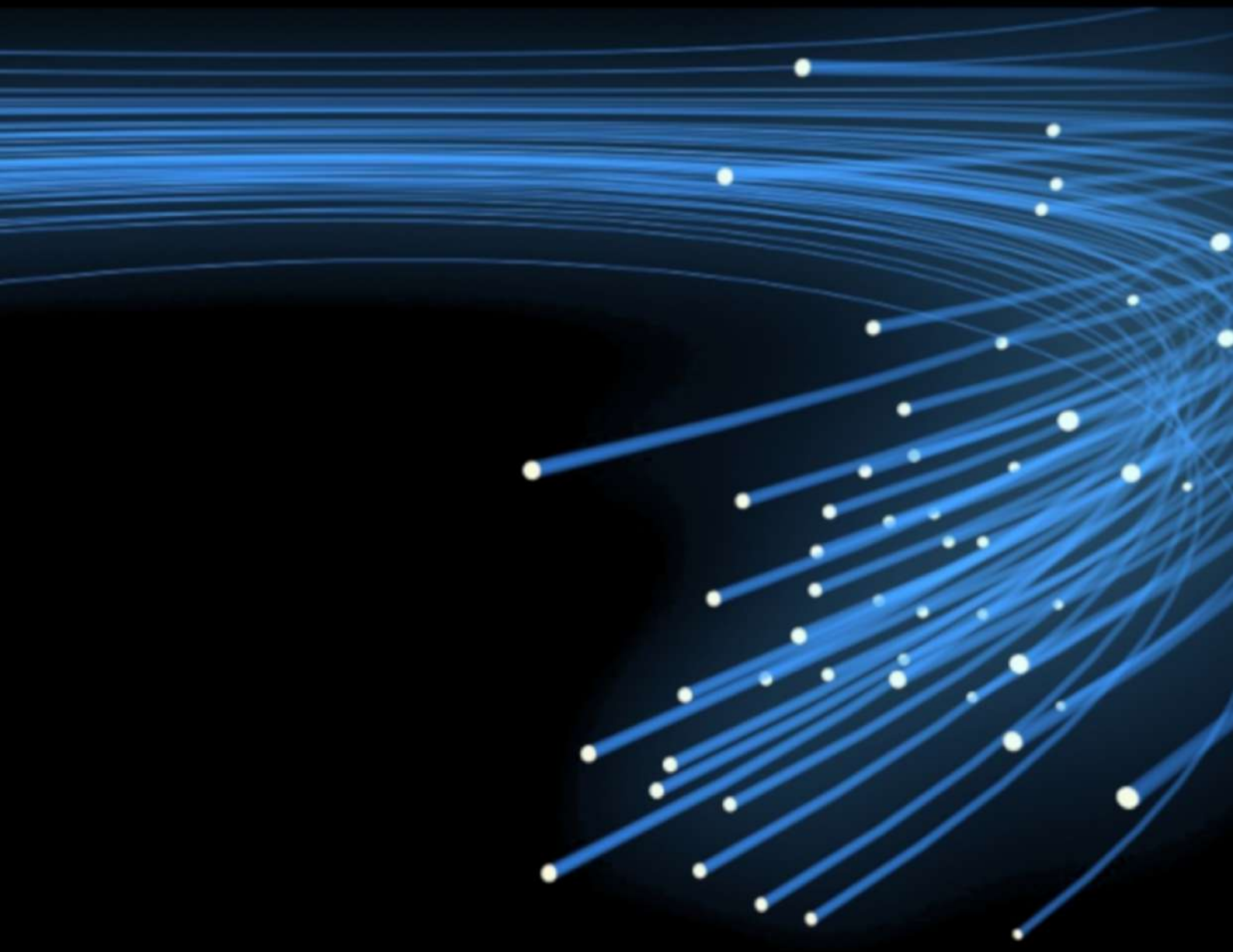
META 2021 Warsaw - Poland

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



Program

July 20 – 23, 2021
Warsaw - Poland

metaconferences.org

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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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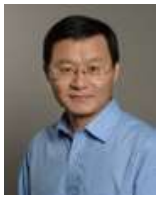

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META 2021 gratefully acknowledges the support of these institutions and companies for their contribution to the success of this conference.

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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

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

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 **105 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

We will use the online event platform **Whova** and **Zoom** to livestream all the presentations. You will need to :

- Download the Zoom Desktop client (http ://zoom.us). You may also download the Zoom App on your Mobile.
- Download the Whova app on you mobile.
- Sign into Whova Web App on your PC (using the Link we sent you by email). Please use Chrome Browser (optional but recommended).

IMPORTANT : Links to the conference live sessions (Zoom) or to the recorded videos will be available on the Whova App (Web/desktop and Mobile) **exclusively**. **The links will not be displayed on the conference website**. You will need to install both Zoom and Whova Apps (both Desktop and Mobile versions).

POSTER PRESENTATIONS

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

Please finalize your poster on your Whova booth using the link we've sent to you. You can post your poster on Twitter (#meta2021 @metaconference is our official hashtag). On the Whova platform you have the possibility to discuss your posters using the Chat and/or live videoconferencing. You need to schedule your own live meeting on your personal Zoom account and upload the link on your Whova booth.

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

08:30 - 09:00 — Victor Veselago Room

Session 1A1

Opening Ceremony

08:30 : Welcome Message
Dorota Pawlak[1], **Piotr Piotrowski**[2], **Said Zouhdi**[3]
[1] *University of Warsaw, Łukasiewicz Research Network, Institute of Microelectronics and Photonics, ENSEMBLE3 Centre of Excellence (Poland),* [2] *University of Warsaw (Poland),* [3] *Paris-Saclay University (France)*

08:40 : Opening Address
Prof. Zbigniew Rogulski, Vice-Dean for Infrastructure and Development
University of Warsaw (Poland)

08:50 : Opening Address
Prof. Alojzy Z. Nowak, Rector of The University of Warsaw
University of Warsaw (Poland)

09:00 - 09:35 — Victor Veselago Room

Session 1A2

Plenary Session I

Chaired by: Philippe Lalanne

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.

Session 1P1

Poster Session I

09:35 - 10:20

Chaired by: Ye Yu

P1: THz Metamaterial Device Design with SRRs
Brinta Chowdhury, Abdullah Eroglu
North Carolina Agricultural and Technical State University (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: 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.

P3: 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.

P4: 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.

P5: 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.

P6: 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.

P7: 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.

P8: 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.

P9: 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

P10: 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

P11: 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.

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

Chaired by: Hyuck Choo

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

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.

11:00 : 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.

11:20 : 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.

11:40 : 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.

12:00 : 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.

12:20 : 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.

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 and Alexander Govorov

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
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

12:10 : 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.

10:20 - 12:30 — Tatsuo Itoh 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
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.

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
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.

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
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.

10:20 - 12:40 — 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

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.

11:00 : 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.

11:20 : 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.

11:40 : 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.

12:00 : 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.

12:20 : Invited talk

Two superior photodetectors empowered by Al metasurfaces and hybrid plasmonic structures
Ching-Han Mao, Abhishek Dubey, Shangjr Gwo, Ta-Jen Yen
National Tsing Hua University (Taiwan)

In this talk, I introduce two superior photodetectors in visible and ultraviolet regimes, respectively. The first photodetector is an ultrasensitive gateless photodetector based on 2D bilayer MoS2-1D Si nanowire-0D Ag nanoparticle hybrid structure

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
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.

10:40 : 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.

11:00 : 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.

11:20 : 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.

11:50 : 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.

12:10 : 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.

10:20 - 12:15 — 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.

10:20 - 12:20 — Gaston Floquet Room

Session 1A9

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

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.

11:40 : 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.

12:00 : 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.

Lunch

12:30 - 14:00

14:00 - 15:30 — Victor Veselago Room

Session 1A10

Symposium II: New Trends in Nanophotonics and Advanced Materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Jennifer Choy

14:00 : 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.

14:20 : 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.

14:40 : 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.

15:10 : Invited talk
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 - 15:20 — Allan Boardman Room

Session 1A11

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: Pedro Hernandez Martinez

14:00 : 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.

14:20 : 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.

14:40 : 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.

15:00 : 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.

14:00 - 15:20 — Tatsuo Itoh Room

Session 1A12

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

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.

14:20 : 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

14:40 : 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.

15:00 : 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.

14:00 - 15:20 — Christian Huygens Room

Session 1A13

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

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.

14:20 : 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.

14:40 : 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.

15:00 : 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.

14:00 - 15:20 — Augustin Fresnel Room

Session 1A14

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
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.

14:20 : 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.

14:40 : 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.

15:00 : 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.

14:00 - 15:15 — Ibn Al-Haytham Room

Session 1A15

Symposium V: Phononics and Acoustic Metamaterials

Organized by: Jensen Li and Guoliang Huang

Chaired by: Jensen Li and Guoliang Huang

14:00 : 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.

14:20 : 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.

14:40 : 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.

15:00 : 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.

14:00 - 15:10 — Gaston Floquet Room

Session 1A16

Plasmonics: Fundamentals and Applications

Organized by: Hong Wei

Chaired by: Hong Wei

14:00 : 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.

14:20 : 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.

14:40 : 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.

14:55 : 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.

Session 1P2

Poster Session II

15:20 - 16:00

Chaired by: Ana Luisa Simoes Gamboa

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: 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.

P3: 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 %.

P4: 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.

P5: 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.

P6: 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.

P7: 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.

P8: 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.

P9: 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.

P10: 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.

16:00 - 17:10 — Victor Veselago Room

Session 1A17

Plenary Session II

Chaired by: Vladimir Shalaev

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 - 19:10 — Victor Veselago Room

Session 1A18

Symposium II: New Trends in Nanophotonics and Advanced Materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Dmitry N. Chigrin

17:30 : 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.

17:50 : 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.

18:10 : 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.

18:30 : 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.

18:50 : 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.

17:30 - 19:10 — Allan Boardman Room

Session 1A19

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: Davy Gérard

17:30 : 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.

17:50 : 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.

18:10 : 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.

18:30 : 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.

18:50 : 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.

17:30 - 19:05 — Tatsuo Itoh Room

Session 1A20

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 : 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.

18:15 : Reversible strain-tuning of quantum optical emission in WSe2 monolayers

Oliver Iff[1], Davide Tedeschi[2], Javier Martin-Sanchez[3], Magdalena Moczala-Dusanowska[1], Sefaattin Tongay[4], Kentaro Yumigeta[4], Kentaro Yumigeta[4], Abel Martínez-Suárez[3], Javier Taboada-Gutiérrez[3], Matteo Savaresi[2], Armando Rastelli[5], Pablo Alonso-Gonzalez[3], Sven Höfling[1], Rinaldo Trotta[2], Christian Schneider[1]
[1] *Universität Würzburg (Germany),* [2] *Sapienza University of Rome (Italy),* [3] *University of Oviedo (Spain),* [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.

18:30 : 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.

18:50 : Tunable hyperbolic metamaterials for wavefront shaping and fingerprint

Alessandro Pianelli[1], Michal Dudek[1], Rafal Kowerdziej[1], Vincenzo Caligiuri[2], Karol Sielezin[1], Janusz Parka[1]
[1] *Military University of Technology Warsaw (Poland),* [2] *Università della Calabria (Italy)*

In this work, we present a tunable multifunctional hyperbolic metamaterial composed of alternating layers of functionalized transparent conductive oxide (ITO) and insulating material (SiO2). Proposed plasmonic architecture allows to guide/squeeze and trapping the light at the nanoscale, which leads to a number of applications ranging from nanophotonic circuits to sensors. Furthermore, a novel sub-wavelength fingerprint recognition system was presented, which can be a milestone for real-time sensing/imaging applications.

17:30 - 19:15 — Christian Huygens Room

Session 1A21

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
Metaphotonic Computational Image Sensors
Arka Majumdar
University of Washington (USA)

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

18:10 : 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.

18:30 : 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 polarization 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.

19:00 : 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.

17:30 - 18:55 — Augustin Fresnel Room

Session 1A22

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
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.

17:50 : The role of plasmonic excitations in the far-field configurational chirality
leeju 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.

18:05 : 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.

18:35 : 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.

17:30 - 18:10 — Ibn Al-Haytham Room

Session 1A23

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.

18:15 - 19:15 — Ibn Al-Haytham Room

Session 1A24

Structural Color for Displays and Imaging

Organized by: Debashis Chanda

Chaired by: Debashis Chanda

18:15 : Invited talk

Controllable generation of large-scale highly-regular gratings for structural coloring applications

Jiao Geng, Xiaoguo Fang, Lei Zhang, Guangnan Yao, Liye Xu, Fengjiang Liu, Weiwei Tang, Liping Shi,

Min Qiu
Westlake University (China)

We demonstrate an optical localization-induced nonlinear competition mechanism to solve the problem of LIPSS' quality control, which occurs at a fluence nearly one order of magnitude below the ablation threshold. The controllable and highly regular ripples are beneficial to the structural coloring effects, as they arise from the light diffraction by the subwavelength gratings.

18:35 : 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.

18:55 : 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.

17:30 - 18:40 — Gaston Floquet Room

Session 1A25

Plasmonics: Fundamentals and Applications

Organized by: Hong Wei

Chaired by: Ning Liu

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 : 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.

18:25 : 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.

18:00 - 19:00 — Lawrence Bragg Room

Session 1A26

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

Chaired by: Giulia Tagliabue

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

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.

09:40 : 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.

10:00 : 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.

10:20 : 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.

10:40 : 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.

09:00 - 11:05 — 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

09:00 : 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.

09:20 : 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.

09:40 : 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.

10:00 : 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.

10:30 : 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.

10:50 : 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 - 10:00 — Tatsuo Itoh 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 : 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.

09:30 : 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.

10:05 - 11:05 — Tatsuo Itoh Room

Session 2A4

Local Enhancement and Control of Light-Matter Interaction

Organized by: Antonio Ambrosio

Chaired by: Antonio Ambrosio

10:05 : 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.

10:25 : 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.

10:45 : 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.

09:00 - 10:40 — 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: Manas Kulkarni

09:00 : 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.

09:20 : 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.

09:40 : Invited talk
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.

10:00 : 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.

10:20 : 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.

09:00 - 10:40 — 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
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.

09:20 : 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.

09:40 : 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.

10:00 : 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.

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.

09:00 - 10:45 — Ibn Al-Haytham Room

Session 2A7

Plasmonics and Nano-Optics

Chaired by: Jean-Jacques Delaunay

09:00 : 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 structures of subwavelength plasmonic systems, which can be extended to a variety of applications via different conformal transformations.

09:15 : 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.

09:30 : 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.

09:45 : 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.

10:00 : 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.

10:15 : 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.

10:30 : 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.

09:00 - 09:30 — Gaston Floquet Room

Session 2A8

Plasmonics: Fundamentals and Applications

Organized by: Hong Wei

Chaired by: Hong Wei

09:00 : 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.

09:15 : 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 resonan-

ces, 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.

09:45 - 10:55 — Gaston Floquet Room

Session 2A9

Metamaterial Enabled New Devices and Applications

Organized by: Weiren Zhu, Ciyuan Qiu and Fajun Xiao

Chaired by: Weiren Zhu

09:45 : 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.

10:05 : 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.

10:25 : 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.

10:40 : 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.

Session 2P1

Poster Session III

11:00 - 11:40

Chaired by: Janusz Parka

P1: 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.

P2: 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.

P3: 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.

P4: 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.

P5: 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.

P6: 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.

P7: 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.

P8: 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

P9: Spectral singularities and non-reciprocal light scattering in 2D PT-symmetric metamaterials

Jinal Kiran Tapar, 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.

P10: 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.

P11: 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 - 12:45 — Victor Veselago Room

Session 2A10

Symposium II: New Trends in Nanophotonics and Advanced Materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Yoshiaki Nishijima

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
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.

12:30 : 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 $\sim$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.

11:40 - 12:40 — Allan Boardman Room

Session 2A11

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: Pedro Hernandez Martinez

11:40 : 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.

12:00 : 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

12:20 : 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.

11:40 - 12:45 — Tatsuo Itoh Room

Session 2A12

Emerging Applications

Chaired by: Markus A. Schmidt

11:40 : Invited talk

Nanoscale imaging of moiré superlattices in twisted van der Waals heterostructures

Yue Luo[1], **Rebecca Engelke**[1], **Marios Mattheakis**[1], **Michele Tamagnone**[1], **Stephen Carr**[1], **Kenji Watanabe**[2], **Takashi Taniguchi**[2], **Efthimios Kaxiras**[1], **Philip Kim**[1], **William L. Wilson**[1]
[1] *Harvard University (USA),* [2] *National Institute for Materials Science (Japan)*

Here we report a versatile scanning probe microscopy employing infrared light for imaging moiré superlattices of twisted bilayers graphene encapsulated by hexagonal boron nitride. We map the pattern using the scattering dynamics of phonon polaritons launched in hexagonal boron nitride capping layers via its interaction with the buried moiré superlattices. We explore the origin of the double-line features imaged and show the

mechanism of the underlying effective phase change of the phonon polariton reflectance at domain walls. The nano-imaging tool developed provides a non-destructive analytical approach to elucidate the complex physics of moiré engineered heterostructures.

12:00 : 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.)

12:15 : 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.

12:30 : 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.

11:40 - 12:40 — Christian Huygens Room

Session 2A13

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: Manas Kulkarni

11:40 : 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.

12:00 : 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 con-

nect 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.

12:20 : Invited talk
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.

11:40 - 12:40 — Augustin Fresnel Room

Session 2A14

Plasmonics and Nano-Optics

Chaired by: Javier Garcia de Abajo

11:40 : 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.

11:55 : 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.

12:10 : 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.

12:25 : 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.

11:40 - 12:45 — Ibn Al-Haytham Room

Session 2A15

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 2A16

Machine Learning for Metamaterials and Metasurfaces

Organized by: Mohamed Bakr and Willie Padilla

Chaired by: Ali Adibi

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.

Lunch

12:40 - 14:00

14:00 - 15:20 — Victor Veselago Room

Session 2A17

Symposium II: New Trends in Nanophotonics and Advanced Materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Junsuk Rho

14:00 : 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.

14:20 : 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.

14:40 : 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).

15:00 : 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.

14:00 - 15:20 — Allan Boardman Room

Session 2A18

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: Davy Gérard

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
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".

15:00 : Invited talk
Optical injection of plasmonic Janus-nanoparticles into living cells
Theobal Lohmüller
LMU München (Germany)

Here, I will present that plasmonic Janus nanoparticles or 'nanopens' that are composed of a gold nanoparticle attached to a dielectric alumina shaft can be optically manipulated and injected into living cells.

14:00 - 15:15 — Tatsuo Itoh Room

Session 2A19

Advanced Modeling Techniques for the Design of Metasurface Devices

Organized by: Patrice Genevet and Stéphane Lanteri

Chaired by: Patrice Genevet and Stéphane Lanteri

14:00 : 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.

14:20 : 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.

14:40 : 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.

15:00 : 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.

14:00 - 15:25 — Christian Huygens Room

Session 2A20

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

14:00 : Invited talk
Ultrathin Acoustic Parity-Time Symmetric Metasurface Cloak
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.

14:20 : 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).

14:40 : 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.

15:10 : 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.

14:00 - 15:00 — Augustin Fresnel Room

Session 2A21

Plasmonics and Nanophotonics

Chaired by: Christin David

14:00 : 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.

14:15 : 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.

14:30 : 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.

14:45 : 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 - 15:20 — Ibn Al-Haytham Room

Session 2A22

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 lattices 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 - 15:20 — Gaston Floquet Room

Session 2A23

Machine Learning for Metamaterials and Metasurfaces

Organized by: Mohamed Bakr and Willie Padilla

Chaired by: Mehdi Keshavarz-Hedayati

14:00 : 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.

14:15 : Deep Neural Networks for the Prediction of the Optical Properties and the Design of Metamaterials
Timo Gahlmann, Philippe Tassin
Chalmers University of Technology (Sweden)

We will present our work on using deep neural networks for the prediction of the optical properties of free-form nanophotonic structures and for their inverse design. We designed neural networks and created training data, which were labelled with the respective optical properties and the degree of manufacturability. Furthermore, a cGAN network with 5 neural networks was developed to overcome problems with non-uniqueness and mode collapse, and to increase the experimental feasibility of the generated structures.

14:30 : 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.

14:50 : 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.

15:05 : 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.

Session 2P2

Poster Session IV

15:20 - 16:00

Chaired by: Søren Raza

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: 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.

P6: 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.

P7: 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.

P8: 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.

P9: 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.

16:00 - 17:10 — Victor Veselago Room

Session 2A24

Plenary Session III

Chaired by: Federico Capasso

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 - 19:10 — Victor Veselago Room

Session 2A25

Symposium II: New Trends in Nanophotonics and Advanced Materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Nader Engheta

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 Jarrahi
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
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.

18:50 : 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.

17:30 - 19:05 — Allan Boardman Room

Session 2A26

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: Alexander Govorov

17:30 : 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.

17:50 : 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.

18:05 : 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 quan-

tum 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.

18:25 : Invited talk
Nonlinear Light Generation from a Single Plasmonic Nanorod Strongly Coupled to a WSe2 Monolayer
Feng Wang, Hayk Harutyunyan
Emory University (USA)

We study the second harmonic optical response of strongly-coupled TMD/plasmonic cavity system and report on the first observation of Rabi splitting in the nonlinear regime in these systems.

18:45 : 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.

17:30 - 18:10 — Tatsuo Itoh Room

Session 2A27

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
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.

17:50 : 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.

18:20 - 19:00 — Tatsuo Itoh Room

Session 2A28

Topology in Photonic Crystals, Metamaterials, and Metasurfaces: Physics and Design

Organized by: Yang Li and Benfeng Bai

Chaired by: Viktoriia Babicheva

18:20 : 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.

18:40 : 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.

17:30 - 18:50 — Christian Huygens Room

Session 2A29

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

17:30 : Invited talk

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.

17:50 : 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.

18:05 : 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] *University of Cambridge (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.

18:20 : 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.

18:35 : 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.

17:30 - 19:00 — Augustin Fresnel Room

Session 2A30

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 2A31

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 lon-

gitudinal 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 - 18:30 — Gaston Floquet Room

Session 2A32

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
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.

17:50 : 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.

18:10 : 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.

18:00 - 19:00 — Lawrence Bragg Room

Session 2A33

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

Chaired by: Junsuk Rho

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
Metasurfaces with Maxwell's demon-like nonreciprocity
Kin Hung Fung
The Hong Kong Polytechnic University (China)

We show that Maxwell's demon-like nonreciprocity can be supported in a class of non-Hermitian gyrotropic metasurfaces in the linear regime. The proposed metasurface functions like a transmission-only Maxwell's demon operating at a pair of photon energies.

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 - 11:10 — 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 and Davy Gérard

09:00 : 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.

09:15 : 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.

09:30 : 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 ($\sim$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.

10:00 : 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.

10:20 : 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.

10:35 : 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.

10:50 : 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.

09:00 - 11:00 — Tatsuo Itoh Room

Session 3A3

Novel Topological Photonic Materials

Organized by: Matthias Saba and Sang Soon Oh

Chaired by: Matthias Saba and Sang Soon Oh

09:00 : 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 pho-

tonic 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.

09:20 : 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.

09:40 : 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.

10:00 : 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.

10:20 : 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.

10:40 : 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.

09:00 - 11:00 — Christian Huygens Room

Session 3A4

Structured and Topological Photonic Fields

Organized by: Jamal Berakdar

Chaired by: Jamal Berakdar

09:00 : 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.

09:20 : 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.

09:40 : 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.

10:00 : 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.

10:20 : 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.

10:40 : 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.

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
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.

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

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.

09:00 - 11:00 — Ibn Al-Haytham Room

Session 3A6

Metasurfaces, Flat Optics, FSS and HIS

Chaired by: Yuriy Mokrousov

09:00 : 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.

09:15 : 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 ul-

trawide 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.

09:30 : 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).

09:45 : 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° ± 0.2° to +1.9° ± 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.

10:00 : 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.

10:15 : 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.

10:30 : 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 microposttype metasurfaces and waveguide-type metasurfaces. These results indicate that the waveguide-type metasurface improves the lens performance of the doublet lens previously introduced.

10:45 : 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.

09:00 - 10:50 — Gaston Floquet Room

Session 3A7

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 : 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.

09:35 : 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.

09:55 : 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.

10:15 : 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.

10:35 : 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.

Session 3P1

Poster Session V

11:00 - 11:40

Chaired by: Haedong Park

P1: ENSEMBLE3 Centre of Excellence for nanophotonics, advanced materials and novel crystal growth-based technologies

Katarzyna Sadecka, Aleksandra Mirowska, Jarosław Kisielewski, Dorota A. Pawlak
Ensemble3 Centre of Excellence (Poland)

The scientific and economic challenge of ENSEMBLE3 is to utilize crystal-growth techniques, as well as developing new methodologies for manufacturing novel advanced materials with special optical/electromagnetic properties, which will find applications in such fields as photonics, optoelectronics, telecommunication, solar energy conversion, medicine and/or aerospace.

P2: 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.

P3: 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).

P4: 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

P5: 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.

P6: 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 $^{\circ}$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.

P7: Towards Spiral-Like Cold Atom States
Anwar Al Rsheed, Vasileios E. Lembessis, 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.

P8: 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.

P9: 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.

P10: 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.

11:40 - 12:40 — Victor Veselago Room

Session 3A8

Symposium II: New Trends in Nanophotonics and Advanced Materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Monika Fleischer

11:40 : 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.

12:00 : 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.

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 3A9

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: Alexander Govorov and Pedro Hernandez Martinez

11:40 : 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.

12:00 : 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.

12:15 : 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.

12:30 : 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.

11:40 - 12:40 — Tatsuo Itoh Room

Session 3A10

Novel Topological Photonic Materials

Organized by: Matthias Saba and Sang Soon Oh

Chaired by: Matthias Saba and Sang Soon Oh

11:40 : 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.

11:55 : 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.

12:10 : 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.

12:25 : 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.

11:40 - 12:30 — Christian Huygens Room

Session 3A11

Structured and Topological Photonic Fields

Organized by: Jamal Berakdar

Chaired by: Jamal Berakdar

11:40 : 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.

12:00 : 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.

12:15 : 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.

11:40 - 12:40 — Augustin Fresnel Room

Session 3A12

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, $[AgSePh]_\infty$. 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 $[AgSePh]_\infty$. 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 - 12:35 — Ibn Al-Haytham Room

Session 3A13

Topology in Photonic Crystals, Metamaterials, and Metasurfaces: Physics and Design

Organized by: Yang Li and Benfeng Bai

Chaired by: Sean Molesky

11:40 : 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.

12:00 : 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.

12:20 : 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.

11:40 - 12:40 — Gaston Floquet Room

Session 3A14

Metamaterials and Metasurfaces

Chaired by: Sir John Pendry

11:40 : 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.

11:55 : 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.

12:10 : 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.

12:25 : 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.

Lunch

12:40 - 14:00

14:00 - 15:20 — Victor Veselago Room

Session 3A15

Symposium II: New Trends in Nanophotonics and Advanced Materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Junsuk Rho

14:00 : 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 pro-

cessing, 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.

14:20 : 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.

14:40 : 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.

15:00 : 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.

14:00 - 15:30 — Allan Boardman Room

Session 3A16

Plasmonics and Nano-Optics

Chaired by: Thomas Pertsch

14:00 : Silver nanowires - remotely excited (bio)sensors
Michal Cwik[1], Karolina Sulowska[2], Dorota Buczynska[1], Ewa Roznіecka[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 : 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.

14:45 : 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.

15:00 : 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.

15:15 : 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.

14:00 - 14:45 — Tatsuo Itoh Room

Session 3A17

Metamaterials and Metasurfaces

Chaired by: Jun-Yu (Bruce) Ou

14:00 : 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.

14:15 : 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 Christensen[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.

14:30 : 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

14:00 - 15:15 — Christian Huygens Room

Session 3A18

Modeling and Application of Complex Materials

Chaired by: Ventsislav K. Valev

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.

14:00 - 15:20 — Augustin Fresnel Room

Session 3A19

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
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.

14:20 : 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.

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 explore 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 - 15:00 — Ibn Al-Haytham Room

Session 3A20

Quantum and Topological Photonics

Chaired by: Alberto G. Curto

14:00 : 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.

14:15 : 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.

14:30 : 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.

14:45 : 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.

14:00 - 15:15 — Gaston Floquet Room

Session 3A21

Micro/Nano Fabrication and Characterization Techniques

Chaired by: Yury Rakovich

14:00 : 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.

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 : 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.

Session 3P2

Poster Session VI

15:20 - 16:00

Chaired by: Michele Tamagnone

P1: 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.

P2: 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.

P3: 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.

P4: 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.

P5: 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.

P6: 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.

P7: 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.

P8: 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.

P9: 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.

P10: 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 3A22

Plenary Session IV

Chaired by: Mona Jarrahi

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 3A23

Symposium II: New Trends in Nanophotonics and Advanced Materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Pierre Berini

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 3A24

Metasurfaces and Flat Optics

Chaired by: Volker J. Sorger

17:30 : 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.

17:45 : 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.

18:00 : 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.

18:15 : 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$\sim$GHz resonant antenna and the metasurface constructed from an array of split-ring structures which are monolithically integrated using a 180$\sim$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.

18:30 : 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.

18:45 : 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.

17:30 - 19:00 — Tatsuo Itoh Room

Session 3A25

Plasmonics and Nano-Optics

Chaired by: Deep Jariwala

17:30 : 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.

17:45 : 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.

18:00 : 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.

18:15 : 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.

18:30 : 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.

18:45 : 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.

17:30 - 18:25 — Christian Huygens Room

Session 3A26

Mesoscale Plasmonics, Nanophotonics and Acoustics

Organized by: Igor V. Minin and Oleg V. Minin

Chaired by: Liyang Yue

17:30 : 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.

17:50 : 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.

18:05 : 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.

17:30 - 18:10 — Augustin Fresnel Room

Session 3A27

Integrated Lithium-Niobate Photonics: Structures, Devices, Systems and Applications

Organized by: Xianfeng Chen and Yang Li

Chaired by: Khaled Mnaymneh

17:30 : 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.

17:50 : 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.

17:30 - 18:30 — Ibn Al-Haytham Room

Session 3A28

Symposium II: New Trends in Nanophotonics and Advanced Materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Andrea Fratalocchi

17:30 : 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.

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
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.

17:30 - 19:10 — Gaston Floquet Room

Session 3A29

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.

18:50 : 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 $\sim$20 L/(m2.day) under standard solar irradiation.

18:00 - 19:00 — Lawrence Bragg Room

Session 3A30

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 - 11:00 — Victor Veselago Room

Session 4A1

Symposium II: New Trends in Nanophotonics and Advanced Materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Philippe Tassin

09:00 : 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.

09:20 : 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.

09:40 : Invited talk

Phase change material based nanophotonics: multiphysics modelling

Dmitry N. Chigrin
DWI Leibniz Institute for Interactive Materials (Germany)

In this presentation we report on recent developments and applications of a multiphysics description of phase change material based nanophotonic systems.

10:00 : 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.

10:20 : 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.

10:40 : 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.

09:00 - 10:55 — Allan Boardman Room

Session 4A2

Thermal Plasmonics and Metamaterials for Environment and Energy Application

Organized by: Junichi Takahara and Kotaro Kajikawa

Chaired by: Junichi Takahara

09:00 : 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.

09:20 : 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.

09:40 : 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.

10:00 : 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.

10:15 : 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.

10:35 : 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.

09:00 - 10:40 — Tatsuo Itoh Room

Session 4A3

Advances in Metamaterials

Organized by: Jeong Weon Wu, Bumki Min and Jonghwa Shin

Chaired by: Jeong Weon Wu

09:00 : 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.

09:20 : Invited talk

Metasurface for on chip nanophotonics
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.

09:40 : 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.

10:00 : 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.

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.

09:00 - 10:20 — Christian Huygens Room

Session 4A4

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.

10:25 - 11:05 — Christian Huygens Room

Session 4A5

Opto-Mechanical Metasurfaces and Metamaterials

Organized by: Dibakar Roy Chowdhury, Jayasri Dontabhaktuni and Harshavardhan Kalathur

Chaired by: Anna Semisalova

10:25 : 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.

10:45 : 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.

09:00 - 10:10 — Augustin Fresnel Room

Session 4A6

Plasmon-Enhanced Photovoltaics, Photocatalysis, and Solar Fuels

Chaired by: Alberto Naldoni

09:00 : 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.

09:20 : 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.

09:40 : 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 ($\sim$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.

09:55 : 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.

09:00 - 10:40 — Ibn Al-Haytham Room

Session 4A7

Metasurface for Information Processing

Organized by: Jensen Li and Xianzhong Chen

Chaired by: Jensen Li and Xianzhong Chen

09:00 : 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.

09:20 : 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 sub-wavelength 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.

09:40 : 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.

09:55 : 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.

10:10 : 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.

10:25 : 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 - 11:05 — Gaston Floquet Room

Session 4A8

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
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.

09:20 : 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.

09:40 : 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.

10:00 : 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 per-

turbations 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.

10:20 : 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.

10:35 : 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).

10:50 : 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.

Session 4P1

Poster Session VII

11:00 - 11:40

Chaired by: Fatima Zohra Goffi

P1: 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.

P2: 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 nano-patch antennas.

P3: 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.

P4: 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.

P5: 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.

P6: 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.

P7: 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.

P8: 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.

P9: 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.

P10: 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.

P11: 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.

11:40 - 12:40 — Victor Veselago Room

Session 4A9

Symposium II: New Trends in Nanophotonics and Advanced Materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Daniel Lanzillotti Kimura

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.

11:40 - 12:15 — Allan Boardman Room

Session 4A10

Thermal Plasmonics and Metamaterials for Environment and Energy Application

Organized by: Junichi Takahara and Kotaro Kajikawa

Chaired by: Kotaro Kajikawa

11:40 : 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.

12:00 : 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 — Tatsuo Itoh Room

Session 4A11

Photonic Crystals

Chaired by: Rasmus Christiansen

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 : 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.

12:10 : 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 4A12

Optical Antennas and Plasmonics-based Devices

Chaired by: Maria Caterina Giordano

11:40 : Invited talk
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.

11:55 : 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.

12:10 : 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 coexistence 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.

12:25 : 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.

11:40 - 12:40 — Augustin Fresnel Room

Session 4A13

Metamaterials and Metasurfaces

Chaired by: Christophe Caloz

11:40 : 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.

11:55 : 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.

12:10 : 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.

12:25 : 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.

11:40 - 12:40 — Ibn Al-Haytham Room

Session 4A14

Plasmonic Nanomaterials for Bio-diagnostics, Environmental Monitoring and Food Safety

Organized by: Lucia Petti

Chaired by: Lucia Petti and Massimo Rippa

11:40 : 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.

12:00 : 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.

12:20 : 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.

11:40 - 12:40 — Gaston Floquet Room

Session 4A15

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
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

12:00 : 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.

12:20 : 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.

Lunch

12:40 - 14:00

14:00 - 16:00 — Victor Veselago Room

Session 4A16

Symposium II: New Trends in Nanophotonics and Advanced Materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Ortwin Hess

14:00 : 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.

14:20 : 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.

14:40 : 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.

15:00 : 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.

15:20 : 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.

15:40 : Invited talk
Wavefront Control of Light Emission from Halide Perovskite Metamaterials
Yixin Chen, Jinze Cai, Xuezhi Ma, Shoufeng Lan, Zi Jing Wong
Texas AM University (USA)

Wavefront Control of Light Emission from Halide Perovskite Metamaterials

14:00 - 15:15 — Allan Boardman Room

Session 4A17

Photonic Bandgap Structures

Chaired by: Bahram Djafari Rouhani

14:00 : 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.

14:15 : 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.

14:30 : 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.

14:45 : 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.

15:00 : 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.

14:00 - 15:15 — Tatsuo Itoh Room

Session 4A18

Plasmonics and Nano-Optics

Chaired by: Paloma Arroyo Huidobro

14:00 : 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.

14:15 : 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.

14:30 : 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.

14:45 : 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.

15:00 : 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.

14:00 - 15:00 — Christian Huygens Room

Session 4A19

Synthesis and Characterization of Plasmonic Nanostructures

Organized by: Mohamed Boutinguiza Larosi and Juan Pou Saracho

Chaired by: Juan Pou Saracho

14:00 : 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.

14:20 : 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.

14:40 : 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.

14:00 - 16:00 — Ibn Al-Haytham Room

Session 4A20

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
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.

14:20 : 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.

14:40 : 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

15:00 : 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.

15:20 : 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.

15:40 : 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.

14:00 - 15:30 — Gaston Floquet Room

Session 4A21

Light-Matter Interactions in New Materials and Meta-Architectures

Organized by: Denis Garoli, Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

Chaired by: Denis Garoli, Nicolò Maccaferri, Vincenzo Caligiuri and Mario Miscuglio

14:00 : 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.

14:20 : 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.

14:40 : Invited talk

High performance infrared magnetoplasmonics with transparent conductive oxide nanostructures

Francesco Pineider[1], Alessio Gabbani[1], Claudio Sangregorio[2], Massimo Gurioli[3]
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Here we show that colloidal dispersions of tin-doped indium oxide (ITO) nanoparticles, with a sharp plasmon resonance in the near infrared, afford a 20-fold enhanced magnetic modulation with respect to Au, as detected by magneto-optical spectroscopies. We ascribe the enhanced magneto-optical response to the reduced free electron effective mass (m*) of free carriers in ITO with respect to most metals, which in turn boosts the magnetic modulation.

15:00 : 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]
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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 %.

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.

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