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We are delighted to announce and honored to invite you to the International Congress and Expo on Optics, Photonics and Lasers (EUROPL2023) on June 28-30, 2023 in Paris, France

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We are looking forward to seeing you in Paris, France!

Sincerely,
Prof. Dieter Bimberg
Conference Chair
EUROPL2023
Executive Director "Bimberg Chinese-German Center for Green Photonics", CIOMP, CAS, China and "Founding Director "Center of NanoPhotonics", TU Berlin, Germany.

Welcome to the Signature Conferences !

Welcome To EUROMSN2023

Dear Colleagues,

We are delighted to announce and honored to invite you to the International Congress and Expo on Materials Science and Nanoscience (EUROMSN2023) on June 28-30, 2023 in Paris, France.

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Green data communication: Intelligent physics and engineering will contribute to a sustainable society

Dieter Bimberg

"Bimberg Chinese-German Center for Green Photonics" CIOMP, Chinese Academy of Sciences, Changchun, China and Center of Nanophotonics and Institute of Solid State Physics, TU Berlin, Germany

Abstract

Since 2014 novel consumer applications like Netflix, Block Chain, LIDAR… not known at that time have led to a huge increase of internet traffic of 60%/year, much more than then originally predicted by companies like Cisco. This increased use of the internet is increasing its electrical power consumption due to increased data traffic mostly inside data centers. New data centers have crossed the 500 MW level. 5G and 6G with their big jumps in data speed will be further enablers for new services, like LIDAR and more, we cannot think about yet, and will increase the energy consumption to an extent not further tolerable.

New research goals are followed presently, focusing on energy-efficiency of data traffic at all hierarchy levels. Inside data centers advanced design of active optical cables, their electronic driver and receiver circuits and the active photonic devices are suddenly in the focus, but now with the goal to minimize their combined power consumption. Vertical-cavity surface-emitting lasers (VCSELs) for 200+ Gbit/s single fiber data transmission across OM5 multimode fiber with a record heat to bit rate ratio (HBR) of only 240 fJ/bit x wavelength @ 50Gbit/s developed in our labs are presented [1]. Photon lifetime management is a new key to adopt the overall energy consumption to the bit rate of the data traffic (e.g. 25 Gb/s, 50 Gb/s,..) [2].

A completely novel design approach for VCSELs will be presented based on etching multiple holes, oxidizing one or several apertures from these holes and refilling them with metal, in order to increase heat conduction and cut-off frequency and reduce parasitic effects. Thermal roll-over is expected to appear at much larger currents compared to the present standard designs, allowing larger single mode output power and possibly dense wavelength multiplexing across distances of several hundred m to 1 km in data centers [3-4].

Finally work on high speed novel drivers based on advanced CMOS design is reported, leading to dramatically reduced energy consumption of VCSEL modules below 500 fJ/bit. A dc-coupled single-ended voltage-mode clock-less driver is demonstrated in 22-nm SOI CMOS eliminating the need for area- and energy-inefficient equalization techniques for data rates up to 60 Gb/s while maintaining error free (BER<1e-12) in our transmission experiments. The highly digitized driver architecture inherently features an impedance (voltage-level) calibration scheme to handle both driver and VCSEL-based process variations. At 60 Gb/s data rate, an energy efficiency of 420 fJ/b is achieved from a single 0.9 V supply which is to the authors knowledge a 3x improvement in terms of energy-efficiency compared to the optical TXs reported to date. The highly digital driver architecture enables the supply scalability down to 0.6 V.

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Recent Advances in III-Nitrides for UV and Visible Photonics Materials and Devices

Steve DenBaars*

Matt Wong, Emily Trageser, Panpan Li, Jake Ewing, Ryan Anderson, Jordan Smith, Vince Rienzi, Michael Gordon, James Speck and Shuji Nakamura

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Abstract

The developments of high performance InGaN based RGB micro-light-emitting diodes (μLEDs) and Blue and Green Laser Diodes are discussed. Through novel epitaxial growth and processing, and transparent packaging we have achieved external quantum efficiencies as high as 58% EQE at 450nm for microLEDs. The critical challenges of μLEDs, namely full-color scheme, decreasing pixel size and mass transfer technique, and their potential solutions are explored. Recently, we have demonstrated efficient microLEDs emitting in the blue to red at dimensions as small of 1 micron. Using strain relaxation methods we have also extending the wavelength range of the InGaN alloys as into the red with emission as long as 640nm. Red InGaN based red MicroLEDs with efficiencies of 6% has been fabricated, and they display superior temperature performance in comparison to AlGaInP based devices. Recently, we have employed novel ALD passivated deep recessed ridge etching and porous GaN to make novel blue and green laser diodes. Green laser diodes with emission wavelengths as long as 524nm have been achieved using novel porous GaN waveguides.

Keywords

MicroLEDs, Green Laser Diodes, red, InGaN, ALD, porous, GaN

Novel properties of 2D materials and device applications

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Abstract

Integrating two-dimensional (2D) materials have widened the spectrum of building blocks for creating hybrid heterostructure systems with unique functionalities and excellent performance. I briefly review recent studies on 2D materials-based heterostructures, especially by focusing on moiré superlattices produced by heterojunction of two transition-metal dichalcogenide (TMD) monolayers (MLs) and their optical properties. We successfully employ TMD and perovskite 2D materials for hybrid heterostructures showing novel functional behaviors, useful for optoelectronic and energy-harvesting device applications. We first report blue shift of energy and strong enhancement of intensity in light emission by twisted heterojunction of TMD MLs in a particular range of twist angle. Recently, we have successfully fabricated Janus MoSSe starting from the growth of MoS2 layer, based on a new method simplified by employing NaCl-assisted single process in a CVD apparatus. The MoS2 layer is shown to still exist at the bottom of the Janus MoSSe, resulting in actual formation of a MoSSe/MoS2 heterostructure, thereby exhibiting interesting I-V characteristics. In addition to the 2D materials, we successfully employ multi-dimensional materials such as graphene, Si quantum dots (QDs), graphene QDs, and perovskites in their mixed-dimensional heterostructures for energy-harvesting devices such as solar cells and piezoelectric cells, showing novel functional behaviors, which are discussed based on the electrical/optical characterizations and possible physical mechanisms. Especially, we report an interface-engineered perovskite 2D|3D heterostructure to realize the multi-functional photonic device in on-chip, exhibiting power-conversion efficiencies of photovoltaics up to 20.7%, external quantum efficiencies of light emission up to 4.6%, and enhanced piezoelectricity. This phenomenon is attributed to carrier transfer resulting in enhanced carrier density/recombination at the 2D|3D interface and energy-band modulation/band-misalignment lessening. The emergence of the heterostructures will make 2D materials a long live hotspot, which might help to find their killer application, ultimately leading to significant breakthroughs in new physics as well as commercialization of 2D materials devices.

Models of the Oral Mucosa Currently used to Study Drug Delivery

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[2]*Fondazione Policlinico Universitario "A. Gemelli", IRCCS, Largo A. Gemelli 8, 00168 Roma, Italy*

Abstract

Among the different routes of drug administration, that one crossing the oral mucosa is a preferential alternative, due to several advantages: excellent drug accessibility, rapid absorption thanks to relatively high blood flow, robust epithelium, bypass of first-pass metabolism and minimal exposure of drugs to the gastro- intestinal environment. For all these reasons, there is a wide interest to investigate the permeability of drugs through this specific region. Accordingly, the purpose of this plenary lecture is to describe the oral mucosa models, ex-vivo and in-vitro, used to study its permeability to conveyed and non-conveyed drugs, trying to highlight the most performing ones. Notably, to date, it is clearly emerging the necessity of standardized models of this specific mucosa suitable for all the necessary determinations when developing a new drug delivery system. In this respect, Oral Mucosa Equivalents (OMEs) could represent a possible future perspective as they manage to overcome some limitations present in most models.

Supramolecular and Polymerized Ionic Liquids for Advanced Materials

John Texter

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Abstract

Polymerized ionic liquids (PIL) have established a new branch of materials science, and some of these new PIL-materials are finding innovative applications as thermodynamically stable nanoparticulate dispersions and as dispersing aids with controllable solubilities. PIL are produced by radical chain-polymerization and by condensation step-polymerization. Such condensation polymeric binders, polyurethanes, polyureas, and polyesters, provide biodegradability pathways for composite materials. We discuss preparations and applications of PILs derived from polymerizable surfactants that are ionic liquids.

These PIL are illustrated to be excellent stabilizers for SWCNT (single-wall carbon nanotubes), MWCNT (multiwall carbon nanotubes), hydrothermal carbon, and graphene in water. SEM (scanning electron microscopy) illustrates that imidazolium-based PIL bind randomly and reversibly from suspension onto nanocarbon surfaces. Excellent aqueous dispersion stabilization is provided by strong binding to sp2-nanocarbon surfaces by π-overlap and by very strong solubilization of imidazolium bromide by water. These strong binding and osmotic-brush effects have provided means to prepare the most concentrated aqueous dispersions of MWCNT (17% w/w) and graphene (6.4% w/w) reported to date via liquid-phase exfoliation in water.

Sedimentation, shear-coating, and electrospinning methods produce: MWCNT and graphene electrodes suitable for conventional and advanced applications, thermally conductive hydrothermal carbon coatings (25 W/m/K), thermally conductive MWCNT coatings in the mid-diamond range (0.5 - 3 kW/m/K), rheo-optical (amorphous-nematic transitions) graphene dispersions, alternative coating methods derived from stimuli-responsiveness of imidazolium-anion exchange, and transformational electrode heterostructures produced by electrospinning.

Ultra precision diamond turning of nanogratings

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Abstract
Fabrication of periodic nanogratings over large area has attracted great interest in recent years due to growing applications of such functional structures in optics, automotive, aerospace, biomedical, and power generation devices. For example, periodic nano-gratings is a typical nanostructures for the excitation of surface plasmon resonance which is the basis of many resonance-coupling based plasmonic devices, such as the plasmonic solar cell and the Surface-Enhanced Raman Spectroscopy for the massively enhancing adsorption of signal onto planar metal surfaces.

The talk will introduce a cost-effective nanofabrication approach to generate nanogratings in large areas by using multi-tip diamond tools. It will firstly review the current nanograting fabrication approaches and then propose a new approach to overcome the challenge in scale up manufacturing. The focus of the talk is on the development of deterministic multi-tip nanoscale diamond tools by using focused ion and follow-on diamond turning. The machining mechanism, influences of processing parameters and tool wear on the generated nanostructures are also thoroughly introduced. The talk concludes with a summary of research challenges, current research achievements and future research directions to systematically establish this nanofabrication approach.

Biography□Xichun Luo is a Professor in ultra precision manufacturing and technical director of Centre for Precision Manufacturing (CPM) at the University of Strathclyde (Glasgow). He is an elected Fellow of the International Society for Nanomanufacturing, the International Academy of Engineering and Science and the International Association of Advanced Materials. He is an associate editor for Proceeding of IMechE Part C: Journal of Mechanical Engineering Science, Journal of Micromanufacturing and Journal of Nanomanufacturing and Metrology. His research has been founded by the EPSRC, EC, Royal Society and Industry. His research interests include ultra precision machining, digital manufacturing, hybrid micromachining and nanomanufacturing, as evidenced by two books and more than 200 papers in peer-reviewed highly ranked journals. He won UK Institution of Mechanical Engineers (IMechE) 2015 Ludwig Mond Prize for his work in the application of digital technology in micro- and nano-manufacturing.

Transparent Photovoltaics for Self-Powered Human Interfaces

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Abstract
Developing a consistent and sustainable energy supply is one of the important missions of modern society. We must free ourselves from the long-term addiction to fossil fuels and make a paradigm shift to sustainable energy.

Sunlight provides a huge quantity of energy and has enormous potential to satisfy energy requirements on a global scale. However, the present class of nontransparent or opaque solar systems hinders the wide adoption of solar energy in natural environments. To overcome this obstacle, we herein discuss the production of solar power through transparent photovoltaic (TPV) systems. A TPV device transmits visible light but uses nonvisible light to produce electric power, which can be used to supply power on-site where power is consumed. The transparency of TPV devices allows them to be used in windows of buildings and vehicles and in displays, thereby supporting the shift to sustainable energy. Moreover, TPV devices are promising for bioelectronics and neuromorphic applications as self-powered invisible devices.

This report illustrates potential transparent photovoltaics as a platform to achieve scalable, multimodal sensory, self-sustainable neural systems of visual cortex, nociception, and electronic skin. We propose a strategy to harvest solar power using a transparent photovoltaic device that provides neuromorphic functionality to implement versatile, sustainable, integrative, and practical applications. The proposed solid-inorganic heterostructure platform is indispensable for achieving a variety of biosensors, sensory systems, neuromorphic computing, and machine learning for self-powered human interfaces.

One day, human will use the invisible energy and relevant devices without losing a vision. 'There's plenty of room at the bottom (Richard Feynman)' to explore the future technologies with the energy ubiquity.

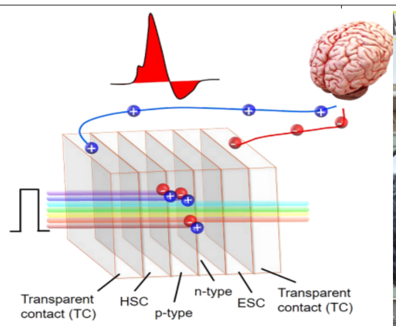

Figure 1. Transparent photovoltaic device to power brain-chip for future sustainable computing.

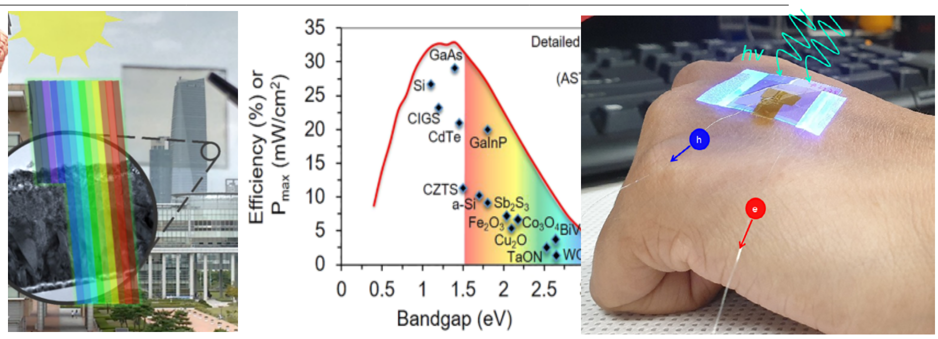

Figure 2. Representative large-scale transparent photovoltaic (TPV) device consisting of all transparent oxides (left), materials for the expected efficiency for TPVs (middle) and TPV on a dorsal of hand for power generation.

Acknowledgement
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Achieving excess noise factor between 1-2 in avalanche photodiodes for low photon detection in infrared wavelengths

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Abstract

For detection of signals with low levels of photon, an internal amplification in an avalanche photodiode (APD) followed by further amplification by a low noise amplifier, is routinely employed in Light Detection and Ranging (LIDAR) to optical communication. To maximise the benefit of using an APD, it is well known that the excess noise factor, F, should be as close to unity as possible. The well-known McIntyre's excess noise model, in which the ratio of electron to hole ionization coefficients, k, produces a minimum value of F~2. This has been thought of the minimum achievable value for F, until reported values of F of 1-2 in HgCdTe electron-APDs. In this work, we present two semiconductor materials capable of achieving F = 1-2. We showed that InAs which has a bandgap of 0.35 eV, suitable for detection of wavelengths upto 3000 nm, exhibits F of 1.3-1.6. We were able to demonstrate low photon detection as low as 15 photons within a 50 □s 1550 nm laser pulse. More recently we discovered that the AlGaAsSb, grown on InP has been developed and exhibit excess noise factor <2. The best performance to date is an AlGaAsSb APD with an InGaAs absorption region that achieves an extremely low noise equivalent power of 69 fW/Hz1/2 at room temperature. This demonstrated the recent breakthroughs in achieving close to noise free avalanche multiplication process in InAs and AlGaAsSb APDs

Keywords

Avalanche Photodiodes; InAs; AlGaAsSb; low excess noise.

Biography

Prof. C. H. Tan obtained his BEng and PhD in Electronic Engineering at the Department of Electronic and Electrical Engineering (EEE), The University Of Sheffield (TUOS) in 1998 and 2002, respectively. He was a Research Associate in 2001-03, appointed as a Lecturer in 2003 and has been a Professor in Optoelectronic Sensors since Jan 2014. He has taken on leadership roles within TUOS, including the Director of Research for EEE and the Deputy Director of Research&Innovations for the Faculty of Engineering. Since 2019 he has been the Head of Department for EEE. His research includes advanced modelling of avalanche process, high quantum efficiency single photon avalanche diodes, APDs with lowest excess noise and APDs with very weak temperature dependence of breakdown voltage. He has led various research projects from the UK Ministry of Defence, Engineering, and Physical Science Research Council and EU. Some of the technologies he developed have been transferred to industry via several knowledge transfer projects to design infrared photodiodes and avalanche photodiodes. He has published more than 100 journal papers and has delivered several invited talks in international conferences. He has carried out editorial roles for Optics Express, IET Optoelectronics and MRS Advances. In 2020 he co-founded a spin-out, Phlux Technology Limited, to commercialise a key breakthrough in low noise avalanche photodiodes. He was a Director of Phlux Technology Limited until 2022.

A Hybrid Learning Machine Approach and Optimization in 3D Printed Sensor Design and Development

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Abstract

Industry 4.0 has tremendous potential to improve productivity, efficiency, and overall sustainability for digital manufacturing industries across the globe. In particular, the industries also want to explore new approaches and designs for smart factory using Internet of Things (IoT), Artificial Intelligent (AI), and 3D Printing (3DP) technologies. Especially, with the recent advances in materials and processes, 3DP technologies are evolving from prototyping to functional part fabrication for a broad range of applications. AJP process is ideal for producing customized electronic components due to its high design flexibility and fine feature deposition. Despite the capability of fine feature deposition, the printed sensor quality can be influenced by the complicated relationship between main process parameters, such as carrier gas, sheath gas, and printing speed. In this talk, I introduce non-contact ink writing techniques based on aerosol jet printing (AJP) for electronics with the state of art in quality optimization and precise control techniques. I propose a hybrid learning machine approach for determining optimal operating process parameters in customized sensor development using AJP and control the printed line morphology for improving the line uniformity of cross-sectional area. In the proposed approach, a genetic algorithm is applied to optimize the values of the process parameters under the conflicting relationship between line width, line thickness and line roughness in the AJP process. Future research directions in 3D technologies and limitations encountered in existing designs are discussed.

Linear and Nonlinear Optical Measurements for Surface Characterization

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Abstract

We utilize both linear and nonlinear optical methods to investigate surface reaction processes and nanostructure formation processes. For the analysis of surface phenomena, such as adsorption, desorption, and growth of atoms and molecules, surface sensitive tools are indispensable. Among the liner optical methods, reflectance difference spectroscopy (RDS)[1], and surface differential reflectance spectroscopy (SDRS)[2] are both considered as a powerful addition to the wide range of existing ultra-high vacuum (UHV) surface science techniques. It is noted that RDS is also called reflectance anisotropy spectroscopy (RAS). To enhance surface sensitivity, these reflectance spectroscopic methods were developed through some technical innovations to reduce signals from the bulk and to predominantly collect signals from the surface region. In the 1980s, Aspnes et al. developed RDS technique, which was initially applied to investigate growth process of III-V semiconductors[3]. Kobayashi et al. developed SDRS using p-polarized light in the same period[4], which was successfully applied to metal organic chemical vapor deposition (MOCVD) process. Here, we summarize some of our studies for surface characterization using RDS[5,6,7,8] and SDRS[7].

Nonlinear optical method such as second harmonic generation (SHG) is also a powerful means with high surface sensitivity. Recently, we have developed SHG microscope[9], and applied to the study of a few layer transition-metal dichalcogenide materials, TX2 (T = Mo, W; X = S, Se), in combination with the linear-type reflectance measurement[10,11].

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New (Chiral) Light on Selection Rules in Nonlinear Optics

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Abstract
Selection rules in nonlinear optics determine which radiation modes are allowed/forbidden in nonlinear processes. Traditionally, the theory accounts for symmetries of the medium only. I will present a more general theory in which the selection rules are derived from the space-time symmetries of the entire system: medium and light. This approach leads to new selection rules, e.g. processes that conserve the polarization ellipticity of the radiation. I will then present applications of the new theory for ultrafast spectroscopy and for describing a new type of light – 'synthetic chiral light'. This light is characterized by a new intrinsic property of electromagnetic fields that evaluates the chirality of the polarization vector trajectory in time. Synthetic chiral light interacts with chiral matter extremely selectively, even in processes in which circularly polarized beams act as achiral objects.

Laser-Synthesized Bi-Based Magnetic Nanoalloys Towards Finding Recyclable Photocatalyst

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Abstract

Fine manipulation with nanoparticles' chemical composition has become very important in recent years; however, it is still unresolved for many types of alloyed bi-metallic nanoparticles composed of metals with different characteristic properties. Here we present successful control of bismuth doping in magnetic nanoalloys composed of magnetic element - nickel or iron. For this, we have used reactive laser ablation (RLAL) of magnetic foil immersed in the acetone or acetic acid solutions with a hard-to-dissolve hydrated bismuth salt. The morphological and composition features of prepared nanoparticles are determined by plasma spectroscopies, SEM, TEM and UV-Vis spectroscopy.

Special attention in the analysis is given to testing different salt concentrations, which shows us that the salt concentrations between 0.01 and 1 mM are optimal for manipulating the nanoalloys' elemental composition. In contrast, higher concentrations lead to salt waste excessing and thus to the not green synthesis of nanoparticles, which is a typical narrative for the laser ablation methodology when the salt is not used as a precursor. Nevertheless, since only room conditions are required during the ablation process, the choice of lower salt concentrations makes the technique highly promising for waste-reducing and easy-processing synthesis.

Among other samples, Fe-based NPs prepared in the acetone with 1 mM of salt display segregated phases leading to two band gaps, one at 2.6 eV and one at 3.7 eV, enabling particle activation by both visible and UV radiation. Moreover, their excellent magnetophoretic motility makes them an auspicious alternative material for photocatalytic reactions.

Biography

Ondrej Havelka is currently pursuing a Ph.D. degree in Applied Sciences in Engineering at the Technical University of Liberec, Czech Republic. His main field of interest is the development of complex nanomaterials employing ultrafast lasers, which leads him to seek to shed light on the questions behind custom designing solutions for our society's needs. Thus, his research interests expand to a wide variety of nanomaterial- application sectors such as antibiotics degradation, development of intelligent fluids, and reclamation of pure water from oily polluted sources. During his scientific career, he received the Czech Republic's Minister of Education Awards in 2019 and 2021. Besides, he is a delegate in the European Council for Doctoral Candidates and Junior Researchers.

Acknowledgments

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Diffuse Optical Imaging System- Instrumentation and Computation

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Abstract

Compared with the medical imaging modalities for breast tumor detection and diagnosis like X-ray mammogram, ultrasonography and breast MRI, a counterpart, near infrared (NIR) diffuse optical imaging (DOI) technique and equipment, has been developed and implemented since middle 1990s. At the D-BioM Lab of the National Central University a diffuse optical imaging system has been constructed and improved continuously since the late 2000s. Our built-up imaging system comprises two main parts including instrumentation and computation. The former for acquiring optical information (light power and phase difference) is a prone-type scanning test bench with moving-flexible optical-fiber channels to accommodate test objects with noncircular profiles, multi-wavelengths and multi-sinusoids driving NIR light sources that enable to obtain functional images and to reduce data acquisition time, respectively. The latter for the reconstruction of optical-property coefficients images comprises the model based and data driven schemes. The model based one is governed by diffusion equation and employs forward finite element method and inverse computation using regularization to minimize the differences between the measured and computed boundary out-emitted NIR radiance. In contrast, the data driven scheme develops various models of deep learning neural networks for reconstructing the images. Further, the transfer learning networks were modeled for the adaptation to noncircular object profiles. Synthesized and experimental phantom cases were designated to justified the developed imaging system. A few in-vivo validation examples have been performed in a medical center. We are presenting our achieved tasks in the conference.

Keywords

diffuse optical imaging, prone-type scanning, forward and inverse computation, regularization, deep learning neural networks, transfer learning, phantom validation.

Recent Developments of Optical in-fiber Transducers for Biosensing

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Abstract

Fiber optic label-free biosensors are currently experiencing wide diffusion, as they combine the performance of optical measurements with the advantages of optical fiber. Their basic structure involves few parts or disciplines and their connection. First is the biological problem involving the right selection of the molecular recognition element (MRE) based on the target molecule, their working condition and capability to be grafted onto transducer. The transducer represents the second pillar of the biosensor and has to meet the high-sensitivity requirements. This paper presents a comprehensive review about the design, development and testing of biosensor solutions based on in-fiber long period gratings (LPG) and lossy mode resonance (LMR) sensors. The attention is focused on optical transducers and methodologies allowing a significant enhancement of the sensitivity. Moreover, we report here about the development of a novel fiber optic biosensor based on unconventional LPG, which is inscribed into a specialty double cladding fiber, whose sensitivity is enhanced through the mode transition phenomenon by chemical etching of the fiber outer cladding. Finally, recent progress about optical fiber transducers based on LMR phenomena will be also presented. Also in this case, the attention will be focused on LMR devices based on unconventional fiber exhibiting impressive advantages in term of sensitivity and robustness.

Keywords

in-fiber biosensor; long period grating; lossy mode resonance.

Biography

Agostino Iadicicco received the Ph.D. degree in information engineering in 2005. Currently he is a Full Professor with the Department of Engineering of the University of Naples Parthenope, Italy where he serves as PhD board coordinator. Moreover, he also serves as the Associate Editor for the IEEE Sensors Journal and take part of the editorial board of MDPI Sensors journal. His research activity has been focused on optoelectronics and photonics devices for sensing applications. He is currently involved in the design, realization and testing of novel in-fiber devices in standard and unconventional fibers including polarization maintaining and photonic bandgap fibers.

Recent advances in molecular-vibrational imaging with stimulated Raman scattering

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Abstract
The ability to observe multiple molecular species with high temporal and spatial resolution is crucial for understanding the complex and heterogeneous biological systems. Fluorescence imaging is commonly used to visualize dynamic biological process, while it is limited by the number of resolvable colors (usually up to five) and the need of tagging bulky fluorescent probes. On the other hand, molecular-vibrational imaging with stimulated Raman scattering (SRS) [1] is a complementary imaging modality that can range from label-free imaging to imaging with Raman probes (molecules with a specific vibrational signature for labeling). The applicability of SRS microscopy has been enhanced by developing SRS spectral imaging methods, where signals from multiple vibrational frequencies are acquired [1-7]. We developed wavelength-tunable/switchable pulse sources and adopted them to SRS spectral imaging [2-5] and multicolor SRS imaging flow cytometry [6].

In this talk, I will highlight the recent advances in SRS microscopy that expand its capabilities. First, I will present super-multiplex imaging using an integrated SRS/fluorescence microscope [7]. This system enables simultaneous acquisition of SRS and fluorescence images with the ability to change the laser wavelength and fluorescence detection wavelength, resulting in 4-color SRS and 4-color fluorescence imaging at an order of magnitude faster speed than previous reports. Secondly, I will discuss a novel type of Raman probes that can be activated by enzymes [8]. These probes can be used to image multiple enzyme activities in cancer cells for improved cancer diagnosis. Third, I will cover SRS imaging of single, less-abundant amino acid through deuterium labeling for metabolic tracing [9]. I will also cover quantum-enhanced SRS, which utilizes squeezed vacuum to reduce shot noise in SRS microscopy [10].

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Solitary and traveling wave solutions to equations governing nematic liquid crystals using the Jacobi elliptic function expansion method

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Abstract

Nematic liquid crystals (NLCs) are an important system in nonlinear optics as they allow the study of many nonlinear phenomena at low power due to a very large nonlinear response via the electro-optic effect [1]. In particular, spatial solitons, also known as nematicons [2], can easily be observed in NLCs and have shown to be remarkably stable in the two transverse dimensions [3]. NLCs are generally described by a pair of interconnected nonlinear differential equations governing the behavior of the wave function of light and the angular tilt of the molecules of the crystal [4]. Various methods have been proposed to solve this system of differential equations, including the tan(φ/2)-expansion method [5], the modified simple equation method [6] and others [4,7].

In this work, we generalize the Jacobi elliptic function (JEF) expansion method, developed in [8] and [9], to find exact solutions to the NLC system of equations. We apply the principle of harmonic balance to both the wave function and the angular tilt and apply matching conditions to obtain the degrees of these two functions in terms of the JEF. These degrees depend on the form of the nonlinearity inside the liquid crystal. Unlike many other models, the form of the wave functions given in [8] and [9] also includes a quadratic dependence on the transverse variables in the phase which is known as the chirp. Solitary and travelling wave solutions to the NLC system of equations are obtained, both with and without chirp.

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Study of Solar Cavities with Several Curved Surfaces for Solar-Pumped Laser

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Abstract

A solar-pumped laser is a laser that uses sunlight as its pumping source and oscillates without electricity through optical-to-optical conversion. Many may think this is a new technology to realize the recent SDGs. However, the first lasing of a solar-pumped laser was achieved in 1966 by C. G. Young. Solar-pumped laser is not so difficult to understand because it is realized by simply replacing the flashlamp of a traditional flashlamp-pumped laser with sunlight. Although solar-pumped lasers have a long history and have been studied for many years, they are far from practical use. This is because of the low output laser power and low efficiency. We developed several solar-pumped laser systems and increased the laser output power and efficiency from 2005. In this presentation, we will introduce the history of our solar-pumped laser and recent results. In the previous studies, we succeeded in developing high power and high-efficiency solar-pumped laser whose maximum output was 120 W and collection efficiency was 30 W/m2. In recent years, we have been developing a new solar-pumped laser system with a 1 m2 class of Fresnel lens and several solar cavities, the 2nd concentrator of the solar-pumped laser. Mainly we are developing solar cavities with several curved surfaces to achieve balanced absorbed power distribution in a laser medium. We will introduce the vase-shaped cavity, the partially elliptical vase-shaped cavity, and the multiple compound parabolic concentrator.

Biography

Tomomasa OHKUBO received a B.S. degree in applied physics and M.S. and D.S. in energy science from the Tokyo Institute of Technology, Tokyo, Japan, in 2001, 2003, and 2006, respectively. He is now an associate professor of the department of mechanical engineering at the Tokyo University of Technology. Before that, he was a specially appointed assistant professor of an integrated research institute and an assistant professor of the department of mechanical engineering at the Tokyo Institute of Technology between 2006 and 2014. He has been actively focused on solar-pumped lasers, laser heating, laser processing, and laser propulsion in laser engineering.

Drone-Based Quantum Links towards Mobile Quantum Network

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Abstract

Before, the transmission of optical quantum information mainly relies on fiber or satellites, while the drone-based mobile information platform can also be used for quantum information transmission. It can complement the existing fiber and satellite quantum channels, and form a new plug-and-play mobile quantum network, which can solve the key problem for terminal access of quantum network.

Basing on optical superlattice, we developed compact polarization entangled photon source with high brightness, and light-weight acquiring, pointing and light weight tracking system with high accuracy. Loading these devices on the home-made small multi-motor experimental drone, we accomplished the first drone-based entanglement distribution and demonstrated its ability of working under multi-weather conditions [1]. It is the first-time daytime quantum information transmission is realized on mobile platform and proves the reliability of using drones to transfer quantum information. Besides this air-to-ground quantum link between drone and ground station, air-to-air quantum link between drones is also necessary for achieving multi-node mobile quantum network. Hence, we further realized such air-to-air quantum link, and achieved the first optical-relayed entanglement distribution using a flying drone as the relayed node [2]. These two types of mobile quantum links found the basis for establishing multi-node mobile quantum network, which is an important compliment that can link the existing fiber and satellite quantum network, fill the gap of the vast sky in-between and solve mobility and multi-weather functionality problems.

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Nanophotonics for Photonic Quantum Information Technology

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Abstract
Nanophotonic devices coupled with single-photon emitters have been attracted attention to realize photonic quantum information technology, such as photonic quantum computers, quantum networks, and quantum sensors. As the nanophotonic devices, we have recently developed nanofiber Bragg cavities (NFBCs), which are optical nanofibers embedded a microcavity in it [1, 2, 3, 4]. NFBCs can realize the high coupling efficiency of photons into single-mode fibers [1, 2]. They can also ultra-widely tune more than 20 nm resonant wavelengths by applying mechanical tension [1, 4]. Here, we report the simulation of the coupling efficiency, the mechanism of the ultra-wide resonant tuning, and the fabrication method of the NFBCs with the high-quality factor using a helium-focused ion beam. Besides these results, we will report our recent results on the NFBCs.

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Biography
Hideaki Takashima has received his Ph.D. from Hokkaido University in Japan. After his postdoctoral research experience at Hokkaido University, Osaka University, and Kyoto University, he worked as an assistant professor at Kyoto University. He is an associate professor at the Chitose Institute of Science and Technology. He focuses on developing the hybrid systems between single-photon emitters and nanophotonic devices toward the realization of photonic quantum technology.

An Experimental Feasible Scheme for Deterministic Multiphoton State Generation Using Lithium Niobate on Insulator Circuit

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Abstract

Large-size quantum state is not only important for fundamental quantum physics study but also determines whether quantum information can be used for practical applications. With low decoherence, large-number photon state is regarded as one of the ultimate goals in quantum optics and quantum information. An ultimate solution is realizing deterministic two-photon generation, and then a deterministic multiphoton state can be achieved by cascading the two-photon processes. Such concept has been proposed and theoretically studied, however, only with the ideal $\chi(2)$ or $\chi(3)$ material assumption.

Here, we propose the first feasible scheme to deterministically generate N-photon state, considering the practical material capability [1]. Such scheme is based on an ensemble of basic units called photon- number doubling units (PDUs), which is used to realize photon number doubling and keep their spectrum unchanged at the same time, as illustrated in Fig. (a). This unit is capable for deterministic parametric down-conversion (DPDC) and deterministic parametric up-conversion (DPUC). Taking advantage of the strong nonlinear interaction in lithium niobate on insulator (LNOI) circuits, this PDU only requires LNOI resonator with ~107 optical quality (Q) factor and mW-level on-chip power, which have already been demonstrated in experiments [2, 3]. With miniaturized footprint in LNOI, PDUs can be integrated for unlimited photon number in principle on a single chip. Fig. (b) shows the N-photon number state generation by direct cascading PDUs. Our scheme can fulfill the fundamental demand for large-size entangled state, such as GHZ and cluster state, as shown in Fig. (c) and (d). The remaining challenges for the experimental demonstration are technical problems, which are not unrealistic in principle, including resonance matching and fabrication error control in the PDUs, etc. This strong single-photon interaction can also be used for photon manipulation to realize quantum gates, quantum storage and so on, to push forward the development of quantum computation, quantum communication and the overall quantum information technology.

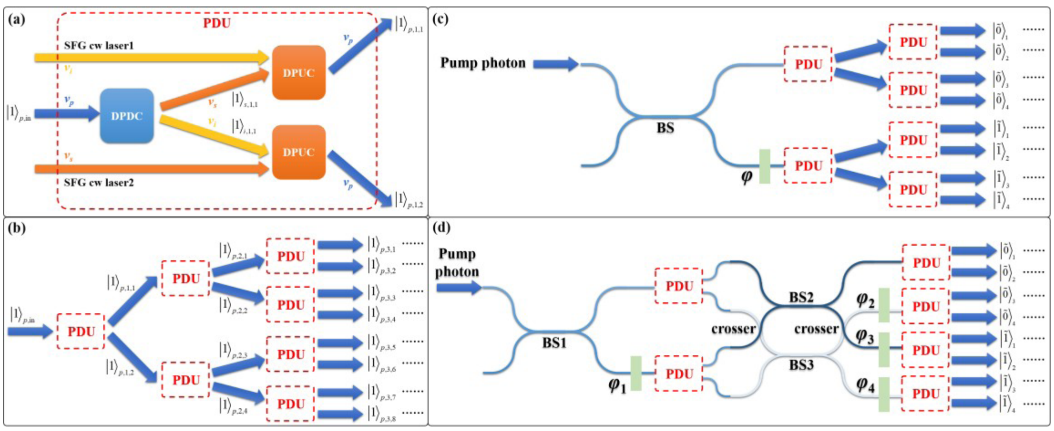

Fig. (a) Scheme for PDU. (b) Scheme for deterministic N-photon state generation using PDUs. (c) Deterministic N-photon GHZ state using PDUs. (d) Deterministic N-photon cluster state using PDUs.

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Half-vortices and Skyrmions of Exciton Polariton Condensates in a Magnetic Field

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Abstract

We investigate the topological excitations of skyrmions and half-vortices in a homogeneous spinor exciton-polariton condensate with TE-TM splitting and subject to an external magnetic field. The spin texture and integrated winding number can be controlled through the pump and magnetic field. Among these textures, the skyrmions can be created with a synchronized excitation condition, i.e., the power on the vortex state is higher than that on the homogeneous (non-vortex) state by a specific amount of value determined by the magnetic field, and the spin texture is characterized by an inversion of circular polarization (spin-flipping) from the center towards the edge. On the contrary, when the synchronized excitation condition is reversed so that the power on the vortex state is lower, the half-vortices can be created with no inversion of circular polarization across the whole condensate.

High-efficiency GaN micro-LEDs fabricated by neutral beam etching

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Abstract

Microdisplays using GaN micro-LEDs as light emitters are considered to be an ideal candidate for next-generation VR/AR smart glasses that require high-resolution, high-luminance, and energy-efficient displays. For this purpose, the size of the micro-LEDs needs to be reduced to the order of a few microns to realize the high-resolution required by VR/AR displays (>4,000 pixels per inch for AR). Furthermore, the micro-LEDs should keep a high emission efficiency at low current densities (<1 A/cm2) to achieve a high luminance while suppressing heat generation during smart glass operation. Unfortunately, fabrication of highly efficient sub-10-μm micro-LEDs is a significant challenge because of the presence of strong nonradiative recombination arising from mesa sidewall defects which are produced during mesa etching by inductively coupled plasma (ICP) owing to ion bombardment and deep ultraviolet photon irradiation. Here, we employed a damage-free etching technique, known as neutral beam etching (NBE), to fabricate high-efficiency GaN micro-LEDs in the sub-10-μm size region. In the NBE technique, a carbon plate with a high-aspect-ratio aperture was placed between the plasma discharge chamber and the etching chamber. As the plasma passes through the aperture, ions are efficiently neutralized through charge exchange with the carbon aperture and ultraviolet photons are blocked by the aperture, resulting in a neutral beam for etching. We have demonstrated that the efficiency of GaN blue micro-LEDs fabricated by the NBE technique was maintained at least down to the chip size of 6 μm, while devices fabricated by the ICP process showed strong decrease with reducing chip size.

Biography

Xuelun Wang received his PhD degree in 1993 from Kyoto University, Japan. He is now the leader of GaN Optical Device Team at GaN Advanced Device Open Innovation Laboratory, National Institute of Advanced Industrial Science and Technology, Japan. His research interests include MOCVD growth of III-V semiconductors and optical devices. He is currently developing high-efficiency and high-directionality GaN micro-LEDs for VR/AR applications.

Optical Characterization of Diffusion Processes for Light Sensing Proteins by Laser Induced Transient Grating

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Abstract
There are many photo-response biological proteins to convert the light energy to chemical energy, or to generate light information. These proteins can be used as useful photonic materials. For applications of these proteins, it is necessary to understand molecular mechanism of the light detection. In general, revealing conformation changes and intermolecular interactions are essential. Although optical spectroscopies developed so far have been used for detecting dynamics of chemical reactions, there are many undetectable (spectrally silent) dynamics in biological reaction systems. It is desirable to develop a new method to overcome this limitation. We have succeeded in detecting many spectrally silent species by the time-resolved optical detection of energies and the diffusion coefficients based on the pulsed laser induced transient grating (TG) method. Here I will demonstrate the method on a reaction of a blue-light sensor protein, PixD.

PixD is one of photosensor proteins containing a sensor of blue-light using FAD (BLUF) domain. SyPixD regulates phototaxis of cyanobacterium. Crystallographic analyses showed that the homologous PixD have oligomeric structures: a decamer comprised of two stacked pentameric rings. We found that the dissociation reaction of the decamer is a key for signal transduction and it will be used for application purposes. Although the initial photochemical reaction of PixD, the red shift of the flavin absorption spectrum, has been extensively investigated, the subsequent reaction dynamics remain unresolved. By using the time-resolved detection of the diffusion process, the reaction scheme has been revealed. We discovered that the conformational change of the decamers depend on the intensity of the excitation light. From the intensity dependence, we found that the multiphoton excitation of this protein is essential for the reaction. More strikingly, disassembly was found to take place only after photoactivation of two PixD subunits in the complex. This result suggests that the biological response of PixD does not follow a linear correlation with the light intensity, but appears to be light-intensity-dependent. We have further characterized the nature of the reaction intermediates.

Intensity decay in external cavity of multiple self-mixing interference for detecting liquid

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Fuyang Normal University, China Title: Intensity decay in enternal cavity of multiple self-mixing interference for detecting liquid

Abstract

Multiple laser self-mixing interference usually consists of a laser cavity and an external cavity. The laser cavity includes the gain material generating the light mode while the external cavity includes some liquid sample to be detected. The emitted light from the laser cavity goes through the sample for several times during the light is multiple reflected within the external cavity. When the light goes through the sample, the intensity might decay due to absorption or scattering by the liquid or some matter in the liquid. And the intensity decay related to the sample concentration is recorded by the reflected lights. The reflected light goes back into the laser cavity resulting in a new mode showing a waveform consisting of some fringes in the time domain which is the superposition of some new fringes caused by the multiple reflected lights on the condition that the reflected lights' phases will increase with the reflection times. Since the fringes' amplitudes record the sample concentration, the liquid sample can be detected by the analysis of the new mode caused by the multiple laser self-mixing interference. The intensity decay caused by the absorption or scattering of the liquid will be much more significant as the light goes through the liquid for several times. Moreover, the reflected lights will be also amplified by the laser cavity via the gain material to make the intensity decay more significant so that the work is helpful for detecting trace liquid based on the intensity decay in external cavity of multiple self-mixing interference.

Rare-earth crystals for optical quantum memory applications

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Abstract

In recent years, quantum repeaters and quantum memories have been actively investigated to realize a global quantum information network. Rare earth ions doped in crystals are very interesting as platform materials for these quantum information devices because of their longer energy relaxation and coherence time with respect to optical transitions and spins than other solid-state materials [1,2]. Furthermore, nuclear spins of rare earth in the hyperfine ground state exhibit longer coherence times than electron spins [3] and are expected to be used for coherence conversion between light and microwaves. Among such rare earth ions, erbium (Er3+), in particular, has an optical transition of 1.5 mm, which corresponds to the optical communication wavelength, and thus can directly interact with telecom-band photons as information carriers. If we can maximize the coherence properties of Er3+ and create new thin film materials with the addition of cavity quantum electrodynamic effects, the application of these materials to quantum information platforms will become a reality.

In this context, we have been working on the magnetic purification of crystalline materials to maximize the coherence time of Er3+ [4], epitaxial thin film growth on Si substrates [5], formation of photonic nanostructures such as optical waveguides and microcavities [6], and the demonstration of memory operation by atomic frequency comb protocol at telecom-band photons [7]. In this talk, I will introduce our efforts and recent progress toward the application of these Er-doped solid-state materials to quantum information platforms.

This work was supported financially by JSPS KAKENHI (24360033, 15H04130, 16H01057, 19H02636, 19H02207, 21H01745, 22H01995).

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Photonic Shaping Tools for Ultrafast Laser Micromachining

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Abstract
A structured light concept is presented enabling to distribute a large number of focus copies at arbitrary positions in a working volume. Applying this holographic 3D-beam splitter concept to ultrashort laser pulses allows to deposit energy along accelerating trajectories in the volume of transparent workpieces. Based on the entirety of the volume modifications created in this way, the material can be separated, for example, to create chamfered display glass edges. This photonic tool impresses with enormous versatility, enabling equally diverse application strategies ranging from cutting and welding to data storing.

Quantum Phenomena of photons and phonons in Nanophotonic Wires

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Abstract
Realizing the promise of quantum computers is dependent on the development of physical systems that can process quantum information. While several candidates have been suggested in recent years, each with its set of advantages and disadvantages, none fulfil the complete set of criteria for achieving efficient quantum computers. For example, photons are by nature non-interacting particles, a fact that makes them unsuitable for quantum information processing, but they are widely used in quantum communication. We introduce nanophotonic structures as a strong candidate for the physical implementation of quantum information processing using photons [1,6]. Nanostructures are made of solid components and serve as quantum devices that can be easily integrated into on-chip platforms. Photons inside nanoscale structures have been shown to strongly interact [2,3,4,5], making them suitable for quantum information processing. Our study serves as an important step toward an all-optical on-chip platform in which the same photons that participate in quantum communication can be involved in quantum computing. We develop a quantum theory for interacting photons and phonons in nanophotonic waveguides made of dielectric materials, where the Brillouin interaction covers radiation pressure and electrostrictive interactions on equal footing [1]. We explore the possibility of achieving a significant nonlinear phase shift among photons propagating in nanoscale waveguides exploiting interactions among photons that are mediated by vibrational modes and induced through Stimulated Brillouin Scattering (SBS) [6]. We introduce a configuration that allows slowing down the photons by several orders of magnitude via SBS involving sound waves in the presence of pump fields. The nonlinear phase among two counter-propagating photons can be used to realize a deterministic quantum logic gate [10]. Such photon-phonon interactions are exploited in order to generate a coherent mix of photons and phonons with manifest quantum phenomena [7-11].

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Synthesis and characterization of nanocomposites from natural sources to reinforce hydrogels, using gamma radiation

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Abstract

Nanocomposites have developed great interest in recent decades as they can help to increase the surface area, mechanical properties, and thermal stability of the common materials. Using natural polymers as polysaccharides gives a plus due to are biocompatible, non-toxic and unexpensive materials, which is very useful to biomedical applications.

In this research, hydrogels of polyacrylamide (PAAm) and poly (ethylene glycol) (PEG) were reinforced by addition of nanocrystalline cellulose (NCC) or nano chitosan (NCS) using gamma radiation, with the objective of improve the mechanical and physicochemical properties.

NCC was synthesized by acid hydrolysis (H2SO4, 65% w/w) from microcrystalline cellulose, while NCS was obtained by reverse emulsion (GA, Triton, hexanol and cyclohexane). The NCC and NCS were dispersed into aqueous solutions of AAm and PEG, respectively. Then, solutions were bubbled with argon to eliminate oxygen and irradiated with gamma rays of 60Co at different doses, to obtain the hydrogels.

Characterization was carried by FTIR, TGA, X-ray diffraction and SEM. Swelling behavior and mechanical properties were also studied. These materials have potential applications as drug delivery systems.

Acknowledgments

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Surface Functionalization: Intermolecular and Molecule/Substrate Interactions Studied by Soft X Ray Absorption and Core Level Photoemission Spectroscopies

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TEMPO beamline, Synchrotron SOLEIL, France

Abstract

The past two decades have shown the emergence of various nanometric scale materials from 1D nanoparticles to 2D materials exhibiting remarkable electronic properties with fundamental and applied interests. Due to their small size, nanomaterials structural and electronic properties drastically differs depending on their chemical environment.

The organic electronic development depends on the functionalization of the surface. Generally, there are two main categories of functionalization, functionalization based on chemisorption and physisorption process. The chemisorption leads to the creation of new covalent bonds between the molecules and the substrate while physisorption involve mainly π-conjugated system exhibiting weaker interactions. The main interest of π-conjugated systems is their ability to self-organize on metal surfaces. The molecular self-assembly results from the subtle balance between intermolecular interactions (formation of hydrogen or halogen bonds) and molecule–surface interactions (Pauli and van der Walls (vdW) interactions). The molecular order goes from compact molecular organization to 2D porous nanostructures. Depending on the surface organization, the electronic and chemical properties of the nanomaterials strongly differs. Due to the nanometric scale, the investigation of the electronic properties of surface and interfaces of nanomaterials remains challenging.

High resolution photoemission spectroscopy (HRPES) is a powerful spectroscopic technique to investigate the electronic and the chemical properties of materials in a surface sensitive fashion. Near edge X-ray absorption fine structure spectroscopy (NEXAFS) sensitive to the chemical species and to the molecular orbital geometry allows to determine the adsorption geometry of the molecules at the surface. Using synchrotron radiation and tuning the incoming photon energy, the combination of HRPES and NEXAFS is an efficient approach to fully assess the molecule/substrate interactions and probe complex interface of hybrid materials at the nanometric scale.

Through examples measured on Self-assembly of organic π-conjugated molecules[1, 2] self-assembled on metal surfaces or lying on semiconductors[3, 4], we will show how HRPES and NEXAFS studies performed in Synchrotron are capable of evidencing complex intermolecular and molecules/substrate interactions leading to peculiar electronic properties.

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Upgrade Mechanical Recycling Process based on the Physical Degradation and Regeneration Theory

Shigeru Yao*

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Abstract

In these days, the amount of plastic waste is being extremely large, and become very serious problem. The best way to reduce them is recycle. An ideal approach would be to mechanical recycle, however, the ratio of mechanical recycle is still remained about 30% in JAPAN. This is because the mechanical properties of products made from mechanical-recycled plastics are inferior to those of products made from virgin plastics. The poor mechanical properties of mechanical-recycled plastics are believed to be due to the chemical degradation. Such chemical degradation is irreversible because it is associated with the breaking of molecular chains. Therefore, material-recycled plastics are only used in low-value-added products and have limited applications.

However, our recent research indicated that the molecular properties of mechanical-recycled plastics has not chemically degraded. We also found that the poor mechanical properties of the recycled plastics come from the change of the inner structure of plastics (that is “Physical Degradation”) and the mechanical properties can physically regenerate. Based on the Physical Degradation and Physical Regeneration theory, we constructed an advanced mechanical recycle process with using a new type extruder with having Molten Resin Reservoir. By using the process, the tensile property, especially elongation, regenerate as same as virgin plastic.

This presentation is based on results obtained from a project, JPNP20012, commissioned by the New Energy and Industrial Technology Development Organization (NEDO).

Keywords

Mechanical Recycle, Waste plastic, Physical Degradation, Physical Regeneration, Extruder, Molten Resin Reservoir

References

[1] P. Phanthong, S. Yao, “Revolutionary Plastic Mechanical Recycling Process: Regeneration of Mechanical Properties and Lamellar Structures”, Recycling - Recent Advances, (2022)

Biography

Dr. Shigeru Yao, Doctor of Engineering, Professor of Department of Chemical Engineering, Fukuoka University, Chairman of Research Association For Feedstock Recycling of Plastics Japan. Researches focus on self-organization mechanism of polymer and especially the crystalline supramolecular interaction between side chain crystalline block co-polymer and crystalline polymer and advanced mechanical recycle theory and process of waste plastics.

Upgrade Mechanical Recycling Process based on the Physical Degradation and Regeneration Theory

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Abstract

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Drug delivery nanosystem for tumor treatment

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Abstract
Traditional tumor treatment measures usually fail due to their poor delivery selectivity, drug resistance, and severe side effects. The continuous in-depth study of tumor microenvironment provides new ideas and new therapeutical targets for improving the antitumor efficiency. The further exploration of the correlationship between tumor microenvironment characters and drug resistance behaviors benefits the development of multi-target synergistic tumor therapy. The application of nanocarrier strategies which are responding to tumor microenvironment have shown great potential in overcoming tumor drug resistance by increasing the efficient drug concentration of target region while achieving well-controlled drug release in tumor tissues, thus achieving high-efficiency and low-toxicity in tumor therapy.

Our group has focused on the causes of tumor drug resistance, and put forward corresponding treatment ideas from the perspective of materials science and biology. On the one hand, based on the materials that with great potential in clinical transformation, such as liposomes and albumin, we have constructed a series of intelligent controlled-release nanocarrier with "tumor microenvironment responsiveness" and "tumor microenvironment-external light/ultrasound/electricity dual responsiveness" to improve drug delivery efficiency[1-2]. On the other hand, considering the tumor-promoting characteristics of microenvironment (including hypoxia, immunosuppression, etc.), we have developed intelligent controlled-release drug carriers for multi-target drug delivery. These new multi-target synergistic therapy strategies effectively overcame tumor drug resistance and improved treatment outcomes of tumor immunotherapy, chemotherapy and photodynamic therapy [3-4].

In conclusion, our work has overcome drug resistance through the controllable delivery of multi-target drugs, the regulation of oxidative stress level, and the regulation of the immune microenvironment, separately, providing feasible ideas to improve drug-resistant tumor therapeutics and prognosis in clinical treatment.

Keywords
drug-resistant tumor, multi-target regulation, oxidative stress, immunotherapy, stimuli-responsive drug release

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Biography
Meng Yu is an Associate Professor (Principal Investigator) and Master Supervisor of Southern Medical University, Guangzhou, China. Now she is working in École Normale Supérieure, Paris, France as a visiting scholar since Sep 2022. In recent years, Meng YU's work has focused on improving the new antitumor nanomedicine strategies to overcome therapeutic resistance by regulating the disease-promoting microenvironment. She has over 40 publications, including ACS Nano, Advanced Science, Nano Letters, Small Methods, Bioactive Materials, Biomaterials, J Control Release and so on. The total SCI citations were over 1400 in the last five years with an H-index of 24. Have 3 authorized Chinese Patents. She is the youth board member of the Asian Journal of Pharmaceutical Sciences and Chinese Chemical Letters, two well-recognized international journals.

Synthesis of ultra-fine ZrC powders using MOF (metal organic framework) process

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Abstract

Among ultra-high temperature ceramics (UHTC), ZrC has received a special attention in the recent years due to the combination of their chemical and physical properties such as right weight, excellent thermal stability and relatively low price. The synthesis of ZrC powder with high purity, controlled shape, fine size and homogeneous chemical composition is important in order to maintain its intrinsic chemical and physical properties and for the synthesis of UHTCMC (Ultra-high temperature ceramic matrix composites) For this purpose, the synthesis of UHTC nano-powders which have the desired properties were performed using the metal organic framework (MOF) method. High purity MOF powders with the size between 50-600nm were successfully synthesized. Subsequently the MOF powder was sequentially converted into ZrO2 and ZrC powder by the calcination in air and subsequent carbo-thermal reduction of the oxide powder. The sizes of the synthesized powders were in the range of 50-300nm. The effects of synthesis temperature and carbon contents on the phase composition and microstructures of the synthesized ZrC powders was also analyzed.

Development of Novel Biodegradable Membrane from Plant Biomass for Daily Used Materials

Pushpamalar Janarthanan[1,2*]

1School of Science, Monash University Malaysia, Jalan Lagoon Selatan, Bandar Sunway 47500, Selangor Darul Ehsan, Malaysia

2Monash-Industry Plant Oils Research Laboratory (MIPO), Monash University Malaysia, Jalan Lagoon Selatan, Bandar Sunway, 47500, Selangor Darul Ehsan, Malaysia.

Abstract

Plant biomass is produced by the commercial agricultural plantation in Malaysia, and the availability of this material led to many studies on its application as a source of renewable energy. Among the various derivatives that can be produced from biomasses, the synthesis of cellulose derivatives has been widely investigated due to their potential as a green substitute for polyethylene terephthalate (PET) plastic. The carboxymethyl cellulose (CMC) and furan dicarboxylic acid (FDCA) were successfully synthesized from cellulose isolated from plant biomass. Moving forward, it is then used in the copolymerization with PEG-4000 to develop a novel copolymer with enhanced mechanical and thermal properties. The copolymer produced displayed a degree of crystallinity (49%) and thermal stability, making it an appropriate plastic packaging.

Keywords

plant biomass, biodegradable, , CMC, FDCA, membrane Email: pushpa.janarthanan@monash.edu; pushvenga@hotmail.com

A stress-driven nonlocal model incorporating surface energy effects for the analysis of the flexural behavior of Bernoulli-Euler functionally graded nanobeams

R. Penna

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Abstract

In recent years, functionally graded composite mate- rials and nanotechnologies are being more and more combined in order to develop hi-tech devices for ap- plications in emerging engineering fields where sen- sors, actuators, biomaterials and multifunctional ma- terials are increasingly used. As we all know, com- pared to macrostructures, ultrasmall structures exhibit a size-dependent behavior, due the nano-size dimen- sions and they are also influenced by surface energy effects, due the large surface area to bulk volume ratio which results in the non-negligible energy associated to atoms near the free surface. However, classical continuum mechanics models are unable to capture any of these effects above, and they also use the prop- erties of the bulk as the material overall properties.

Moreover, to the author's knowledge, coupled models based on the stress-driven theory of elasticity incorpo- rating surface energy, nonlocal parameter and mate- rial gradient index capable to capture the statical re- sponse of nanobeams made of functionally graded ma- terial are less studied. Therefore, the motivation of this paper is to propose a well-posed nonlocal approach which combine the stress–driven nonlocal model and the surface elasticity theory for the bending analysis of functionally graded nanobeams.

The proposed model is used to investigated the flex- ural behavior of FG Bernoulli-Euler nanobeams com- posed of a bulk volume and a surface layer regarded as a membrane of zero thickness perfectly adhered to the bulk continuum. In particular, the bulk material is made of a mixture of metal and ceramic, whose distri- butions spatially vary from the bottom to the top sur- face of the FG nanobeams. The nonlocal governing equations of the elastostatic bending problem are de- rived by using the virtual work principle. The main re- sults of a parametric investigation are also presented and discussed varying the nonlocal parameter, the ma- terial gradient index and the boundary conditions at the ends of the nanobeams.

They show how the proposed model is able to study the bending behavior of inflected FG nanobeams including surface effects.

Keywords

Functionally Graded Materials, Ber- noulli-Euler nanobeams, Stress-Driven Nonlocal Model, Bending Analysis, Surface Energy Effects.

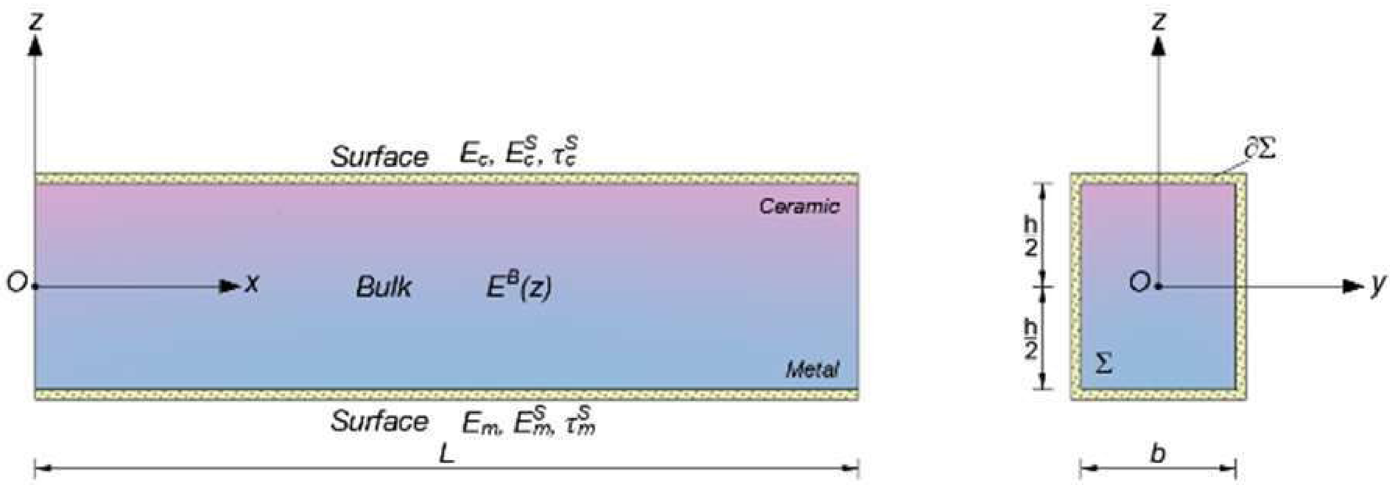

Figure 1: Coordinate system and configuration of the FG nanobeam: bulk continuum (mixture of ceramic and metal) and surface layer.

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Acknowledgements

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Antireflective and Antifogging Coating of Porous Silica

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Abstract

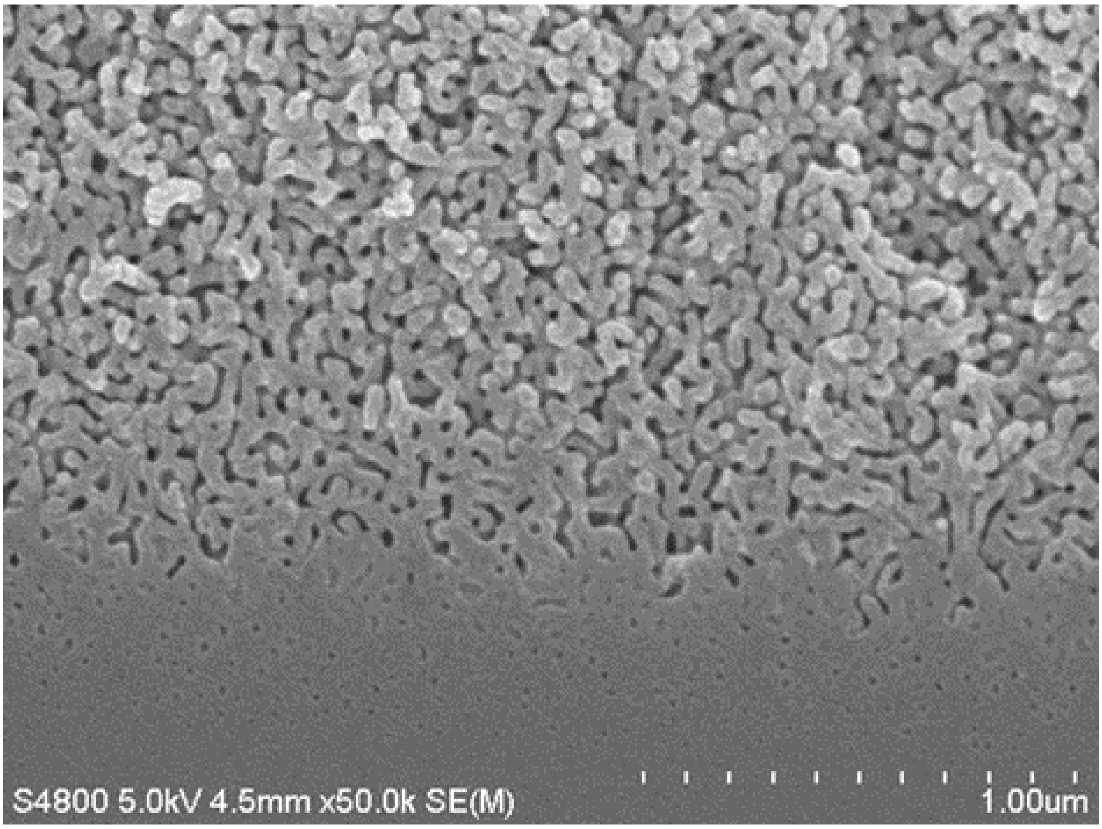

Fig. 1. SEM micrographs of the cross section od the porous coating. A graded region was formed between the coating and substrate. [1]

In order to strengthen AR coating of low refractive index and to realize the surface property of antifogging, spinodal porous silica has been prepared onto silica substrate based on the phase separation of sodium borosilicate glass [1]. A glass past was applied onto silica substrates, which contained the powder of glass capable of phase separation. Then, the glass powder was melted to form a film on the substrate at 900 to 1000℃, and then allowed to phase separate at 600℃. Finally, the coating film was etched to a porous state. By this method, antireflection property as low as 0.5% in reflection was achieved, where a graded region was formed at interface with the substrate as shown in Fig. 1. As to the mechanism of the optical properties, simulations based on a 3-layer model was carried out, into which a graded layer with a linear distribution of refractive index was incorporated. Furthermore, the mutual coherence degree between the reflections from surface and from interface region was proposed for the first time to interpret the oscillations in the spectra. As to the properties of antifogging, porous glasses with pores ranging from 10 to 50 nm in diameter were investigated for adsorbing / desorbing of water with humidity and the structural parameters related to the antifogging were clarified [2]. In the presentation, our approaches towards the fundamental properties of the antireflection and the antifogging will be reviewed. In addition, we want to present how the spinodal structures should be designed from the point of view of the antifogging.

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Innovative Crystal Growth Method and Functional Optical Single Crystals

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Abstract

Many optical single crystals have been developed by various melt-growth methods such as Czochralski (Cz), Vertical Bridgman (VB) and Floating Zone (FZ) methods. However, there are many optical materials with strong hygroscopicity and high melting point, and they can't be grown by the conventional melt-growth methods although high optical performance can be expected. Therefore, we have developed innovative melt-growth methods for their material research of optical single crystals with strong hygroscopicity and high melting point.

The Halide-micro-pulling-down (H-m-PD) method with a removable chamber system has been developed for the crystal growth of halide single crystals with strong hygroscopicity[1]. We have grown various halide single crystals with high quality as a scintillator, and they indicated great scintillation performance. In addition, the Halide-Vertical-Bridgman (H-VB) method with the removable chamber system has been developed for the crystal growth of bulk halide single crystals over 1 inch in diameter. SrI_2:Eu bulk single crystal grown by the H-VB method indicated more than 80,000 photons/MeV light yield under gamma-ray irradiation.

In addition, we have developed an innovative melt-growth method for oxide single crystals with high melting temperature using a tungsten (W) crucible. The melt-growth method can grow oxide single crystals with melting point (m.p.) of more than 2100°C that can't be grown by the conventional melt-growth method using the Iridium crucible. $La_2Zr_2O_7$ (m.p.: 2283°C) and $La_2Hf_2O_7$ (m.p.: 2418°C) single crystals could be grown by the melt-method and they are expected to be gamma-ray scintillator with the high stopping power.

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Reflection-typed miniature atomic clocks and micro-optical systems

Hitoshi Nishino
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Abstract

Recently miniature atomic clocks are expected to be mounted on mobile devices like smartphone in order to have accurate time synchronization between the terminal and base station, or terminal and another terminal [1]. To achieve mounting on the smartphones, it has been developed reflection-typed vapor cells [2]. However, it is challenging to have long-term stability using the commercialized alkali dispensers, and to implement the coil for the magnetic field and the heater for control the temperature. In this presentation, we introduce the development of reflection-typed vapor cells implemented 45° mirrors and 90° mirror by microfabrication. Then, we report the development for the vapor cell with long-term stability [3] and the design for the reflection-typed miniature atomic clocks implemented the reflection mirrors outside the vapor cell to improve the challenging points of the reflection-typed vapor cells implemented 45° mirrors (show Fig.1). Finally, it is concluded the development of the miniature atomic clocks using reflection mirrors from the perspective of micro-optical systems.

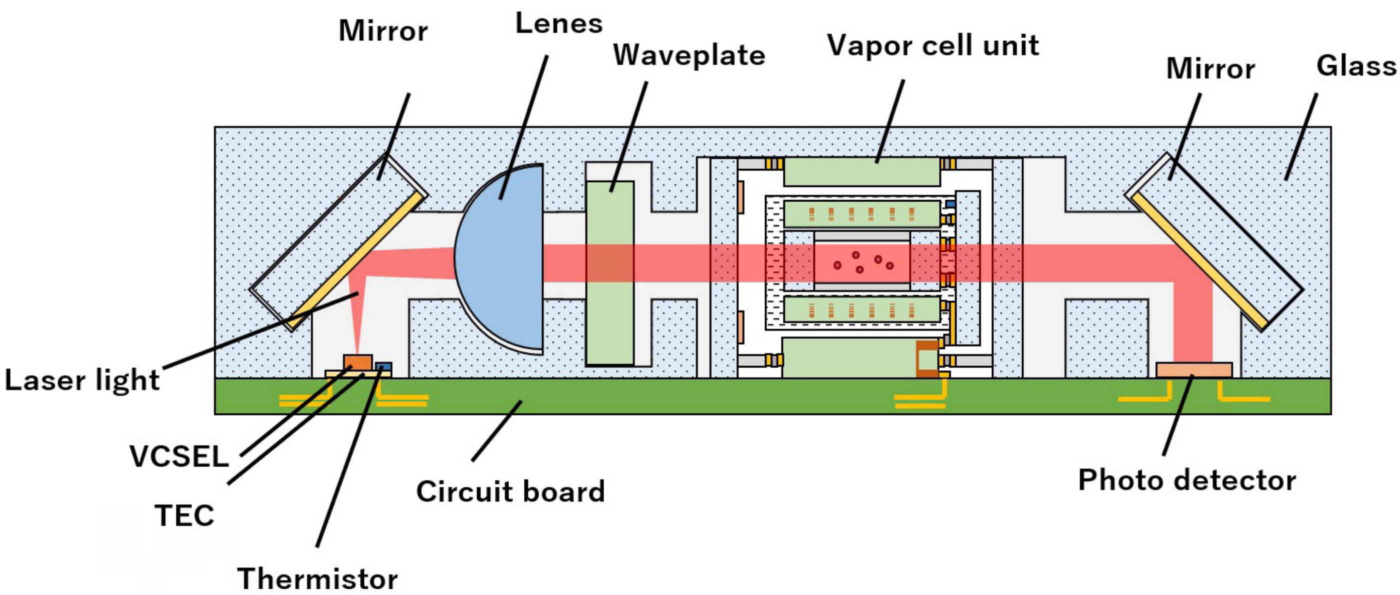

Figure 1. Proposed reflection-typed miniature atomic clocks

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ToF-camera-based 3D Human Joint Extraction and Applications

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Abstract

Human joint extraction has a wide range of applications in human-computer interaction, virtual reality, augmented reality, intelligent video surveillance, intelligent medical care, etc. Unlike the current human joint extraction method based on two-dimensional images, which is easily affected by the environment and light, the infrared Time-of-Flight (ToF) depth camera has significant advantages in dark light conditions and other complex environments, and can quickly and accurately acquire the target's depth information. To realize human joint extraction based on single-frame point cloud, a ToF depth camera is used to capture the human point clouds with different poses, and two human joint extraction algorithms have been proposed. The former determines the positions of the human joints based on the geometric characteristics of 3D human silhouettes in different poses. The algorithm is validated on the public dataset and in-house captured dataset, and the average distance error of the extracted joints is <5.8 cm. The latter uses the PointNet++ deep learning network method to realize the part segmentation of the human body point cloud, and combines different human body parts in the model through mathematical analysis methods to realize the extraction of human body joints. The results show an average normalized error of <4.2 cm. Based on this, we further investigate the multi-size measurement method of the human body. The results show that, with the appropriate parameters, the average measurement error for all the related sizes was <4.1 cm.

Magnetic-free quantum nonreciprocity

Keyu Xia

Nanjing University, China

Abstract

Quantum nonreciprocity, breaking the Lorentz reciprocity in the quantum regime, promises a manner for unconventional quantum information processing. Here, this presentation will show two routines to achieve on-chip quantum nonreciprocity by using a chiral cavity quantum electrodynamics system and quantum squeezing in the absence of magnetic fields. These works pave the way to nonreciprocal manipulation of quantum information.

Development of Electrocardiogram (ECG) Knit Armband Using a Simulation-Based Contact Pressure Model

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Abstract

The integration of textile sensors into wearable technology has enabled long-term ECG monitoring; however, challenges still exist in optimizing biosignal quality, reducing motion artifacts (MAs), and ensuring wearer comfort in electronic textiles (E-textiles). A crucial aspect in addressing these challenges is the design of appropriate contact pressure, which currently lacks guidance on material selection and sizing for achieving optimal contact pressure. Additionally, the potential of three-dimensional garment simulation (3DGS) technology in optimizing E-textile garments remains unexplored. To address these gaps, this work presents a novel contact pressure prediction (CP) model that leverages 3DGS to optimize E-textile garments for health monitoring. The CP model is developed by utilizing simulation parameters and modifying Laplace's theoretical law. Its accuracy is validated against experimental contact pressure values, demonstrating a higher precision with an R-squared value of 0.90. To showcase the effectiveness of the CP model, a customized ECG armband is presented, incorporating strategically selected knits and screen-printed dry electrodes. Through an analysis of ECG signals, contact pressure, and applied strains, the benefits of these design choices are confirmed. The optimized design achieves the desired contact pressure range of 1-1.5 kPa, enhancing functionality and wearer comfort. This study showcases the potential of digital technology and simulation-based approaches in manufacturing health monitoring garments.

Polymer Membranes for Water Reuse, Seawater Desalination, and Clean Energy

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Department of Chemical and Biomolecular Engineering, National University of Singapore (NUS), Singapore

Abstract
Clean water, clean energy, global warming and affordable healthcare are four major concerns globally resulting from clean water shortages, high fluctuations of oil prices, climate changes and high costs of healthcare. Clean water and public health are also highly related, while clean energy is essential for sustainable prosperity. Among many potential solutions, advances in membrane technology are one of the most direct, effective and feasible approaches to solve these sophisticated issues. Membrane technology is a fully integrated science and engineering which consists of materials science and engineering, chemistry and chemical engineering, separation and purification phenomena, environmental science and sustainability, statistical mechanics-based molecular simulation, process and product design. In this presentation, we will introduce and summarize our efforts on membrane development for modern water and clean energy production. Various polymer materials and fabrication strategies to enhance membrane performance will be discussed.

Photonic Nanojets: Toward Manipulation and Detection Beyond the Diffraction Limit

Yao Zhang

Institute of Nanophotonics, Jinan University, China

Abstract

With the great advances in imaging of objects at nanoscale, a flexible and precise manipulation of nano-objects, especially nanoparticles or biomolecules with a size less than 100 nm, has also become highly desired in the fields of materials science, biophysics and biomedical optics. Although optical tweezers have become a powerful tool to manipulate microparticles or cells, they face challenges when dealing with sub-100-nm objects due to the diffraction limit of light. The arising near-field methods, such as localized surface plasmons and photonic crystal resonators, showed the ability to surpass the diffraction limit. However, these methods are usually restricted to two-dimensional manipulation and may lead to local heating effect that causes damage to biological samples. In this presentation, we show a near-field technique that uses photonic nanojets (PNJs) to perform the three-dimensional (3D) optical manipulation and detection of sub-100-nm objects. With the PNJs generated by a dielectric sphere or biomicrolens bound to a fiber probe, 3D optical manipulation and signal enhancement were achieved for fluorescent nanoparticles, cells and biomolecules. We've also extended the applications of PNJs to low-laser-power optogenetics, the formation of cell-based micromotors and the optofluidic identification of single microorganisms.

Electrically tuneable focusing or transmission of light through elastomeric thin structures

Prof. Federico Carpi

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Abstract

This presentation will describe our research activities on the use of electrically deformable elastomeric thin membranes to create tuneable lenses and tuneable transparency devices. They are based on a technology known as dielectric elastomer actuation, which is used to electrically deform either soft silicone lenses or membranes with stretch-dependent transparency. The presentation will show lenses that can be electrically deformed either radially or along selectable directions, so as to tune defocus or astigmatism, up to about 3 wavelengths. It will also show devices with an optical transmittance that can electrically be modulated within a broad range, between 25% and 83%. The possibility to electrically control the focal length, other aberrations or the transparency of thin elastomeric structures holds promise to develop highly versatile new components for adaptive optics.

Biography

Federico Carpi is an Associate Professor in Biomedical Engineering at the University of Florence. His main research interest concerns smart material-based biomedical and bioinspired mechatronic devices. From 2013 to 2017 he has served as the first President of the ‘European Society on Electromechanically Active Polymer Transducers and Artificial Muscles’. Since 2019, he is included in the ranking of the top 100,000 most influential scientists according to standardized citation metrics (source: PLoS Biology). He is an Editorial Board member of several journals, and member of the scientific committees of several conferences. His publications include around 80 articles in international journals, 3 edited books and several contributions to books and conferences.

Ultrafast Supercontinuum Generation by Ghost Pulses

Karsten Heyne
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Abstract
Ultrafast spectroscopic methods are very successful and widespread in spectroscopy. The reason for this success is the broad tunability of ultrafast laser pulses based on spectrally broad seed pulses used in non-linear processes. Starting with a short fundamental laser pulse, e.g at 1030 nm and 200 fs, focused into a non-linear material enables the generation of a supercontinuum. The underlying processes are self-phase modulation creating new frequencies red- and blue-shifted with respect to the fundamental frequency, self-focusing decreasing the focal spot in the non-linear material and thus increasing the intensity, and other higher-order effects. Properties of the supercontinuum are spectral widths greater than up to 10,000 cm-1 and stable phase properties allowing for pulse compression below 10 fs. Supercontinuum generation in the visible spectral range is typically performed in non-linear material with normal dispersion. This leads to a positive chirped supercontinuum with red-shifted frequencies at the leading edge of the fundamental pulse and blue-shifted frequencies at the trailing edge, resulting in pulse lengths longer than the fundamental pulse. The chirped pulse has to be compressed to gain ultrashort pulses.

Here, we present a method to generate a supercontinuum with a negative chirp generated in non- linear material (sapphire) with normal dispersion. We use ghost pulses, i.e. ultrafast pulses with negative intensity, imprinted on a long carrier pulse to generate negatively chirped supercontinuum pulses and use them to seed a NOPA. The output pulses of the NOPA showed self-compressed pulse length much shorter than the fundamental pulse. This new method allows to generate supercontinuum pulses with new properties not able to achieve with standard setups.

Optofluidic memory and self-induced nonlinear optical phase change for reservoir computing in silicon photonics

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Abstract

Implementing optical-based memory and utilizing it for computation on the nanoscale remains an attractive but still a challenging task. While significant progress was achieved in nanophotonics, allowing to explore nonlinear optical effects and employ light-matter interaction to realize non-conventional memory and computation capabilities, light-liquid interaction was not considered so far as a potential physical mechanism to achieve computation on nanoscale. Here, we experimentally demonstrate a self-induced phase change effect which relies on the coupling between geometry changes of thin liquid film to optical properties of photonic modes, and then employ it for neuromorphic computing. In particular, we employ optofluidic Silicon Photonics system in order to demonstrate thermocapillary-based deformation of thin liquid film capable of operating both as a nonlinear actuator and memory element, both residing at the same compact spatial region, thus realizing beyond von Neumann computational architecture. Our experimental results indicate that the magnitude of the nonlinear effect is more than one order of magnitude higher compared to the more traditional heat-based thermo-optical effect, capable to support optically-driven periodic deformation of frequencies of several kHz, and furthermore allows to implement Reservoir Computing at spatial region which is approximately five orders of magnitude smaller compared to state-of-the-art experimental liquid-based systems.

Acoustofluidic Scanning Nanoscope for Large Field-of-view Optical Imaging

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Abstract
Optical imaging with nanoscale resolution and a large field of view are highly desirable optical imaging. This talk introduces an acoustofluidic scanning nanoscope that can achieve both super-resolution and large field-of-view imaging.

Despite the widespread usage of optical microscopes in different fields, a conventional optical microscope lacks the ability to simultaneously realize high-resolution imaging while also achieving a large field of view (FOV), features which are both highly desirable in many practical applications such as nanoscale metrology[1] and bioimaging[2]. Although the ability to achieve high-resolution imaging over a large FOV can be accomplished on a conventional optical microscope by mechanically scanning the desired area through the focus of a high numerical aperture (NA) objective lens, this process requires complex mechanical manipulators and autofocusing features. Extensive work must be done to guarantee that the sample is always in focus as the stage moves, and a low speed is needed to maintain during the mechanical scan, adding to the complexity and cost of the technology and reducing the speed of analysis.

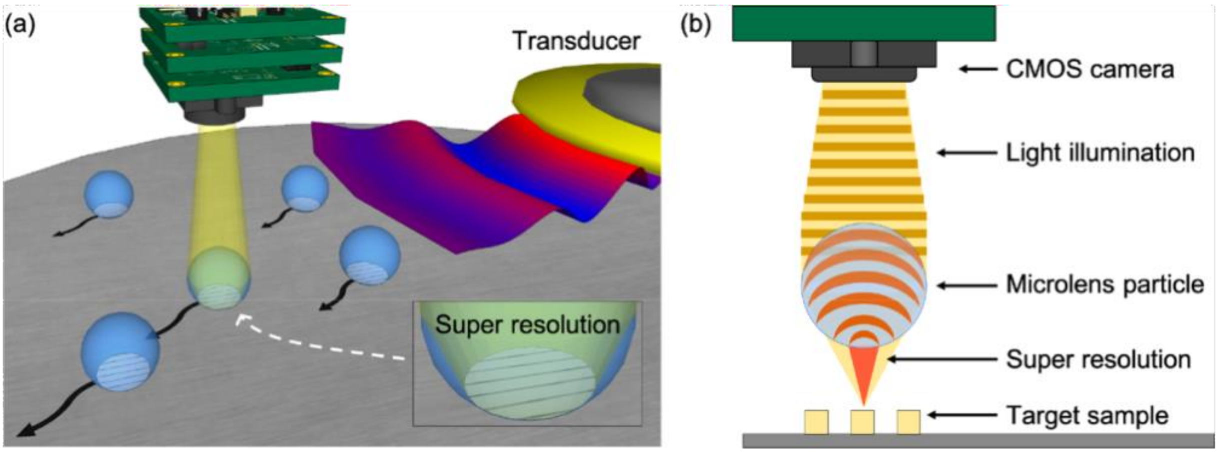
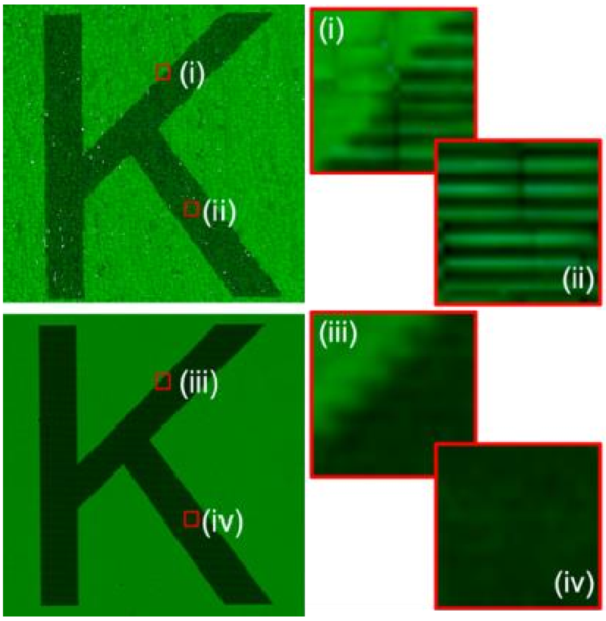


Figure 1. Schematic of the nano-imaging method. (a) Flexural acoustic waves are transmitted by the piezoelectric transducer for microparticle manipulation during the scanning process. Microparticles can achieve super-resolution effects to resolve nanometer- sized features. (b) The 2D schematic of the super-resolution effect utilized in the nanoimaging. Reprinted with permission from ref. 3. Copyright (2020) American Chemical Society.

To address these shortcomings, we introduce an acoustofluidic scanning nanoscope (AS-nanoscope), which can achieve subdiffraction-limit resolution and large FOV simultaneously. Figure 1a shows a schematic of the AS- nanoscope. Acoustofluidic technology is used to scan multiple microparticles on a sample surface. Each microparticle serves as a high-NA objective lens with a limited FOV (Figure 1b). The final large-FOV image of the sample is obtained by numerically combining the superresolution images from each particle. The AS-nanoscope has the following exceptional features: (1) super resolution and large FOV; (2) autofocusing achieved by maintaining a constant working-distance from the surface topography of the sample; (3) direct imaging without a complex phase retrieval algorithm.

Using moving microparticles, a series of nanoscale-resolution images corresponding to different positions of particles can be acquired; moving the microparticles ensures that a high-resolution image of each area within the FOV can be obtained. Stitching all of the acquired images together generates a high-resolution image over a large FOV. To experimentally demonstrate the capability of the AS-nanoscope, a target sample with the letter “K” was fabricated on a glass mask with 800 nm wide chrome grating lines and 800 nm spaces between adjacent features. A video was captured on a normal color CCD camera as the letter is imaged with moving PS-20 particles and a 10× objective. A

MATLAB image-processing tool was developed to process the images in the video and to form the final image with a high resolution and large FOV. The image-processing tool includes two parts: (1) particle



recognition and position identification; and (2) recursive image merging. First, we developed a particle recognition algorithm which includes particle locating, cropping, and pasting. Second, we designed a recursive image merging algorithm that can merge the scanned images captured through the microparticles.

Figure 2. Image processing procedure for automatic 2D scanning through acoustofluidic microparticle manipulation. Reprinted with permission from ref. 3. Copyright (2020) American Chemical Society.

The top and bottom rows of Figure 2 show the scanned images of the letter “K” based on our acoustofluidic method, and using a 10× objective in isolation, respectfully. Each image generated with the acoustofluidic method consists of 3500 image frames, which covers 99% of the imaged area. The image in the red boxes (i) and (ii) of Figure 2 provide close-ups of parts of the letter “K”. The fine detail of the letter is well resolved when using the acoustofluidic method, as opposed to boxes (iii) and (iv) which provide images from the 10× objective lens. In this experiment, the PS-20 particles in combination with the 10× objective lens (NA = 0.3, visibility of 0.682) have a resolving power similar to a 20× objective lens (NA = 0.45, visibility of 0.664) but has a much larger FOV than that of a 20× objective lens. The FOV of the AS-nanoscope is only limited by the field view of the 10× objective lens, which is 2 times larger than the 20× objective lens.

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Laser-assisted see-through technology for locating sound sources inside a solid structure

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Abstract

The underlying principles of all state-of-the-art sound source localization methodologies are built on the assumption that the line of sight between any sound source and sensor is not blocked. If this assumption does not hold true, source localization cannot be done. This restriction has necessarily limited sound sources localization in open space up to an obstacle or a boundary surface. Meanwhile, the root causes of all noise and vibration issues are housed inside a solid structure, making noise diagnosis and mitigation very challenging. In this presentation, a laser-assisted see-through technology is developed and the feasibility of using this new technology to locate sound sources inside a solid structure made of plexiglass of dimensions 64 × 64 × 64 cm3 of a thickness of 1 cm is examined. The reason for using plexiglass is to make it easy to monitor the accuracy in source location. The hardware of this see-through technology consists of six lasers to measure the normal component of the velocity on the surface of a solid structure from certain distances in a non-contact manner. Input data is then fed to SODAR (SOnic Detection And Ranging) algorithms to determine the location of a sound source inside. SODAR can be likened to radar, except it utilizes the sound waves rather than radio waves to determine the coordinates of multiple sound sources in free space simultaneously. Therefore, in essence, this laser-assisted see-through technology bypasses a solid structure to locate sound sources inside, as if the line of sight is not blocked by the solid enclosure.

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