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Ultrafast charge transfer in 2D TMDCs heterostructues

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The performance of a photovoltaic device is strongly dependent on the light harvesting properties of the absorber layer as well as the charge separation at the donor/acceptor interfaces. Atomically thin two-dimensional transition metal dichalcogenides (2-D TMDCs) exhibit strong light-matter interaction, large optical conductivity and high electron mobility, thus they can be highly promising materials for next-generation ultrathin solar cells and optoelectronics. However, the short optical absorption path inherent in such atomically thin layer limits practical applications. A heterostructure geometry comprising 2-D TMDCs and a strongly absorbing material with long electron-hole diffusion lengths such as methyl ammonium lead halide perovskites (CH3NH3PbI3) may overcome this constraint to some extent. Herein, we demonstrate that the intrinsic band offset at the CH3NH3PbI3/MX2 interface can be overcome by creating sulfur vacancies in MX2 using a mild plasma treatment; ultrafast hole transfer from CH3NH3PbI3 to MX2 occurs within 320 femtoseconds with 83% efficiency following photoexcitation. Ultrafast electron transfer from WSe2 to MoS2 takes place within 200 fs upon optical excitation with 99% charge transfer efficiency, leading to drastic PL quenching and decreasing lifetime. Our findings demonstrate that MoS2/WSe2 heterostructure can be used in ultrathin high-efficiency ultrafast optoelectronic and photovoltaic devices. Importantly, our work highlights the feasibility of applying defect-engineered 2-D TMDCs as charge-extraction layers in perovskite-based optoelectronic devices.

Keywords: **TMDCs, charge transfer, heterostructures, perovskite**

Model of Transistor Lasers with Franz-Keldysh Photon-Assisted Tunneling

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With both the high-speed characteristics of heterojunction bipolar transistors and enhanced radiative recombination of quantum wells, transistor lasers (TLs) have a great potential for high-speed optical interconnect and optoelectronic integrated circuits. In this paper we will propose a model to explain the direct-current (DC) characteristics and optical responses of the TL via Franz-Keldysh (FK) photon-assisted tunneling. The TL has unique three terminals (emitter, base, and collector) allowing us to bias each terminal voltage independently. As the TL is operated at forward-active mode, the junction between base and collector (BC junction) is reversed biased. Because of the large electric field applied in the BC junction, the photons generated from the active region will be absorbed, which is known as FK photon-assisted tunneling. In order to describe the lasing characteristics in the TL, we will discuss the effects of the FK absorption using the modified rate equations. The DC light-versus-current curves under different voltage biases have different threshold currents and slopes, which can be observed in experiment. The physics and mechanisms are described clearly in this model, including the additional electron-hole pairs generated by the FK absorption. TLs provide not only the current modulation but also direct voltage-controlled modulation scheme of optical signals via FK photon-assisted tunneling effect. In addition to DC characteristics, we use the small-signal method to analyze optical responses including current-controlled and voltage-controlled modulation of the TL.

Keywords: **Transistor Lasers, Light-emitting Transistor, Franz-Keldysh absorption, photon-assisted tunneling**

Microbeam-laser-induced coronal structure and its sensing application

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The microbeam-laser-induced transformation of coronal structure has been developed and its unique sensing application is conducted. The material used to, in this paper, demonstrates the evolution of coronal structure is zinc oxalate which was prepared by two-precursor sol-gel method by graphene and zinc oxide. Subsequently, the resultant material was canned the microbeam laser and then the coronal structure is formed. The property of gas sensing were performed for application. The coronal structure of zinc oxalate can be sensing at room temperature and optimum operable temperature of 150 oC, and able to overcome the high energy loss of conventional resistance sensor. The characteristics were examined by a field-emission electron scanning microscopy, an x-ray diffraction, and a Raman spectroscopy. The light-induced transformation and sensing capability of alpha-ZnC2O4 and beta-ZnC2O4 are also discussion. Several gas sensing tests were carried out, such as, sensing response, sensitivity, recovery, and selectivity. The strong attraction for sensing is well related to the nano-coronal structure and carbon contents.

Keywords: **coronal, zinc oxalate, deduction graphene oxide, zinc oxide, sensing**

Structured AR coatings for thin film solar cell

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The reflection loss of solar radiation for solar cells can be reduced by suitable antireflection coatings. In this talk two novel methods to fabricate structured antireflection coating will be introduced. The average reflectance of bullet structures is 1.47% in the spectral range of 300~1000 nm for incident angle at 8o. A single layer of 65-nm-thick ZnO using ALD method deposited on the surface of the structure has reduced the reflectance even further to 0.69%. The reflection of 0.58% in the spectral range of 400 ~1000 nm for incident angle of 8o by a nano-cone structure based on AAO mask lithography technique has been achieved.

Electrical and optical properties of chemically and thermally reduced graphene oxide films with large-size sheets

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We synthesize large-size graphene oxide sheets by Hummer's method with sheet size reached several-tens micrometer. We have prepared graphene oxide films on glass substrate by the spin-coating method. The graphene oxide films made of large-sized sheets were reduced, respectively, by chemical and thermal treatment to form transparent conductive films. The influence of sheets size, reduction temperature and reduction time, was examined. X-ray diffraction, scanning electron microscopy, optical microscopy, four-point probe and UV-visible spectroscopy were used to explore the possible changes in electrical and optical properties of reduced graphene oxide film with large-size sheets. The sheet resistance and the transmittance at the wavelength of 550 nm are 50 kohm*sq-1 and 60 T%, respectively.

Keywords: **large-size graphene oxide sheet, Hummer's method, reduced graphene oxide sheets**

Functional near-infrared imaging techniques for clinical applications

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Functional near-infrared spectroscopy (fNIRS) is a recently developed technology for monitoring functional brain activity based on the absorption and scattering properties of near-infrared light. fNIRS allows non-invasive measurements of the spatiotemporal characteristics of neural activity in the frontotemporal region by measuring changes in the concentrations of oxy-hemoglobin ($\Delta HbO2$), deoxy-hemoglobin (ΔHb), and total hemoglobin (ΔHbT). fNIRS has several advantages over existing imaging techniques, such as PET, SPECT, and fMRI, because it is noninvasive, is easy to administer, tolerates small movements, is inexpensive, and provides excellent time resolution and moderate spatial resolution. Although spatial resolution is limited, fNIRS offers more comprehensive information of brain activity than blood-oxygenation- level-dependent (BOLD) signal of fMRI. Furthermore, the optical method can provide completely patient-oriented measurement. The fNIRS is also applicable for psychological test because its temporal resolution is high enough to detect the changes of short duration such as the brain activation during cognitive task. In previous studies, fNIRS method has been shown to be sensitive enough for monitoring of physiological blood oxygenation changes during cognitive activation in neuro-degenerated diseases. To date, fNIRS has been applied in many studies to explore the functional integration among brain regions during different states, including resting and task states in normal people and patients with psychiatric disorder. In this talk, I will provide the background knowledge of fNIRS and its clinical applications.

Keywords: **functional near-infrared spectroscopy (fNIRS), neurophotonics, optical brain imaging, brain connectivity**

Water-splitting gas production and characteristics of CIGSO films prepared by different sputtering method

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CIGS is widely used for photovoltaic application; however, its preparation normally requires a high-temperature selenization process. A simple one-step synthesis of CIGS, needing no selenization process, by sputtering one sing target is recently developed. In our previous work, we have demonstrated that CIGSO film, containing small CIGS crystals, could be also grown by one-step synthesis and is potential to produce gas via water splitting. In this work, we are going to study water-splitting gas production and characteristics of CIGSO films prepared by different sputtering method. The films are grown onto glass substrate by either RF or DC sputtering method. Film resistivity, bang gap, CIGS crystallinity and gas production rate show strong dependences on annealing condition. After annealing at 2500C for 30 min, XRD signal related to CIGS (1 1 2), (2 0 4/2 2 0), and (3 1 2/1 1 6) crystal orientation are observed. The gas production rate is ~67.8 μmol/cm2•hour. When the annealing temperature is increased to 3500C, CIGS crystallinity is improved and the gas production rate is augmented to >100 μmol/cm2•hour. Many reports have shown that CIGS (2 0 4/2 2 0) is beneficial to enhance the property of photovoltaic device which is related to its absorption, we thus investigate the influence of sputtering power, annealing temperature, annealing time, and etc. on crystallization of the CIGS and on the water splitting gas production. Difference between CIGSO films grown by RF and DC sputtering will be demonstrated.

Keywords: **CIGS, water-splitting, sputter**

Chlorophyll-motivated Room-Temperature DNA-Catalyzed Hydrogen Oxidation Reaction (HOR)

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Hinted by the key structural features on chlorophyll in plants for photosynthesis and its derivative form -pheophytin (pheo) responsible for the catalytic decomposition of hydrogen gas, this current research aimed for similarly suggestive clues within generic DNA's of all living beings on earth. Verified by the 1st-principle quantum mechanical simulations and subsequent wet and dry hydrogen fuel cell experiments, the feasibility of room-temperature DNA-catalyzed hydrogen oxidation reaction (HOR) was unambiguously evidenced. In other words, very low-cost DNA-catalyzed fuel cells, containing no platinum on the negative electrode side, can be put to work under room condition and thus might be easily available in every household in the very near future.

Keywords: **Pheophytin, DNA, Catalyst, Hydrogen oxidation reaction**

A Suspected Derivative Morphology for Pheophytin and the Possible Proton Conductive Path It Provides

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Both chlorophyll and its derivative form -- pheophytin are profoundly involved in the photosynthesis reaction. A new derivative morphology of pheophytin was proposed and supported by the photo-spectral comparison and experimental verification. In short, when in the presence of an entering hydrogen gas molecule (or a proton pair, after their electrons were stripped by external means), a lower-energy structure of pheophytin existed wherein each nitrogen atom on its porphyrin ring was saturated with the N–H bond. That is, the originally two double bonds associated with the two N atoms became single bonds, and all adjacent carbon atoms became carrying formal charge of +1 and thus possessing only three bonds. Such a lower-energy structure was found to constitute a general purpose proton traverse path, especially in a pheophytin-catalyzed hydrogen decomposition process.

Keywords: **Photosynthesis, Catalysis, Porphyrin ring, Proton transport, Derivative morphology of pheophytin**

Properties of ITO Films on Cholesteric Liquid Crystal Layer by Two-step DC Magnetron Sputtering

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Indium tin oxide (ITO) films were deposited at room temperature by DC magnetron sputtering and grown on a cholesteric liquid crystal (Ch-LC) layer. The surface morphology and electrical properties of ITO thin films were analyzed using a scanning electron microscope, an X-ray diffraction, a 3-dimensional microscope, and a four-point probe. In a systematic study, the electrical properties of ITO films were improved using a two-step deposition process and the sheet resistance decreased from 165 to 100 ohm/sq. The surface roughness of ITO films deposited on Ch-LC layers was improved as well and a smooth surface roughness of 0.6 um was obtained.

Keywords: **Cholesteric liquid crystal (Ch-LC), Sputtering, Indium tin oxide (ITO)**

Atmospheric Pressure Plasma Jet Processed Nanomaterials for Electrochemical Solar Cell and Supercapacitor Applications

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Screen-printed nanomaterials featured with high specific surface area are desirable in electrochemical solar cell and supercapacitor applications. To fabricate these screen-printed nanomaterials usually involves high-temperature furnace calcination processes with long duration. In this study, an ultrashort process was developed to lower the thermal budget for the fabrication of photoanodes and counter electrodes in dye-sensitized solar cells (DSSCs) and nanocomposite electrodes in supercapacitors by using an atmospheric pressure plasma jet (APPJ) technology. To determine the endpoint of the APPJ treatment, optical emission spectroscopy analysis was carried out during the process. For DSSC photoanode fabrication, APPJ treatments as short as 1 to 2 min were successfully used to sinter the nanoporous TiO2 layer, to simultaneously deposit particulate TiO2 scattering layer, and to produce a dual-scale porous TiO2 layer from a mixture of TiO2 nanoparticle paste and NaCl solution. For catalytic counter electrode fabrication, APPJ processes with treatment durations of 1 min, 11 sec, 5 sec have been applied to facilitate the formation of Pt nanoparticles, reduced graphene oxide (rGO) foams, and carbon nanotube (CNT)/TiO2 composites, respectively. For supercapacitor applications, the required APPJ processing duration were merely 5 and 15 sec for the Fe2O3/CNT composite and rGO on carbon cloth, respectively. In particular, enhancement of catalytic activities of carbon-based nanomaterials via morphology modification was observed. This new methodology provides a facile approach for the fast production of electrochemical solar cell and supercapacitor applications.

Keywords: **Solar cell, Supercapacitor, Atmospheric Pressure Plasma Jet**

Spatial Nonuniformity in exfoliated WS2 Monolayers

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The boundaries of 2D Transition Metal Dichalcogenide (TMDs) crystals are reported to be non-atomically sharp and extremely susceptible to their environment, affecting not only the optical but also their transport properties. Therefore, the edge-dependence of the TMDs' electronic properties, as well as the strain characteristics of the TMDs' edges are yet to be explored.

Here we report on the extraordinary strain and photoluminescence (PL) properties, not only of the physical but also of intentionally created via femtosecond laser ablation, boundaries of mechanically exfoliated WS2 monolayers. In particular, it is shown that the edges of such monolayers exhibit significant Raman shifts as well as remarkably increased PL efficiency compared to their respective central area. The observed strain varies among the different edges of an individual monolayer and can be inhomogeneous, depending on the mechanical history of the edges during exfoliation (Fig.1). Moreover, there is a 3-fold enhancement of the PL intensity at the edges compared to the monolayer center (Fig.2), with the emission channels being of different origin. Finally, the relation of the observed properties with the chemical nature of the edges is analyzed via Scanning Auger Microscopy (SAM) with high spatial and analysis-depth resolution and discussed accordingly. We envisage that these novel findings could find diverse applications in the development of TMDs-based optoelectronic devices.

Keywords: **Photoluminescence, Raman, exfoliated WS2, edges, inner regions, variations, charged excitons, neutral excitons, inhomogeneous strain, femtosecond patterning**

Insights into the excitations of solids from Resonant Inelastic X-ray Scattering

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Resonant Inelastic X-ray Scattering (RIXS) has made tremendous progress with the advent high-brilliance synchrotron X-ray sources. This spectroscopic technique in principle provides direct access to the elementary charge, spin and orbital excitations of materials. From the theoretical perspective the fundamental question is to precisely which low-energy correlation functions RIXS is sensitive. Depending on the experimental RIXS setup, the measured charge dynamics can include charge-transfer, phonon, d-d and orbital excitations [1]. The focus of this talk will be on RIXS as a probe of spin dynamics and superconducting gap of high-Tc cuprates [2-4] and the combined magnetic and orbital modes in strongly spin-orbit coupled iridium-oxides [5-7].

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Nanophotonic perovskite-TiO2 nanodendrite solar cells

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Nanophotonic perovskite-TiO2 nanodendrite (ND) solar cells, which active layer is composed of MAPbI3 scaffolded by a quasi-single-crystalline TiO2 ND array, have been fabricated in this work. Compared to the perovskite-TiO2 nanorod (NR) solar cell, the enhancement of PCE through improved controls of both electron collection and light propagation has been achieved in the perovskite-TiO2 ND solar cell. Finite difference time domain simulation results indicate that the ND in the MAPbI3 matrix exhibits superior light trapping performance compared to the NR. Moreover, the branches developed from the trunks of the NDs will extract the photoelectrons from MAPbI3 to reduce the electron transport length in the MAPbI3 matrix. Therefore, the TiO2 ND array in the active layer not only performs as efficient electron collector but also induces significant light trapping in the perovskite solar cells due to the three dimensional configuration. Compared to the MAPbI3-TiO2 NR solar cell, the 18% and 25% enhancements in the average Jsc and PCE are respectively attained in the MAPbI3-TiO2 ND solar cells.

Keywords: **Perovskite solar cell, Nanophotonic structure, Three-dimensional nanostructured array, Light trapping, Electron collection**

Voltage Reduction and Lifetime Elongation of Blue Organic Light-emitting Device with Triplet-triplet annihilation Host

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Efficiency improvement and lifetime elongation of blue light generation is one of key bottlenecks of organic light-emitting diode (OLED) for display and lighting applications. Although commercial phosphorescent materials have been applied to green and red OLEDs with satisfactory efficiency and lifetime, devices with blue phosphors exhibited lower efficiency and (much) lower lifetime. Instead, triplet-triplet annihilation (TTA-) based material is commercially used for the blue OLED.

In this talk, we investigated the possibility to transfer the energy from an exciplex with yellow emission to a TTA blue host, which reduced the driving voltage of a blue TTA-OLED. The blue emission was observed as low as 2.3 V, which was even lower than the blue photon energy (~450 nm, corresponding to ~2.8 eV). The second part of this talk was about the lifetime extension of a TTA-OLED. With suitable design the emitting layer, ~2x operation lifetime was achieved due to the recombination zone broadening and diffusion length increase.

Keywords: **Organic light-emitting diode (OLED), efficiency, lifetime**

Interactions of Photons and Phonons(Light with phonons): Raman Scattering, Laser cooling and Biosensing

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Here I will report the interaction of light with maters, especially with phonons. I will show three examples including: 1) Raman scattering in 2D layer materials. I will show how to use Raman scattering to detect the phonon vibration in 2D materials from bulk to monolayer scale such as interlayer and intralyer vibration in topological insulator、graphene and non-graphene 2D crystals. 2) Laser cooling in semiconductors, i.e. how to use photon to remove the heat (phonon) from materials. By using of strong coupling between excitons and longitudinal optical phonons (LOPs), we not only can cool the whole semiconductor sample from room temperature by 40 Kelvin, but also can selectively cool one specific LO phonon down to quantum ground state. 3) Plasmonic based biosensing. In this part I will show how to use surface enhanced Raman spectroscopy to sensitively detect bio-molecules. It includes our several recent achievements in the development of LSPR nanosensors based on colorimetry, single and arrayed nanoparticle spectroscopy for the detections of several cancer biomarkers.

Keywords: **2D materials, Raman scattering, Laser cooling, Biosensing**

Piezopotential-Induced Schottky Behavior of Zn1-xSnO3 Nanowire Arrays and Piezophotocatalytic Applications

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The piezotronic- and piezophototronic-effect-enhanced photocatalysis (piezophotocatalysis) of Zn1-xSnO3 (ZTO) nanowires fabricated through a two-step hydrothermal reaction will be presented in this talk. The highlights include 1) tailoring hydrothermal synthesis parameters to obtain well-aligned LN-type single-crystalline ZTO nanowire arrays; 2) exploring the piezopotential-driven piezotronic and piezophototronic effects of ZTO nanowires; 3) identifying Schottky barrier height variations; and 4) exploiting synergistic piezophotocatalysis for decomposing methylene blue (MB). Transmission electron microscopy, electron probe energy-dispersive spectroscopy, and X-ray photoelectron spectroscopy analyses reveal highly crystalline Zn-deficient ZTO nanowires. The band gap is estimated to be approximately 3.8 eV. The ZTO nanowires exhibit piezopotential-modulated piezotronic and piezophototronic effects. The corresponding Schottky barrier height variation is calculated using thermionic emission-diffusion theory. The calculated photodegradation rate constant k of the sample, under pressure from ultrasonic vibration and a piece of glass, is approximately 1.5 x 10-2 min-1, approximately four times higher than that of ZTO nanowires in the absence of stress. The observed synergistic piezophotocatalysis is attributed to 1) band bending of ZTO nanowires; 2) application of alternating ultrasonic vibration; 3) MB mass transfer enhancement; and 4) abundant active reaction sites generated from ZTO nanowire surface sweeping.

Luminescent Properties of Long Persistent Zirconium Compound Phosphors and the Local Structure of Zr

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A small portion of phosphors have long fluorescence lifetime. These long persistent phosphors show weak luminescence after removing the excitation source. Basically, these materials are composed of a host crystal and admixture dual lanthanide ions. The lanthanide ion, e.g., Nd3+ and Eu2+, plays an efficient role as luminescent center and the other ion, e.g., Dy3+, cause the formation of metastable trap center. However, behavior of the metastable state is poorly understood yet. Clarification of these issues are quite important for improvement of brightness and lifetime. Y. Cong et al. [J. Electrochem. Soc. (2008)] reported the monoclinic ZrO2 without any lanthanide-doping shows the blue-green fluorescence and long persistent luminescence at room temperature. It is supposed that the metastable state at long persistent phosphors exist in the host crystal structure. In this study, we synthesized some zirconium compounds and analyzed the crystal structures by a powder X-ray diffraction (XRD) analysis using Cu Ka radiation. We carefully investigated the spectroscopic features in order to clarify the origin of luminescent properties. The experimental result at thermoluminescent (TL) measurement shows existence of at least two types of metastable state, the one is active at room temperature, the other is more stable. From these result, we suggested that the coordination environment of Zr greatly influence the properties of persistent luminescence. We discuss relations between local structure of Zr and luminescent properties for development of new high-brightness persistent phosphors.

Keywords: **long persistent phosphors (LPP), long lasting phosphors (LLP), Afterglow, ZrO2, Fluorescence, Photoluminescence (PL), Thermo-luminescence (TL)**

Material and System Development for Biophotonics in the OTN-NIR (NIR II/III)

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Material and System Development for Biophotonics in the OTN-NIR (NIR II/III)

The wavelength over-1000-nm (OTN) in the near infrared (NIR) range is attracting interests of researchers from biomedical filed since the observation depth can be expected to be ten times deeper (several cm) compared to the conventional one under 1000 nm. Some other expressions for the same range is the second/third biological windows or NIR II/III. The reason of the low loss is the decrease of the scattering loss which causes not only the loss but blurring of the image. From 1000 nm up to 1800 nm, one can expect much more transparent optical propagation in biological tissues. The authors have developed fluorescent probes for the OTN-NIR fluorescence bioimaging, as well as developed the imaging system for the OTN-NIR biophotonics. This presentation will review whole materials and systems development in the past decade.

Keywords: **bioimaging, OTN-NIR, animal imaging, nanothermometry**

Active fiber devices enabled by graphene's photothermal effect

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Active all-in-fiber devices, including phase shifter, switching and tuned-fiber Bragg grating (FBG), are crucial for fiber technologies. Various active fiber devices have been developed based on mechanical deformation, acousto- and electro-optic effects. Compared with these techniques, all-optical method is advantageous because of simple implementation, low cost, and remote. Nonlinear processes in fibers or doped fibers have been employed to achieve all-optically controlled devices. However, these techniques were limited by either high-power requirement or complicated device fabrication. Here, we report an alternative method by integrating microfibers with graphene film, which promises optically controlled phase shifter and FBGs relying on graphene's photothermal effect. We pulled a standard telecom single-mode fiber into a 10 μm thick microfiber by flame heating and wrapped the tapered rigon with a CVD graphene film using a wetting transfer technique. To examine the thermally induced phase change, we established a Mach-Zehnder interferometer (MZI) by inserting the GMF in one arm. By tuning the signal light from 1550 nm to 1551 nm with a step of 0.002 nm, we measured the MZI output with different powers of the 980 nm pump. From the shifts of the interference fringe of the MZI output, we obtained the phase shifts induced by the pump light. With the incident pump power increased to 230 mW, we achieved a phase change exceeding 21π with a nearly linear slop of 0.091π/mW. By integrating graphene over an etched micro fiber Bragg grating (FBG), we also achieved effectively controlling of FBG using a the photothermal effect, which promise an optical bistability in the micro-FBG. These graphene-controlled microfiber devices with all-optical operation, ease of fabrication, moderately fast response, and low-power consumption may find applications in signal processing, fiber laser, and sensing.

Silicon Waveguide Bragg Gratings for Optical Filtering and Delay

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Silicon-based integrated waveguide Bragg gratings are compact structures and have been widely studied and employed in various devices, such as optical filters, optical delay lines, wavelength division multiplexers, polarization beam splitters and optical sensors. We review our recent work on Bragg gratings made of strip silicon waveguides. The stopband spectrum of a Bragg grating is dependent on the grating structure design. Various gratings including apodized, chirped, and spiral-shaped designs will be discussed with particular emphases on their effects on the optical signal filtering and delay applications. As the Bragg grating period is very short for a regular silicon waveguide with a core thickness of 220 nm, it is quite challenging to fabricate the device with predictable performances. We propose to use 60-nm-thick silicon waveguides to make the grating structures. The ultra-thin waveguide processes a fundamental mode with much lower optical confinement in the waveguide core. A small coupling coefficient thus can be achieved using relatively large corrugations on the strip waveguide sidewalls. As the mode of the ultra-thin waveguide interacts weakly with the sidewalls, the waveguide is less sensitive to the sidewall roughness. The gratings in the ultra-thin waveguides can be patterned using 248-nm DUV photolithography with lower fabrication cost than e-beam lithography. A spiral-shape is used to wrap the grating into a small area so as to reduce the height variation. A single narrow transparent peak with a Q-factor of 1e5 is observed in the grating stopband, induced by the phase shift of the S-junction at the spiral center.

Keywords: **Silicon photonics, Optical filter, Optical delay line, Bragg grating**

Formation of Zinc Oxide Nanostructures by Wet Oxidation of Vacuum Deposited Zn Thin Film

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ZnO nanostructures, such as nanorods, nanotubes, and nanolotus, were formed by oxidation of vacuum deposited Zn hexagonal platelets in hot water. The Zn layer was initially deposited on an ITO/glass substrate with a top ZnO seed layer, comprising of ZnO nanoparticles having diameters of 20 – 30 nm. The Zn thin film was then immersed in water at 90 C for 6 – 24 h. Pointed ZnO nanorods with mean diameter of about 150 nm were grown after wet oxidation for 6 h. The ZnO nanorods grew in length after prolonged oxidation of 16 h. Interestingly, nanotubes were also present, together with the nanorods, in some areas of the substrates. These tubes possibly evolved from the dissolution of the nanorods. Lastly, lotus-like structures were formed after oxidation for 24 h. The ZnO nanolotus film appears transparent to visible light with a transmittance of about 85 %. XRD analysis shows that the ZnO nanolotus film has a wurtzite structure. A hybrid solar cell was fabricated incorporating the ZnO nanolotus. The photovoltaic performance of the device has power conversion efficiency (PCE) of 1.06 % for the open circuit voltage (Voc) of 0.45 V, the short circuit current density (Jsc) of 5.77 mA/cm2 and a fill factor (FF) of 40.4 %

Keywords: **ZnO Nanostructures, Wet Oxidation, Hybrid Solar Cell**

One-Pot Fabrication of Functionalized Graphene Inks by Soft Processing under Ambient Pressure and Temperature

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Different forms of carbon prepared from diverse syntyetic routs are currently being used in various fields of research including energetical, environmental, electrical, chemical, and biomedical application. In general, carbon based materials like graphene, carbon nanotube, carbon nitride, diamond like carbon etc. are prepared from gaseous precursors such as CVD, PVD and ion-assisted sputtering techniques [1]. We believe that the large scale synthesis of nanostructured carbon should be free from using excess energy for firing, sintering, melting and expensive equipment. We, propose herewith “Submerged Liquid Plasma (SLP)” technique for direct formation of functionalized Graphenes at ambient conditions. The SLP process provides number of advantages which includes (a) simple reaction set up (b) reaction can be carried out at ambient conditions (c) periodic collection of samples gives clear information about the product (d) simple procedure and less operating cost.

In the present study, we utilized SLP technique for the direct synthesis of Nitrogen functionalized Graphene Nano sheets from Graphene suspension and/or Graphite electrode in acetonitrile liquids.[1,2] Products contains few layers (< 5) Graphene nanosheets. Under SLP, unsaturated or high energy functional group (e.g. C＝C, C＝N and C≡N) have formed in the products. We could confirm those functionalized Graphenes are electrochemically active. Using pencil rods instead of Graphite rods we have also succeeded to prepare the Nano-clay/Graphene hybrids by this SLP methods [3]. Reduction and functionalization of Graphene oxides also realized by SLP[2]. It should be noted that SLP can directly produce “Graphene Ink”;Graphenes dispersed in various liquids, under mild conditions.. Soft

Processing:Low temperature and/or direct production of Functionalized Graphenes by SLP process will open up new possibilities for the development of functionalized/hybrid nanostructured carbon materials for various applications[4] including Li-Batteries, Supercapacitors, Solar-Cell ,Conducting Electrodes and Catalysts areas.

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Room Temperature Planar Spiral Metal-Gallium-Nitride Nanowire UV Laser with High Circular Dichroism

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Circularly polarized light and chiroptical effect have received considerable attention in advanced photonic and electronic technologies including optical spintronics, quantum-based optical information processing and communication, and high-efficiency liquid crystal display backlights. Moreover, the development of circularly polarized photon sources has played a major role in circular dichroism (CD) spectroscopy, which is important for analyses of optically active molecules, chiral synthesis in biology and chemistry, and ultrafast magnetization control. However, the conventional collocation of light-emitting devices and additional circular-polarization converters that produce circularly polarized beams makes the setup bulky and hardly compatible with nanophotonic devices in ultrasmall scales. In fact, the direct generation of circularly polarized photons may simplify the system integration, compact the setup, lower the cost of external components, and perhaps enhance the power efficiency. In this work, with the spiral-type metal-gallium nitride (GaN) nanowire cavity, we demonstrated an ultrasmall semiconductor laser capable of

emitting circularly-polarized photons. The left- and right-hand spiral metal nanowire cavities with varied periods were designed at ultraviolet wavelengths to achieve the high quality factor circular dichroism metastructures. The dissymmetry factors characterizing the degrees of circular polarizations of the left- and right-hand chiral lasers were 1.4 and −1.6 (+-2 if perfectly circular polarized), respectively. The results show that the chiral cavities with only 5 spiral periods can achieve lasing signals with decently high degrees of circular polarizations.

Keywords: **GaN, Plasmonic laser, Circular dichroism**

Control over photosynthetic energy transfer by rearrangements of its basic building blocks

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Primary photosynthetic events are an excellent experimental filed for studying effects at the quantum/classical border. In recent years we a number of systems which show a potential for such processes.

For example, desert sand crust cyanobacteria that can completely desiccate and then resume functional photosynthesis within seconds after rehydration. Biological desert sand crusts are the foundation of desert ecosystems, stabilizing the sands and allowing colonization by higher order organisms. Facing the harsh conditions of the desert, these organisms must withstand frequent desiccation–hydration cycles, combined with high light intensities. We characterized structural and functional modifications to the photosynthetic apparatus that enable a cyanobacterium to thrive under these conditions.

Using multiple in vivo spectroscopic and imaging techniques, we identified two complementary mechanisms for dissipating absorbed energy in the desiccated state. The first mechanism involves the reorganization of the phycobilisome antenna system, increasing excitonic coupling between antenna components. This provides better energy dissipation in the antenna rather than directed exciton transfer to the reaction center. The second mechanism is driven by constriction of the thylakoid lumen which limits electron transfer from plastocyanin to P700. These protection mechanisms employ existing components of the photosynthetic apparatus, forming two distinct functional modes.

Small changes in the structure of the photosynthetic apparatus are sufficient for quenching of all absorbed energy in the desiccated state, protecting the photosynthetic apparatus from photoinhibitory damage. These changes can be easily reversed upon rehydration, returning the system to its high photosynthetic quantum efficiency.

Keywords: **Photosynthesis, Light Harvesting, Biology**

New photonics devices; construction of polymer-arrayed waveguides on upconversion luminescence layers for application to photon matrix devices.

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We demonstrate fabrication technique arrayed waveguide gratings on upconversion luminescent layers for a new photonics devices operated with photon matrix modes. Rare-earth-ion-doped (Er, Ho, Yb) ceramic (Y2O3, NaYF4) nanoparticles are synthesized by photon upconversion luminescent materials which can convert two photon of near-infrared to single photon of visible light. Transparent films consisting of high refractive index and low refractive index polymers on the upconversion luminescent ceramic nanoparticle films exhibit mechanical flexibility and high transparence by 90 % in visible region. Patterning technique of upconversion luminescent ceramic films are studied by calcination-free technique using photolithography, and soft lithography because conventional fabrication techniques of upcnversion luminescent layers require calcination process at more than 500 C, leading to the difficulty of upconversion luminescent layers on flexible plastic sheets. Polymer-based arrayed waveguide gratings are fabricated on the patterned two frequency photon upconvernsion luminescent nanoparticle films by soft lithography to operate visible upconversion luminescence on photon matrix mode. This devices enable for the upconversion luminescence at 550 nm on the cross points of 850 nm-waveguides and 1500-nm waveguides which serves as photon matrix devices, leading to operation of transparent displays without mirrors, transparent electrodes, and electric circuits.

Keywords: **Upcnversion luminescence, rare-earth-ion-doped nanoparticle, polymer-arrayed waveguide, soft lithography, photon matrix**

New Design of A Low-cost Micro Machine Tool with the High-precision Variable-resolution Mechanism

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Due to the manufacturing requirement of miniature high-tech products, micro machining using a micro machine tool and the application of micro-desk-factory have been recognized as important technologies for modern industry. A low cost micro machine tool with more friendly functions can facilitate the practical implementation of micro machining for industry. Thus, the main goal of this study is to design a low-cost and high-precision micro machine tool which can perform high-resolution and high-accuracy machining without use of expensive drive components and a high-end CNC controller. The machine can also provide adjustable feed resolution and works range for different micro machining application. New configuration design, structure design/analysis, development of kinematics equations, prototype development, and sensitivity error analysis were made in this study. Finally, verification experiments were conducted, and the results showed that the machine can provide micro machining with positioning accuracy of 400 nm.

Keywords: **Micro machine tool, Micro machining, Structure optimization,Structure analysis, Error analysis**

Development of Blue-green InGaN/GaN Vertical Surface Emitting Lasers with Metal-cavity

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The main purpose of this talk is to investigate metal-assisted blue-green GaN-based vertical surface emitting lasers (VCSELs). On account of the small gain volume of VCSELs, it was essential to confine the optical-field intensity as much as possible in the quantum wells in order to achieve maximum modal gain. The optical confinement factor was crucial for the resonant cavity to decide the capability of optical property. Simulation of wave guiding for optimum optical confinement told us the required scales of device to attain the threshold condition. The COMSOL software was chosen for calculating the optical properties including optical confinement factor, optical quality factor of cavity and correspondent patterns of electric fields. We also fabricated metal-cavity blue-green GaN-based VCSELs and got lasing spectrum by optical pumping. With the experimental results, it is proved the blue-green GaN-based VCSELs is feasible with employing metal-cavity.

Keywords: **vertical cavity surface emitting laser (VCSEL), metal cavity, blue-green laser**

Observation of Optical Birefringence in the Thin Film of Polymer

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Optical birefringence is the numerical difference between the maximum and minimum principal refractive indices. Due to the different of refractive indices, the two components of light travel through the sample at different velocities and therefore exit with a path difference or retardation, resulting spherulites with positive or negative birefringence. The formation of weak and strong birefringence has been discussed in this study by using poly(L-lactid acid) (PLLA) as example. It has been found that the influencing factors for the formation of weak and strong birefringence of concentric ring-banded spherulites are film thickness and lamellar arrangement/pattern. Instead of those factors, the optical birefringence of spherulite is also affected by lamellar orientation as can be observed in the blend system of PLLA/poly(1,4-butylene adipate) (PLLA/PBA) and PLLA/poly(*p*-vinyl phenol) (PLLA/PVPh).

Keywords: birefringence, lamellar, PLLA, PBA, PVPh, spherulites.

Laser Engineering and Diagnostics of Materials at the Micro- and Nano- Scales

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This presentation will review our recent work on the laser micro/ nano processing and diagnostics of materials, placing emphasis at electronics and tissue engineering applications. In particular, rapid and facile methodologies for the photochemical synthesis, functionalization and doping of 2D nanosheets (NSs), as well as its diagnostics, will be demonstrated and discussed. The application of laser fabricated materials in all the three major components of organic photovoltaic devices, i.e. in transparent electrodes, photoactive layer and interfacial (buffer) layers is demonstrated and discussed. The second part of the presentation will review our recent progress on the laser-based biomimetic modification of conductive materials for neural tissue engineering applications. We show that the laser textured materials obtained comprise dual scale quasiperiodic structures at the micro- and nano- length scales that better simulate the morphology of the extracellular matrix. It is shown that the geometrical characteristics of the structured surfaces alone could drive the directional outgrowth of neurons, glial cells as well as complex cell cultures of the peripheral nervous system. This distinct inherent property of the microstructures to direct cell outgrowth, combined with the conductance of the material, could potentially be useful for patterning neurons into artificial networks, as well as for the development of microchip-based devices that can electrically interface neuronal networks of defined directional topologies.

Keywords: **Laser processing, two-dimensional materials, Organic Electronics, Tissue engineering**

Effect of annealing temperature on the optoelectronic characteristic of Al and Ga co-doping on ZnO thin film

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In this study, it investigates the optical and electronic properties of Al and Ga co-doped on ZnO thin films on glass substrates by using radio frequency magnetron sputtering(RF-sputtering). The structural, electric and optical characteristics of AGZO thin films with various deposition parameters are investigated. All films illustrate strong (002) for AGZO preferential orientation by using XRD analysis. The results show that the average transmittance of AGZO thin films are about 85% for all thin films in the visible light field. Moreover, the resistivity of AGZO is 3.5×10-3 Ω-cm and Hall mobility of 25 cm2/Vs for the process parameter of 3 torr bias, deposition time of 80 min and 100W.

Keywords: **Aluminum, Gallium doped ZnO, RF sputtering, optical and electronic property**

High temperature operated surface plasmon polariton nanolasers

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Nanolasers with ultra-compact footprint can provide high intensity coherent light, which can have various potential applications in high capacity signal processing, biosensing, and sub-wavelength imaging. Among various nanolasers, those lasers with cavities surrounded with metals have shown to have superior light emission properties due to the surface plasmon effect providing better field confinement capability and allowing exotic light-matter interaction. In this talk, we report robust ultraviolet ZnO nanolaser by using silver (Ag) and aluminum (Al) to strongly shrink the mode volume. The nanolasers operated at room temperature and even high temperature (353K) shows several distinct features including an extremely small mode volume, large Purcell factor and group index. Comparison of characteristics between Ag- and Al-based will also be made.

Keywords: **Surface plasmon polariton (SPP), Nanolasers, ZnO, Ag, Al**

High Efficiency Blue Phosphorescent Organic Light-emitting Diode using a Novel Host o-DiCbzBz

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A high efficiency blue phosphorescent organic light-emitting diodes (OLED) using a novel bipolar host (o-DiCbzBz) [1,2] doped with blue emitter FIrpic as the emitting layer to achieve ultrahigh external quantum efficiency over 30%. By well optimizing the doping ratio among o-DiCbzBz and FIrpic, and designing the device structure to balance carrier in the emitting layer, a ultrahigh efficiency blue OLED could be obtained with a peak current efficiency 61.8 cd/A, a peak power efficiency 53.8 lm/W, and a peak external quantum efficiency over 30.4%.

Keywords: **phosphorescent organic light-emitting diode**

Scale-up Synthesis and Applications of Erbium-doped Lanthanum Oxyhalide Nanophosphors

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Er3+-doped ceramic nanophosphors exhibit visible emission under near infrared excitation (upconversion emission). The unique phenomenon potentially enhances the performance of security printings and fluorescence bio-imaging. It is, however, essential to develop mass synthesis of ceramic nanophosphors with controlled compositions and particle sizes. Here, we demonstrate a low-cost and high-speed synthesis of Er3+-doped LnOX-type (Ln: lanthanoid, X: halogen) ceramic nanophosphors. First we prepare an aqueous solution of Er3+-doped LaCl3 where ~0.05 to 10 mol% of La3+ ions are replaced with Er3+ ions. The solution is spray-dried at 200℃ to produce micro powder of Er3+-doped LaCl3･7H2O. Next the micro powder is heated at 400 to 800℃ in a N2 atmosphere. The surface of particles loses crystal water to form anhydrous shell. Meanwhile, a portion of inner crystal water reacts with chlorides to form nanometer-sized oxychloride (LaOCl:Er3+) cores. The agglomeration of cores is prevented because they are spatially separated by shells. Since the shell is hygroscopic, the cores are easily extracted in water. The mean size of obtained LaOCl:Er3+ nanoparticles is controlled from ~50 nm to submicron by changing the heating temperature in N2. The emission radiation of prepared phosphors was visible to the naked eye when excited by 5 mW of 980 nm laser diode. The emission wavelength and intensity are finely tuned by the host composition, which is of great advantage to security printings. The high-speed drying contributes to controlled dispersion of Er3+ ions in a host matrix preventing segregation. The synthesis technique combines the merits of rapid powder synthesis using spray drying and the simple synthesis of nanoparticles using core-shell method.

Keywords: **Rare-earth-doped ceramic nanophosphor, Upconversion emission, Spray drying, Core-shell method, Scale-up synthesis**

Photoluminescence Materials and Applications

Toshiya Okazaki

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A novel procedure for effective synthesis of covalently oxygen-doped single-walled carbon nanotubes (SWCNTs) has been developed. The SWCNT thin film is directly irradiated by UV light and oxygen atoms substitute into the tube wall via the produced ozone molecules. The photoluminescence spectroscopy studies reveal that the obtained SWCNTs exhibit the characteristic spectroscopic features of epoxide-type oxygen-doped SWCNTs. Advantageously, the emission peak of the doped (6, 5) SWCNTs is centered at around 1300 nm, which is most transparent region of biomaterials. We demonstrate immunoassay, fluorescence vascular angiography and observation of the motion of organs of a mouse by using the produced oxygen-doped SWCNTs as infrared fluorescent labels and imaging agents.

Keywords: **carbon nanotubes, near infrared, fluorescent agents**

Stacking Plasmonic Resonators for Enhanced Spontaneous Emission of Semiconductor Quantum Dots

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The plasmonic nano-resonators array exhibits strong optical field confinement from the interactions between the constituent nanostructures and the surrounding materials. Different plasmonic nanostructures can be artificially engineered to support the couplings at different resonant frequencies, providing the opportunity to compensate the losses with gain in plasmonic nanosystems and further employing in promising applications such as the compact nano-lasers, lasing spasers and miniature light-emitting devices. Among the tremendous research efforts conducted recently, various plasmonic resonators hybridized with active materials have been proposed, leading to the great photoluminescence enhancement and flexible control of the PL properties. In this paper, we investigate the PL emission enhancement from semiconductor quantum dots (QDs) accompanied with stacking metallic asymmetric split-rings (ASR) nanostructures. The hybrid nanosystem can be employed to achieve a multifold intensity increase in the photoluminescence performance. The luminescence enhancement results from the in-turn interactions of exciton-plasmon couplings and can be controlled by controlling spacing distance with the dielectric layer thickness. Therefore, the interactions between the ASR meta-molecules in the longitudinal direction may be modified, giving the enhanced optical properties at different resonant frequencies.

Keywords: **plasmonic hybridization, asymmetric split-ring, quantum dots**

Tunable nanoblock lasers and stretching sensors

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Reconfigurable, reliable, and robust nanolasers with wavelengths tunable in the telecommunications bands are currently being sought after for use as flexible light sources in photonic integrated circuits. In this report, we propose and demonstrate nanolasers based on 1D nanoblocks embedded within stretchable polydimethylsiloxane. In addition to small device footprint and lasing with a low threshold of 260 μW, the large wavelength tunability of 7.65 nm/% via stretching also shows the potential of this design to serve as a tunable nanolaser. Most importantly, via repeating stretching/relaxing tests, our demonstrated nanoblock laser shows reconfigurable and reliable wavelength tuning operation. In addition, by applying excessive stretching, wide wavelength tuning over a range of 80 nm (spanning the S, C, and L telecommunications bands) is successfully demonstrated. On the other hand, as a stretching sensor, an enhanced wavelength response to stretching of 9.9 nm/% is obtained via signal differential from two nanoblock lasers positioned perpendicular to each other. The minimum detectable stretching is as small as 0.056 %. We believe our presented nanoblock lasers can provide new scenario in reliable tunable light sources in telecommunications and highly sensitive environmental/structural monitoring applications.

Keywords: **Photonic crystal, Nanocavity, Nanolaser, Stretching sensor**

Tunble lasing action via morphological control of solution-processed lead-halide perovskites

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Solution-processed organometal halide perovskites are fascinating for their remarkable photo-conversion efficiency and the abilities to enable the cost-effective, versatile and large-scale manufacturing of optoelectronics devices. Meanwhile, recent studies have shown that the photoluminescence (PL) quantum efficiencies exceed 70% and the lasing behavior in hybrid perovskite films exhibits an emission wavelength tunability at different halide compositions. In this paper, we demonstrate that lead-halide perovskite nanocrystals can be simply synthesized and manipulated by changing the solution concentrations in a two-step sequential deposition process, achieving the feasible manipulation of the extonic properties and the lasing performance. Furthermore, we found that the efficient stimulated emission may originate from the multiple random scattering provided by the micro-meter scale rugged morphology and polycrystalline grain boundaries. Compared to the conventional lasers normally served as a coherent light source, the randomly distributed cavity sources with spatially incoherent radiation may suggest that the perovskites are promising in making practical thin-film lasing devices for flexible and speckle-free imaging applications.

Keywords: **Perovskite, Metal-halide, Solution-processed, Nanocrystals, Random lasing**

Highly Enhanced Light Outcoupling in Flexible Organic Light-Emitting Diodes

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It’s difficult to detect single nanoparticle and virus because their sizes are too tine, which is below 100nm. However, nano pollutants and virus in the water and atmospheric environment have a serious impact on human life. We present a method to detect the single nanoparticle and virus by direct imaging the surface plamon scattering induced by nanoparticle or virus. Single 39nm polystyrene particle has been “seen”, and three viruses, e.g. T4 phage, PR8 influenza virus and EV71 enterovirus, have been detected in PBS buffer solution. This method is fast, high sensitivity, simple and low cost, which has a potential application to in-situ monitor the water and atmospheric environment.

Keywords: **Single nanoparticle, virus, Surface plasmon scattering, imaging**

Graphene-silicon integrated devices for high-performance on-chip modulators and photodetectors

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Graphene has attracted great interesting in the development of optoelectronic devices due to its broadband optical response, ultrahigh carrier mobility, and potentially CMOS-compatible. Here, we describe the integration of graphene and silicon-based nanophotonic devices, which enable high-performance electro-optic modulators and photodetectors. By electrically gating the graphene monolayer coupled with a planar photonic crystal nanocavity, electrooptic modulation of the cavity reflection was possible with a contrast in excess of 10 dB and a switching energy of 300fJ. Moreover, a novel modulator device based on the cavity-coupled graphene-boron nitride-graphene capacitor was fabricated, showing a modulation speed up to 1.2 GHz. A cavity-coupled graphene photodetector was also demonstrated with an enhancement of the photocurrent by a factor of 26 at resonant wavelengths. A waveguide-integrated graphene photodetector that simultaneously exhibits high responsivity, high speed and broad spectral bandwidth has also been reported. Using a metal-doped graphene junction coupled evanescently to the waveguide, the detector achieves a photoresponsivity exceeding 0.1 A/W together with a nearly uniform response between 1,450 and 1,590 nm. Under zero-bias operation, a response rate exceeding 20 GHz and an instrumentation-limited 12 Gbit/s optical data link. The integration of graphene with nanophotonic architectures promises a new generation of compact, energy-efficient, and ultrafast electrooptic graphene devices for on-chip optical communications.

Keywords: **Graphene, optoelectronic devices, silicon photonics**

Optically controlled bioreactor for the bacterial with synthetic light sensors

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Many system biological processes such as metabolism require precisely controlled temporal, and spatial gene expression.Researchers control gene expression using chemical signal effectors that bind transcription factors and thereby regulate expression from output promoters. Optogenetics is a technology where light signal is used to control molecular biological processes in genetically modified micro organisms. Optical means to control genetic circuits provides more precise way as compared to the chemical effector the current standard in controlling gene circuits in synthetic biology. We demonstrated a bioreactor with light sensing E Coli with gene expression controlled by illumination of light. The device has integrated sensors for optical density measurement for the microbial population and the light source for control of gene expression. The synthetic light sensing circuit in E Coli consists of phycocyanobilin (PCB) and CCAS/CCAR, which are orginally from cyanobacteria Synechocystis sp. PCC 6803. The device is also furnished with micropump and can operate in chemostat mode to sustain the E Coli in a steady state and program the gene expression via light emitting diode(LED) light source. In the future, we expect such a bioreactor can be used in bio process based on microbial cultivation.

Keywords: **optogenetics, photobiology, bioreactor, microbial cultivation, synthetic biology**

Highly Enhanced Light Outcoupling in Flexible Organic Light-Emitting Diodes

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Because of their mechanical flexibility, organic light-emitting diodes (OLEDs) hold great promise as a leading technology for display and lighting applications in wearable electronics. The development of flexible OLEDs requires high-quality transparent conductive electrodes (TCEs) with superior bendability and roll-to-roll manufacturing compatibility to replace indium tin oxide (ITO) anodes. Here we present a flexible TCE on plastic, which exhibits excellent optical, electrical and mechanical properties, allowing little degradation of electrical properties upon bending [1-6]. By combining an improved outcoupling structure for simultaneously extracting light in waveguide and substrate modes and reducing the surface plasmonic losses, flexible, highly power-efficient large-area green and white OLEDs can be achieved. Flexible green OLEDs yield a power efficiency (PE) > 120 lm/W and current efficiency (CE) >140 cd/A at a brightness of 1000 cd/m2. Moreover, flexible white OLEDs exhibit a maximum external quantum efficiency (EQE) of 49% and a record PE of 106 lm/W at 1000 cd/m2 with angular color stability, which is significantly higher than all other reports of flexible white OLEDs. These results represent an exciting step towards the realization of large-area ITO-free, high-efficiency OLEDs for use in a wide variety of high-performance flexible applications.

Keywords: **Organic light-emitting diodes, light out-coupling, flexible OLED, nano imprinting**

Nanostructured plasmonic lenses for superfocusing far beyond the diffraction limit

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Perfect lens was first proposed by J. B. Pendry based on the negative index material (NIM) (PRL, 2000, 85, 18: 3966.), which was later experimentally demonstrated by X. Zhang group employing a thin silver slab to efficiently magnify the evanescent waves and improve the imaging resolution to overcome the diffraction limit (Science, 2005, 308: 534.). However, the imaging plane in their case should be extremely close to the lens as the evanescent waves outside the silver slab still decay exponentially with the increasing propagation distance. Here, we show our recent research progress of the nanostructured plasmonic lenses, whose focusing properties are well controlled and can be modulated according to the specific requirements. Furthermore, by considering the size effect, the coupling effect between two adjacent nanostructures, and utilizing the immersion technology, we successfully realize a superfocusing plasmonic lens with the FWHM of the focal point better than $\lambda/11$. We believe that the focusing capability can be further improved by the ongoing effort of optimization.

Keywords: **Plasmonic lens, Superfocusing, Perfect lens, Diffraction limit, Negative index material**

Chiral molecules based optical and electrical nano spin memory

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With the increasing demand for miniaturization, nano-structures are likely to become the primary components of future integrated circuits. Different approaches are being pursued towards achieving efficient electronics, among which are spin electronics devices (spintronics). A new, promising, effective approach for spintronics has emerged using spin selectivity in electron transport through chiral molecules, termed Chiral-Induced Spin Selectivity (CISS). Studying the CISS effect it was found that chiral molecules, and especially helical ones, can serve as very efficient spin filters. Recently, by utilizing this effect we demonstrated a magnet less spin based magnetic memory. The presented technology has the potential to overcome the limitations of other magnetic-based memory technologies to allow fabricating inexpensive, high-density universal and embedded memory-on-chip devices. Another option is to achieve local spin-based magnetization generated optically at ambient temperatures, as well as local charge separation using light induced configuration.

Keywords: **Optical spin memory, Optical charge seperation, spintronics , Local Magnetization, Nano particles**

Stokes-Mueller Matrix Polarimetry for Thin Film Characterization

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A new Stokes-Mueller matrix polairmetry model was proposed to characterize the physical/optical property of thin film samples with surface roughness. In the proposed approach, the depolarization Mueller matrix MD and reflectance matrix MN were employed to describe the scattering effects from surface roughness and the multiple reflectance though the thin film, respectively. A genetic algorithm (GA) was used to extract the physical property (d - thickness of thin film) and optical properties (no, ne - refractive index) of the thin film sample based on the measured Stokes vectors and effective ellipsometry paramters. The validity of the proposed approach was confirmed by comparing the extracted physical and optical properties with the known values of thin film. The results showed extracted d, no, ne values of the thin film sample from the effective ellipsometry parameters were slightly better than those extracted from measured Stokes vectors. Furthermore, the thickness of surface roughness Ra was able to extract by using the depolarization Mueller matrix MD. The results showed that the corresponding standard deviations of extracted d and Ra value for a high surface roughness of thin film sample (Ra=2000 Å, d=251 nm) are +/-0.54 nm and +/-1.4 Å, respectively. In general, the propose technique provides a versatile and efficiency method for characterizing thin film samples with high surface roughness.

Keywords: **Stokes-Mueller matrix polarimetry, thin film, surface roughness**

Spatial mode control of surface plasmon polariton excitation with gain medium: From spatial differentiator to integrator

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In optical analogue computation, optical differentiator and integrator are the key element devices for ultrafast parallel data processing. Here we demonstrate that a Kretschmann configuration prism can directly perform spatial differentiation for the incident beam profile. Additionally, we realize all-optical reconfiguration from differentiator to integrator by modulating the propagation loss of surface plasmon polariton with optical pump. The feature of reconfiguration opens directions to ultrafast beam transformation, reconfigurable imaging processing, and all-optical analogue computing.

Keywords: **Surface Plasmon, Optical analog signal processing, Spatial differentiator, Spatial integrator**

Scale-up Synthesis and Applications of Erbium-doped Lanthanum Oxyhalide Nanophosphors

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As more comprehensive investigations on graphene occur, two dimensional (2D) materials have been attracting wide interest due to their peculiar structural properties and fascinating applications in the areas of electronics, optics, biology, and catalysis. As the promising substitutes for the gapless graphene, transition metal dichalcogenides (TMDCs) which also have layered crystalline structure with strong in-plane bonding but weak interlayer action (van der Waals force) show natural band gaps. In this paper, we reported the novel 2D semiconducting systems based on atomically thin crystals of MoS2. Several alloys and heterostructures were successfully fabricated. Their optical properties and utilization in multifunctional optoelectronics were systematically investigated.

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Keywords: **2D, MoS2, Optoelectronics, Alloy, Heterostructure**