ABSTRACTS
Student presentations

Enhancing the properties of dendritic Ru(II) complexes for Dye-Sensitised Solar Cells

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Since their development in 1991, dye-sensitised solar cells (DSSCs) have been the most efficient organic photovoltaics, with efficiencies of ~11% being the highest reported to date. DSSCs are also some of the easiest photovoltaic devices to construct, which can be performed at room temperature and pressure in standard atmosphere, in contrast with both inorganic solar cells and other thin-film based organic photovoltaics.

Progress in improving the properties of DSSCs has been slow in recent years. Stability of the cells is now a major concern for commercialization of DSSCs. I will describe our strategy of using dendritic architectures to improve the lifetime of solar cell dyes. I will also show how dendrimers can provide the ability to modify the physical properties of the Ru(II) dyes whilst keeping favourable electronic properties that are necessary for usable efficiencies from a DSSC.

A reconfigurable fishnet metamaterial design using MEMS principle

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We present reconfigurable fishnet metamaterial design employing MEMS principle. Tuning is based on changing the geometry of the unit cell. Parametric study of tunability with respect to the fishnet slab width proves that this approach can result in a tunability range of around 100%, what is considerably wider than can be achieved by modifying the substrate properties. Transmission characteristics of the reconfigurable structure in switch up and switch down states show two different operating frequencies in GHz frequency range.

Optofluidic Dispersion Engineering of Photonic Crystal Waveguides

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We use optofluidic infiltration to precisely and reversibly engineer the dispersion of a photonic crystal defect waveguide post-fabrication. The amount of fluid infiltrated into the photonic crystal microstructure strongly influences the waveguide dispersion.

A Solution Processed Non-fullerene Electron Acceptor for Organic Solar Cells

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We introduce a new highly soluble organic electron accepting small molecule (K12) for organic solar cell applications. We observe excellent photoluminescence quenching of the donor polymer P3HT and photovoltaic power conversion efficiencies (PCE) of solution processed bulk heterojunction devices of up to 0.73%. We find the large permanent dipole of the acceptor results in self-organisation, even at ambient temperature, allowing device fabrication at temperatures as low 65 ^{o}C, suitable for flexible plastic substrates.

Biophysical measurements of neurosecretory vesicle microenvironment during stimulation of exocytosis

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Neurosecretory vesicles are important carriers loaded with neurotransmitters in neurons and neurosecretory cells that underpin neuronal and hormonal communication. In response to stimulation, neurosecretory vesicles undergo a journey in the cytosol of the neurosecretory cells to the plasma membrane where they fuse in a process called exocytosis. Changes in the dynamics of vesicles due to local viscosity variation have been hypothesized to tightly control exocytosis by regulating the number of vesicles diffusing to the plasma membrane. Although much work has been done in understanding the dynamics of the cortical actin cytoskeleton in this process, no direct measurement of the viscoelasticity of the microenvironment surrounding the secretory vesicles has been attempted before.

Here we propose two complementary experimental strategies to study general and particular dynamics of neurosecretory vesicles in cultured bovine chromaffin cells.

The first experiment uses 3D confocal image stacks of a cell of interest to extract the 3D trajectory. Chromaffin cells are transfected by electroporation with hGH-GFP which is stored within secretory vesicle and imaged by confocal microscopy. Using image analysis we track these

multiple vesicles in three dimensions before and after stimulation of the cells by nicotine. Such an experiment allows us to track multiple vesicles at the same time and then to obtain the major trends in positions (relative to the membrane), trajectories and speed of the vesicles.
The second experimental strategy relies on real-time physical tracking of a single vesicle. The fluorescent sample is imaged by a fast camera and the signal is analysed in real time. By selecting a region of interest including a vesicle, specially developed software including a feedback loop allows us to follow the vesicle in three dimensions using a piezo-driven stage. This real time tracking added to the fast camera allows us to measure the power spectrum of Brownian motion of the vesicle during its journey and thus to detect any changes in the mechanical properties of its surroundings.
The three main paradigms are caged diffusion, directed diffusion and free diffusion. In previous work, changes in behaviour have been observed after stimulation, depending on the location of the vesicle within the cell. Actin filaments of the cytoskeleton may be the vectors of such changes in behaviour and greatly influence the dynamics of vesicles moving through the cell.
The effect on the dynamics of exocytosis of different secretagogues (as KCl and nicotine), the actin filament disruption, and the effect of relevant drugs can be monitored with these non-invasive techniques and will be used to quantify the change in the microenvironment surrounding neurosecretory vesicles.

Phase-sensitive Surface Plasmon Resonance biosensor based on metal-modulator

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A novel phase-sensitive SPR sensor will be introduced. It use goldfilm to modulate the phase of incident light, and get a nice resolution result in testing the concentration of glycerin solution.

Efficient Inverted Tandem Organic Solar Cells with Multiple Layers as Intermediate Layer

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We will present efficient inverted tandem solar cells with multiple metal and metal oxides layers as the intermediate layer. This intermediate layer is of advantage in high transparency and low series resistance. Different intermediate layers have been compared. The optimal one exhibits a doubled open-circuit voltage in the inverted tandem cells, compared to that in single inverted cells. Moreover, the inverted tandem cells have been optimized from the views of the thickness of each sub-cell and the corresponding layers. The final inverted tandem cells have a comparable or higher power conversion efficiency compared to single inverted cells. Therefore, our intermediate layer provides a potential pathway towards the high device performance of inverted tandem organic solar cells.

Effect of doping buffer layer in inverted organic solar cell

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We studied sol-gel derived indium-doped zinc oxide (IZO) with various indium contents as a functional buffer layer in inverted polymer:fullerene bulk-heterojunction solar cell. The short-circuit current density was observed to increase by doping indium in pure ZnO buffer layer. The maximum current density was obtained with a 1 at. % indium doping. Although the open-circuit voltage and fill factor reduced slightly, the inverted organic solar cell with 1 at. % indium-doped zinc oxide buffer layer showed a power conversion efficiency of 3.3%, which is higher compared to that (2.94%) of the device with undoped ZnO buffer layer under illumination of AM1.5G. The better performance is due to combined effects of improvement in charge collection and higher optical transmittance of electrode/buffer layer stack.

Progress towards a planar fluid-infiltrated waveguide platform

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Fast and accurate identification of a fluid's refractive index is an important part of optofluidic analysis. We present a novel planar fluid-infiltrated waveguide platform for the investigation of refractive index changes in fluids. The platform consists of hollow waveguides embedded in epoxy polymers. The device is fabricated using a combination photolithography and the lamination of thin films. The hollow waveguides are infiltrated to enable liquid core waveguides. The modulation of the fluid's refractive index instantly results in a change of the light propagation in the waveguides and coupling to adjacent waveguides. This relation is exploited to develop ultra-sensitive refractive index sensors. The proposed platform may be further extended to enable sensing applications in various fields ranging from fundamental physics to applied biology.

Extraordinary Transmission and Surface Plasmon on 1D-2D Plasmonic Crystal

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A pioneering paper of Ebbesen et al. reported on an extraordinary optical transmission (ET) through periodic holes array in metallic films [1]. That can be explained by SPP (Surface Plasmon Polations) effect. The enhanced transmission process is suggested to follow three steps: the coupling of light to SPPs, transmission through the holes and reemission. To examine this phenomenon, several experiments have been done: Transmission measurement of 2D square lattice diamond periodic array, polarization dependent in 1D Plasmonic crystal and finally optical response upon MPA functionalization

1D slits with period of 500 nm has also been done have a complete different behavior. Figure (4) reports the transmission spectra at normal incidence at several polarization angles of incident light. An interesting feature is the presence of an intersection point common to all spectra, corresponding to 560nm wavelength, which represents invariance symmetry of the system.

Some preliminary measurement has been done on 500nm square array of Si3N4 coated with Au. The sample was further coated with 3- mercaptopropionate (MPA) solution. The enhancement for bare hole array can be seen in centre peak for incident angle 0° at 650nm, or coated region the enhancement is moved to 670nm. The peak next to centre peak in bare array is greatly enhanced more than the centre one and again the peak moves from 680 to 715nm due to changes in refractive index (Figure 3 and 4). In addition we will present the Raman spectra achieved from the metallic-hole array, upon functionalization with thiophenol. The spectra are collected both in back scattering and transmission configuration.

Liquid Crystal Active Glasses for 3-D Cinema

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Liquid crystals have been extensively studied and are massively used in display technology. However, their recent use to provide optical shutters in active glasses for 3-D cinema has focused the attention on new specific requirements. Recent improvements in the quality of 3-D movies production and projection (involving for instance triple flash projectors) have resulted in the need for high quality glasses with no ghosting, no colour banding, large viewing angle and good residual light. In this paper we present the main parameters to assess the quality required today by the studios and we compare the main liquid crystal options which can be used with their respective advantages.

A New Era in Ground-Based IR Astronomy Using Photonics

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Current observational sensitivity at near-infrared wavelengths (1000 - 1800 nm) is completely dominated by the bright background of the night sky, 98% of which comes from the bright, narrow emission lines of atmospheric OH molecules. GNOSIS is a breakthrough sky-suppressing facility, which utilises revolutionary photonics technologies to filter out hundreds of bright sky-lines and pass the OH-emission-cleaned signal to an existing near-infrared spectrograph on any telescope. It will increase the sensitivity of infrared astronomical observations by a factor of 40 or more. This will revolutionise the ability of astronomers to carry out research on all types of infrared sources, including: the coolest stars, brown dwarfs and planets; dust-embedded star clusters; active and starburst galaxies; and the youngest galaxies forming in the distant universe.

Organo-metallic complexes in electronic devices: An effective model Hamiltonian beyond the molecular orbital picture

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Synthetic organometallic complexes have great potential as inexpensive alternatives to silicon in photovoltaic and electroluminescent devices. We investigate an effective model Hamiltonian for organometallic complexes in electronic devices. We will show that while the lowest singlet state is always a nearly pure metal-to-ligand charge transfer (MLCT) state, the lowest triplet states character varies, changing from ligand centered (LC) to MLCT with a strongly hybridized region that depends on the strength of the exchange interaction. This strong LC-MLCT mixing in the lowest triplet state means that small changes in parameter values can cause large changes in the properties of the emissive state. This sensitive dependence gives us some insight into the large observed changes in the photophysical properties of organometallic complexes caused by small changes in the ligands.

The growth and optical caractérisation of the thin films of silicon nanocrystallin

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The market for flat panel active matrix and solar cells based on thin film silicon is now dominated by hydrogenated amorphous silicon (a-Si: H), despite its poor transport properties of sounds and instability when it is exposed to light or subjected to electric stress.

In recent years the microcrystalline silicon (nc-Si: H) aroused great interest. Indeed, it could play a role through its transport properties and better stability compared to those of thin film amorphous silicon. But this requires an understanding / control properties of this heterogeneous material. Indeed, there is not a nanocrystalline-Si: H but a wide range of materials that are differentiated by their crystalline fraction, orientation and grain size, hydrogen content.

We study the structure of nanocrystalline silicon thin films (nc-Si:H) deposited by rf magnetron sputtering technique of high-purity crystalline silicon , this films has been studied with spectrophotometer, infrared spectroscopy, Raman, complemented with ellipsometry spectroscopy measurements.

Characterization of ZnO thin films grown by pulsed filtered cathodic vacuum arc system

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Zinc oxide, ZnO, is a wide-bandgap semiconductor with hexagonal crystal structure (wurtzite type). ZnO has been applied in many practical devices such as transparent conducting electrodes in solar cells, surface acoustic wave devices, optical waveguides, and chemical (gas) sensors. The growth of high quality n-type ZnO films has been available for many years. The development of good quality p-type conduction with low resistivty is more recent and is difficult to achieve. The most successful acceptor dopants have been the group V elements.

The transparent, conductive and very precise thickness controlled p-type semiconducting ZnO thin films are prepared by pulsed filtered cathodic vacuum arc deposition (PFCVAD) method. Structural, optical and electrical properties of these films are investigated.

Transparent p-type ZnO thin films were produced by oxidation of PFCVAD deposited zinc nitride. Zinc nitride thin films were deposited with various thicknesses and under different oxygen pressures on glass substrates. Zinc nitride thin films, which were deposited at room temperatures, were amorphous and the optical transmission was below 70%. For oxidation zinc nitride, the sample was annealed in air starting from 350 ^{o}C up to 550 ^{o}C for one hour duration. XRD pattern of these films have diffraction peaks with (100), (101) and (110) orientations. These XRD patterns imply that zinc nitride thin films converted to zinc oxide thin films with the same hexagonal crystalline structures of ZnO. The optical measurements were made at each temperatures and the optical transmissions of ZnO thin films were over 90% in visible range after annealing over 350 ^{o}C. By oxidation zinc nitride the film converted to p-type zinc oxide and the film became more transparent. During the oxidation process at each temperature Hall measurements were made to determine carrier type, carrier concentration, mobility and resistivity. Hall effect measurements indicated that ZnO films were p-type and the highest carrier concentration of 1.08x1018 cm^{-3} and mobility of 93.53 cm^{2}/Vs. Hall effect measurements proved that after annealing at 350 ^{o}C up to 500 ^{o}C the film was p-type. By increasing the oxidation temperature over 550 ^{o}C the ZnO thin films turned into n-type due to the lack of N atoms in the film.

The good quality n and p-type ZnO thin films were used to produce hetero-structures. P-type ZnO deposited on the n-type Si substrate and indium was evaporated as metal contacts (n-p). On the other hand n-type ZnO deposited on p-type Si substrate for p-n structure. Both structures have shown good diode output (I-V) characteristic.

Self-Assembly of gold nanoparticle in liquid crystal

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Optical metamaterials potentially offer sub- diffraction limited optical imaging, negative refraction, and invisibility cloaks. Liquid crystals and metal nanoparticles are essential building blocks for self- assembled mesomorphic tunable optical metamaterials. However fundamental understanding of the influence of nanoparticle shape and size on alignment and self-assembly of the nanoparticles in liquid crystals is strongly needed for these composite metamaterials to be realized. We have successfully dispersed nanoparticles in liquid crystal and observed end to end self-assembly of long rods through Freeze Fracture TEM. The lines form a periodic structure which is essential for metamaterial applications. We conclude that liquid crystalline molecular self-assembly provides a powerful platform for the self-assembly-based mass fabrication of optical metamaterials.

Study of Tactoidal and Toroidal Inclusions in DSCG-Spm Mixture

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We simulated optical behavior of toroidal LCLC materials and observed the formation and growth of tactoidal and toroidal structure with polscope. Base on the observation, we studied the formation motivation and growth process of toacoidal and toroidal LCLC in DSCG-Spm Mixture.

Nanoparticles in Liquid Crystals: Dispersion and Self-Assembly

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For many metamaterial applications, such as cloaking at optical wavelengths, optical circuits, and superlenses, periodic arrays of nanoparticles are required. Self-assembly-based fabrication techniques of these arrays could allow for mass production of metamaterial devices. I study nanoparticle interactions in liquid crystals because liquid crystals provide the order and fluidity at the nanoscale needed for self-assembly of nanoparticles. I study the interactions of fluorescent CdSe quantum rods and surfactant capped gold nanospheres and nanorods in various mesophases of liquid crystals. In this poster I will describe techniques for nanoparticle dispersion into liquid crystals and how to use defects in liquid crystals to self-assemble the nanoparticles. I conclude by discussing how the blue phase, a liquid crystals with periodic defects, can be used to assemble nanoparticles into periodic arrays.

Direct and particle-assisted optical manipulation of defect structures in liquid crystalline media

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Inclusion of colloids in liquid crystals gives rise to new kinds of elastic interactions leading to directed-assembly of colloids and particle-stabilized network of defects. These inter-particle & particle-defect interactions can be probed with the help of optical tweezers. We have combined holographic optical trapping with fluorescence confocal polarizing microscopy (FCPM) for simultaneous 3D optical manipulation of particles & defects in liquid crystalline media and 3D imaging of the resultant changes in the director pattern brought about by the performed manipulation. Our experiments in cholesteric media show that topologically unstable oily streaks of zero-Burgers-vector can mediate distance-independent colloidal interactions in these anisotropic fluids. An ability to control and manipulate defects in liquid crystals opens up possibilities of designing soft-materials with controlled elasticity by introducing networks of dislocations and oily streaks.

Optical properties of Cr and Mn-doped SrTiO3 nanomaterials

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$SrTiO_3$ is incipient ferroelectric, which properties may be affected with particle size, especially in nanoscale, allowing to obtain optic, photocatalytic or gas sensing materials. Luminescent Cr and Mn-doped $SrTiO_3$ nanoparticles (5-50 nm) were prepared and the correlation between particle size, lattice constant and band gap investigated. To obtain multiferroic material, $Sr(Ti,Mn)O_3$ solid solutions with Mn content till 50 mol.% and particle size 5-50 nm were prepared and their properties described.

Influence of index contrast in 2D photonic crystal lasers

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The influence of index contrast variations for obtaining single-mode operation and low threshold in dye doped polymer 2D photonic crystal (PhC) lasers is investigated. We consider lasers made from Pyrromethene 597 doped Ormocore imprinted with a rectangular lattice PhC having a cavity in the middle of the crystal structure. We demonstrate that the index contrast, n_eff,high/n_eff,low, is an essential parameter for achieving low threshold, and we indentify a trade-off between low threshold and single-mode operation. The index contrast is varied in the range [1.004;1.034] in seven steps. In our studies we find that an index contrast of 1.010 corresponding to a PhC with an imprint depth of 90 nm in a film thickness of 423 nm is optimal for lowest threshold and single-mode operation.

Novel composite materials made of flying carbon nanotube carpets infiltraited with liquid crysals

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We are studying the effects of liquid crystal directors on the organization of carbon nanotube carpets in an attempt to develop cheap, flexible, and efficient photovoltaics.

Opto-Elastic Manipulation of Colloidal Architectures using DMR Monolayers

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Controlled structural assembly of micro- and nano-sized particles is essential for many technologies, ranging from optical metamaterials to photovoltaic devices. We demonstrate a low-intensity “opto-elastic” method of manipulating micron- and submicron- sized colloidal particles and colloidal architectures suspended within a nematic liquid crystal. By optically controlling an azobenzene self assembled monolayer (SAM), we define the surface boundary conditions on the substrates of a sample and, consequently, the liquid crystal (LC) director field throughout the sample bulk. This control can be used to create large elastic deformations within and at the interface between adjacent domains of different director orientations with which we can rotate and translate particle architectures dispersed throughout the LC medium. By exploiting elastic forces acting on the particles near the defects, we have demonstrated lateral translation of micron and sub-micron-sized particles such as melamine resin polymer microspheres and silver nano-rods. This method of “opto-elastic” manipulation requires light intensities three orders of magnitude smaller than in the case of laser tweezers utilizing optical gradient forces and enables massively-parallel manipulation of multiple particles on the scales of millimeters and centimeters.

Double-helix point spread functions for 3D imaging

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We present a jointly optimized optical-digital imaging system using a double helix point spread function (DH-PSF) and demonstrate its use in 3D imaging. The DH-PSF enhances the 3D position estimation capabilities of the complete system relative to conventional designs. Experimental results from task-specific macroscopic imaging and 3D single-molecule diffraction unlimited imaging are presented.

Theory of ferroelectric nanoparticles in nematic liquid crystals

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Several experiments have reported that ferroelectric nanoparticles have drastic effects on nematic liquid crystals--increasing the isotropic-nematic transition temperature by about 5 K, and greatly increasing the sensitivity to applied electric fields. In a recent paper [1], we modeled these effects through a Landau theory, based on coupled orientational order parameters for the liquid crystal and the nanoparticles. This model has one important limitation: Like all Landau theories, it involves an expansion of the free energy in powers of the order parameters, and hence it overestimates the order parameters that occur in the low-temperature phase. For that reason, we now develop a new Maier-Saupe-type model, which explicitly shows the low-temperature saturation of the order parameters. This model reduces to the Landau theory in the limit of high temperature or weak coupling, but shows different behavior in the opposite limit. We compare these calculations with experimental results on ferroelectric nanoparticles in liquid crystals.

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Controlled Rotation of a Tilted Nanofibers with an Optical Tweezers

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Using a focused linear polarized Gaussian beam, in an optical tweezers configuration, we can control the rotation of an optically trapped polymeric nanofiber (isotropic cylinder and its end faces) by varying trapping power or fiber tilt angle with respect to incident beam. Different from previous approaches for rotation of trapped objects, there is no need to microstructure the trapped object or to manipulate the trapping beam (profile or polarization).

A T-Matrix formalism, accurately reproduces the measured data. It is reported that the trapping point at the fiber tip is shifted as a function of the fiber tilt. This work provides an alternative strategy to previously reported approaches for the rotation of nano-objects.

Manipulation of nematic disclination loops with optical tweezers: numerical simulation

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Here we present initial results of our numerical study of the nematic disclination loops manipulated with optical tweezers. Nematic liquid crystals are typically highly responsive to an external electric field. Consequently, director field of the nematic can be easily affected also by local electric field of optical tweezers. Therefore, optical tweezers can be used for dragging or pushing defect lines in desired directions. Moreover, a substantial deformation of the order parameter field can also lead to a restructuring and reshaping of the disclination loops.

Modelling is based on numerical minimization of phenomenological Landau de Gennes free energy including electric field contribution. Electric field of optical tweezers is incorporated by using Gaussian beams. The study demonstrates the principles of restructuring, dragging and pushing of defect lines with different topological properties. The study is focused to nematic colloids where beside simple disclination loops also complex loops entangling two or more particles occur. Various distortions of a nematic defect lines that may lead to the formation of complex nematic colloids are discussed.

Dispersion, alignment, and optical manipulation of graphene flakes in liquid crystals

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Graphene is a promising nanoscale material that can exist in the form of single-atom-thick layers and exhibits interesting optical and electronic properties. It has a great potential for electro-optic, electronic, and photonic applications that could potentially lead to improvements in a number of different technologies and consumer devices such as TVs, photovoltaic solar cells, and adjustable lenses. These applications, however, often require dispersion and long-range alignment of graphene flakes of various shapes as well as the robust control of this alignment by using external fields.

In this work, we demonstrate that liquid crystals (LCs) provide a means of long-range alignment and control of orientation of graphene flakes. We have produced amorphous graphene flakes through mechanical cleavage and shape-controlled flakes through a combination of photolithography and chemical vapor deposition. We have analyzed the flake quality and properties using a combination of transmission electron microscopy, atomic force microscopy, and laser-based optical techniques. The flakes were then dispersed in a number of different LC media. We have analyzed the three-dimensional structures of molecular alignment associated with the LC-incorporated flakes in each system using fluorescent confocal microcopy and polarizing microscopy. We have achieved bulk dispersion of monolayer and multilayer graphene flakes along with their optical manipulation in both thermotropic and lyotropic liquid crystals. The monolayer graphene flake imposes planar boundary conditions on the LC director without causing defects. Graphene monolayers are extremely flexible and responsive to the changes of LC director fields so that their orientation and spatial position can be controlled using electric fields and optical laser tweezers. Further, we observe elasticity-mediated interactions of the graphene flakes with topological defects and periodic structures in field-controlled cholesteric liquid crystals. In the short-pitch cholesterics, graphene flakes spontaneously self-align parallel to the cholesteric layers (orthogonally to the helical axis) and we observe flake rotation we pull it through the layers using laser tweezers. We also observe interactions of these flakes with colloidal spheres, enabling two-dimensional colloidal self-assembly in liquid crystals at the graphene surface. Our study shows that graphene-LCs composites are a promising new class of electrically-and optically-reconfigurable materials of interest from both fundamental science and applications standpoints.

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Transmission diffraction gratings for daylighting applications

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A method for redirection of sunlight for daylighting applications using diffraction gratings embedded in the surface of window glass is presented. A smeared out diffraction pattern is obtained from a chirped grating with linearly increasing period. The smeared out effect of the diffraction pattern induces a substantial mixing of colours in the pattern, reducing the chromatic effects which limits the daylighting potential of linear gratings. The reduced chromatic effects make the chirped grating promising for daylighting applications.

Relative Intensity Noise in Parametric Amplifiers

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We present a novel method for finding the relative intensity noise in parametric amplifiers, and look at the consequences. The model is also tested again known results for forward pumped Raman amplifiers.

Current induced second-harmonic generation at metal surface

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Second order nonlinear-optical effects and particularly second-harmonic generation (SHG) have been intensively studied and used during the recent decades. The effect of second-harmonic generation has revealed to be one of the most efficient and precise methods of diagnostics of volume and surfaces [1]. In the electric dipole approximation SHG is forbidden in a centrosymmetric medium so it is basically generated by surfaces and interfaces of metals where the inversion symmetry is broken. Moreover, central symmetry can be broken by application of an external field, causing so-called field-induced SHG.

Effects of SHG in centrosymmetric medium under the influence of external electric and magnetic fields have been thoroughly studied by the time being. However in metals and semiconductors these effects can be overwhelmed by another symmetry-breaking mechanism related to the shift of equilibrium electron density distribution. As a result electric current flows in the sample and non-zero second order nonlinear susceptibility appears proportional to the current density [2]. This effect known as current induced second-harmonic generation (CSHG) has been theoretically predicted for simple direct-band semiconductor and experimentally proved for silicon [3]. However by the mean time neither theoretical description nor experimental studies of the CSHG effect have been carried out for metals.

Our goal was to observe the CSHG effect at metal surface and characterize its magnitude numerically. Homogenious planar metallic structures were formed by a layer of silver from 100 to 300 nm thickness on the silicon substrate. Fabrication of the samples was performed by ionbeam sputtering.

For the nonlinear-optical experiments, the p-polarized output of a Nd:YAG laser at 1064 nm wavelength, pulse duration of 10 ns, repetition rate of 25Hz and s-polarized output of Ti:Sapphire laser at the wavelength the range of 730-800 nm, pulse duration of 100 fs, repetition rate of 80MHz were used. SHG reflected from the samples was spectrally separated by appropriate set of filters and detected by a PMT and gated electronics.

SHG polarization diagrams show that reflected SHG radiation is basically specular and polarized, proving sufficient silver surface smoothness. For the direct CSHG measurements *pp* combination of polarizations of fundamental and SHG waves was chosen as providing effect of presumably higher magnitude. As a measure of CSHG relative intensity so-called current contrast was used, defined as $\rho_J = 2\frac{I^{2\omega}(J)-I^{2\omega}(0)}{I^{2\omega}(0)}$. In case of the samples studied with current density of about 10^6 A/cm^2 applied the effect of additional SHG was observed. Current contrast was found to reverse its sign with change of current direction to the opposite. Counted current contrast value was about 35 %. Sensibility to the current direction is regarded as a poof that observed effect is related to above mentioned mechanism and not thermal or mechanical changes in the sample due to the application of the current.

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Light Emission and Propagation in Photonic Crystals

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The scope of the project is to examine the scattering processes between multiple quantum dots to develop a model for understanding the interaction between quantum dots in different media, e.g. in photonic crystals.

Photoluminescence and Raman studies of Graphene thin films prepared by reduction of Graphene Oxide

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Graphene has increasingly attracted attention owing to its fascinating physical properties including quantum electronic transport, tunable band gap, extremely high mobility, high elasticity, and electromechanical modulation. In this report, Photoluminescence (PL) and Raman studies have been performed to investigate the optical properties of graphene thin films prepared by chemical and thermal reduction of graphene oxide (GO). The G peak in Raman spectra red-shifted after reduction of GO. Thermal reduction resulted in a more red-shift of the G peak than chemical reduction. A strong intensity of the D peak indicated that the prepared graphene films have significant structural disorders. A blue-shifted emission in PL spectra suggested that sp2 clusters are embedded in a sp3 matrix that acts as a tunnel barrier, causing a strong fluctuation in the local band gap.

Coupled-resonator optical waveguides: Q-factor influence on slow-light propagation and the maximal group delay

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Coupled-resonator optical waveguides hold potential for slow-light propagation of optical pulses. The dispersion properties may adequately be analyzed within the framework of coupled-mode theory. We extend the standard coupled-mode theory for such structures to also include complex-valued parameters which allows us to analyze the dispersion properties also in presence of finite Q factors for the coupled resonator states. Near the band-edge the group velocity saturates at a finite value while in the band center, the group velocity is unaffected by a finite Q factor as compared to ideal resonators without any damping. However, the maximal group delay that can be envisioned is a balance between having a low group velocity while not jeopardizing the propagation length. We find that the maximal group delay remains roughly constant over the entire bandwidth, being given by the photon life time of the individual resonators.

Wide temperature range blue phase liquid crystals for display applications

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Chemical Physics Interdisciplinary Program & Liquid Crystal Institute, Kent State University, USA

We report wide temperature range blue phase liquid crystals for display applications. Systematical analysis of the relationship of dielectric anisotropy value and the blue phase liquid crystal (BPLC) temperature range shows that the BP temperature range increases as the dielectric anisotropy value decrease. Additionally, we also find that as the chiral concentration of the blue phase increases, the BP temperature range decreases. The studied BPLCs also exhibit fast response time of 400 ?s using IPS cells with a fixed cell gap and electrode line and space of 10 ?m. These results can be explained based on the defect theory and would give effective guidance during the application of BPLC. Detailed physical, optical, dielectric and electro-optical study will be presented.

An Efficiently Tunable Micro-Ring Resonator Using a Liquid Crystal-Cladded Polymer Waveguide

TAO CAI
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An electrically tunable polymer micro-ring resonator (MRR) of large tunability and low applied voltage is demonstrated using active liquid crystal (LC) cladding. A large tuning range of 0.73 nm is achieved due to more homogenous LC molecular alignment and enhanced interaction of the light with the LC cladding in the simplified polymer waveguide structure. The operating voltage decreases to 10 V with a threshold of only 3 V by the utilization of interdigital electrodes.

Application of Lidar (Light detecting and ranging) application

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Introduction to a collaborative project of Zhejiang University (China) and Lund Institution of Technology (Swenden), to give a overview of Lidar used in protection of historical relics, insect migration and environment monitoring.

A surface plasmon resonance sensor based on metal modulator

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A SPR sensor was presented in the poster. The system was constructed to detect extremely tiny fluctuation in refractive index of sample. A novel metal modulator was employed to modulate the input beam.

Self-Alignment of Plasmonic Gold Nanorods in Reconfigurable Anisotropic Fluids for Tunable Bulk Metamaterial Applications

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We demonstrate the bulk self-alignment of dispersed gold nanorods imposed by the intrinsic cylindrical micelle selfassembly in nematic and hexagonal liquid crystalline phases of anisotropic fluids. External magnetic field and shearing allow for alignment and realignment of the liquid crystal matrix with the ensuing long-range orientational order of well-dispersed plasmonic nanorods. This results in a switchable polarization-sensitive plasmon resonance exhibiting stark differences from that of the same nanorods in isotropic fluids. The device-scale bulk nanoparticle alignment may enable optical metamaterial mass production and control of properties arising from combining the switchable nanoscale structure of anisotropic fluids with the surface plasmon resonance properties of the plasmonic nanorods.