinduced Forces on Dielectric Nanoantennas
Martin Poblet[1], Yi Li[2], Gustavo Grinblat[1], Emiliano Cortés[2], Stefan Maier[2], Andrea Bragas[1]
[1] *Universidad de Buenos Aires (Argentina),* [2] *Ludwig-Maximilians-Universität München (Germany)*

In this work we study optical forces produced by an all-dielectric germanium nanoantenna illuminated at resonance, through Photo-Induced Force Microscopy (PIFM). We investigate the electric and magnetic components of the optical forces and analyze the results through numerical simulations.

18:15 : Ultrafast all-optical modulation in dielectric nanoantennas at anapole resonances
Gustavo Grinblat[1], Michael Nielsen[2], Rodrigo Berté[3], Haizhong Zhang[4], Yi Li[3], Leonid Krivitsky[4], Benjamin Tilmann[3], Emiliano Cortés[3], Arseniy Kuznetsov[4], Rupert Oulton[5], Stefan Maier[3]
[1] *Universidad de Buenos Aires (Argentina),* [2] *University of New South Wales (Australia),* [3] *Ludwig-Maximilians-Universität München (Germany),* [4] *A*STAR (Singapore),* [5] *Imperial College London (United Kingdom)*

In this investigation we study the ultrafast optical modulation performance of individual silicon and gallium phosphide (GaP) nanoantennas through pump-probe spectroscopy using sub-10 fs pulses. We find that a GaP nanoantenna excited at the anapole resonance outperforms its analog silicon resonator by two orders of magnitude, showing modulation depths close to $30\ \%$ at sub-30 fs time scales.

18:30 : Epitaxial Growth of Single Crystal Noble Metals for Plasmonic and Nanophotonic Applications

Sasan V. Grayli[1], **Xin Zhang**[2], **finlay MacNab**[2], **Dmitry Star**[2], **Gary Leach**[2], **Michael Reimer**[1]
[1] *University of Waterloo (Canada),* [2] *Simon Fraser University (Canada)*

Plasmonic structures made from monocrystalline metals display lower absorption losses and much higher stability than polycrystalline devices which are subject to many losses due to the presence of grain boundaries. With the help of an epitaxial electroless chemistry, ultrasmooth gold films are grown on monocrystalline silver. Our approach enables the growth of gold with improved pattern transfer yield, reduced optical and resistive losses, and tailored local fields to yield greater optical response as compared to those of polycrystalline films.

18:45 : Width-graded plasmonic resonator arrays for broadband infrared spectroscopy
Katelyn Dixon[1], **Arthur Montazeri**[2], **Liang Chen**[2], **Moein Shayegannia**[1], **Stefano Cabrini**[2], **Nazir Kherani**[1], **Hoi-Ying Holman**[2]
[1] *University of Toronto (Canada),* [2] *Lawrence Berkeley National Laboratory (USA)*

Plasmonic field enhancement is used to amplify signals in various optical sensing techniques. However, the design of resonant devices in the infrared remains a challenge due to the high aspect ratios required and lack of repeatable fabrication methods. We present a facile technique for the fabrication of metal-insulator-metal (MIM) thin film resonator arrays suitable for field enhancement across the infrared range. Plasmonic absorption in these arrays is demonstrated through infrared spectroscopy and corroborated via simulation.

17:30 - 18:30 — Christian Huygens Room

Session 3A35
Metamaterials and metasurfaces

17:30 : A perfect lens for static magnetic fields
Rosa Mach-Batlle[1], **Mark G Bason**[2], **Nuria Del Valle**[1], **Jordi Prat-Camps**[2]
[1] *Universitat Autonoma de Barcelona (Spain),* [2] *University of Sussex (United Kingdom)*

Perfect lenses are one of the most intriguing devices brought by negative refraction. In this work, we show that the recent introduction of negative permeability in magnetostatics enables the creation of a device analogous to a perfect lens in the magnetostatic limit. Experimental results demonstrate that this lens achieves a strong focusing of magnetic fields and makes it possible to create and cancel magnetic sources remotely, something unachievable with conventional devices with positive permeability.

17:45 : Microplotter printing of ultra-thin metasurfaces for the sub-terahertz domain
Cyprien Brulon, Arthur Salmon, Baptiste fix, Patrick Bouchon
ONERA (France)

Inkjet printing is a promising low-cost alternative to conventional optical lithography for the fabrication of terahertz metasurfaces. In this work, we discuss a new printing process and the fabrication of sub-terahertz metallic metasurfaces composed of periodical arrays of split ring resonators on ultra-thin substrate. The optical response in transmission of the metasurfaces shows resonances around 70 GHz, which is consistent with numerical simulations and demonstrates the use of microplotter system for rapid prototyping of low-loss terahertz passive components.

18:00 : A dielectric metasurface-polarimeter for single-shot detection of arbitrary polarization states
Yash Diptesh Shah, James P. Grant, Charles Altuzarra, Ashley Lyons, Daniele Faccio
University of Glasgow (United Kingdom)

We present a dielectric metasurface using an asymmetric design that exploits exotic multipolar interactions forming polarisation-dependent resonant eigenmodes. We experimentally demonstrate single-shot full-state polarimetry.

18:15 : Reconfigurable Terahertz Holographic CMOS Metasurface using Electromagnetic-Circuit Co-design Approach
Suresh Venkatesh, Xuyang Lu, Hooman Saeidi, Kaushik Sengupta
Princeton University (USA)

In this article, we demonstrate a digitally reconfigurable metasurface at 0.3THz exploiting the electromagnetic-circuit co-design approach. The metasurface is fabricated using industry-standard 65-nm CMOS process and the reconfiguration happens through digitally controlled CMOS switches. We also show scalability by chip tiling approach and also demonstrate multi-functionality (beamforming, holographic projections, spatial light modulation).

17:30 - 18:50 — Augustin Fresnel Room

Session 3A36

Light-matter interactions in new materials and meta-architectures

Organized by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

Chaired by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

17:30 : Invited talk
Ultra-Compact Photonic Modulator based on Accumulation-Layer Surface Plasmons
Viktoriia Babicheva
University of New Mexico (USA)

Most commonly studied electro-optic modulators employ several electro-optical mechanisms such as Pockels, Kerr, or carrier concentration change effects to modulate the phase and amplitude of light propagating through the device. In this work, we consider a transparent conducting oxide (TCO) based electro-optic modulator and demonstrate the propagation of surface plasmons due to the accumulation of carriers in the thin TCO layers under external electrical bias.

17:50 : Invited talk
Photonics with Metallic Alloys
Marina S. Leite
University of California (USA)

We propose metallic alloys and intermetallic materials as a platform to control the electromagnetic spectrum in the UV-NIR range. Opportunities for developing optical components using metallic materials beyond noble metals for applications including superabsorbers, NIR photodetectors, and catalysis, among others will be discussed.

18:10 : Invited talk
Polar Semiconductors as Long-Wavelength Epsilon-Near-Zero Materials
Milan Palei, Irfan Khan, Owen Dominguez, Junchi Lu, Ryan Roeder, Anthony Hoffman
University of Notre Dame (USA)

Polar semiconductors exhibit a region of negative permittivity between the longitudinal optical (LO) and transverse optical (TO) phonons. At energies close to the LO phonon energy, the real part of the optical permittivity approaches zero and the imaginary part is also very small, the so-called epsilon-near-zero (ENZ) spectral regime. We show how the ENZ and negative permittivity regions can be leveraged for a new generation of long-wavelength optical devices and materials.

18:30 : Invited talk
Diagnostic Colorimetric Metasurfaces Visualize Disease in fibrous Biological Tissue
Lisa V. Poulikakos[1], Zaid Al Haddadin[1], Trinity C. Pike[1], Jebin J. Moses[1], Aniket S. Puri[1], Mark Lawrence[2], David R. Barton[3], Stefanie S. Jeffrey[4], Jennifer A. Dionne[4]
[1] *University of California (USA),* [2] *Washington University St. Louis (USA),* [3] *Harvard University (USA),* [4] *Stanford University (USA)*

We leverage the unique properties of anisotropic, colorimetric metasurfaces to scale down the complex manipulation of light and selectively visualize disease-relevant fiber density and orientation in biological tissue. Ranging from Alzheimer's disease to heart disease, fibrosis or cancer, we discuss the potential of metasurfaces to yield rapid, precise, low-cost diagnostics.

17:30 - 19:00 — Ibn Al-Haytham Room

Session 3A37
Quantum and topological photonics

17:30 : Optical Magnetism in a Quantum System without Matematerials
Kyle Ballantine, Janne Ruostekosk
Lancaster University (United Kingdom)

We propose how to synthesize optically active magnetism without metamaterials using quantum-mechanical electric dipole transitions of naturally occurring atoms. We extend the method for toroidal dipoles and anapoles, and a physical realization of a quantum Huygens' surface that allows for extreme wavefront engineering even at a single photon level. Examples of focusing and steering light, and generations of entangled quantum superposition states with additional photons are provided.

17:45 : Majorana-like bound state in Kekule distorted sonic lattices
Penglin Gao[1], Daniel Torrent[2], Francisco Cervera[3], Pablo San-Jose[4], Jose Sanchez-Dehesa[3], Johan Christensen[1]
[1] *Universidad Carlos III de Madrid (Spain),* [2] *Universitat Jaume I (Spain),* [3] *Universitat Politecnica de Valencia (Spain),* [4] *Instituto de Ciencia de Materiales de Madrid (ICMM-CSIC) (Spain)*

Topological phases have recently been unveiled in bosonic systems to facilitate the manipulation of waves in unprecedented ways. Here we demonstrate a new type of matter supporting non-propagating localized state that is topologically protected and robust against any parameter perturbations given that the intrinsic particle hole symmetry is preserved, ie., an acoustic analogue of Majorana bound state. Our work might broaden exciting avenues for robust sound confinement and energy harvesting in industries.

18:00 : Integration of nitrogen-vacancy center into an one-dimensional photonic crystal cavity
Jan Olthaus[1], Philip P. J. Schrinner[2], Carsten Schuck[2], Doris E. Reiter[1]
[1] *University of Munster (Germany),* [2] *Center for NanoTechnology CeNTech and Center for Soft Nanoscience SoN (Germany)*

Photonic crystal cavities based on on-substrate tantalum pentoxide waveguides are optimised for coupling to nitrogen vacancy centers in nanodiamond using 3D-FDTD simulations. Coupling conditions depending on the position and size of the nanodiamonds are studied. Antibunching of the photoluminescence signal of an integrated nitrogen-vacancy center in nanodiamond coupled to a 1D photonic crystal cavity is observed experimentally.

18:15 : Spontaneous emission enhancement of handed molecules
Karolina Slowik, Miriam Kosik
Nicolaus Copernicus University (Poland)

A theory of interactions of nanostructured quantum vacuum with atomic systems beyond the electric dipole approximation has recently been developed. Based on that input, in this work we investigate spontaneous emission enhancement of right- and left-handed molecules via the Purcell effect in proximity of plasmonic or dielectric nanocavities. Our conclusion is that the handedness of an atomic system may have major influence on its emission rate in suitably tailored nanophotonic environments.

18:30 : Dispersion engineering for an ultraviolet frequency comb
Ali E. Dorche[1], Dogan Timucin[2], Krishnan Thyagarajan[2], Noble Johnson[2], Thomas Wunderer[2], David E. Schwartz[2]
[1] *Georgia Institute of Technology (USA),* [2] *Palo Alto Research Center (PARC) Inc. (USA)*

Anomalous dispersion engineering in the ultraviolet (UV)spectrum is used for efficient bright soliton-based optical frequency comb generation. We have overcome normal dispersion in a III-Nitride platform to create a wideband Kerr frequency comb, with a free spectral range of 400GHz, centered at 442 nm, to ensure that the Raman gain does not compete with the four-wave mixing gain. This paves the way for applications of fine UV spectral linesin quantum computing, metrology, optical clocks, inertial navigation and secure communication technologies.

18:45 : Lamb-Dicke Confinment of Cold Atoms in Ferris Wheels

V. E. Lembessis, A. Lyras, O. M. Aldossary
King Saud University (Saudi Arabia)

We investigate the case of strong confinement of a Cs cod atom that is trapped in an optical Ferris wheel light field. We show that it is possible to reach the Lamb-Dicke limit for parameter values that are typically used in cold atom physics experiments.

17:30 - 18:50 — Gaston Floquet Room

Session 3A38

Topology in photonic crystals, metamaterials, and metasurfaces: physics and design

Organized by: Yang Li and Benfeng Bai

Chaired by: Yang Li and Benfeng Bai

17:30 : Invited talk
Inverse design of metasurfaces and photonic systems for enhanced Raman scattering
Rasmus E. Christiansen[1], Jérome Michon[2], Ying Pan[2], Ole Sigmund[1], Juejun Hu[2], Steven G. Johnson[2]
[1] *Technical University of Denmark (Denmark),* [2] *Massachusetts Institute of Technology (USA)*

We propose and investigate designs for nano-patterned surfaces and devices, tailored to maximize the surface enhanced Raman scattering (SERS) occurring from molecules placed near them. The designs are created using our extended version of a recently proposed approach, utilizing topology optimization as an inverse design tool. The modified approach takes additional limitations in the fabrication process into account in order to minimize the discrepancies between the design blueprint and the fabricated metasurface.

17:50 : Invited talk
Inverse Design Towards Global Performance Bounds
Owen Miller
Yale University (USA)

We demonstrate the capability to design structures approaching fundamental nanophotonic performance limits. We use inverse design in tandem with analytical and computational bound techniques to identify opportunities for improvement across various applications, and discover designs with state-of-the-art performance. We design minimal-thickness perfect absorbers, maximal-efficiency grating couplers, and minimal-mode-volume dielectric resonators (where we show the capability to incorporate fabrication and multi-frequency constraints). More broadly, we discuss general principles for identifying nanophotonic limits and designing devices to approach them.

18:10 : Invited talk
T Operator Bounds for Electromagnetic Power Transfer
Sean Molesky[1], Pengning Choa[1], Prashanth S. Venkataram[1], Weiliang Jin[2], Alejandro W. Rodriguez[1]
[1] *Princeton University (USA),* [2] *Standford University (USA)*

We present a method for utilizing power transfer constraints on the electromagnetic scattering operator to set physical bounds on any single material design problem that can be framed as a net emission, scattering or absorption process. The technique is found to predictively quantify and differentiate the relative performance of dielectric and metallic materials for both far and near-field sources. The broad applicability of scattering theory means that similar application to acoustics, quantum mechanics, and other wave physics are likely possible.

18:30 : Invited talk
Multi-Layered Meta-Optics by Inverse Design
Zin Lin, Steven G. Johnson
Massachusetts Institute of Technology (USA)

To successfully address the issues besetting the state-of-the-art LPA-based metasurface designs, we pro-

pose a novel computational approach with three key components: multiple interacting layers with deeply sub-wavelength separations (three-dimensional single-piece nanophotonics) designed by large-scale optimization techniques (inverse design and topology optimization), using more sophisticated overlapping domain-decomposition methods superior to LPA.

17:30 - 19:00 — Lawrence Bragg Room

Session 3A39
Nonlinear metamaterials

17:30 : All-Optical Switching of an Epsilon-Near-Zero Plasmon in ITO
Justus Bohn[1], Craig Tollerton[1], Ting Shan Luk[2], Igal Brener[2], Bill Barnes[1], Euan Hendry[1]
[1] *University of Exeter (United Kingdom),* [2] *Sandia National Laboratories (USA)*

A new class of materials with a vanishing permittivity, known as epsilon-near-zero (ENZ) materials, has been reported to exhibit unprecedented ultrafast nonlinear efficiencies within subwavelength propagation lengths. We study the pump dependent near perfect absorption ENZ plasmonin a thin indium tin oxide (ITO) layer. Utilising the Kretschmann configuration combined with the ENZ plasmon resonance could pave the way towards ultrafast switching from near-perfect absorption to total internal reflection or vice versa.

17:45 : Negative refraction in time-varying, strongly-coupled plasmonic antenna-ENZ systems
Vincenzo Bruno[1], Clayton DeVault[2], Stefano Vezzoli[3], Zhaxylyk Kudyshev[2], Tahiyat Huq[3], Sandro Mignuzzi[3], Andrea Jacassi[3], Soham Saha[2], Yash Diptesh Shah[1], Stefan Maier[4], David Cumming[1], Alexandra Boltasseva[2], Marcello Ferrera[5], Matteo Clerici[1], Daniele Faccio[1], Riccardo Sapienza[3], Vladimir Shalaev[2]
[1] *University of Glasgow (United Kingdom),* [2] *Purdue University (USA),* [3] *Imperial College London (United Kingdom),* [4] *Ludwig-Maxilimians-Universitat Munchen (Germany),* [5] *Heriot-Watt University (United Kingdom)*

We demonstrate high efficiency in the generation of optical induced time-reversal phase conjugate and negative refraction waves, from a temporal modulated deeply subwavelength epsilon-near-zero (ENZ) film integrated within a plasmonic metasurface. The strong coupling between the plasmonic resonance and the ENZ modes leads to a conversion efficiency that is more than 4 orders of magnitude greater than the bare ENZ film.

18:00 : Interaction based nonlinearity of a deep subwavelength plasmonic heterodimer
Avi Niv
Ben-Gurion University of The Negev (Israel)

Conventionally, optical nonlinearity emerges from the linear fields that echo the linear optical response. Contrarily, we demonstrate a pure second-harmonic resonance, without a linear counterpart, and propose a dynamic model of its origin.

18:15 : Modelling the Thermo-Optic Non-Linear Behavior of 2D Photonic Crystal Cavities
Simone Iadanza[1], Marco Clementi[2], Changyu Hu[3], Sebastian A. Schulz[4], Dario Gerace[2], Matteo Galli[2], Liam O'Faolain[1]
[1] *Cork Institute of Technology (Ireland),* [2] *Universita di Pavia (Italy),* [3] *University College Cork (Ireland),* [4] *University of St. Andrews (United Kingdom)*

We present a first principles model for the thermo-optic nonlinearities of PhC cavities. The match between the calculations and experiments demonstrated here renders the model a crucial predicting tool for the development of nonlinear microcavities

18:30 : Exploiting time-dependent metamaterials for frequency conversion in guided-wave structures
Victor Manuel Pacheco Peña[1], Nader Engheta[2]
[1] *Newcastle University (United Kingdom),* [2] *University of Pennsylvania (USA)*

In this work we study theoretically the effect of using time-dependent metamaterials filling the cladding of optical waveguides and ring resonators as a technique to effectively change the frequency of the wave traveling in such guided-wave structures in real time. The physics behind using such temporal metamaterial clads is

discussed and demonstrated numerically at telecommunication wavelengths.

18:45 : A quasi-planer approach to dynamic meta-surfaces via band-gap engineered, electrio-optic quantum effects
Walter R Buchwald
University of Massachusetts Boston (USA)

finite element simulations motivate placement of a 2-level quantum well within the near surface depletion region of a Schottky contact producing a quantum system of three-dimensionally confined hetero-interface charge allowing both voltage and optical control of electron occupancy. This electro-optic quantum system is discussed in relation to dynamic nano-photonic metasurfaces.

17:30 - 18:40 — Rene Descartes Room

Session 3A40

Structured and topological photonic fields

Organized by: Jamal Berakdar

Chaired by: Jamal Berakdar

17:30 : Invited talk
Matter and optical vortices and their interactions
M. Babiker[1], V. E. Lembessis[2], Koray Kooksal[3], J. Yuan[1]
[1] *University of York (UK),* [2] *King Saud University (Saudi Arabia),* [3] *Bitlis Eren University (Turkey)*

This talk deals with optical and matter vortices, singly and interacting. The ability to generate optical matter vortices, suggests scenarios where vortex atoms interact with vortex photons. These lead to new physics, most notably exchange of orbital angular momentum, spin-orbit coupling where the longitudinal optical field component comes into play. We highlight novel situations with chiral trapping potentials due to bi-chromatic doughnut beams. The spin-orbit interaction and the longitudinal field components are emphasised to be crucial in this context.

17:50 : Invited talk
Structured ultrafast high-harmonic pulses
Carlos Hernández-García
Universidad de Salamanca (Spain)

Coherent extreme-ultraviolet/soft x-ray pulses structured in their temporal (attosecond), spectral (line spacing) and angular momentum (polarization and topological charge) properties is nowadays possible thanks to high harmonic generation. In this talk we review our recent work in the generation and control of ultrafast structured harmonic pulses through the use of infrared driving beams with custom angular momentum properties.

18:10 : Photonic simulation of Rashba-Dresselhaus spin-orbit coupling in a tunable birefringent cavity
Katarzyna Rechcinska[1], Mateusz Krol[1], Rafal Mazur[2], Przemyslaw Morawiak[2], Rafal Mirek[1], Karolina lempicka[1], Witold Bardyszewski[1], Michal Matuszewski[3], Przemyslaw Kula[2], Wiktor Piecek[2], Pavlos G. Lagoudakis[4], Barbara Piętka[1], Jacek Szczytko[1]
[1] *University of Warsaw (Poland),* [2] *Military University of Technology (Poland),* [3] *Polish Academy of Sciences (Poland),* [4] *University of Southampton (United Kingdom)*

Rashba and Dresselhaus effects well known in semiconductor physics have inspired the field of spintronics by providing a means of spin manipulation. In this communication we will demonstrate how these phenomena can be simulated in a purely photonic system. Experimental spectra of a tunable liquid-crystal-based device will be presented opening the avenue for novel technical solutions which exploit the analogy between the electron's spin and photon's polarization.

18:25 : Three-dimensional vectorial holography based on machine-learning inverse design
Haoran Ren[1], Wei Shao[2], Yi Li[3], Flora Salim[2], Min Gu[4]

[1] *Ludwig-Maximilians-Universitat Munchen (Germany),* [2] *RMIT University (Australia),* [3] *Southern University of Science and Technology (China),* [4] *University of Shanghai for Science and Technology (China)*

We demonstrate 3D vectorial holography where an arbitrary 3D vectorial field distribution on a wavefront can be precisely reconstructed using the machine-learning inverse design based on multilayer-perception artificial neural networks. Such 3D vectorial holography allows the lensless reconstruction of a 3D vectorial holographic image with near-unity 3D polarization purity. Holographic information can thus be encoded and encrypted on the wavefront of a 3D vectorial field.

18:00 - 19:00 — Tutorial Room

Session 3A41

Conference Tutorials III

Organized by: Ishwar Aggarwal

18:00 : Tutorial

New Artificial-Intelligence Techniques for Electromagnetic Metastructures

Ali Adibi

Georgia Institute of Technology (USA)

A survey of new artificial-intelligence-based approaches for analysis, design, optimization, and knowledge discovery in electromagnetic metastructures will be presented. Recent advances in using both deep learning and machine learning techniques, and their application to practical problems will be covered. These techniques will not only enable more efficient designs of the electromagnetic metastructures (e.g., photonic metasurfaces) but also provide valuable insight about the complex physics of light-matter interactions in such structures. Details of the training process for these algorithms as well as the challenges and limitations of these techniques for different classes of metastructures will be discussed. Knowledge discovery using these techniques includes the study of feasibility of a certain optical response from a given class of metastructures and comparing the roles of different design parameters to facilitate the inverse design process.

Friday 23rd July, 2021

09:00 - 10:55 — Victor Veselago Room

Session 4A1

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

09:00 : Biomimetic Ultra-Broadband Perfect Absorbers Optimised with Reinforcement Learning
Trevon Badloe, Inki Kim, Junsuk Rho
Pohang University of Science and Technology (POSTECH) (Korea)

A double deep Q-learning network (DDQN) is used to design ultra-broadband, biomimetic, perfect absorbers with various materials, based the structure of a moth's eye. By training a DDQN with chromium-based design, we transfer the learned knowledge to other, similar materials to quickly and efficiently find the optimal parameters from the ∼1 billion possible options. The previously learned knowledge helps the network optimise new materials in fewer steps, dramatically increasing the efficiency of finding the best designs for ultra-broadband absorption.

09:15 : Invited talk
Near-field heat flux control with many thermal emitters: theory and applications
Philippe Ben-Abdallah
Laboratoire Charles Fabry (France)

Near-field radiative heat transfer between two bodies is an old problem in physics. In 2011, the theoretical foundations have been introduced to deal with near-field heat exchanges in many-body systems. In this presentation I will introduce the theoretical framework to describe this physics and i will discuss some of its potential applications.

09:35 : Invited talk
Arbitrary Order Exceptional Point Induced by Photonic Spin-Orbit Interaction
Shubo Wang[1], Bo Hou[2], C. T. Chan[3]
[1] *City University of Hong Kong (China),* [2] *Soochow University (China),* [3] *The Hong Kong University of Science and Technology (China)*

Exceptional points in non-Hermitian systems have many intriguing properties and novel applications. High order exceptional points normally require delicate variations of multiple parameters and are difficulty to achieve. In this talk, we will show that photonic spin-orbit interaction can induce exceptional points of arbitrary order without tuning any parameters.

09:55 : Invited talk
Compact and Integrated Imaging Based on Metalenses
Tao Li, Chen Chen, Beibei Xu, Shining Zhu
Nanjing University (China)

Recent progresses in metasurface have opened a door of new type of ultra-thin optical elements for versatile applications. Here, I would like to show our recent progress in the spectral tomographic imaging based on aplanatic metalens, which was implemented by sweeping the wavelength the tuning the focal length and achieved and DOF resolved microscopic imaging. Afterwards, an integrated device has been constructed by mounting metalens directly onto a CMOS sensor to access a compact, stable, and wide-field microscopy.

10:15 : Invited talk
Highly efficient nanophotonic color router for sub-micron-pixel CMOS imagers
Hongkyu Park, Sookyoung Roh, Sangyun Lee, Minwoo Lim, Hyuck Choo, Seokho Yun
Samsung Advanced Institute of Technology (Korea)

We have demonstrated novel nanophotonic color-routing structures that can efficiently split and focus different

colors onto corresponding pixels of an image sensor. Direct color-separating capability without the use of absorptive filters provides each pixel with more photons of the desired wavelength, resulting in higher signal-to-noise ratios.

10:35 : Invited talk
Metasurfaces with Maxwell's demon-like nonreciprocity
Kin Hung Fung
The Hong Kong Polytechnic University (China)

09:00 - 10:10 — Allan Boardman Room

Session 4A2

Symposium I: Hybrid Nanomaterials and Metastructures for Photonics, Sensing and Energy

Organized by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

Chaired by: Jérôme Plain, Alexander Govorov, Davy Gérard and Pedro Hernandez Martinez

09:00 : Invited talk
Extracting Meaning from the Analysis of Photoluminescence Decays of Colloidal Quantum Dots: What's in a Function?
Ana Luisa Simões Gamboa[1], **Evgeny N. Bodunov**[2]
[1] *ITMO University (Russia),* [2] *Emperor Alexander I Petersburg State Transport University (Russia)*

We discuss functions for the description of the room-temperature photoluminescence decay of colloidal quantum dots that are practical to use and whose parameters have a straightforward physical meaning. We introduce a function that accounts for the long-time tails of the decays, highlighting processes that may be related to photoluminescence blinking, and which use can provide valuable information concerning the nature of the trap states involved in the recombination of charge carriers.

09:20 : Invited talk
High quality factor Tamm structures for the development of laser sources at room temperature
Clementine Symonds, Vincent Toanen, Jean-Michel Benoit, Alban Gassenq, Joel Bellessa
Université de Lyon (France)

Tamm structures offer very versatile approaches to develop confined lasers, polarized lasers or plasmon sources. We propose here an optimized design of these structures, enabling an increase by a factor 5 of their quality factor, which is a critical parameter for various applications. In particular, we will show that these optimized structures enable room temperature lasing operation. This first demonstration is an important step toward future applicative developments of Tamm devices.

09:40 : Surface-enhanced Absorption Principle of Thin film Sensing in the Mid-infrared
Dmytro Chubich, Roman Zvagelsky, Danila Kolymagin, Anstasia Pisarenko, Elena Zhukova
Moscow Institute of Physics and Technology (Russia)

We fabricated arrays of periodic nanoantennas with plasmonic resonances between 1300 cm-1 and 2300 cm-1 on a single chip and demonstrated the ability of infrared signal enhancement on specific analyte with vibrational lines close to resonances of fabricated nanoantennas.

09:55 : Single molecule studies of metal-enhanced fluorescence and resonance energy transfer interplay in graphene-metallic hybrid nanostructure
Kamil Wiwatowski[1], **Karolina Sulowska**[2], **Sebastian Mackowski**[2], **Joanna Niedziolka-Jönsson**[1]
[1] *Polish Academy of Sciences (Poland),* [2] *Nicolaus Copernicus University (Poland)*

In this work, we use single molecule fluorescence spectroscopy to probe nanoscale interactions in hybrid nanostructures composed of graphene and silver nanowires. The presence of metallic nanoparticles or graphene in hybrid nanostructure can induce fluorescence enhancement, fluorescence quenching or their interplay in nearby emitter, depending on nanostructure arrangement.

10:10 - 10:55 — Allan Boardman Room

Session 4A3

Photonic bandgap structures

10:10 : Hybrid External Cavity Laser based on Silicon Nitride 1D Photonic Crystals Cavities for optical sensing in gasses and liquids
Simone Iadanza, A. Tedesco, G. Giannino, M. Grande, L. O'Faolain
Cork Institute of Technology (Ireland)

In this paper we demonstrate a 1D silicon nitride photonic crystal cavity for optical sensing operating in the NIR wavelength range, in liquids and gasses.

10:25 : Vertical assisted directional-coupler from Silicon-on-Insulator to Silicon Nitride platforms
L. Zagaglia[1], S. Argiolas[2], S. Iadanza[1], L. O'Faolain[1], G. Mura[2], F. Floris[1], P. O'Brian[1]
[1] *Tyndall National Institute (Ireland),* [2] *DIEE-University of Cagliari (Italy)*

Silicon (Si) and Silicon Nitride (Si3N4) are two leading materials for the creation of photonic integrated circuits (PICs). The necessity of efficiently couple light between Si-PICs and Si3N4-PICs is becoming more relevant to face crucial applications in various technologic sectors, as high bandwidth optical interconnects and mid-infrared and visible optical sensing. However, the strong refractive index mismatch between Si and Si3N4 leads to challenging coupling between the elements used to carry the light throughout the PICs (waveguides). We propose a solution based on a vertical assisted directional-coupler allowing a theoretical -2.2dB insertion-loss and a 30nm bandwidth.

10:40 : Near-field optical investigation of Hyperuniform Disordered photonic structures
Nicoletta Granchi[1], Richard Spalding[2], Matteo Lodde[3], Maurangelo Petruzzella[3], Frank Wan Otten[3], Andrea fiore[3], Francesca Intonti[1], Riccardo Sapienza[4], Marian Florescu[2], Massimo Gurioli[1]
[1] *University of Florence (Italy),* [2] *University of Surrey (United Kingdom),* [3] *Eindhoven University of Technology (The Netherlands),* [4] *Imperial College London (United Kingdom)*

Located in-between random structures and perfectly ordered photonic crystals, there is a special class of disordered heterostructures called hyperuniform disordered (HuD) photonic structures. These materials, due to the presence of a photonic bandgap, combine the advantages of disordered systems and ordered systems: here, we underline and experimentally prove all these advantages by means of the first near-field optical characterization of HuD photonic structures in the near IR.

09:00 - 11:00 — Tatsuo Itho Room

Session 4A4

Advances in Metamaterials

Organized by: Jeong Weon Wu, Bumki Min and Jonghwa Shin

Chaired by: Jeong Weon Wu, Bumki Min and Jonghwa Shin

09:00 : Invited talk
Strain Responsive Elastomeric Metamaterials Made from PnP
Seokwoo Jeon
KAIST (Korea)

We propose a new type of three-dimensional (3D) nanocomposite film consisting of an ultrathin (∼60 nm) alumina nanoshell inserted between the elastomers in a perfectly periodic 3D nanonetwork. Numerous light-scattering nanogaps form at the interfaces of the alumina and the elastomers under stretching. This results in the uniform modulation of transmission from ∼90 % to 16 % at visible wavelengths and maintains its performances during repeated stretching/releasing over more than 10,000 cycles thanks to the perfect uniformity of the 3D structure.

09:20 : Invited talk
Elastic Metasurfaces tailoring reflections and refractions
Min Soo Kim, Sung Won Lee, Joo Hwan Oh
Ulsan National Institue of Science and Technology (Korea)

In this presentation, recent researches on elastic metasurfaces, thin artificial surface that can tilor elastic waves as desired, will be introduced. first, the reflection-type elastic metasurface will be focused, and a new idea of transmodal elastic metasurface will be introduced. After that, the refraction type elastic metasurface that can control the transmitted waves with a single doubly-negative unit will be explained. From these basic results, various new applications such as vibration and ultrasonic devices are expected.

09:40 : Invited talk
Metasurface for on chip nanophotnics
Soo Jin Kim
Korea University (Korea)

Metasurface has been drawn great scientific and practical interests due to its potential applications in novel optical devices. In this work, we build the designing strategy of metasurfaces for the applications in chip scale devices which feature effective spectral sorting on the nano-scaled photodetection systems. Furthermore, we show the electrical tuning of metasurface for the dynamic control of optical spin using the transparent conductive oxide combined with plasmonic metasurfaces.

10:00 : Invited talk
Soft Matters for Extremely High-Index Meta-Optics
Seungwoo Lee
Korea University (Korea)

Conventionally, meta-optics has benefitted from the rapid advances in semiconducting processing such as lithography and lift-off/etching of hard materials. Here, I'll introduce that it is time to widen our view of materials and relevant processing for meta-optics. Especially, colloidal self- assembly can extremely increase the polarization of effective medium and resultant refractive index.

10:20 : Invited talk
Cyclic group symmetric metasurface for optical spin-dependent beam separation
Yeon Ui Lee[1], Igor Ozerov[2], Frederic Bedu[2], Ji Su Kim[1], Frederic Fages[2], Jeong Weon Wu[1]
[1] *Ewha Womans University (Korea),* [2] *Aix-Marseille University (France)*

Geometric phase is introduced when a cross-polarization from nano-rod takes place. Here we introduce a cyclic symmetric metasurface composed of tapered arc nano-rods and explore how azimuthal angluar dependence determines the feature of spin-dependent beam separation.

10:40 : Invited talk
On-Demand Electrical Tuning of Metasurface with Complex Modulation for Arbitrary Wavefront Shaping
Junghyun Park, Byung Gil Jeong, Sun Il Kim, Duhyun Lee, Jisan Lee, Inoh Hwang, Hyuck Choo, Kyoungho Ha
Samsung Advanced Institute of Technology (Korea)

We present an ultrafast, electrically-tunable, 50-channel metasurface array that can generate arbitrary phases and amplitudes of light in reflection and achieves on-demand beam steering. The individual metasurface of the demonstrated array consists of an index-modulating indium tin oxide layer sandwiched between the individually addressable top and bottom electrodes. Applying separate biases to the electrodes modulates the charge concentration in the ITO layer, which allows independent control of the complex reflection coefficient and consequently the phase and amplitude of reflected light.

09:00 - 10:35 — Christian Huygens Room

Session 4A5

Metasurfaces and 2D Metamaterials in microwave region

Organized by: Badreddine Ratni and Shah Nawaz Burokur

Chaired by: Badreddine Ratni and Shah Nawaz Burokur

09:00 : Invited talk
Metasurface Hologram with High Quality in Microwave Region
Xumin Ding, Tianhao Wu, Chunsheng Guan, Zhuochao Wang, Kuang Zhang, Qun Wu
Harbin Institute of Technology (China)

Metasurfaces have shown great potential in controlling the propagation of light through the well-tailored scattering behavior of the constituent ultrathin planar elements with a high spatial resolution, making them suitable for holographic beam-shaping elements. Here, we review recent developments in the field of metasurface holography in microwave region.

09:20 : Invited talk
Independent Manipulation of Orthogonal Circular Polarizations based on Microwave Metasurface
Yueyi Yuan[1], Kuang Zhang[1], Xumin Ding[1], Badreddine Ratni[2], Shah Nawaz Burokur[2], Qun Wu[1]
[1] *Harbin Institute of Technology (China),* [2] *Université Paris Nanterre (France)*

In this paper, a transmissive-type metasurfaces based on multi-layer structure is proposed to independently manipulate the orthogonal circularly polarized wave in microwave region. Through combining the propagation phase and geometry phase principles, the opposite circularly polarized transmitted wave can be imposed independent spatial phase distributions to perform different wavefronts. Experimental measurement are conducted and effectively verified the feasibility of the proposed theory for artificial manipulation of circular polarization manipulation in microwave region.

09:40 : Invited talk
Angular Scattering Control with Multilayer Metasurface Stacks
Karim Achouri, Olivier J. F. Martin
EPFL (Switzerland)

In order to implement metasurface-based optical analog processing systems, we develop an analysis technique for computing the angular scattering response of multilayer metasurface stacks. This technique is based on an improved scattering matrix method and applies to bianisotropic metasurfaces for optimal field control.

10:00 : Invited talk
Glide-Symmetric Luneburg Lens Based on Substrate-Integrated-Holes
Oskar Zetterstrom, Ramez Hamarneh, Oscar Quevedo-Teruel
KTH Royal Institute of Technlology (Sweden)

We propose a novel parallel plate waveguide (PPW) metasurface. The PPW is periodically loaded with glide-symmetrically arranged dielectric-filled cavities in both conductors. By filling the cavities with dielectric, the equivalent refractive index increases. To facilitate the manufacturing using conventional methods, the walls of the cavities are implemented with metallic vias and the proposed structure is used to design a Luneburg lens. Compared to previous works on holey metasurfaces, the designed lens is cheaper and more resilient to manufacturing errors.

10:20 : Design Concept of Dual-Polarized Microwave Superscatterers
Vitalii Shcherbinin[1], Volodymyr Fesenko[1], Vladimir Tuz[2]
[1] *National Academy of Sciences of Ukraine (Ukraine),* [2] *Jilin University (China)*

It is shown that a subwavelength perfectly-electrically-conducting (PEC) cylinder with doubly periodic dielectric-filled slots features anisotropic surface impedance, which may ensure superscattering of both TEz- and TMz-polarized waves at a single frequency. Owing to this property, a slotted cylinder is demonstrated to operate as a dual-polarized superscatterer. A prototype of such superscatterer is designed to provide a broadband dual-polarized superscattering in the microwave range.

10:35 - 11:05 — Christian Huygens Room

Session 4A6

Metasurfaces, flat optics, FSS and HIS

10:35 : Efficient Mie Resonance of Metal-masked Titanium Dioxide Nanopillars
Xiao Shang, Lina Shi, Jiebin Niu, Changqing Xie
Chinese Academy of Sciences (China)

Here, we propose a simple design approach based on metal-masked titanium dioxide nanopillars, which can realize strong Mie resonance in metasurfaces and enables light confinement within itself over the range of visible wavelengths. By selecting the appropriate period and diameter of individual titanium dioxide nanopillars, the coincidence of resonance peak positions derived from excited electric and magnetic dipoles can be achived. And the optical properties in this design have been investigated with the finite-Difference Time-Domain(FDTD) solutions.

10:50 : Harnessing the Optical Performance of Metalenses with Numerical Aperture
Haowen Liang, Juntao Li
Sun Yat-sen University (China)

We present a crystalline silicon based metalens with effectively low loss and high-NA in air. This metalens can be further front-immersed in high index liquids, presenting much higher NA and diffraction-limited focusing.

09:00 - 10:00 — Augustin Fresnel Room

Session 4A7

Organic and Perovskite Optoelectronics

Organized by: Erik Lotfi

09:00 : Invited talk
Colloidal inorganic halide perovskite quantum dots optoelectronics
Chenghao Bi, Jifeng Yuan, Shixun Wang, Jianjun Tian
University of Science and Technology Beijing (China)

Colloidal inorganic halide perovskite CsPbX3 (x=Cl, Br, I) quantum dots (QDs) show great promising for high-performance photovoltaics and electro-optical converters owing to outstanding optoelectronic properties, such as potential multi-excitons generation, tunable band gap, high carrier mobility and narrow emission width. However, they are still suffering from low power conversion efficiency (PCE) and poor stability, which are hindering their practical application. In this talk, I will demonstrate our recent works that aimed at solving the issues above.

09:20 : Invited talk
Unique Room-Temperature Solution-Processes for High Performance Organic and Perovskite Optoelectronic Devices
Wallace Choy
The University of Hong Kong (Hong Kong)

Room-temperature solution process will be discussed for various optoelectronic devices fabrication, while high-temperature evaporation and sputtering are commonly used. Room-temperature-processed metal-oxides-based carrier transport layers are attractive candidates for all-solution-processed optoelectronics such as organic solar cells, perovskite solar cells, dye-sensitized solar cells, and organic light-emitting diodes, which can favor the efficient transport of carriers between the photoactive layer and electrode as well as optical transparency. Additionally, new class of heavy-duty room-temperature-processed Ag nano-network is developed as efficient transparent flexible electrodes.

09:40 : Invited talk

Hole Transporting Materials with Strategy of Flexible Core and Tunable Conformation for Efficient and Stable Perovskite Solar Cells

Aung Ko Ko Kyaw
Southern University of Science and Technology (China)

I will present three HTMs based on this strategy, employing flexible saddle-shaped cyclooctatetrathiophene or bifluorenylidene as core and triphenylamine units as arms. Both cyclooctatetrathiophene and bifluorenylidene more flexible than rigid spiro unit in Spiro-OMeTAD and fit well into our strategy. The influence of the location of arms on the dihedral angles, molecular configuration, packing characteristics and the resultant film morphology will be discussed. In addition to HTMs, the passivation of perovskite with organic molecular materials will be briefly discussed.

10:00 - 11:00 — Augustin Fresnel Room

Session 4A8

Synthesis and characterization of plasmonic nanostructures

Organized by: Mohamed Boutinguiza Larosi and Juan Pou Saracho

Chaired by: Juan Pou Saracho

10:00 : Invited talk

Plasmonics in a Variable Temperature Thermodynamic Bath

Francesco Bisio[1], Michele Magnozzi[2], Marzia Ferrera[2], Maurizio Canepa[2]
[1] *CNR-SPIN (Italy),* [2] *Università di Genova (Italy)*

Electromagnetically-heated metal nanoparticles can be exploited as efficient heat sources at the nanoscale. The assessment of their temperature is, however, often performed indirectly by modelling their temperature-dependent dielectric response. Direct measurements of the optical properties of metallic nanoparticles in equilibrium with a thermodynamic bath provide a calibration of their thermo-optical response, to be exploited for refining current thermoplasmonic models or whenever direct temperature assessments are practically unfeasible.

10:20 : Invited talk

Synthesis, characterization and example applications of anisotropic plasmonic metal nanoparticles

Jan Krajczewski
University of Warsaw (Poland)

In some metallic nanoparticles, incident light of an appropriate frequency excites the collective oscillation of electron plasma, a phenomenon known as surface plasmon resonance. Electron plasma oscillations lead to a high local enhancement of the electromagnetic field near the plasmonic structure which generates increase in the effectivity of many optical processes. In this contribution various methods of synthesis of such structures and examples of their applications (in spectroscopy, catalysis, cancer detection and treatment) will be presented.

10:40 : Invited talk

Colloid- and Polymer-Based Self-Assembled Meta-atoms and Metasurfaces

Rajam Elancheliyan[1], Cian Cummins[1], Alberto Alvarez-Fernandez[2], Philippe Barois[1], Alexandre Baron[1], Olivier Mondain-Monval[1], Guillaume Fleury[3], Virginie Ponsinet[1]
[1] *Centre de Recherche Paul Pascal (France),* [2] *University College London (United Kingdom),* [3] *Univ. Bordeaux (LCPO-CNRS) (France)*

We present some examples of meta-atoms and metasurfaces fabrication processes, which implement a bottom-up approach based on colloid and polymer directed self-assembly. Scalability and tunability of the processes are demonstrated, as well as the final optical properties reached by these self-assembled nanostructures.

09:00 - 10:15 — Ibn Al-Haytham Room

Session 4A9

Optical antennas and plasmonics-based devices

09:00 : Confined Orbit Angular Momentum in Deep-subwavelength Plasmonic Resonator
Xuanru Zhang, Tie Jun Cui
Southeast University (China)

Chiral symmetry broken is introduced into the double-layer microwave plasmonic resonator, to realize confined orbit angular momentum (OAM) in deep-subwavelength scale. Electromagnetic field and chirality distributions are analyzed quantitatively. OAM mode within 1/11 free space wavelength has been demonstrated, exhibiting superchiral fields and envisioning the potential in detecting chiral structures.

09:15 : Self-powered photoresponse enhanced by asymmetrically integrated optical patch antennas in a metal-graphene-metal structure
Jing Zhou, Shangkun Guo, Jie Ding, Yu Yu, Wei Lu, Xiaoshuang Chen
Chinese Academy of Sciences (China)

Optical patch antennas are integrated into the metal-graphene-metal structure in an asymmetrical manner for a prominent self-driven photoresponse. A 105 times high contrast between the photoresponses at the two contact-graphene junctions is achieved, and the responsivity enhancement by this structure is one order of magnitude higher than that by a subwavelength metal grating. The resonant behavior of the antenna enables spectrum-selective photoresponse. The photoresponse time is shorter than several microseconds, and the photoresponse mechanism is mainly attributable to photothermoelectric effect.

09:30 : Independent engineering of individual plasmon modes in plasmonic dimers with conductive and capacitive coupling
Vlastimil Krapek[1], Michal Horak[1], Martin Hrton[1], Andrea Konecna[2], Michael Stoger-Pollach[3], filip Ligmajer[1], Tomas Sikola[1]
[1] *Brno University of Technology (Czech Republic),* [2] *Materials Physics Center CSIC-UPV/EHU (Spain),* [3] *Vienna University of Technology (Austria)*

We revisit plasmon modes in nanoparticle dimers with conductive or insulating junction. In our study which combines electron energy loss spectroscopy, optical spectroscopy, and numerical simulations, we show co-existence of strongly and weakly hybridized modes. While the properties of the former ones strongly depend on the nature of the junction, the properties of the latter ones are nearly unaffected. This opens up a prospect for independent engineering of individual plasmon modes in a single plasmonic antenna.

09:45 : Angular emission of second harmonic from GaP antennas reveals multipolar modes
Pawel Wozniak, Vikas Remesh, Niek F. van Hulst
ICFO-Institut de Ciencies Fotoniques (Spain)

An SHG interaction can be enormously enhanced using resonant antennas due to their ability to confine light within sub-wavelength volume. Our investigation demonstrates a great influence of the antenna size on the SHG efficiency and, more importantly, on the SHG angular emission. Detailed modal studies reveal the excitation of an antenna mode via the nonlinear interaction, which is not allowed in the linear regime, and a nontrivial conversion of the polarization state between these two regimes.

10:00 : Subwavelength mapping of optical modes in all-dielectric nanoantennnas
Aleksandr Yu. Frolov[1], Niels Verellen[2], Jiaqi Li[2], Xuezhi Zheng[2], Hanna Paddubrouskaya[2], Denitza Denkova[3], Maxim R. Shcherbakov[1], Guy A. E. Vandenbosch[2], Vladimir I. Panov[1], Pol Van Dorpe[2], Andrey A. Fedyanin[1], Victor V. Moshchalkov[2]
[1] *Lomonosov Moscow State University (Russia),* [2] *KU Leuven (Belgium),* [3] *Macquarie University (Australia)*

We report on near-field mapping of higher order optical modes in all-dielectric nanoantennas (rod, disk, square, triangle shape) by using aperture type scanning near-field optical microscopy (SNOM). Nanoantennas have been made of amorphous Si on the glass substrate. The correspondence of the electromagnetic field components of the excited optical modes with features on SNOM maps is demonstrated by means of full 3D FDTD modeling of the scanning process.

10:15 - 11:00 — Ibn Al-Haytham Room

Session 4A10

Plasmon-enhanced photovoltaics, photocatalysis, and solar fuels

10:15 : High-Index Optical Metamaterial for Perovskite Solar Cells
Kwangjin Kim, Seungwoo Lee
Korea University (Korea)

Recently, perovskite solar cells have attracted considerable attentions from the solar cell society due to their exotic properties such as high quantum efficiency and low recombination rate. However, the power conversion efficiency (PCE) of the perovskite solar cells, reported thus far (∼25 %), is not yet comparable to their fundamental limit (referred to as Shockley-Queisser Limit). Here, we show that an increase in refractive index of perovskite via high-index optical metamaterial can further enhance the PCE of solar cell.

10:30 : Ultraviolet radiation impact on the efficiency of crystalline silicon-based photovoltaics
George Perrakis, Anna C. Tasolamprou, George Kenanakis, Eleftherios N. Economou, Stelios Tzortzakis, Maria Kafesaki
FORTH-IESL (Greece)

We evaluate the ultraviolet radiation impact on the temperature and efficiency of realistic photovoltaic modules. We perform this investigation for crystalline silicon-based photovoltaics that operate outdoors, by employing a thermal-electrical modeling approach, which takes into account all the major intrinsic processes affected by the temperature variation in the photovoltaic devices.

10:45 : Near-field spectroscopy of Silicon Carbide phonon polaritons resonators
Andrea Mancini[1], Christopher R. Gubbin[2], Rodrigo Berte[1], Alberto Politi[2], Yi Li[3], Simone De Liberato[2], Stefan A. Maier[1]
[1] *Ludwig-Maxilimians-Universitat Munchen (Germany),* [2] *University of Southampton (United Kingdom),* [3] *Southern University of Science and Technology (China)*

Antennas supporting surface phonon polaritons are an interesting alternative to common plasmonic resonators in the infrared region, due to their reduced losses and higher field confinement. However, many applications involving SPhPs antennas require knowledge of their near-field response, which cannot be directly inferred from common far-field measurements. We study the near-field spectral response of arrays of Silicon Carbide antennas by means of scattering scanning near field microscopy and discuss the influence of the AFM tip on the experimental results.

09:00 - 10:50 — Gaston Floquet Room

Session 4A11

Metasurface for information processing

Organized by: Jensen Li and Xianzhong Chen

Chaired by: Jensen Li and Xianzhong Chen

09:00 : Invited talk
SP3: Metasurface for information processing
Lingling Huang[1], Qunshuo Wei[1], Basudeb Sain[2], Yongtian Wang[1], Bernhard Reineke[2], Xiaowei Li[1], Thomas Zentgraf[2]
[1] *Beijing Institute of Technology (China),* [2] *Paderborn University (Germany)*

We propose and experimentally demonstrate a novel meta-device that integrates color printing and computer-generated holograms within a single-layer dielectric metasurface by modulating spectral and spatial responses at subwavelength scale, simultaneously. In our design, such metasurface appears as a microscopic color image under white light illumination, while encrypting two different holographic images that can be projected

at the far-field when illuminated with red and green laser beams. Such a method can further extend the design freedom of metasurfaces.

09:20 : Reconfigurable Optical Switch based on Metasurface-Coated Liquid Crystal Elastomer
Jianxun Liu[1], Xiaoguo Fang[1], Ming Cheng[1], Changxiong Zheng[1], Jiawei Wang[1], Hao Zeng[2], Yanjun Liu[1]
[1] *Southern University of Science and Technology (China),* [2] *Tampere University of Technology (finland)*

Liquid crystal elastomer, whose ordered arrangement of mesogens can be changed under light stimulation and leading reversible mechanical deformation, have emerged as an intensively explored soft material in recent years. In this work, we introduce an active optical switch with broadband working and all-optical control using a metasurface-coated liquid crystal elastomer. As a reconfigurable substrate, LCE film deforms by photothermal effect. The results demonstrate a low-cost technique to realize complex and reconfigurable light-driven optical devices of active metasurfaces.

09:35 : Measuring Both Phase and Polarization Singularities of Light with Plasmonic Spin-Hall Nanogratings
Changjun Min
Shenzhen University (China)

Measuring the phase and polarization singularities of light is essential for modern optics, but it is still a challenge especially in integrated optical systems. Here, we propose an on-chip plasmonic spin-Hall nano-grating structure that individually or simultaneously detects the polarization and phase singularities of incident light. We experimentally demonstrated that the nano-grating structure enables unidirectional excitation of surface plasmon polariton depending on the topological charge of optical vortex, and shows chiral responses for vectorial polarization state detection.

09:50 : Anomalous Brewster Effects and Ultra-broadband Reflectionless Brewster Absorbers Protected by Reciprocity
Jie Luo[1], Jensen Li[2], Yun Lai[3]
[1] *Soochow University (China),* [2] *The Hong Kong University of Science and Technology (Hong Kong),* [3] *Nanjing University (China)*

The Brewster's law predicts zero reflection of p-polarization on a dielectric surface at a particular angle. However, when loss is introduced into the permittivity of the dielectric, the Brewster condition breaks down and reflection unavoidably appears. Here, we found an exception by creating a class of nonmagnetic anisotropic metamaterials, where anomalous Brewster effects with independently tunable absorption and refraction emerge. Ultra-broadband reflectionless Brewster absorbers with bandwidth covering from dc to optical frequencies, are bestowed by the anomalous Brewster effects.

10:05 : Polarized Light Interference Imprinted Plasmonic Metasurface
Zhen Yin, Yue Shi, Jianxun Liu, Huilin He, Xiaoguo Fang, Dan Luo, Yan Jun Liu
Southern University of Science and Technology (China)

An approach for direct fabrication of silver nanoparticles structured plasmonic metasurface imprinted by two orthogonal circularly polarized light interference is presented. The correlation between the spatial distributed silver nanoparticles and the state of polarization of the interference field is investigated. The proposed approach can be further extended to create even more complex and unconventional plasmonic metasurfaces by tailoring the polarization interference.

10:20 : Anticounterfeiting visible metaholograms multiplexed with spin, direction and wavelength
Junsuk Rho, Inki Kim
Pohang University of Science and Technology (POSTECH) (Korea)

Computer-generated holography (CHG) involves iterative numerical algorithms to obtain the phase and/or amplitude profiles needed to physically realize holograms. Metasurfaces consist of arrays of subwavelength nanoresonators that can control the wavefront of light in a desired way.

10:35 : Coherent unitary transformations of light using metasurfaces
Ming Kang, Kai Ming Lau, Tsz Kit Yung, Shengwang Du, Wing Yim Tam, Jensen Li
Hong Kong University of Science and Technology (China)

We propose to combine coherent and wavefront control with metasurfaces to carry out designer unitary

transformations on SU(2) and SU(4). The developed framework will be useful for carrying out mathematical operations and quantum information processing.

09:00 - 10:55 — Lawrence Bragg Room

Session 4A12

Light-matter interactions in new materials and meta-architectures

Organized by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

Chaired by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

09:00 : Invited talk

Phase change reprogrammable visible photonics

Li Lu[1], Parikshit Moitra[2], Ramon Paniagua-Dominguez[2], Vytautas Valuckas[2], Sander F. G. Reniers[3], Harish N. S. Krishnamoorthy[4], Arseniy I. Kuznetsov[2], Yuqing Jiao[3], Cesare Soci[4], Robert E. Simpson[1]
[1] *Singapore University of Technology and Design (Singapore),* [2] *A*STAR (Singapore),* [3] *Eindhoven University of Technology (The Netherlands),* [4] *Nanyang Technological University (Singapore)*

Phase change materials (PCMs) play an important role in tuneable photonics applications. Here, we designed reprogrammable hyperbolic metamaterials, nanoantenna beam-steering metasurfaces, and tuneable waveguide devices that operate at visible and near infrared wavelengths. All three devices exploit the the large change in refractive index associated with the amorphous-crystalline phase transition in antimony trisulphide (Sb2S3). This particular phase change material has a 2 eV band gap, which deems it transparent to visible and near infrared light.

09:20 : Invited talk

Hexagonal boron nitride for integrated quantum photonics

Sejeong Kim[1], Johannes E. Fröch[2], Ngoc My Hanh Duong[2], Igor Aharonovich[2]
[1] *University of Melbourne (Australia),* [2] *University of Technology Sydney (Australia)*

Integrated quantum photonic circuitry is an emerging topic that requires efficient coupling of quantum light sources to waveguides and optical resonators. Here, we present the hBN quantum emitters integrated into photonic waveguides and photonic cavities.

09:40 : Collective response of liquid crystal based metasurfaces

Raviteja R. Mosali[1], Madhunika Atmakuri[1], Sushanth R. Amanaganti[1], Miha Ravnik[2], Jayasri Dontabhaktuni[1]
[1] *Mahindra Ecole Centrale (India),* [2] *University of Ljubljana and Jozef Stefan Institute (Slovenia)*

In our earlier work, we studied the collective response of high refractive index cubic Te metasurface using full-wave electromagnetic simulations. In the present work, we investigate the effect of anisotropy of lattice constant and anisotropy of the medium on the collective response and further, we also study the effect of quasicrystalline symmetry on the electromagnetic response of Penrose tiling made of pentagonal shaped sub-micron dielectric structures.

09:55 : Invited talk

Metal-Insulator-Metal cavities for light enhancement and modulation

Vincenzo Caligiuri[1], Aniket Patra[1], Giulia Biffi[2], Renuka Devi Pothuraju[2], Antonio De Luca[1], Roman Krahne[2]
[1] *University of Calabria (Italy),* [2] *Istituto Italiano di Tecnologià (Italy)*

Metal-Insulator-Metal (MIM) nanocavities that sustain epsilon-near-zero (ENZ) resonances constitute a versatile platform for light modulation and amplification. They act as optical quantum wells for photons, and an analogy to quantum mechanics facilitates the analytic prediction of the resonances. Multiple cavities lead to coupled resonances, and we demonstrate how a MIMIM system can enhance both the absorption and emission of a dye. Ourapproach can be extended to ENZ bands, which can be described by the Kronig-Penney model.

10:15 : Invited talk
Controlling light with magneto-optical gratings
Ioan-Augustin Chioar[1], Merlin Pohlit[1], Christina Vantaraki[1], Richard Rowan-Robinson[1], Bjorgvin Hjorvarsson[1], Evangelos Papaioannou[2], Vassilios Kapaklis[1]
[1] *Uppsala University (Sweden),* [2] *Martin-Luther-Universität (Germany)*

We report on the use of a continuous magnetic film of YIG for the control of light with mesoscale magnetic textures. We investigate in real and reciprocal space, the connection between the magnetic domain structure developed and the resulting scattering pattern of the transmitted light.

10:35 : Invited talk
Active tuning of thermal radiation in the far-field and near-field range with emerging low-dimensional materials
Georgia Theano Papadakis
ICFO - The Institute of Photonic Sciences (Spain)

Controlling the flow of a thermal current is of critical importance for any application requiring thermal regulation. Previous approaches focused largely on modulating thermal conductance via tailoring the propagation of acoustic phonons. In contrast, in this talk, I consider means of controlling the flow of heat mediated by thermal radiation. I will discuss how leveraging the unique properties of low-dimensional materials like graphene and monolayer hexagonal boron nitride yields significant tuning of radiative heat transfer.

09:00 - 11:00 — Rene Descartes Room

Session 4A13

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

09:00 : Invited talk
Dynamic Control of Terahertz Polarization Based on Babinet Inversion of Anisotropic Metasurfaces with Vanadium Dioxide
Toshihiro Nakanishi[1], Yosuke Nakata[2], Yoshiro Urade[3], Kunio Okimura[4]
[1] *Kyoto University (Japan),* [2] *Osaka University (Japan),* [3] *RIKEN (Japan),* [4] *Tokai University (Japan)*

We propose anisotropic metasurfaces, which realize dynamic polarization control by switching between two states of the structures. We have to design only one of the two states linked through Babinet's principle, because the other state automatically satisfies the required conditions. We demonstrate a reconfigurable polarizer and a reconfigurable quarter-wave plate in terahertz regions utilizing insulator-to-metal transition of vanadium dioxide in the metasurfaces. The polarization control can be realized by switching the local conductivity of the vanadium dioxide.

09:20 : Invited talk
Photo thermal energy conversion in mid infrared metasurfaces
Yoshiaki Nishijima, Naoki To
Yokohama National University (Japan)

Mid infrared wavelength is unique to apply the detection of the small amount of molecules with molecular vibration or rotational modes. Especially absorption type of meta surface can be used for the mid infrared light source, detectors according to the Kirchhoff's thermal radiation low. Here we summarized the recent progress of plasmonic meta surfaces in mid infrared wavelength region. The experimentally measured optical properties were compared with simulations by finite difference time-domain calculations. Also, we demonstrate applications of these structures for the plasmonic IR-light sources and detectors.and another sensing devices.

09:40 : Invited talk
Metamaterial-based Production of Acoustic Orbital Angular Momentum in Three- and Two-dimensional Systems

Bin Liang[1], Jianchun Cheng[1], Jing-jing Liu[1], Xue Jiang[1], Yifan Zhu[1], Xuefeng Zhu[2], Yong Li[3], Yun Jing[4], Likun Zhang[5], Chengwei Qiu[6]
[1]*Nanjing University (China),* [2]*Huazhong University of Science and Technology (China),* [3]*Tongji University (China),* [4]*North Carolina State University (USA),* [5]*University of Mississippi (USA),* [6]*National University of Singapore (Singapore)*

In this talk, I will review the recent advance in metamaterial-based production of acoustic orbital angular momentum (OAM) in three-dimensional systems with a planar and thin device and in two dimensional systems with an irregularly-shaped and compact enclosure.

10:00 : Invited talk
Plasmonic nanolasers modulated by current on graphene-insulator-metal structures
Tien-Chang Lu, Heng Li, Zhen-Ting Huang
National Chiao Tung University (Taiwan)

We propose a plasmonic nanolaser on graphene-insulator-metal structures and experimentally demonstrate the current modulated lasing behavior. Graphene serves as a two-dimensional material with high electron mobility, which is beneficial to external current injection. When the current is applied, it is obvious to observe the peak intensity dissipation and blue-shifted of the lasing signal. This work exhibits the great potential in active plasmonic devices.

10:20 : Invited talk
Optical Waveguide Using Off-Γ Bound States in the Continuum in One Dimensional Grating Structures
Yuto Moritake, Masaya Notomi
Tokyo Institute of Technology (Japan)

We proposed and numerically investigated filtering waveguides using off-Γ bound states in the continuum (BICs) in one dimensional grating structures. By using propagating feature of off-Γ BIC, light transmission is guided only around the BIC frequency without radiation leakage. The designed structure is composed of Si grating structure integrated with optical waveguide. Numerical simulations confirm the proposed filtering function at off-Γ BIC frequency.

10:40 : Invited talk
High-Performance Laser Based on Topological Photonic Crystal
Xiao Hu
NIMS (Japan)

We find a new light confinement mechanism emerging from photonic topology, namely the parity of eigen modes in a topological photonic crystal is different from those in a trivial photonic crystal below the band edge, which prevents light to transport freely across the interface. We then develop a high-performance laser with vertical cavity surface emission, which meets the IEEE and VCSEL standards.

Coffee Break and Exhibit Inspection

Session 4P1

Poster session VII

11:00 - 11:40

P1: The idea and technical realization of the structure for the observation of inverse Faraday effect.
Piotr A. Drozdz, Valentin Kachorovskii, Pawel Prystawko, Mateusz Slowikowski, Maciej filipiak, Dmitri Yavorski, Maria Szola, Wojciech Knap
CENTERA Laboratories (Poland)

In this work, the idea of the observation of Inverse Faraday Effect (IFE) is presented. The mechanism of the effect is described and the main conclusions from theoretical calculations of IFE in two dimensional electron gas (2DEG) are presented. finally, the practical realization of the structure for IFE observation is presented. The structure is based on the GaN/AlGaN HEMT structure with back - gate layer. The processing as well as the basic characterization of the structure will be presented.

P2: Spherically-shaped WGM resonators for lasers and biodetection
Piotr Paszke[1], Rafal Nowaczynski[2], Hancza Barbara Surma[1], Piotr Piotrowski[1], Kamil Szlachetko[1], Joel Bellessa[3], Clementine Symonds[3], Vincent Toanen[3], Andrea Csaki[4], Dorota Anna Pawlak[1]
[1] University of Warsaw (Poland), [2] Warsaw University of Technology (Poland), [3] Université Claude Bernard Lyon 1 (France), [4] Leibniz Institute of Photonic Technology (Germany)

This work presents the results of doping glasses with both silver nanoparticles and quantum dots, fabrication of WGM resonators based on these active glasses and their properties. The authors are mainly interested in applications of such resonators as biosensors, therefore the biofunctionalization tests of glass surfaces was also done.

P3: Photonic liquid crystal fibers with gold nanoparticles-doped cubic blue phases for enhanced electric field tunability and thermal stability
Kamil Orzechowski[1], Wiktor Lewandowski[2], Olga Strzezysz[3], Martyna Tupikowska[2], Tomasz R. Wolinski[1]
[1] Warsaw University of Technology (Poland), [2] University of Warsaw (Poland), [3] Military University of Technology (Poland)

In this work, optical properties of photonic crystal fibers infiltrated with gold nanoparticles-doped cubic blue phases liquid crystals are demonstrated. It is presented that the investigated complex photonic systems can provide promising tunable properties for particular wavelengths in the visible light spectrum. Moreover, the presence of gold nanoparticles with an appropriate organic coating in a liquid crystal matrix can enhance the external electric field sensitivity and temperature stability of the examined photonic liquid crystal fibers.

P4: Dynamic and chiral plasmonics using freezing-directed self-assembly of nanoparticles
Wiktor Lewandowski
University of Warsaw (Poland)

Nanostructures with chiral symmetry and plasmonic properties attract considerable interest. Here, we present endeavors towards achieving thin films of chiral, reconfigurable nanostructures. This approach relies on mixing liquid crystals with gold nanoparticles, melting and freezing composites. Due to the soft character of liquid crystals, these nanoarchitectures exhibit helical, hierarchical and switchable structure. With this method we achieved durable, configurable, chiral plasmonics systems in the bulk.

P5: Plasmonic Enhancement of Second-Harmonic Generation with film-Coupled Nanopatch Antennas
Ahsan Noor[1], Anoop R. Damodaran[2], In Ho Lee[2], Stefan Alexander Maier[3], Sang Hyun Oh[2], Antonella D'Orazio[4], Cristian Ciracı[5]
[1] Politecnico Di Bari (Italy), [2] University of Minnesota, Minneapolis (USA), [3] Ludwig-Maximilians Universitat Munchen (Germany), [4] Politecnico di Bari (Italy), [5] Istituto Italiano di Tecnologia (Italy)

Field enhancements associated with resonant excitation of plasmonic structures have shown tremendous potential to improve the efficiencies of nonlinear wave-mixing processes at the nano-scale. In this work, we present an optimal mode-matched second-harmonic generation from hybrid plasmonic film-coupled nanopatch antennas.

P6: Local intensity enhancement and Purcell factor in hyperbolic metamaterials - spontaneous emission engineering
Karol Sielezin, Alessandro Pianelli, Michal Dudek, Marek Olifierczuk, Rafal Kowerdziej, Janusz Parka
Military University of Technology (Poland)

In this work, we theoretically study the quantum mechanisms that are an effective tool for analyzing the increase in the photonic density of states (PDOS) in relation to hyperbolic metamaterials (HMMs). Numerical results of the Purcell factor of HMM stack built on the basis of alternating layers of silica and silver are reported. We theoretically show that interplay of plasmon polaritons leads to an increase in the spontaneous emission and, as a result, to an increased PDOS.

P7: All-dielectric metasurface linear polarizer for visible wavelengths utilizing the first Kerker condition
Amr Mohamed Soliman, Calum Williams, Timothy Wilkinson
University of Cambridge (United Kingdom)

Polarizers are indispensable elements integrated within a myriad of optical setups across many applications, from imaging assemblies to display technology. Commercially available polarizers are typically characterized by a low damage threshold, low extinction coefficient, and low operating bandwidth. In this paper, we present

an all-dielectric metasurface linear visible polarizer with high extinction ratio. The polarizer consists of sub-wavelength titanium dioxide (TiO2) structures which utilize Kerker's first condition in order to generate the desired transmission response across the visible spectrum. In addition, the reported all-dielectric polarizer has a high damage threshold and can be tuned to different wavebands through geometry modification.

P8: Hyperuniform Disorder for Tailored Light Scattering Metasurfaces
Peter M. Piechulla[1], Bodo Fuhrmann[1], Evgeniia Slivina[2], Carsten Rockstuhl[2], Ralf B. Wehrspohn[1], Alexander N. Sprafke[1]
[1] *Martin Luther University Halle-Wittenberg (Germany),* [2] *Karlsruhe Institute of Technology (Germany)*

Nanoparticle arrays exploited for scattering commonly feature either periodic or random arrangements. For the periodic case, scattering is governed by spatial correlations, expressed by the structure factor. For the random case, structural correlations cancel each other out and scattering is governed by properties of the individual scatterer, expressed by the form factor. In contrast to these extremes, hyperuniform disorder enables both structure and form factor to impact the resulting scattering pattern, offering novel means to tailor light scattering.

P9: Localization of Surface Acoustic Waves in 2D Disordered Phononic Crystals Using Pump and Probe Spectroscopy
Thibault Deletang[1], Bernard Bonello[1], Rock Akiki[2], Bahram Djafari-Rouhani[2], Yan Pennec[2], Eric Lheurette[2]
[1] *Université Pierre et Marie Curie (France),* [2] *Université de Lille (France)*

We report here some experimental results and reflections on localization. Some advancements have been made on the sample fabrication and the experimental set-up which allows us to study which allows us to study the dynamics of structure vibration related to the propagation of a surface wave in a disordered medium using pump and probe spectroscopy.

P10: Light amplification by silver nanoparticles surface plasmon resonance
Jelena Mikelsone, Aivars Vembris
University of Latvia (Latvia)

Organic materials have several advantages in the fields of an organic light-emitting diode organic photovoltaics, etc., but in the same time they have lower stability and efficiency in comparison to inorganic compounds. It can be improved by introducing metallic nanoparticles in the organic media. In this work we study silver nanoparticles synthesis in aqueous solution, their transfer to organic solutions, their impact on luminescent material's photoluminescence quantum yield.

P11: High refractive index dielectric rings in liquid crystals as tunable metasurfaces
Madhunika Atmakuri, Pratiksha A. Sakhare, Sushanth R. Amanaganti, Jayasri Dontabhaktuni
Mahindra University (India)

In the present work, we study the resonant characteristics of high refractive index (RI) circular and square rings using full wave electromagnetic simulations. Effect of geometry, Thickness of structures and RI on the EM response is studied in the sub-wavelength regime. This rings when placed in birefringent liquid crystal medium orientation of liquid crystal molecules are observed to enhance certain modes over the other giving rise to tunable metasurfaces. Also, electric dipole, quadrupole and toroidal modes are observed in air.

P12: Resonance characteristics of sub-wavelength high refractive index dielectric metasurfaces as a function of lattice constant
Jayesh Sadasivan[1], Sivarama Krishnan[2], Jayasri Dontabhaktuni[1]
[1] *Mahindra University (India),* [2] *Indian Institute of Technology Madras (India)*

In our earlier work, we had studied the collective response of high refractive index dielectric Te metasurfaces of small periodicity using electromagnetic simulations. In this work, we perform a detailed investigation of the response spectrum as a function of increasing periodicity. We observe the suppressions of electric dipolar modes, observation of novel modes like hybrid modes and BIC. Some of the states observed at the smaller periodicity regimes were found to be independent of the lattice constant.

P13: Observation of localized states induced by curved acoustic topological insulators
Hong-Wei Wu, Jia-Qi Quan, Yun-Kai Liu, Yi-Ming Pan
Anhui University of Science and Technology (China)

In this work, we design a two-dimensional curved acoustic topological insulator by perforating on a curved

rigid plate. We experimentally demonstrate that a topological localized state stands erect in the bulk gap, and the corresponding pressure distributions are confined at the position with the maximal curvature. The robustness of the localized state is demonstrated by introducing defects near the localized position. The interaction between the geometrical curvature and topology provides a novel scheme for manipulating and trapping wave propagation.

P14: Giant enhancement of chiral selective many-body correlation among emitters coupled with spirally stacked metal structures
Hirofumi Shiraki[1], **Nobuhiko Yokoshi**[1], **Hajime Ishihara**[2]
[1] *Osaka Prefecture University (Japan),* [2] *Osaka Prefecture University and Osaka University (Japan)*

We have studied the anomalously enhanced cooperative effect by metal structures sustaining the localized surface plasmons. In this contribution, we consider chiral spatial structures of the metal and emitter arrangements, and calculate the emission intensity of superfluorescence. The results show the remarkable difference by chirality in emission intensity, correlation between the emitters, and polarization distribution. We can expect that these results will lead to a new methodology in chiral research.

P15: Resonance-order dependent PIT in orthogonally arranged nanoscale cavities
Naoki Ichiji, Atsushi Kubo
University of Tsukuba (Japan)

We investigate the Plasmonic Induced Transparency (PIT) in a resonator structure consisting of two orthogonally arranged metal-insulator-metal (MIM) nanocavities by FDTD simulation and a classical mechanical model. The model calculations show the PIT caused in the orthogonally arranged cavities possesses a clear resonance order dependence. These results demonstrate the order selective spectrum modulation effect in nanoscale resonator structures.

P16: Tunability of Epsilon-Near-Zero behavior in a Self-assembled Liquid Crystal - Nanoparticle Hybrid Metamaterial
Amit Bhardwaj
Centre for nano and soft matter sciences (India)

We report experimental evidence of tunable epsilon-near zero (ENZ) behavior in a self-assembled lamella superstructure consisting of Au nanoparticles capped with aphoto-active chiral liquid crystal ligand. Upon irradiation with UV, the LSPR peak of Au red-shifts by $\sim$10 nm which restores with white light. The effective permittivity indicates ENZ behavior in the visible spectrum with aband width of $\sim$45 nm which gets enhanced by a factor of 1.6 on UV illumination. Theoretical calculations based on effective medium approach, support the experimental findings.

P17: Wideband and High-gain Metasurface-Based Circularly Polarized Antenna
Kam Eucharist Kedze, Ikmo Park
Ajou University (Korea)

A metasurface-based circularly polarized microstrip patch antenna with wide bandwidth and high gain is presented. The antenna structure is a square modified microstrip patch that is sandwiched between a metasurface and the ground plane. The microstrip patch and cross slot, in conjunction with the metasurface, generate multiple resonances and AR minimum points that are combined to produce large impedance, AR, and 3-dB gain bandwidths.

P18: Engineering Plasmon-Enhanced Upconversion via Transformation Optics
Avi Mathur, Abhishek Mukherjee, Jasvith Raj Basani, Kannan Ramaswamy
Birla Institute Of Technology and Science (BITS) (India)

Plasmon Enhanced photon upconversion via nanoparticles has shown promise experimentally with a vast multitude of geometries. Applying transformation optical techniques to transform the geometry into a structure that is more feasible to fabricate, is an idea that is attractive in its prospects. These techniques are based on the invariance of the basic laws governing the light matter interactions and also scale up the output in comparison with the original geometry, replacing the initially used materials with the transformed ones.

P19: Longitudinal and Transverse Surface Plasmon-Enhanced Upconversion in Nanopillar shaped geometries
Abhishek Mukherjee, Avi Mathur, Jasvith Raj Basani, Kannan Ramaswamy

Birla Institute Of Technology and Science (BITS) (India)

Upconversion Fluorescence, which refers to a process of converting low energy photons to higher energies, has received an explosion of interest owing to its potential use in applications such as temperature sensing, biological imaging, etc. A feasible strategy to improve upconversion efficiencies has been manipulating light-matter interaction at the position of an upconverting emitter. Thus, surface plasmon resonance has come into the spotlight. This work aims to demonstrate a nanopillar geometry which can exhibit longitudinal and transverse plasmon resonances.

P20: Plasmonic color filters: angular dependence
Katarína Rovenská[1], Filip Ligmajer[1], Jan Chochol[2], Jiří Liška[1], Tomáš Šikola[1]
[1] *Brno University of Technology (Czech Repub),* [2] *ON Semiconductor (Czech Repub)*

Plasmonic color filters promise a potential solution to miniaturization of color-filtering elements in modern devices. Yet, the dependence of plasmonic filters' spectral responses on the incident angle of light rays has been addressed minimally. In this work, we analyze the angular dependence in plasmonic color filters consisting of nanoholes in metallic film. For these purposes, various plasmonic color filtering arrays (differing in structure size, shape, periodicity, etc.) were characterized with transmission optical spectroscopy for nonzero incident light angles.

P21: A Software for Simulation and Computer Aided Inverse Design of Nanophotonic Metamaterials Based on Periodically Patterned Metasurfaces
Roy Avrahamy[1], Moshe Zohar[2], Benjamin Milgrom[3], Mark Auslender[1]
[1] *Ben Gurion University of the Negev (Israel),* [2] *Shamoon College of Engineering (Israel),* [3] *Jerusalem College of Tech (Israel)*

A software for simulation and inverse design of micro- and nano-optical devices embedding smooth and periodically patterned layers is described. With this tool, a $\sim 100\,\%$ efficient, silicon (Si) based, photodetector (PD) for a near-infrared (NIR) wavelength is designed, and on this example the topological photonics features are shown.

11:40 - 12:40 — Victor Veselago Room

Session 4A14

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

11:40 : Invited talk
Transverse Spin States at Momentum Topological Interfaces utilizing Optical Anisotropy
Xianji Piao, Sunkyu Yu, Namkyoo Park
Seoul National University (Korea)

Here we investigate the topological interface between different momentum geometry, as an optical analogy of the quantum spin Hall effect. By exploiting the alteration of optical anisotropy, the spatial transition of the differential geometry of momentum states are demonstrated. We show that this topological interface leads to the excitation of a transverse-spin state with robust spin-dependent unidirectional transport.

12:00 : Invited talk
A New Type Terahertz Quantum Cascade Laser Using Graphene-based van der Waals Heterostructures
Taiichi Otsuji
Tohoku University (Japan)

This paper reviews recent advances in the research for graphene-based van der Waals heterostructures towards a new type of terahertz quantum-cascade lasers.

12:20 : Invited talk
Ultrafast THz Absorption Modulation in a Graphene-Based Thin Absorber

Anastasios Koulouklidis[1], Anna Tasolamprou[1], Christina Daskalaki[1], Eydokia Kyriakou[1], M. Said Ergoktas[2], George Kenanakis[1], George Deligeorgis[1], Maria Kafesaki[1], Coskun Kocabas[2], Eleftherios Economou[1], Costas Soukoulis[3], Stelios Tzortzakis[4]
[1] *IESL-FORTH (Greece),* [2] *University of Manchester (United Kingdom),* [3] *Iowa State University (USA),* [4] *Texas AM Universtity at Qatar (Qatar)*

We study experimentaly and theoretically an ultrafast, optically tunable graphene-based thin film absorption modulator for operation in the THz regime. Graphene hot carriers generated by an ultrafast near-IR pulse, induce negative photoconductivity with a decay time of 2.79ps. As a result, a modulation of 40 % in the THz absorption at 2.17THz is observed in the structure. Additionally, we show that the modulation can be further increased at 60 % by simultaneously varying the conductance of graphene via ionic gating.

11:40 - 12:40 — Allan Boardman Room

Session 4A15
Metasurfaces, flat optics, FSS and HIS

11:40 : High Efficiency Titanium Dioxide Huygen's Metasurfaces In UV
Yu Cheng Chou, Ta-Jen Yen
National Tsing Hua University (Taiwan)

Metasurfaces possess the capability to manipulate multi aspects of light and have been used to demonstrate wavefront engineering devices. In this project, we choose Huygens' metasurfaces with high efficiency and small thickness to wavelength ratio to achieve wavefront shaping. Overlap of electric and magnetic resonances in titanium dioxide nanodisk employs Huygens' condition which gives our device a full phase coverage and close unity transmission in UV. Such properties enable an efficient light focusing flat optical device.

11:55 : Beam-type Elastic Metagratings for Selective Reflections of Longitudinal Waves
Shin Young Kim[1], Woorim Lee[1], Joong Seok Lee[2], Yoon Young Kim[1]
[1] *Seoul NationalUniversity (Korea),* [2] *Chungnam National University (Korea)*

Metagratings have recently received much attention inelectromagnetic and acoustic wave research fields.Governed by the diffraction grating theory, metagratingsenable precise wavefront steering by suppressing undesiredhigh-order scattering modes. Recently, we proposed a novelelastic metagrating model using a periodic arrangement ofbeam-type members in order to realize efficient steering oflongitudinal waves [1]. Based on analytical modeling of thebeam-type elastic metagratings, anomalous reflections andasymmetric splitting of longitudinal waves were realizedsuccessfully in numerical and experimental studies.

12:10 : Optically tunable nanoantennas for visible range based on vanadium dioxide
Filip Ligmajer, Peter Kepič, Martin Hrtoň, Tomáš Šikola
Brno University of Technology (Czech Repub)

Implementing dynamic tunability into the design of metasurfaces is one of the major challenges of the field today. In our contribution we will review various approaches to incorporation of vanadium dioxide into metasurfaces. In particular, we will explore utilization of VO2 nanostructures as both Mie resonant and also propagation-phase building blocks of tunable metasurfaces.

12:25 : All-dielectric metasurface doublet enabling beam steering and polarizing beam splitting
Changyi Zhou[1], Woo-Bin Lee[1], Chul-Soon Park[1], Song Gao[1], Duk-Yong Choi[2], Sang-Shin Lee[1]
[1] *Kwangwoon University (Korea),* [2] *Australian National University (Australia)*

Multifunctional metasurfaces, fulfilling a variety of tasks, have attracted drastically growing interest. Here we proposed and embodied an all-dielectric metasurface doublet (MD) by vertically concatenating twosome arrays of rectangular nanoresonators on either side of a quartz substrate, in which distinct phase profiles are encoded for orthogonally polarized light. Bifunctional beam manipulation including enlarged steering and polarizing beam splitting was enabled by the MD. The superior performance of the proposed device paves the way to large-scale photonic integrated applications.

11:40 - 12:40 — Tatsuo Itho Room

Session 4A16
Photonic Crystals

11:40 : Self-assembled Photonic Crystals for Colorful Radiative Coolers
Hyeon Ho Kim, Eunji Im, Seungwoo Lee
Korea University (Korea)

Recently, radiative cooling has been actively studied, as objects can be cooled without using additional energy. Here, we demonstrate a new class of radiative cooler, this is silica photonic crystals, which are used for the structural colorization. The intrinsic phonon vibration of silica leads to the absorption of mid-infrared (mid-IR) waves, which in turn cool the objective in a radiative way. At daytime, these assembled photonic crystals effectively reduce the temperature of the crystalline-silicon (c-Si), while maintaining appearing colors.

11:55 : Enhancement of Laser-Induced Damage Threshold by 3D Photonic Crystal Structure
Lei Pan, Hongbo Xu, Ruizhen Lv, Yao Li
Harbin Institute of Technology (China)

Enhancement of laser-induced damage threshold by 3D photonic crystal (3D-PC) structure is demonstrated using both experimental and simulation methods. A polystyrene 3D-PC with a reflection peak at 1064nm is fabricated. The laser-induced damage threshold (LIDT) of 3D-PCs is as 2.4 times high as the LIDT of disordered polystyrene films. The simulation results show that the electric field is contained in the pores of 3D-PCs while is reduced in the solid part, which may be responsible for the high LIDT.

12:10 : Laser emission from atoms placed in vacuum
Iliya Doronin[1], Alexander Zyablovsky[1], Evgeny Andrianov[1], Alexander Pukhov[1], Yurii Lozovik[1], Alexey Vinogradov[1], Alexander Lisyansky[2]
[1] Dukhov Research Institute of Automatics (Russia), [2] Queens College of the City University of New York (USA)

We consider pumped active atoms placed in a free space. We show that such atoms can emit coherent laser-like radiation at sufficient pump rate. This is possible due to the fact that active atoms interact with electromagnetic field of vacuum with a finite strength, even though there are no distinct modes of electromagnetic field. Our results suggest the possibility of creating new types of low-cost laser devices, as well as open new perspective on fundamental physics behind lasers.

12:25 : Light trapping with subwavelength compound parabolic concentrators
Ashsih Prajapati, Gilad Marko, Gil Shalev
Ben Gurion University of the Negev (Israel)

Light trapping and the broadband absorption of the solar radiation is of interest to solar energy applications. In the current work, we report a new paradigm for light trapping, that is light trapping based on arrays of subwavelength nonimaging light concentrators (NLCs). We numerically show that NLC arrays provide $\sim$50 % broadband absorption enhancement of the solar radiation compared with that of optimized nanopillar arrays. We show that CPC arrays (in contrast to nanopillar arrays) function as anti-transmission layers.

11:40 - 12:40 — Christian Huygens Room

Session 4A17
New materials for photonics

11:40 : Guided mode resonant gratings with van der Waals materials: A platform for high-Q resonances and its applications
Qilin Hong, Xingqiao Chen, Xiaodong Yuan, Zhihong Zhu, Jianfa Zhang
National University of Defense Technology (China)

A type of remarkably high-quality resonant nanostructure based on atomically thin two-dimensional materials

is proposed. It is shown theoretically and numerically that the excitation of leaky modes in the proposed structures can achieve resonances with extremely narrow linewidths down to 0.0005 nm and high Q-factors up to millions in the telecom range. This new type of 2D material resonant nanostructure can be employed for a variety of applications ranging from lasers, filters and polarizers to nonlinear optical devices.

11:55 : Graphene-metal hybrid for strongly enhanced terahertz harmonics
Jan-Christoph Deinert[1], David Alcaraz Iranzo[2], Hassan A. Hafez[3], Frank Koppens[4], Mischa Bonn[3], Dmitry Turchinovich[5], Michael Gensch[6], Sergey Kovalev[1], Klaas-Jan Tielrooij[7], Klaas-Jan Tielrooij[7]
[1] Helmholtz-Zentrum Dresden-Rossendorf (Germany), [2] ICFO - Institut de Ciencies Fotoniques (Spain), [3] Max-Planck-Institut für Polymerforschung (Germany), [4] The Barcelona Institute of Science and Technology (Spain), [5] Universität Bielefeld (Germany), [6] Technische Universität Berlin (Germany), [7] Catalan Institute of Nanoscience and Nanotechnology (ICN2) (Spain)

By combining the peculiar ultrafast heating-cooling dynamics of graphene electrons with the enhancement of incident electromagnetic fields by a metallic grating, we have created a hybrid structure with an unprecedently large third order (sheet) susceptibility in the terahertz range. In particular, we observe terahertz (THz) third harmonic generation with a field conversion efficiency above 1 %. The nonlinear enhancement furthermore allows for the observation of signatures of higher harmonics (up to 9th order) using a table-top laser setup.

12:10 : Local Variations of Light Absorption and Emission in Monolayer WS2 Flakes
Marzia Ferrera[1], Michele Magnozzi[1], Theo Pflug[2], Simona Pace[3], Lorenzo Ramò[1], Markus Olbrich[2], Paolo Canepa[1], Hasret Agircan[4], Alexander Horn[2], Stiven Forti[5], Ornella Cavalleri[1], Camilla Coletti[3], Francesco Bisio[6], Maurizio Canepa[1]
[1] Università di Genova (Italy), [2] Laserinstitut Hochschule Mittweida (Germany), [3] Istituto Italiano di Tecnologia (Italy), [4] Istanbul Technical University (Turkey), [5] Center for Nanotechnology Innovation IIT@NEST (Italy), [6] CNR-SPIN (Italy)

The investigation of the local excitonic response of two-dimensional transition metal dichalcogenides is crucial both for fundamental research and in view of their implementation in novel optoelectronic devices. In this work, we compare the photoluminescence spatial patterns of monolayer WS2 flakes grown by chemical vapor deposition with their position-resolved dielectric function probed by imaging spectral ellipsometry. The two datasets show both correlated and uncorrelated spatial patterns. Micro-structural variations within the flakes are deemed responsible for the observed discrepancies.

12:25 : The role of trion excitation in the shear-induced optical bandgap tunability of MoS2
Assaf Ya'akobovitz, Avi Niv
Ben-Gurion University of the Negev (Israel)

With high strength, valley polarization, and direct bandgap, Mono-layered MoS2 is becoming an essential member of a growing family of materials that will shape our optoelectronic future. In this talk, we will describe bandgap tuning under shear strain. Our study reveals an intricate connection between the global electronic structure and the localized excitons and trions of this material.

11:40 - 12:40 — Augustin Fresnel Room

Session 4A18
Plasmonics and nanophotonics

11:40 : Photothermal characteristics in silicon nanoparticles
Yongqian Li[1], Xingyu Yang[1], Yidyu Yu[1], Binbin Wang[2], Xiaoying Li[1], Rafael Salas-Montiel[2]
[1] Key Laboratory of Micro/Nano Systems for Aerospace of Ministry of Education (China), [2] Université de technologie de Troyes (France)

Photothermal characteristics of nonspherical dielectric nanoparticles was reported. The significant nanoheating effect of silicon cuboid nanoparticles is attributed to the resonant modes of electric and magnetic resonances of different orders. Especially, the remarkable photothermal effect arises from the hybrid modes, the overlapping of different resonant modes, due to the varying ratio of cuboid nanoparticles. The thermal radiation of these nanoparticles due to interactions and interference between both electric and optically-induced

magnetic resonances of different orders are investigated.

11:55 : Nanoscaled VO2 insulator-to-metal transition controlled by plasmonic single-nanoantenna
Luca Bergamini[1], Bigeng Chen[2], Daniel Traviss[2], Yudong Wang[2], C. H. de Groot[2], Jeffrey M. Gaskell[3], David W. Sheel[3], Nerea Zabala[1], Javier Aizpurua[4], Otto L. Muskens[2]
[1] *UPV-EHU (Spain),* [2] *University of Southampton (United Kingdom),* [3] *University of Salford (United Kingdom),* [4] *CSIC-UPV/EHU and DIPC (Spain)*

Resonant plasmonic nanoantennas are known to concentrate light at the nanoscale around its surface.VO2 is of interest for its insulator-to-metal transition when heated up above the relatively low critical temperature of 68C.In this study we show how the plasmonic feature of a single antenna can be used to induce and control the insulator-to-metal transition in a VO2 film.

12:10 : Non-classical light source with single photon and squeezing properties in a nanoscale photonic-crystal-plasmonic system
Lingxiao Shan, Juanjuan Ren, Qi Zhang, Yun Ma, Xueke Duan, Qihuang Gong, Ying Gu
Peking University (China)

Single photon and squeezing properties are important in on-chip quantum applications. Single photon sources were investigated in microstructures like nanowires. However, on-chip squeezing light sources remain exploring. Here, a photonic-crystal-plasmonic nanostructure is proposed with strong mode-emitter coupling from a band-edge mode. Our calculation shows non-classical light is achieved with degree of squeezing 0.46 dB and $g^2(0)<0.1$ under strong coupling. Besides 70 % emission are channeled in the 2D line defect. The system provides possibilities to on-chip versatile non-classical light sources.

12:25 : Hot electrons remote excitation and their ultrafast harvesting
Romain Hernandez[1], Renato Juliano-Martins[1], Mario Lodari[2], Michele Celebrano[2], Marco finazzi[2], Lamberto Duo[2], Giovanni Isella[2], Marlène Petit[1], Adrian Agreda[1], Jean-Claude Weeber[1], Alexandre Bouhelier[1], Monica Bollani[2], Olivier Demichel[1], Paolo Biagioni[2], Benoit Cluzel[1]
[1] *Laboratoire Interdisciplinaire Carnot de Bourgogne (France),* [2] *Politecnico di Milano (Italy)*

Generation, collection and relaxation of hot electrons within plasmonic devices are studied with two approaches. The first consists in investigating with a hyperspectral nearfield imaging technique the delocalized hot electrons produced along a Au waveguide by a propagative surface plasmon. The second, in producing hot electrons with localized surface plasmons within a Au grating on top of a siliconon-insulator substrate. This Schottky barrier hot electron photodetector allows studying the absorbtion and transportdynamics of hot electrons.

11:40 - 12:40 — Ibn Al-Haytham Room

Session 4A19
Metamaterials and metasurfaces

11:40 : Multi-band middle-infrared-compatible camouflage with thermal management via simple photonic structures
Ziquan Xu[1], Meiyan Pan[1], Huanzheng Zhu[1], Min Qiu[2], Qiang Li[1]
[1] *Zhejiang University (China),* [2] *Westlake University (China)*

We demonstrate two simple photonic structures for visual and MIR camouflage with thermal management utilizing thin-film interference. The additional laser camouflage is realized by further incorporating simple wavelength-scale grating structures. The fabricated structures exhibit dual-band MIR camouflage by low emission, radar camouflage to carbon dioxide laser by high absorption at 10.6 micron, visual camouflage by structural colors and thermal management by high emission in 5-8 micron band.

11:55 : Tunable Fano Resonance in a Liquid Crystal Colloidal Metamaterial
Amit Bhardwaj
Centre for nano and soft matter sciences (India)

A colloidal metamaterial is realized by dispersing submicron-sized high-refractive-index dielectric resonators

in a nematic liquid crystal medium. Darkfield hyperspectral imaging reveals that when the NLC molecules reorient on application of an ac electric field a doughnut-shaped scattering pattern is obtained, indicating the occurrence of Fano resonance. The theoretical simulation based on the "Multi-pole Fano interference model' confirms the experimental findings. With increasing voltage, the value of Fano parameter q decreases and approaches unity corresponding to an ideal Fano shape.

12:10 : Meta-lenses Using Metal-Dielectric-Metal Plasmonic Waveguide at Optical Frequency
Boopalan Ganapathy, Jayanth N. V., Subramaniam Chittur K.
Vellore Institute of Technology (India)

Meta-lenses are proved to be effective in different regions of the electromagnetic spectrum. The study presented here is on meta-lenses working at an optical frequency. Plano-concave meta-lenses are designed at red wavelength (660 nm) of the visible region. Metal-dielectric-metal plasmonic parallel plate waveguide is used as the unit cell to emulate an Epsilon-Near-Zero medium. Zoning technique is also presented that has an advantage of less volume compared to the non-zoned one.

12:25 : Switching the Optical Chirality by Magnetic fields in Magnetoplasmonic Metesurfaces
Jun Qin[1], Longjiang Deng[1], Tongtong Kang[1], Gaspar Armelles[2], Lei Bi[1]
[1] *University of Electronic Science and Technology of China (China),* [2] *Instituto de Micro y Nanotecnologia (INM-CNM-CSIC) (Spain)*

We report a magneto-optical metasurface device using low loss Ce:YIG thin films for active chiroptical photonic device applications. A far field modulation of the circular dichroism from -0.6° $\pm$ 0.2° to +1.9° $\pm$ 0.1° at 950 nm wavelength is observed under applied magnetic fields, enabling efficient control of optical chirality both in the far field and near field at the subwavelength scale.

11:40 - 12:35 — Gaston Floquet Room

Session 4A20

Metasurface for information processing

Organized by: Jensen Li and Xianzhong Chen

Chaired by: Jensen Li and Xianzhong Chen

11:40 : Invited talk
Terahertz Active Metasurface
Yan Zhang, Xinke Wang, Teng Wang, Jinying Guo
Capital Normal University (China)

Metasurface provides a number of approaches to manipulate the wavefront of light. Active control of the metasurface will bring more fascinate applications. We introduce two terahertz active metasurface devices which are fabricated with vanadium dioxide. With thermal exciting, the functions of devices can be switched on and off. The performances of the devices are characterized with a focal plane terahertz imaging system. It was found that the fabricated devices can achieve the preset functions well.

12:00 : Invited talk
Optical Metasurface for Engineered Polarization Profile
Xianzhong Chen, Yuttana Intaravanne
Heriot-Watt University (United Kingdom)

The unprecedented capability of optical metasurfaces in the manipulation of the light's polarization at subwavelength resolution has provided an unusual approach for arbitrary manipulation of polarization profiles. A compact metasurface platform has been demonstrated to arbitrarily engineer a polarization profile that is very difficult or impossible to realize with conventional optical elements. We have developed various metasurfaces to engineer the polarization profile of a light beam.

12:20 : 3D-printed complex-amplitude metasurface for orbital angular momentum holography

Haoran Ren[1], **Xinyuan Fang**[2], **Jaehyuck Jang**[3], **Johannes Burger**[1], **Junsuk Rho**[3], **Stefan A. Maier**[1]
[1] *Ludwig-Maximilians-Universitat Munchen (Germany),* [2] *University of Shanghai for Science and Technology, (China),* [3] *Pohang University of Science and Technology (POSTECH) (Korea)*

Metasurface holograms, consisting of subwavelength structures on a flat surface for wavefront shaping, promise new applications in information technologies. To increase the bandwidth of a metasurface hologram, different degrees of freedom of light and in particular, orbital angular momentum with an infinite quantum number hold great promise. Here, we demonstrate the design and 3D laser printing of a large-scale complex-amplitude metasurface hologram for high-dimensional orbital angular momentum-multiplexing holography.

11:40 - 12:40 — Lawrence Bragg Room

Session 4A21

Light-matter interactions in new materials and meta-architectures

Organized by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

Chaired by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

11:40 : Invited talk
A Deep Learning Approach to the Forward Prediction and Inverse Design of Plasmonic Metasurface Structural color
Mehdi Keshavarz Hedayati, Nathan Roberts
Durham University (United Kingdom)

Here, optimized Deep Neural Network models are presented to enable the forward and inverse mapping between metamaterial and corresponding color. The forward model can predict color with $textgreater96\,\%$ accuracy, with a 105 order of magnitude decreases in computational time when compared to simulations. For the first time, the use of synthetic training data for self-learning is reported which results in a $15\,\%$ improvement in training accuracy of the inverse model. The findings enable the discovery of new photonic materials.

12:00 : Invited talk
Space-time metamaterials: homogenization theory, giant bianisotropy and light drag without moving media
Paloma A. Huidobro[1], **Mario Silveirinha**[1], **Emanuele Galiffi**[2], **John Pendry**[2]
[1] *University of Lisbon (Portugal),* [2] *Imperial College London (United Kingdom)*

Here I will present a theory of homogenisation of space-time metamaterials, which yields expressions for the effective permittivity, permeability and magnetoelectric coupling in the long wavelength limit. The derived parameters show that synthetic motion can result in giant bianisotropy and the dragging of electromagnetic fields down to the quasistatic limit and without any moving matter

12:20 : Invited talk
Watching operating Li:ion batteries by Raman through hollow-core optical fibres
Ermanno Miele, Wesley M. Dose, Ilya Manyakin, Michael H. Frosz, Philip St.J. Russell, Clare P. Grey, Jeremy J. Baumberg, Tijmen G. Euser
University of Cambridge (United Kingdom)

We demonstrate a fibre-optic sensing method capable of monitoring chemical changes within Li:ion cells under real working conditions. Our technique is based on optofluidic single-ring hollow-core fibres, that uniquely allow light to be guided at the centre of a microfluidic channel. We integrate the fibres into working Li:ion cells, use them to take sub-microlitre samples of the electrolyte liquid, and analyse these by background-free Raman spectroscopy to identify early signs of battery degradation.

11:40 - 12:40 — Rene Descartes Room

Session 4A22

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

11:40 : Invited talk

Fabrication of ultrathin multilayer structures and their characterization

Andrei V. Lavrinenko, Johneph Sukham, Maryam Mahmoodi, Osamu Takayama, Seyed Hassan Tavassoli, Radu Malureanu

Technical University of Denmark (Denmark)

Multilayer structures have been in the focus of research for decades. They exhibit various optical properties starting from anti-reflection coating, Bragg gratings and finishing with hyperbolic metamaterials. Meantime they accept quite simple theoretical analysis and straightforward modeling In spite of such intensive study there are still numerous questions about quality of fabrication processes, accessible parameters ranges and adequate models accurately explaining their performance. We report on our activity in fabrication of ultrathin dielectric and metal-dielectric layers, and their characterization.

12:00 : Invited talk

Scattering properties of Parity-Time symmetric chiral metamaterials

Maria Kafesaki[1], Ioannis Katsantonis[2], Sotiris Droulias[2], Costas Soukoulis[3], Eleftherios Economou[2]

[1] FORTH-IESL and University of Crete (Greece), [2] FORTH-IESL and Univ. of Crete (Greece), [3] FORTH-IESL and Iowa State University (USA)

Combining parity-time (PT) symmetry and chirality one can achieve a variety of novel electromagnetic properties and effects. Here we demonstrate some of those effects in a simple bi-layer PT-symmetric chiral structure illumined by a plane wave. Phenomena such as asymmetric transmitted wave ellipticity, mixed PT-related phases, simultaneous coherent perfect absorption and lasing of circularly polarized waves, etc., are numerically demonstrating. All those phenomena, realizable with realistic chiral metamaterials, empower PT-symmetric chiral systems with unique possibilities regarding electromagnetic wave control.

12:20 : Invited talk

Polarisation study of the light scattered by nanoporous plasmonic microparticles

Pritam Khan, Grace Brennan, Daragh Rice, Syed A. M. Tofail, Ning Liu, Christophe Silien

University of Limerick (Ireland)

Nanoporous microparticles exhibit large surface-to-volume ratio and can detect chemicals and biomolecules. Using dark-field microscopy, we observed that, when the nanoporous microparticles are illuminated by circularly polarized lasers, the scattered light polarization is inverted. The inversion is interesting as the microparticles are (nearly-)spherical, and the nanopores do not exhibit symmetry. We observed that the scattered light polarization is tunable when plasmonic nanoparticles and short molecules are in the pores. We discuss these findings and their exploitation as sensors.

Lunch

12:40 - 14:00

14:00 - 16:00 — Victor Veselago Room

Session 4A23

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

14:00 : Invited talk

The Revolutionary Advent of Magnetless Nonreciprocal Metasurfaces

Christophe Caloz[1], **Toshiro Kodera**[2]
[1] *Katholieke Universiteit Leuven (KU Leuven) (Belgium),* [2] *Meisei University (Japan)*

We present a narrative overview of our work on magnetless nonreciprocal metasurfaces over the past decade, showing how the spacetime telescoping of the two emerging areas of magnetless nonreciprocity and metasurface transformation has lead to the revolutionary technology of magnetless nonreciprocal metasurfaces.

14:20 : Invited talk
Photonic entanglement based quantum metrology
Laurent Labonté[1], **Mattis Reisner**[1], **Florent Mazeas**[1], **Djeylan Aktas**[1], **Florian Kaiser**[1], **Romain Dauliat**[2], **Philippe Roy**[2], **Raphael Jamier**[2], **Sebastien Tanzilli**[1]
[1] *Université Côte d'Azur (France),* [2] *Université de Limoges (France)*

During the conference, we show how we take advantage of these capabilities to gather optical fiber photonic engineering with quantum optics. More specifically, we aim at presenting two quantum-based method for (i) high-accuracy (10-5) and dispersion-free measurement of refractive index difference and (ii) chromatic dispersion measurement based on the concept of quantum white-light interferometry that allows absolute measurement of chromatic dispersion with 2.5 times improved accuracies compared to state-of-the-art realizations at telecom wavelengths.

14:40 : Invited talk
Nanomechanics with plasmonic nanoantennas
Hilario D. Boggiano[1], **Rodrigo Berté**[2], **Alberto F. Scarpettini**[3], **Emiliano Cortés**[2], **Stefan A. Maier**[2], **Andrea V. Bragas**[1]
[1] *Universidad de Buenos Aires (Argentina),* [2] *Ludwig-Maximilians-Universitat Munchen (Germany),* [3] *Universidad Tecnologica Nacional (Argentina)*

The measurement of the mechanical properties of thin films is a key factor both for their integration into large-scale devices and to determine their duration as advanced coatings, sensors or optoelectronic components among other applications in the current technological landscape. Here we introduce a new method using optical antennas as nanomechanical sensors to determine the nanoscale mechanical response of polymeric films in the GHz range, although the method can be extended to a wide range of materials

15:00 : Invited talk
Transition to strong coupling regime for quantum emitters coupled to a plasmonic resonator
Tigran V Shahbazyan
Jackson State University (USA)

We present a model for exciton-plasmon coupling based on energy exchange between emitters and localized surface plasmons in metal-dielectric structures. Plasmonic correlations between emitters give rise to a collective state exchanging its energy with a resonant plasmon mode. By accurately defining the plasmon mode volume, we relate the QE-plasmon coupling to collective energy transfer rate. For QEs distributed in extended region enclosing a plasmonic structure, the ensemble QE-plasmon coupling saturates to a universal value independent of system size and shape.

15:20 : Invited talk
Magneto-optical control with non-reciprocal surface waves for nanoscale thermotronics
Svend-Age Biehs
Carl von Ossietzky Universitat (Germany)

Magneto-optical materials have been proposed as promising candidates for an active control of nanoscale heat radiation. Unexpected effects like the thermal radiative Hall effect, persistent currents, giant magnetoresistance, and circular heat fluxes, persistent angular momentum and spin of thermal radiation have been highlighted. We review recent developments in this new direction of magneto-optical thermotronics focusing on the rectification of nanoscale heat fluxes by means of non-reciprocal surface wave and reveal the spin coupling mechanism behind this effect.

15:40 : Invited talk
Long-range FRET-mediated exciton diffusion in highly efficient self-assembled monolayers of cesium lead halide perovskite nanocrystals
Monica Lorenzon, Matthew Jurow, Min Ji Hong, Yi-Hsien Lu, Edward S. Barnard, Miquel Salmeron, Yi

Liu, Alexander Weber-Bargioni, Erika Penzo, Adam Schwartzberg
Lawrence Berkeley National Laboratory (USA)

Colloidal perovskite nanocrystals (PNCs) are solution-processable functional materials whose emission can be easily tuned via both size and composition. In this work, we investigate exciton diffusion in a self-assembled, close-packed monolayer of inorganic PNCs and measure a record diffusion length of 480nm, one order of magnitude large than what previously observed for traditional cadmium-based quantum dots. Moreover, we report a detailed investigation of the effect of a ceramic protective coating on our PNC monolayers, deposited via atomic layer deposition.

14:00 - 15:15 — Allan Boardman Room

Session 4A24
Chiral and hyperbolic metamaterials

14:00 : Active Chiral Metasurfaces via Colloidal Self-Assembly
Andreas Fery[1], Patrick T. Probst[2], Martin Mayer[2], Vaibhav Gupta[2], Anja Maria Steiner[2], Gunter K. Auernhammer[2], Tobias A. F. Koenig[2]
[1] *Technische Universitat Dresden (Germany),* [2] *Leibniz-Institut fur Polymerforschung Dresden e.V. (Germany)*

Active chiral metasurfaces enable continuous on-chip polarization engineering, detection and encoding. Here, we introduce a facile bottom-up approach that produces circular dichroism of up to 11 degrees in the visible-near-infrared spectral region. This pronounced effect surpasses previous colloidal approaches by two orders of magnitude. Furthermore, the presented design of stacked particle chain arrays allows in-situ re-stacking and local compression to tune dynamically all aspects of circular dichroism: sign, magnitude and spectral position.

14:15 : Towards dynamic and chiral plasmonics using liquid crystals
Wiktor Lewandowski
University of Warsaw (Poland)

Nanostructures with chiral symmetry and plasmonic properties attract considerable interest. Here, we present endeavors towards achieving thin films of chiral, reconfigurable nanostructures, which resolve some of the current synthetic challenges. Here, synthesis relies on mixing (chiral) liquid crystals with gold nanoparticles. Due to the soft character of liquid crystals, these nanoarchitectures exhibit helical, hierarchical and switchable structure. Durability, configurability and tailorability of such nanomaterials in the solid state, is particularly attractive for real world applications.

14:30 : Tailored Hyperbolic Metamaterials for Enhanced Superlensing Effects along the entire Visible Regime
Nadia Pinton[1], Vincenzo Caligiuri[2], Giulia Biffi[1], Antonio De Luca[2], Roman Krahne[1]
[1] *Istituto Italiano di Tecnologia (Italy),* [2] *University of Calabria (Italy)*

Superlensing effects have been established in presence of an Epsilon-Near-Zero (ENZ) resonance. However, ENZ engineered metamaterials in the visible spectral range have been elusive. In this paper, we demonstrate that, by using Hyperbolic Metamaterials (HMMs) composed of a periodic stack of metal/high-refractive index dielectric bilayers and varying the oxidation degree of the dielectric material, the ENZ resonance and thus the superlensing effects can be shifted in wavelength along the entire visible range.

14:45 : Giant third-harmonic dichroism in all-dielectric chiral metasurfaces based on quasi-bound states in the continuum
Marco Gandolfi, Andrea Tognazzi, Davide Rocco, Costantino De Angelis, Luca Carletti
CNR-INO (National Institute of Optics) (Italy)

We develop a new approach based on quasi-BICs to develop chiral metasurfaces exhibiting nonlinear circular dichroism (up to 99.9 %) and high conversion efficiency. Tuning mode interference allows selective linear and nonlinear circular dichroism.

15:00 : Asymmetricity leading to Circular Conversion Dichroism in Optical Regime
Ahsan S. Rana[1], Inki Kim[2], Muhammad Zubair[1], Junsuk Rho[2], Muhammad Q. Mehmood[1]
[1] *University of the Punjab (Pakistan),* [2] *Pohang University of Science and Technology (POSTECH) (Korea)*

Asymmetric transmission (AT) of light is an intriguing phenomenon of chirality that can lead to fashion optical diodes. However, achieving AT in the optical regime is a monumental task because of dielectric losses. In this research, we present a novel approach that utilizes nano bars of hydrogenated amorphous silicon to obtain AT in the optical regime with the maximum at 633 nm. The design also uses dielectric loss to engineer circular conversion dichroism (CCD), which can completely eradicate backscattering.

15:15 - 16:00 — Allan Boardman Room

Session 4A25
Super-resolution imaging

15:15 : Exploring object sub-wavelength features using transformation-optics based imaging systems
Mircea Giloan[1], Robert Gutt[2], Gavril Saplacan[3]
[1] *Babes-Bolyai University (Romania),* [2] *National Institute for Research and Development of Isotopic and Molecular Technologies (Romania),* [3] *Company for Applied Informatics (Romania)*

The information about the fine sub-wavelength details of an object are carried by waves with high transverse wave vectors which become evanescent and decay exponentially inside a classical material. The proposed optical imaging systems made of transformation-optics inspired lenses are capable to process the waves with high transverse wave vectors and enable their contribution to the reconstructed image. The capability of these optical imaging systems to perform magnified images of sub-wavelength features of arbitrary objects is theoretically analyzed.

15:30 : Plano-Convex-Microsphere (PCM) super lens for direct laser nano-fabrication and optical super-resolution imaging in far-field
Bing Yan[1], Liyang Yue[1], Rakech Dhama[1], Daniel Siebadji Tchuimeni[1], Xibin Yang[2], Daxi Xiong[2], Zengbo Wang[1]
[1] *Bangor University (United Kingdom),* [2] *Chinese Academy of Sciences (China)*

This paper proposes and demonstrates a high-performance all-dielectric compound superlens, formed by integrating a conventional Plano-Convex lens with a high-index Microsphere lens. We call such lens the Plano-Convex-Microsphere (PCM) lens, which is developed for far-field super-resolution applications. The compound PCM lens is highly versatile and can be simply adapted into an existing optical system to realize super-resolution function. Here, the super-resolution features of the PCM lens were demonstrated for two applications: direct laser nanofabrication and white light nano-imaging.

15:45 : Investigation of proximity effects in light funnel arrays using near-field optical microscopy
Ankit Chauhan, Gil Shalev
Ben Gurion university of the Negev Beer Sheva (Israel)

Surface arrays of silicon light funnels (LF) were suggested as a promising platform to produce broadband absorption that is considerably superior to that of the well-known nanopillar (NP) arrays, for example. The current study explores the underlying mechanism of broadband absorption in LF arrays. To this end the optical near-field of LF and NP arrays is experimentally probed. We show that in LF arrays the near-field increases as the array period decreases in contrast with NP arrays.

14:00 - 16:00 — Tatsuo Itho Room

Session 4A26
Theory, Fabrication, Experiments, and Applications

14:00 : Bound states in the continuum in asymmetric waveguides: role of proportionate coupling
Nikolay Shubin, Vladimir Kapaev, Alexander Friman, Alexander Gorbatsevich
Russian Academy of Sciences (Russia)

We perform theoretical analysis of bound states in the continuum (BIC) formation in a resonator coupled to two waveguides. Analytical description provides clues on BIC conditions - a single point in the parameter space, when exact numerical calculations become cumbersome. The Friedrich-Wintgen mechanism can be realized in asymmetric system with proportionate couplings to waveguides. The derived conditions are universal and can be implemented to electronic or electromagnetic waveguides. As an example we present BIC in an asymmetric quantum billiard.

14:15 : A low-dimensional nonlinear eigenproblem for the complete complex bandstructure and microscopic fields of arbitrary two-domain metamaterials
Antonio Günzler, Cedric Schumacher, Matthias Saba
University of Fribourg (Switzerland)

Homogenization theories for plasmonic metamaterials usually start with crude approximations that are valid in certain limits in zero order, such as small frequencies, wave vectors and material fill fraction. We here instead present a rigorous solution to Maxwell's equations in binary periodic materials employing a combined Green's-Galerkin procedure to obtain the complex-valued eigenmodes of the material. Our theory can be generalized and remains valid in regimes outside of those accessed by standard approaches.

14:30 : Electromagnetic Modeling of finite Fragments of Metamaterials and Metasurfases based on Method of Minimal Autonomous Blocks
Yauheni Arlou[1], Sergei Maly[1], Eugene Sinkevich[2]
[1] *Belarusian State University (Belarus),* [2] *Belarusian State University of Informatics and Radioelectronics (Belarus)*

Technique to model finite fragments of frequency-selective screens, metasurfaces and flat layers of metamaterials based on method of minimal autonomous blocks is proposed. Use of multichannel macroblocks (scattering matrices) corresponding to unit cells of the material and surrounding space is the basis. The technique significantly decreases requirement to RAM compared to other methods. It can model arbitrary excitation modes of finite structures by local and remote sources. Modeling results of finite fragment of frequency-selective surface are given.

14:45 : Fluorescent Multi-layered films for Label-Free Detection of Volatile Organic Compounds
Heba Megahd[1], Paola Lova[1], Andrea Pucci[2], Davide Comoretto[1]
[1] *University of Genova (Italy),* [2] *University of Pisa (Italy)*

The detection of vapors is fundamental in many different applications, such as air pollution analysis, industrial process monitoring and breath analysis. This work utilizes a styrene copolymer with fluorescent molecular rotors exhibiting aggregation-induced emission as a promising vapor sensor. Capping thin films of such copolymers with different polymers provides a quick and selective means of detecting volatile organic compounds through fluorescence quenching.

15:00 : Near-field luminescence of two-dimensional semiconductors
Vlastimil Krapek, Petr Dvorak, Lukas Kejik, Martin Konecny, Zoltan Edes, Martin Hrton, Michal Kvapil, Michal Horak, Tomas Sikola
Brno University of Technology (Czech Republic)

Two-dimensional semiconductors are ideal light sources for on-chip integration. They exhibit strong luminescence, and are capable of single-photon emission. Since the wavelength of the light is considerably larger than the physical dimensions of the emitter, near-field handling of the emission with a deeply subwavelength spatial resolution would be of great importance. Here we present fully near-field photoluminescence study of two-dimensional semiconductors, with a surface plasmon interference device used for the excitation and scanning near-field optical microscopy for the collection.

15:15 : Efficient Implementation of Active Exterior Cloak in Three Dimensions
Cheuk-Him Yeung, Tom Shearer, William J. Parnell
University of Manchester (United Kingdom)

We describe a cloaking strategy for the 3D Helmholtz equation by using a number of multipolar sources to construct a silent region which shields any object inside from the incoming wave and minimizes the scattering.

Their amplitudes are expressed in a surface integral as we solve the Kirchhoff-Helmholtz integral equation by applying the addition theorem for Bessel functions. The positioning of the sources at the vertices of a Platonic solid simplifies the integral and allows for efficient numerical evaluation.

15:30 : Spark discharge synthesis of noble metals and GeSi nanoparticles for UV-vis-NIR plasmonics
Anna Lizunova, Vladislav Borisov, Dana Malo, Kirill Khabarov, Viktor Ivanov
Moscow Institute of Physics and Technology (Russia)

Noble metals (Pt, Au and Ag) and alloy GeSi aerosol nanoparticles were synthesized by spark discharge in pure argon atmosphere with additional in-flow sintering of nanoparticles at temperatures from 25 to 950 °C. The size, morphology, crystal structure and optical properties of obtained nanomaterials were investigated. It has been established that the thermal treatment of aerosol nanoparticles leads to crucial change in absorption properties and vary the morphology from branched agglomerates to spherical nanoparticles.

15:45 : Synthesis and characterization of palladium nanoparticles by laser ablation in liquids
Mónica Fernández-Arias[1], Ana M. Vilas-Iglesias[1], Mohamed Boutinguiza[1], Daniel Rodríguez[2], Felipe Arias-González[3], Pablo Pou[1], Antonio Riveiro[1], Javier Gil[3], Juan Pou[1]
[1] *University of Vigo (Spain),* [2] *UPC-Barcelona TECH (Spain),* [3] *Universitat Internacional de Catalunya (Spain)*

The outstanding catalytic and electronic properties of palladium nanoparticles, make them useful in a wide variety of applications including the biomedical field. In this work, palladium nanoparticles are obtained by laser ablation in water and methanol with two different laser sources (a Green nanosecond and a IR picosecond laser) and their physical-chemical properties are analyzed.

14:00 - 15:15 — Christian Huygens Room

Session 4A27

Mesoscale Plasmonics, Nanophotonics and Acoustics

Organized by: Igor V. Minin and Oleg V. Minin

Chaired by: Igor V. Minin and Oleg V. Minin

14:00 : Invited talk
Super-enhancement focusing of Teflon sphere in terahertz band
Liyang Yue[1], Zengbo Wang[1], Bing Yan[1], Oleg Minin[2], Igor Minin[2]
[1] *Bangor University (United Kingdom),* [2] *Tomsk State University (Russia)*

A Teflon sphere can focus the light near its shadow surface. In this paper, two circular hotspots having the extremely large field-intensity were discovered around the poles of a specifically sized Teflon sphere irradiated by a plane wave in terahertz band using an analytical algorithm. A huge contribution of scattering amplitude from a single order of mode in electric-field or magnetic-field is considered as the main factor to trigger this phenomenon of super-enhancement focusing.

14:20 : Dielectric Microstructures for Extended Photonic Nanojet Generation
Ksenia Sergeeva, Aleksandr Sergeev
Russian Academy of Sciences (Russia)

The functional aluminum oxide microstructures of various geometry for the generation of extended photonic nanojets in transmission, as well as in reflection modes, were developed. The numerically calculated parameters of photonic nanojets are in good agreement with the experimentally obtained ones. The preliminary studies of the photoluminescence enhancement of sensitive layers under excitation by photonic nanojets revealed up to four-time an increase in its emission intensity.

14:35 : Invited talk
High Intensity Photonic Nanojets from a Gradient Low Refractive Index Profile
Alexander Littlefield, Jinlong Zhu, Lynford Goddard
University of Illinois at Urbana-Champaign (USA)

Designs for photonic nanojet (PNJ) generators are examined. The maximum intensity of the PNJ is used as an objective for optimization under the constraint of maximum refractive index and fixed generator size. Building on the work of Patel et al. with a generator of a step-index profile across tangent microspheres, we propose a gradient index (GRIN) design. Our design has a higher intensity focus yet requires lower index contrast. This eases fabrication while improving resolution in applications including photolithography.

14:55 : Invited talk
Zero-group-velocity mechanical metamaterial
Rafael A. Mendez-Sanchez[1], Bryan Manjarrez[1], Enrique Flores[2], Arturo Arreola[2], Gabriela Baez[2]
[1] *Universidad Nacional Autonoma de México (Mexico),* [2] *Universidad Autonoma Metropolitana-Azcapotzalco (Mexico)*

A quasi-one-dimensional mechanical metamaterial, with a zero-dispersion band, was designed. Each metaatom consists of an aluminum plate weakly connected to neighbouring metaatoms through aluminum beams. The band structure of the perturbative metamaterial was calculated using COMSOL. Depending on the location of the beams a flat band, separated of all other bands, can be engineered. The resulting metamaterial has a group velocity of less than 1 % of the velocity of compressional waves in aluminum.

14:00 - 16:00 — Augustin Fresnel Room

Session 4A28
Plasmonics and nano-optics

14:00 : Silver nanowires - remotely excited (bio)sensors
Michal Cwik[1], Karolina Sulowska[2], Dorota Buczynska[1], Ewa Rozniecka[1], Martyna Domagalska[2], Sebastian Mackowski[2], Joanna Niedziolka-Jönsson[1]
[1] *Polish Academy of Sciences (Poland),* [2] *Nicolaus Copernicus University (Poland)*

We synthesized silver nanowires (AgNWs) with varying diameters and lengths by changing reducing agent. We found that choice of the reducing agent leads to nanowires with desired dimensions and thus plasmonic properties. For hybrid nanostructures consisting of AgNWs and photoactive proteins we observe that with increase of AgNWs diameter surface plasmon propagation length increases, yet fluorescence enhancement decreases. We show that synthesized AgNWs can be utilized for remote excitation of molecules localized hundred of microns from excitation spot.

14:15 : A refractive index sensor based on a Au inverted honeycomb lattice
Javier Rodriguez Alvarez[1], Lorenzo Gnoatto[2], Marc Martínez Castells[3], Albert Guerrero[4], Xavier Borrisé[5], Arantxa Fraile Rodríguez[1], Xavier Batlle[1], Amílcar Labartaa[1]
[1] *IN2UB - University of Barcelona (Spain),* [2] *University of Barcelona (Italy),* [3] *University of Barcelona (Spain),* [4] *Institut de Microelectrónica de Barcelona (IMB-CNM, CSIC) (Spain),* [5] *Catalan Institute of Nanoscience and Nanotechnology (ICN2) (Spain)*

We present an efficient refractive index sensor consisting in a Au inverted honeycomb lattice. Numerical simulation showed high sensitivity values up to 99 nm/RIU for test layers of 50 nm. In addition, the figure of merit of the sensor detecting slight changes of the refractive index of a water medium at a fixed wavelength was 199 RIU-1. As an experimental proof of concept, the heterostructure was manufactured by electron beam lithography and the measured optical response agreed with the simulations.

14:30 : Towards perfect metallic behavior in optical resonant absorbing nanostructures
Clément Verlhac, Mathilde Makhsiyan, Riad Haidar, Jérôme Primot, Patrick Bouchon
Université Paris-Saclay (France)

Looking for a perfect metallic behavior is a crucial research line for metamaterials scientists. We propose a strategy based on a contrast of dielectric index to control losses in metals within waveguides and resonant nanostructures. This permits to tune the quality factor of the guided mode and of the resonant absorption over at least four orders of magnitude. This concept is applied to a practical design to finely control the localization of dissipation in an absorbing photonic structure.

14:45 : Plexcitons in Thermoresponsive Dextran-Graft-PNIPAM / Au Nanoparticles / CdTe Quantum Dots Nanosystem: Temperature Effects

Oleg Yeschhenko[1], Pavlo Khort[1], Nataliya Kutsevol[1], Olga Kapush[2], Volodymyr Dzhagan[1]
[1] *Taras Shevchenko National University of Kyiv (Ukraine),* [2] *National Academy of Sciences of Ukraine (Ukraine)*

The temperature driven plasmon-exciton coupling in thermoresponsive dextran-graft-PNIPAM / Au nanoparticles / CdTe quantum dots (D-g-PNIPAM / Au NPs / CdTe QDs) nanosystem was studied. A large (0.84 eV) splitting of plexciton states was observed. The heating-cooling cycle of the aqueous solution of the studied nanosystem leads to a reversible quenching-recovery alteration of the QD photoluminescence. The quenching was rationalized as a result of an increased probability of nonradiative resonance energy transfer (RET) from CdTe QDs to Au NPs.

15:00 : Up-conversion luminescence activated by surface plasmon polaritons

Maciej Cwierzona, Karolina Sulowska, Michal Zebrowski, Sebastian Mackowski, Dawid Piatkowski
Nicolaus Copernicus University (Poland)

In this work we discuss remote activation and detection of up-conversion photoluminescence, coming from submicron Er3+/Yb3+ co-doped nanocrystals (NCs) droplet, deposited locally at one end of long single silver nanowire. We show that different polarization of the laser beam as well as dimeter of the nanowire change optical response of the nanocrystals in this polariton-mediated, remote up-conversion process.

15:15 : Semiconductor-based nanostructures for spectral filtering

Clément Maes[1], Grégory Vincent[1], Fernando Gonzalez-Posada Flores[2], Laurent Cerutti[2], Riad Haïdar[1], Thierry Taliercio[2]
[1] *ONERA (France),* [2] *Université de Montpellier (France)*

We present a theoretical study of a nanostructured guided-mode resonant (GMR) spectral filter operating in the long-wave infrared (LWIR) wavelength range. The component is made of III-V semiconductors: heavily n-doped InAsSb for the grating and GaSb for the waveguide of the GMR resonator.

15:30 : Spin-orbit coupling in dielectric nanostructures: a new recipe to realize sorting and boost diffusion at the nanoscale

Adria Canos Valero[1], Denis Kislov[1], Egor A. Gurvitz[1], Hadi K. Shamkhi[1], Alexander A. Pavlov[2], Dmitrii Redka[3], Sergey Yankin[4], Pavel Zemanek[5], Alexander S. Shalin[1]
[1] *ITMO University (Russia),* [2] *INME - RAS (Russia),* [3] *Electrotechnical University (Russia),* [4] *LLC COMSOL (Russia),* [5] *Institute of Scientific Instruments (Russia)*

State-of-the-art microfluidics requires a variety of controllable components to perform operations inside microchambers. Brand-new nanophotonic approaches can significantly enhance existing capabilities via light-matter interactions. We propose a novel concept featuring dual on-chip functionality: boosted optically-driven diffusion and sorting. Well-designed high-index nanoantennae mediate spin-orbit coupling from a laser beam, producing subwavelength optical nanovortices that drive spiral motion of plasmonic nanoparticles, inducing fluid flow, enabling moving-part-free nanomixing. Moreover, we achieve precise sorting of gold NPs, demanded for on-chip separation and filtering

15:45 : Plasmonic nano-patterning on optical fibers for optical neural interfaces

Rosa Mach-Batlle[1], filippo Pisano[1], Di Zheng[1], Leonardo Sileo[1], Massimo De Vittorio[2], Ferruccio Pisanello[1], Cristian Ciracì[1]
[1] *Istituto Italiano di Tecnologia (Italy),* [2] *Universita del Salento (Italy)*

Optogenetics makes it possible to control the activity of neurons by light. Optical fibers are the most common device for delivering light to the brain, but they do not offer much control over the light distribution and intensity reaching the brain tissue. Here, we explore the possibility of designing a plasmonic nano-patterning at the fiber facet able to enhance the interaction between light and brain tissue in a controlled manner, which could lead to significant advances in the field.

14:00 - 16:00 — Ibn Al-Haytham Room

Session 4A29

Plasmonic Nanomaterials for Bio-diagnostics, Environmental Monitoring and Food Safety

Organized by: Lucia Petti

Chaired by: Lucia Petti and Massimo Rippa

14:00 : Invited talk

Pixeled metasurface for multiwavelength detection

Valentina Di Meo[1], Alessio Crescitelli[1], Massimo Moccia[1], Annamaria Sandomenico[2], Angela M Cusano[3], Marianna Portaccio[4], Maria Lepore[4], Vincenzo Galdi[1], Emanuela Esposito[1]

[1] University of Sannio (Italy), [2] Institute of Biostructure and Bioimaging, National Research Council (Italy), [3] CeRICT scrl (Italy), [4] University of Campania "Luigi Vanvitelli"(Italy)

We present a plasmonic biosensor based on SEIRA spectroscopy, which exploits resonant coupling between plasmonic nanoantennas and vibrational excitation of small molecules. Our platform features a large-area metasurface made of gold nanoantennas fabricated on a silicon substrate, comprising different macroregions "pixels". A single chip is capable of performing analysis from the region of functional groups to that of fingerprint. We detect a concentration as low as 86 pmol/L of a small molecule which is the best marker of vitamin D3.

14:20 : Invited talk

Hybrid Plasmonic Nanomaterials: Functional Platforms for Bio and Food

Bruno Miranda, Ilaria Rea, Principia Dardano, Carlo Forestiere, Luca De Stefano

ISASI-CNR (Italy)

We design, fabricate and analyze a hybrid nanoplasmonic device by using gold nanoparticles and polyethylen glycole. We characterize the absorption spectra of spherical gold nanoparticles embedded in polyethylene glycol diacrylate. The designed wearable platforms could detect specific target analytes in localized surface plasmon resonance and fluorescence modes. The proposed fabrication strategy represents a good candidate for becoming a functional platform for Bio and Food screening.

14:40 : Invited talk

Photometric station for in-vitro diagnostic analysis using organic-based opto-electronic devices and photonic crystals

Giuseppe Nenna[1], Maria Grazia Maglione[1], Pasquale Morvillo[1], Tommaso Fasolino[1], Anna De Girolamo Del Mauro[1], Rosa Ricciardi[1], Riccardo Miscioscia[1], Giuseppe Pandolfi[1], Giovanni De filippo[1], Francesco Pascarella[1], Carla Minarini[1], Rosita Diana[1], Massimo Rippa[2], Lucia Petti[2], Paolo Tassini[1], Salvatore Aprano[3], Giorgio Allasia[3]

[1] ENEA, Italian National Agency for New Technologies (Italy), [2] Università di Napoli Federico II (Italy), [3] FOS S.p.A. (Italy)

This work describes, for the first time, the use of innovative organic optoelectronic devices and photonic crystals to prepare an absorbance apparatus for plate readers, for the invitro detection of antibodies or antigens in biological samples.

15:00 : Invited talk

Towards label-free, implantable neuro-plasmonic probes

filippo Pisano[1], Antonio Balena[1], Muhammad Fayyaz Kashif[2], Marco Pisanello[1], Antonio Qualtieri[1], Leonardo Sileo[1], Tiziana Stomeo[1], Antonella D'Orazio[2], Marco Grande[2], Ferruccio Pisanello[1], Massimo De Vittorio[1]

[1] Istituto Italiano di Tecnologia (Italy), [2] Politecnico di Bar (Italy)

Optical fibers are widely applied to stimulate and monitor neural activity in deep brain regions expressing light-sensitive genetically-encoded sensors and actuators. Recent progress has demonstrated that these probes allow for endoscopic imaging and depth-resolved tissue interrogation. However, label-free sensing of neural events in vivo is still beyond the reach of currently available technologies. To remediate to this shortcoming, we have developed novel methods to fabricate multiple plasmonic bio-sensors on the optically active surface of flat-cleaved and tapered optical fibers.

15:20 : Invited talk

Plasmonic nanostructures for label-free detection of water contaminants

Massimo Rippa[1], Ambra Vestri[1], Radoslaw Kolkowski[2], Joseph Zyss[3], Jun Zhou[4], Lucia Petti[1]

[1] Institute of Applied Sciences and Intelligent Systems .E. Caianiello.of CNR (Italy), [2] Center for Nanophotonics, AMOLF (The Netherlands), [3] Institut d'Alembert (France), [4] Ningbo University (China)

In this work we design, fabricate and characterize novel periodic arrangements of gold nanoelements. We tested the detection performance of our nanostructures analyzing different concentrations in water of fipronil and imidacloprid insecticides using both the Localized Surface Plasmon Resonance (LSPR) and Surface Enhanced Raman Spectroscopy (SERS) sensing approach.

15:40 : Invited talk

Bioanalytics using plasmonic nanostructures

David Zopf, Angelina Pittner, Philipp Muller, Cornelia Reuter, Matthias Thiele, Ondrej Stranik, Andrea Csaki, Wolfgang Fritzsche

Leibniz Institute of Photonic Technology (IPHT) (Germany)

Novel requirements for bioanalytical methods emerge due to trends such as personalized medicine. Upon binding of molecules, the localized surface plasmon resonance (LSPR) of these structures is changed, and can be used as sensoric readout. We will show how plasmonic nanostructures provide sensing capabilities with the potential for ultrasensitive and robust assays in a high parallelization, and without the need for markers.

14:00 - 16:00 — Gaston Floquet Room

Session 4A30

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

14:00 : Invited talk

Brillouin Spectroscopy in Optophononic Micropillars at 18 GHz

Anne Rodriguez, Edson Cardozo de Oliveira, Priya Priya, Abdelmounaim Harouri, Isabelle Sagnes, Luc Le Gratiet, Martina Morassi, Aristide Lemaitre, Loic Lanco, Pascale Senellart, Martin Esmann, Norberto Daniel Lanzillotti-Kimura

Centre de Nanosciences et de Nanostructures - C2N (France)

We measured the Brillouin spectrum on an elliptical optophononic micropillar resonator based on AlAs/GaAs superlattices designed to confine light and sound simultaneously. The ellipticity has associated two polarized modes used to discriminate the reflected laser and the Brillouin signal.

14:20 : Invited talk

Dynamics of Nanomechanical Metamaterials: Pico-vibrometry with Light and Electron Beams

Jun-Yu Ou, Tongjun Liu, Jinxiang Li, Dimitrios Papas, Eric Plum, Kevin F. MacDonald, Nikolay I. Zheludev

University of Southampton (United Kingdom)

We report on the detection and quantitative mapping of picometre (sub-atomic) amplitude, thermal (phonon-induced) and driven movements in photonic nanostructures, using light and electron beams. These techniques enable measurements of the dynamic mechanical properties that underpin the functionality of a growing range of micro/nano-opto-mechanical (meta)materials, devices, sensors and systems, and present new opportunities in the exploration of fundamental nonequilibrium (opto)mechanics.

14:40 : Invited talk

Slow-light dissipative Kerr solitons in coupled-cavity waveguides

Juan Pablo Vasco, Vincenzo Savona

Ecole Polytechnique Fédérale de Lausanne (Switzerland)

We study frequency combs and dissipative Kerr solitons in silicon coupled-cavity waveguides (CCW) with globally optimized dispersion at telecom wavelengths. The corresponding threshold for comb generation is

found to explicitly depend on the main CCW figures of merit, namely, mode volume, normal mode quality factor and slow-light group index. Our results set the CCW as a new paradigm for low-threshold comb generation via advanced dispersion engineering and slow-light enhancement.

15:00 : Invited talk
Topological Pillared Phononic Crystals: Edge States, Fano Resonance and Their Robustness Against Disorder
Wei Wang[1], Yabin Jin[2], Wan Wang[2], Bernard Bonello[1], Romain Fleury[3], Daniel Torrent[4], Yan Pennec[5], Bahram Djafari Rouhani[5]
[1] *Sorbonne Université (France),* [2] *Tongji University (China),* [3] *EPFL (Switzerland),* [4] *Universitat Jaume I (Spain),* [5] *Université de Lille (France)*

We study theoretically the topological properties of pillared phononic crystals. By breaking the space inversion symmetry in a honeycomb lattice, we show different topological phases emulating the analogs of quantum valley and spin Hall effects. Robust edge states with one-way propagation are demonstrated as well as a rich variety of refraction phenomena at the outlets. A robust topological Fano mechanical resonance is achieved in a pillared beam from the superposition of a dark and a bright edge mode.

15:20 : Invited talk
Enhancing chiral fields with arrays of achiral nanoparticles
T. V. Raziman
Eindhoven University of Technology (The Netherlands)

Chiral light-matter interaction forms the basis for molecular circular dichroism spectroscopy, optical spin manipulation, and optical torques. Magnifying chiral effects using nanophotonics requires preserving the chiral near field. We propose conditions and limits for enhancing chiroptical effects near achiral metasurfaces. We prove that a nanostructure cannot be universally optimal for different chiral applications. We also predict an analytical limit of maximum circular dichroism in highly evanescent Fourier orders. Our results establish guidelines for nanophotonic enhancement in diverse chiroptical applications.

15:40 : Invited talk
Integrated nonlinear photonics in AlGaAs-on-insulator devices
S. May[1], J. McPhillimy[1], C. Klitis[1], B. Guilhabert[1], M. Kues[1], M. D. Dawson[2], M. J. Strain[2], M. Clerici[1], M. Sorel[1]
[1] *University of Glasgow (United Kingdom),* [2] *University of Strathclyde (United Kingdom)*

The heterogeneous integration of AlGaAs-on-insulator (AlGaAs-OI) has proven to be a powerful material platform for nonlinear optics. This talk will explore how chip-scale bonding and transfer printing techniques can be used for the fabrication of integrated photonic chips for highly efficient second and third order nonlinear interactions. Examples to be presented will include devices for second harmonic, super-continuum and four-wave missing generation, as well as vertical geometries to engineer the interaction between different spatial modes.

14:00 - 16:05 — Lawrence Bragg Room

Session 4A31

Light-matter interactions in new materials and meta-architectures

Organized by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

Chaired by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

14:00 : Invited talk
Near-field directionality with higher order multipolar sources
Michela Florinda Picardi, Francisco Rodriguéz Fortuño
King's College London (United Kingdom)

We reveal the near-field directionality properties of multipolar sources comprised of superpositions of electric

and magnetic dipoles and quadrupoles. We build a table of elementary sources comprised of the superposition of two multipoles, either both electric, both magnetic or one of each nature.

14:20 : Invited talk
Large-area optical metasurfaces: from plasmonic color routing to energy harvesting in 2D materials
Maria Caterina Giordano[1], Matteo Barelli[1], Andrea Mazzanti[2], Giuseppe Della Valle[2], Francesco Buatier de Mongeot[1]
[1] *Universitadi Genova (Italy),* [2] *Politecnico di Milano (Italy)*

The nanofabrication of nanoscale metasurfaces able to feature tunable optoelectronic response is crucial in view of sensing and flat-optics applications. Here the engineering of large-scale metasurfaces based either on self-organized plasmonic nanoantennas or on two-dimensional (2D) semiconductor layers will be shown. These templates enable accurate tuning of localized plasmon resonances and can feature broadband color routing properties with strong impact in flat-optics, photonics and sensing applications.

14:40 : Invited talk
Designing with spins: magnonic metamaterials based on nanoengineered spin textures
Edoardo Albisetti[1], Silvia Tacchi[2], Raffaele Silvani[3], Giuseppe Scaramuzzi[1], Simone finizio[4], Sebastian Wintz[4], Christian Rinaldi[1], Matteo Cantoni[1], Jorg Raabe[4], Giovanni Carlotti[3], Elisa Riedo[5], Riccardo Bertacco[1], Daniela Petti[1]
[1] *Politecnico di Milano (Italy),* [2] *Istituto Officina dei Materiali del CNR (CNR-IOM) (Italy),* [3] *Università di Perugia (Italy),* [4] *Paul Scherrer Institut (Switzerland),* [5] *New York University (USA)*

Magnonics seeks to control the excitation, propagation and transduction of spin waves, i.e. propagating perturbations in the arrangement of spins in magnetic materials, for information processing. Here, we present our work on the manipulation of spin waves in nanoengineered magnetic materials. first, we present a technique, tam-SPL, for nanopatterning spin textures in magnetic multilayers. Then, we discuss the use of spin textures for controlling the emission, propagation and interference of spin waves, aiming to develop energy-efficient wave-based computing platforms.

15:00 : Solar light with sub-microns hyperboloids non-imaging light concentrators arrays
Ashish Prajapati, Gil Shalev
Ben-Gurion University of the Negev (Israel)

Metamaterials based on arrays of subwavelength dielectric structures have recently proved to be a viable research tool towards the realization of various photonic devices. In the current study we introduce a new approach towards efficient light trapping and broadband absorption of solar radiation based on silicon surface arrays composed of subwavelength trumpet non-imaging light concentrators (henceforth, trumpet arrays). We show superior broadband absorption of solar radiation in trumpet arrays compared with that of the optimized NP arrays ($\sim$26 % enhancement).

15:15 : Photo-magnetic recording with L-band ultrashort laser pulses in dielectric medium
Antoni Frej, Tomasz Zalewski, Andrzej Stupakiewicz
University of Bialystok (Poland)

We experimentally demonstrated the possibility of the potential use of ultrashort laser pulses at telecommunication L-band to all-optical magnetic recording. A single linearly polarized laser pulse near 1590 nm wavelength switch the magnetization between two states in Co-doped YIG thin transparent film. Changing the linear polarization of the laser pulse, we can write-erase magnetic area in the sample.

15:30 : Single-shot time-resolved imaging of all-optical ultrafast photo-magnetic switching
Tomasz Zalewski, Antoni Frej, Andrzej Stupakiewicz
University of Bialystok (Poland)

The understanding of fundamental mechanism allowing for all-optical magnetization switching in femtosecond time scale is a key for providing novel outperforming applications. Recently, it has been discovered that only by a single laser pulse, extremely fast (about 20 ps), reversible and repeatable photo-magnetic switching in Co-doped yttrium iron garnet films can be obtained. Here, we demonstrate the experimental technique enabling visualization of magnetization switching at femtosecond time scale using single-shot time-resolved magneto-optical imaging in YIG:Co films.

15:45 : Invited talk

Resonant Heat Transfer in Nanophotonics Driven Thermal Water Desalination

Alessandro Alabastri, Pratiksha D. Dongare, Oara Neumann, Peter Nordlander, Naomi J. Halas
Rice University (USA)

Light absorbing nanoparticles can efficiently convert electromagnetic radiation into heat in nanoscale regions. This photothermal effect can be exploited to locally increase the temperature of water, promoting its evaporation and thus purification. Optothermal nonlinearities and resonant thermal phenomena have been uncovered to improve the efficiency of this process. Here we show how these concepts together can be engineered to achieve fresh water production rates up to ∼20 L/(m2.day) under standard solar irradiation.

14:00 - 15:30 — Rene Descartes Room

Session 4A32
Metasurfaces and thermal metamaterials

14:00 : Dynamic optical MEMS Metasurfaces

Paul Thrane[1], Chao Meng[2], Christopher A. Dirdal[3], Jo Gjessing[3], Fei Ding[2], Sergey L. Bozhevolnyi[2]
[1] *University of Southern Denmark (Norway),* [2] *University of Southern Denmark (Denmark),* [3] *SINTEF Microsystems and Nanotechnology (Norway)*

We present a versatile platform for achieving dynamical metasurfaces by combining micro-electro-mechanical systems (MEMS) with plasmonic nanostructures. By varying the separation of a gold piezoelectric MEMS mirror and gold nanostructures we adjust the behavior of the reflective metasurface. The concept is demonstrated for several cases, including switchable gratings and lenses. Few optical MEMS metasurfaces have been demonstrated previously, and this platform has the advantage of allowing full freedom in the metasurface design and decoupling the MEMS and nanostructure fabrication.

14:15 : Ion-beam-doped transparent conductive oxides for metasurface applications

Alexander Koch[1], Hongyan Mei[2], Jura Rensberg[1], Martin Hafermann[1], Jad Salman[2], Chenghao Wan[2], Ray Wambold[2], Mikhail Kats[2], Carsten Ronning[1]
[1] *Friedrich Schiller University (Germany),* [2] *University of Wisconsin-Madison (USA)*

Doped transparent conductive oxides have gained a lot of attention for applications in plasmonics and nanophotonics due to their low optical loss, metal-like behavior, tailorable optical properties, and well-established fabrication procedures. N-type doped zinc oxide, like gallium-doped ZnO is attractive because its permittivity can be engineered over a broad wavelength range across the infrared. Here, we demonstrate how the optical properties of ZnO can be modified by doping with gallium using a commercial focused ion beam system and post-implantation annealing.

14:30 : Enhanced Evanescent field Confinement Driven by Bound States in the Continuum

Sergei Lepeshov, Andrei Bogdanov
ITMO University (Russia)

Here, the enhancement of electromagnetic field confinement in an all-dielectric metasurface is demonstrated. The enhanced confinement is achieved when the polarization singularity, corresponding to accidental bound states in the continuum, moves to the domain of evanescent fields (under the light line). Such a hybridization of the bound states and evanescent waves results in the 70-fold increase of the electric field enhancement on the top of the metasurface and boosting of the electric field localization.

14:45 : Broadband high-efficiency achromatic meta-device based on phase and dispersion independently controlled metasurface

Wenye Ji, Paul Urbach
Delft Universityof Technology (The Netherlands)

Achromatic devices have wide application prospect in radar or fields. However, chromatic aberration and limited bandwidth restrict their development. In this paper, we achieve broadband high-efficiency transmission achromatism based on metasurface. In order to verify the theory and design method, we design an achromatic anomalous deflector and fabricate the sample. The experimental results are in good agreement with theory. Our findings provide valuable theory and strategy for achromatic device design.

15:00 : Investigation of electromagnetic coupling between the antenna and split-ring-based metasurface in CMOS technology
Alexander Vladimirovich Chernyadiev[1], Dmytro But[1], Cezary Kolaciński[1], Kestutis Ikamas[2], Alvydas Lisauskas[1]
[1] *Institute of High Pressure Physics PAS (Russia),* [2] *Vilnius University (Lithuania)*

In this contribution we investigate the electromagnetic coupling between the 350∼GHz resonant antenna and the metasurface constructed from an array of split-ring structures which are monolithically integrated using a 180∼nm silicon-based CMOS technology. We examine how the coupling between these structures and the number of split-rings affects the high frequency impedance of the whole system. The efficient control of impedance is important for designing passive and active terahertz components, such as tunable detectors and sources.

15:15 : Designing and Fabrication of efficient nano-materials for thermoelectric generator
Wiqar Hussain Shah
International Islamic University (Pakistan)

The electrical and thermal properties of the doped Tellurium Telluride chalcogenide nano-particles are mainly characterized by a competition between metallic (hole doped concentration) and semi-conducting state. nano-particles, prepared by solid state reactions in sealed silica tubes and ball milling method. These increasing behavior of Seebeck coefficient leads to high power factor which are increases with increasing temperature and Sn concentration, because of lowest electrical conductivity but its power factor increases well with increasing temperature.

Break

16:00 - 16:30

16:30 - 17:25 — Victor Veselago Room

Session 4A33

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

16:30 : Invited talk
Plasmonic aerosols to govern light
Jake Fontana, Jeff Geldmeier, Paul Johns, Nicholas J. Greybush, Jawad Naciri
U.S. Naval Research Laboratory (USA)

We show the experimental demonstration of a plasmonic aerosol and discuss the significance of uniting the fields of plasmonics and aerosols. We find that the aerosols are optically homogeneous, thermodynamically stable, with wide wavelength tunability, and extremely large sensitivities to their environment. Plasmonic aerosols may therefore provide a novel medium to govern light-matter interactions, thereby opening up innovative opportunities.

16:50 : Invited talk
Graphene Plasmonic Oscillators for Terahertz Light Emission
Yuyu Li, Pablo Ferreyra, Anna Swan, Roberto Paiella
Boston University (USA)

We report the measurement of electrically-driven narrowband THz light emission from graphene. The underlying radiation mechanism involves the generation of hot carriers under current injection and their subsequent energy relaxation through the excitation of plasmonic resonances in graphene nanoribbons. Free-space THz radiation is then emitted by the resulting collective oscillations of the graphene electron gas. These results are technologically relevant for the development of highly miniaturized and broadly tunable THz radiation sources.

17:10 : Wavefront Control of Light Emission from Halide Perovskite Metamaterials

Yixin Chen, Jinze Cai, Xuezhi Ma, Shoufeng Lan, Zi Jing Wong
(USA)
Wavefront Control of Light Emission from Halide Perovskite Metamaterials

16:30 - 17:30 — Tatsuo Itho Room

Session 4A34
Plasmonics and nano-optics

16:30 : Casimir induced instabilities at metallic surfaces and interfaces
Kun Ding[1], Daigo Oue[1], C. T. Chan[2], J. B. Pendry[1]
[1] *Imperial College London (United Kingdom),* [2] *Hong Kong University of Science and Technology (China)*

Surface plasmons subject to a surface distortion split asymmetrically in energy resulting in a net lowering of zero-point energy. This is because surface plasmon eigenvalues are the square of frequencies, a statement generally true for electromagnetic excitations. We utilize the conformal mapping method to demonstrate asymmetric splitting under surface corrugations can lead to a decrease in zero-point energy of a single corrugated metallic surface and drive the instability of a metallic thin film and cavity.

16:45 : Resonant Plasmon Enhancement of Light Emission from CdSe-Based Nanocrystals on Au Nanodisk Arrays
Alexander Milekhin[1], Mahfujur Rahaman[2], Ilya A. Milekhin[2], Tatyana A. Duda[3], Ekaterina E. Rodyakina[3], Kirill Anikin[3], Roman B. Vasiliev[4], Volodymyr Dzhagan[5], Alexander V. Latyshev[6], Dietrich R.T. Zahn[2]
[1] *Novosibirsk State University (Russia),* [2] *Chemnitz University of Technology (Germany),* [3] *A.V. Rzhanov Institute of Semiconductor Physics (Russia),* [4] *Moscow State University (Russia),* [5] *V. E. Lashkaryov Institute of Semiconductor Physics (Ukraine),* [6] *A. V. Rzhanov Institute of Semiconductor Physics (Russia)*

We report on resonant plasmon enhancement of Raman scattering (RS) and photoluminescence (PL) from colloidal CdSe-based nanocrystals (NCs) deposited on Au nanodisk arrays. The enhancement factors of RS and PL depend on the nanodisk size and reach maximal values at 75 and 7, respectively. These maxima are observed for the nanodisks having plasmon energy close to the interband transition energies in semiconductor NCs. Tip-Enhanced RS allowed us to perform local spectral analysis of CdSe NCs with nanometer spatial resolution.

17:00 : Controlling surface plasmons using all-metallic structures
Joseph Riley, Noel Healy, Victor Pacheco Peña
Newcastle University (United Kingdom)

In this work, we propose a method to manipulate and control the propagation of surface plasmons using all-metallic plasmonic structures. In this technique, a metallic structure is inserted within a semi-infinite block made of a different metal. The effective medium approach at each air-metal interface is exploited to control the propagation direction of surface plasmons. As an example, a plano-convex lens is designed and evaluated demonstrating the ability to focus the incident surface plasmons to the desired focal distance.

17:15 : Plasmonic metasurfaces for magnetic field enhancement at THz frequencies
Katarana Rovenska[1], Martin Hrton[1], filip Ligmajer[1], Peter Kepic[1], Vlastimil Krapek[1], Rainer Hillenbrand[2], Tomas Sikola[1]
[1] *Brno University of Technology (Czech Republic),* [2] *CIC Nanogune (Spain)*

Enhanced magnetic fields at terahertz frequencies are indispensable in many situations where analysis or modification of magnetic properties of matter is needed. Here we study a plasmonic metasurface formed by diabolo antennas, which exhibits such magnetic field enhancement, and using numerical simulations and subsequent terahertz time-domain spectroscopy we confirm a clear relationship between the antenna geometry and the spectral shape and position of the plasmonic resonance.

16:30 - 17:30 — Ibn Al-Haytham Room

Session 4A35

Plasmonic Nanomaterials for Bio-diagnostics, Environmental Monitoring and Food Safety

Organized by: Lucia Petti

Chaired by: Lucia Petti and Massimo Rippa

16:30 : Invited talk
Light-induced Aggregation of Gold Nanorods on Graphene controlled by Radiation Pressure for SERS Detection of Biomolecules
Antonino Foti, Maria Grazia Donato, Onofrio Maria Marago, Pietro Giuseppe Gucciardi
CNR-IPCF (Italy)

Radiation pressure is used to push gold nanorods on multilayered graphene and create hybrid active surfaces for Surface-Enhanced Raman Spectroscopy (SERS) in liquid. As a proof of concept, ultrasensitive detection of bovine serum albumin is shown, and the aggregation kinetics is studied as a function of the irradiation time. Our results enlarge the spectrum of materials that can be used for optical aggregation and SERS detection of biomolecules, highlighting the importance of controlling the physical properties of the surfaces

16:50 : Invited talk
Plasmonic tools to study interactions relevant for food science and eco/nanotoxicology
Duncan Sutherland
Aarhus University (Denmark)

Nanosized sensors based on the local refractive index sensitivity of plasmonic nanostructures can be applied to study interactions occurring at biointerfaces relevant in understanding protein effects in eco and nanotoxicology and in food science. Plasma protein interactions with silver nanoparticles modulate the biotransformation of silver to silver sulfide while saliva proteins coupled to plasmonic sensors can be used to quantify astringency through interactions with polyphenols.

17:10 : Invited talk
Enhanced Refractive Index Imaging Based on Quasi-Bound States in the Continuum
Silvia Romano[1], Maria Mangini[2], Stefano Cabrini[3], Erika Penzo[3], Anna Chiara De Luca[2], Ivo Rendina[1], Vito Mocella[1], Gianluigi Zito[1]
[1]*National Research Council ISASI (Italy),* [2]*National Research Council IBBC (Italy),* [3]*Lawrence National Laboratory of Berkeley (USA)*

We achieve a condition of enhanced hyperspectral refractometric, imaging on all-dielectric photonic crystal slabs, (PhCS) using a scheme of surface-enhanced fluorescence, (SEF) combined with refractometric sensing. The scheme is based on two high-Q resonances in proximity of bound, states in the continuum (BICs). The mechanism of quasi-, BIC spatially-variant gain, tracked by quasi-BIC refractometric, sensing, can find application in many fields for monitoring, physical and biochemical processes. In this study it is applied for surface cell analysis.

16:30 - 17:00 — Lawrence Bragg Room

Session 4A36

Light-matter interactions in new materials and meta-architectures

Organized by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

Chaired by: Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

16:30 : Ultrastrong interaction between plasmons and photons in a terahertz photonic crystal cavity
Fanqi Meng, Mark D. Thomson, Bernhard Klug, Dovile Cibiraite, Qamar Ul-Islam, Hartmut G. Roskos
Goethe-University Frankfurt (Germany)

Realization of strong interaction between photons and the plasmons of metamaterials in a cavity is of practical interest. Here, by employing a photonic crystal cavity and a metallic metamaterial, we achieve strong light-matter interaction between plasmons and photons in the terahertz frequency range. The measured Rabi splitting indicates that the ultrastrong coupling regime is reached. We demonstrate the nonlocal collective character of the interaction. Moreover, ultrastrong coupling between Babinet-complementary metamaterials and photons is also observed and explained.

16:45 : Ultrafast reflectance switching based on artificial epsilon-near-zero modes in a metal-insulator-metal nanocavity
Joel Kuttruff[1], Denis Garoli[2], Jonas Allerbeck[1], Roman Krahne[2], Antonio De Luca[3], Daniele Brida[4], Vincenzo Caligiuri[3], Nicolo Maccaferri[4]
[1] *University of Konstanz (Germany),* [2] *Istituto Italiano di Tecnologia (Italy),* [3] *Universita della Calabria (Italy),* [4] *University of Luxembourg (Luxembourg)*

Ultrafast control of light-matter interactions is crucial in view of new technological frontiers of information processing. Here, we exploit high-quality-factor artificial epsilon-near-zero (ENZ) modes of a metal-insulator-metal nanocavity to establish all-optical, ultrafast control of light reflectance. Pumping the system at its high-energy ENZ mode, the low-energy mode strongly redshifts because of the transient increase of the local dielectric function, which leads to a sub-3-ps control of the reflectance with a modulation depth of about 120 %.

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