It is our pleasure to welcome you to the CFP / NIM International Workshop on “Functional Photonics and Nanosystems” which will be held at City University of Hong Kong (CityU) on May 27–29, 2015. Recent progress in nanoscience and nanotechnology allows us to explore photonic functions of artificially fabricated nano-structures, expanding fundamental studies of light-matter interactions and their potential applications in photonics, electronics and biomedicine to the nanoscale. This Workshop will exploit the strengths of participating Research Centres CFP (Hong Kong) and NIM (Germany) in these rapidly evolving fields.

The Centre for Functional Photonics (CFP) has been established in 2010 with the mission to promote, coordinate, and bundle interdisciplinary research in the field of functional photonics at CityU, and to become a leading centre in the Asia-Pacific region in this field. Fundamental research in photonics is essential for the successful development of innovative and practical solutions in many areas vital to mankind such as energy, health, environmental protection, communications and data processing, to name a few.

Since its foundation in 2006, the Nanosystems Initiative Munich (NIM) has established itself as an internationally recognized Cluster of Excellence. The design and the control of artificial and multifunctional nanosystems are the keystones of the scientific program of NIM which brings together scientists from nanophysics, chemistry and the life sciences. The integration of these functional nanosystems in complex and realistic surroundings is the central research aspect at NIM. Artificial nanosystems have a wide range of potential applications in areas like information- and biotechnology, as well as in the efficient use of solar energy.

Both CFP and NIM have launched their own series of Workshops on selected topics in contemporary science. The Workshop on “Functional Photonics and Nanosystems” in Hong Kong is the first jointly organized event, which brings together internationally renowned experts and committed young scientists, enabling top-level exchange of scientific knowledge. It is financially supported by CFP, NIM, and also by the Department of Physics and Materials Science of City University of Hong Kong and by the RGC (Hong Kong) Theme-Based Research Scheme on Challenges in Organic Photovoltaics and Light Emitting Diodes.

Please enjoy the science at the Workshop, the communication with colleagues, and please enjoy Hong Kong!

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ACKNOWLEDGEMENTS
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08:20 – 17:00, Wednesday, 27 May 2015

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Lunches are covered for all registered participants
Lunch tickets will be issued at the registration desk

Internet
Access to the WLAN internet will be available at CityU campus. You will receive the login account and password at the registration desk.

Conference Excursion
13:00 – 18:00 on Thursday, 28 May 2015
Bus trip to “The Peak” and “Stanley”
Bus pick up at 13:00 from the University Circle (see the map above)

Conference Dinner
18:00 – 20:00 on Thursday, 28 May 2015
Neptune Restaurant Ocean Park
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Development of synthetic methods for nanostructures has introduced new approaches for engineering functional materials for photonics and optoelectronics. Nanocrystal assemblies provide a powerful platform for designing two- and three-dimensional solids with tailored electronic, magnetic, optical and catalytic properties. Unlike atomic and molecular crystals where atoms, lattice geometry, and interatomic distances are fixed entities, the arrays of nanocrystals represent solids made of “designer atoms” with potential for continuous tuning their physical and chemical properties.

The assembly of functional materials from nanoscale building blocks combines advantages of crystalline inorganic semiconductors with inexpensive solution-based device fabrication. Along these lines, colloidal semiconductor quantum dots are explored as the functional elements in printable electronics, light emitting devices, photodetectors and solar cells. All the above applications rely on efficient charge transport in nanocrystal arrays. In the recent years significant progress has been achieved in development of chemical approaches to improve electronic transport and control doping in nanocrystal arrays. By using optimized surface chemistries we prepared nanocrystal solids exhibiting carrier mobilities comparable to those in single crystal materials. I will demonstrate the power of “modular” materials fabrication for electronic, thermoelectric and photovoltaic devices.

I will also discuss our recent work with two-dimensional (2D) colloidal quantum wells (CQWs) that produce amplified spontaneous emission (ASE) with low threshold of 6 µJ/cm² and a high gain of 600 cm⁻¹, both a significant improvement over colloidal nanocrystals. This exceptional performance can be attributed to slow Auger recombination rates, large optical cross-sections, and narrow ensemble emission linewidths. Additional opportunities for photonic applications of CQWs come from record fast, sub-10ps, fluorescence resonance energy transfer (FRET) in cofacial CQW stacks, that outpaces Auger recombination. Our results suggest that CQWs are, in many aspects, superior to quantum dots and rods for lasing and optical amplification.
Recent works in our laboratory have shown that novel photonic materials could be assembled through the use of various organic and metal-ligand chromophoric building blocks. In this presentation, various design and synthetic strategies together with the successful isolation of new classes of molecular materials will be described. A number of these compounds have been shown to display rich chromophoric and luminescence behaviour. The chromophoric and luminescence properties have been studied and their spectroscopic origins elucidated. Some of these compounds have also been shown to undergo supramolecular assembly to give a variety of nanostructures and morphologies. By understanding the spectroscopic origin and the structure-property relationships, the characteristics of these compounds could be fine-tuned for specific applications and functions through rational design and assembly strategies based on various coordination motifs and supramolecular non-covalent interactions. These compounds may find potential applications and functions as organic photonic materials.
Quantum Confinement in Ligand-Stabilized Perovskite Nanoplatelets

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Lead halide perovskites have emerged within the last five years as a highly promising semiconductor, not only exceeding 19% efficiency in solar cells but also showing their potential for light-emitting applications. To improve on this efficiency and harness all of the potential of this material will require a detailed understanding of the photophysical processes occurring in such systems. This however requires a highly controllable nanoscale structure, where several parameters can be varied to study their effects on the optical properties of the system. One approach is to fabricate single nanoparticles using ligand molecules, which are incorporated into the perovskite crystal structure and arrest the growth leading to small, separate nanocrystals. To achieve this we use varying ratios of methylammonium to octylammonium and find that higher octylammonium contents lead to a strong blue-shift in absorption and photoluminescence of bulk samples. TEM images confirm the existence of thin rectangular shaped nanocrystals, which XRD show to be cubic perovskite. Infinite square-well calculations show that the observed blue-shifts can be well explained by the presence of thin (<15 nm) nanoplatelets. These results confirm quantum-confinement in perovskite nanocrystals and provide a method for fabricating tunable emitting perovskite nanoparticles.
Quantum dots (QDs) synthesized in colloidal solutions can be post-preparatively treated to make their surface compatible with the various solvents and / or assembly techniques. Moreover, proper balancing of a surface ligand shell helps to improve the stability and the photoluminescence quantum yield of the QDs. Three various assembly approaches will be presented here to demonstrate the effect and the applicability of the ligand exchange. Firstly, assembly of QDs into gels and aerogels with the controlled content and porosity is possible by applying tetrazole based ligands. Selective and reversible complexation of these ligands with several metal ions opens up an opportunity for bridging separate QDs into the extremely porous 3D networks. Another example is an incorporation of QDs into the ionic salts. Making various QDs compatible with the saturated salt solutions is a challenging task, especially for the QDs originally synthesized in the unpolar organics. Resulting QD-salt composites are exceptionally stable emitters desired for the applications in the solid state lighting, solar concentrators and lasing. Finally, we will demonstrate a ligand exchange to halogenide ions as a tool allowing enhanced interparticle interactions. 2D films of halogenide-passivated QDs possess enhanced carrier mobility and are attractive for the solution processable electronics.
In this presentation, I will describe the synthesis of six types of colloidal Au and Ag nanocrystals and briefly discuss their plasmonic properties and applications. They are Au nanospheres, Au nanorods, Au nanobipyramids (NBPs), Au NBP-directed Ag nanowires, Au NBP-templated Ag nanostructures and Au nanoplates. All of them have very narrow size distributions. Their sizes and therefore their localized plasmon resonance energies can be readily varied over broad ranges by carefully controlling the synthetic conditions. The synthesizes of these nanocrystal samples are all based on the seed-mediated growth method. Fine size tuning is realized through mild oxidation and anisotropic overgrowth, which allows for precise control of the plasmon resonance energies, because the plasmon resonance energy is often sensitively dependent on the nanocrystal size. Precise control of the plasmon resonance is very important for many plasmon-based applications.

Specifically, we have been able to grow Au nanospheres in a diameter range from ~20 nm to ~300 nm. Due to the simple geometry and the availability of analytical solutions for nanospheres, Au nanospheres are preferred for assembly and for checking experiments / simulations with theories. We can tailor the diameter and the aspect ratio of Au nanorods. The former can be employed for adjusting the relative contributions of scattering and absorption to the total extinction, and the latter can be used for adjusting the longitudinal plasmon energy. Our Au NBP samples are monodisperse. Compared to Au nanorods, they exhibit larger field enhancements, narrower plasmon peak widths and higher refractive index sensitivities. By use of Au NNBP as templates, we can grow Ag nanowires with excellent control on both diameter and length, and synthesize Ag nanostructures with extremely narrow plasmon peak widths. Moreover, we have been able to synthesize Au nanoplates with narrow distributions on both side length and thickness. The thickness of these nanoplates can be varied from ~10 nm to ~50 nm. Such thickness control has not been demonstrated before, to the best of our knowledge.

Taken together, the colloidal Au and Ag nanocrystals that are available from our group will be very useful for exploring various plasmon-derived optical behaviors as well as various plasmon-based technological applications.
Energetic materials (pyrotechnics, propellants and explosives) are being widely used in airbag igniters, automobile belt tensioners, mining, de-construction, fuses, joining, soldering, brazing, and many defence-rated areas. Lithium ion batteries have attracted significant attention as they show great promise as power sources for portable electronic devices because of their high energy density, flexible light weight design and long cycle life. This talk will introduce our recent work on CuO nanowires based energetic materials and anode materials for batteries.

Notes
The polarized emission from quantum rods (QRs) is regarded to be a potential tool to improve the overall efficiency of modern displays and photonic devices [1, 2]. However, controllable QR alignment is critically important to realize device-scale polarized emission, which has proven to be a real challenge for the scientific community. In this study, we disclose an approach to align highly luminescent CdSe/CdS core-shell QRs in microscopically defined geometry. Photosensitive sulfonic azo dye (SD1) is employed to indirectly align QRs, embedded in a liquid crystal polymer (LCP) matrix, after being irradiated with polarized light ($\lambda = 450$ nm). The SD1 provides high anchoring energy, which increases with the irradiation energy, with good control on the easy axis of the alignment. It therefore offers very high alignment quality for the LCP [3, 4]. Due to the interaction between the surface ligands of the QRs and the surrounding LCP matrix, the alignment orientation of the QRs is found to be perpendicular to the easy axis of the SD1 and LCP, similar as reported before for a QR / block copolymer hybrid system [5]. The alignment quality of the films is analyzed by fluorescence spectroscopy and TEM (Fig. 1). After being illuminated with polarized light ($\lambda = 450$ nm), QR films show polarized emission with an extinction ratio of up to 3.5:1 (55 % polarization). Furthermore, a patterned aligned QR thin film is realized by means of two-step irradiation of the SD1 alignment layer. The easy axis in the two alignment domains is fixed orthogonal to each other, in plane [6]. By turning the illuminated substrate at a fixed polarizer position, the orthogonal orientation of the QRs in both alignment domains is clearly observable (Fig. 2), which demonstrates the large flexibility and control of this method.

References


We present economical and versatile approaches to achieve structural precision, good scalability and novel periodicity of nanomaterials. For example, our approach provides flexible composition/porosity profiles along the film thickness direction (e.g., a sine wave). Our approaches build on the well-established electrochemical techniques. They are bottom-up approaches that are applicable to a wide range of materials and functions, e.g., 1) electrochemically fabricated nanoporous metallic films, 2) electrochemically modified metal oxides and 3) electrochemically treated bulk metal frameworks of large surface areas. We will further present theoretical simulation work to understand the structure-property correlations, particularly for novel photonic devices. Applications based on these fabricated porous nanomaterials, such as optical sensors, photocatalysts, and supercapacitors, will also be discussed.
Will review our scientific work on photocatalytic hydrogen generation utilizing II-VI semiconductor nanocrystals decorated with catalytic metal clusters. Key issues are the role of hole scavengers, the size and density of catalytic clusters, and dependencies on external parameters such as pH. Hydrogen generation efficiencies are compared to results of transient absorption experiments in order to find out the limiting microscopic processes.

References


*in collaboration with the group of Andrey Rogach, Centre for Functional Photonics (CFP), City University of Hong Kong
During the last years, alloyed semiconductor nanomaterials based on copper chalcogenides have attracted significant interest owing to their potential in photovoltaic, thermoelectric, lighting, biolabeling and other applications. Colloidal copper chalcogenide-based nanocrystals (NCs), such as ternary CuInS(Se)_2, Cu(In,Ga)S(Se)_2, and quaternary Cu_2ZnSnS(Se)_4, are commonly prepared by a direct synthesis, where all precursors (i.e., compounds serving as Cu, Zn, In, Ga, Sn, S (or Se) sources) are utilized together in one pot. Since these multiple precursors have different reactivities, the synthesis suffers from inherently poor control over NC nucleation and growth, which lead to broad variations in the size and, in some cases, in morphology and composition of the materials.

To overcome these limitations of the direct synthesis we propose a straightforward and reproducible approach to prepare multinary alloyed NCs. Our strategy includes two main steps: 1) synthesis of binary copper chalcogenide nanoparticles [1] with 2) subsequent partial in-situ cation exchange (i.e. partial replacement of host Cu^+ ions by guest cations, such as Zn^2+, In^3+ or Sn^4+) with preservation of anionic framework, and thus without major altering of the size and shape of parent NCs [2, 3]. In this way, our synthesis scheme combines a facile NC morphology control with its compositional tunability by simply adjusting the initial feed ratio of guest cation-precursors to copper chalcogenide particles in the reaction mixture. As an additional advantage, cation exchange on already synthesized nanoparticles prevents possible separated nucleation events of corresponding binary and ternary compounds (e.g., ZnS(Se), SnS(Se)_2, Cu_2SnS(Se)_3) and ensures a homogeneous distribution of elements within the resulting alloy NCs.

References

Notes
Solar hydrogen from water splitting reaction, an ultimately clean energy carrier, is expected to be a frontline resource in the foreseeable energy mix scenario. Here, we will present our strategies in designing efficient semiconductor photoelectrodes, covering aspects of heterojunction engineering, morphology design, sensitisation and interfacing with graphene. In particular, we will examine the underlying characteristics of charge transport in these simple to complex systems. Understanding such fundamental behaviour is key towards enabling various photoinduced reactions, which besides water splitting, also includes emerging ones such as carbon dioxide reduction.

References


We have been interested in utilizing the interesting luminescence properties of rhenium(I) and iridium(III) polypyridine complexes to develop new biological labels and cellular probes. In this presentation, new complexes that function as 1) glucose and fructose uptake indicators, 2) photocytotoxic agents, 3) bioorthogonal probes to label membrane-bound glycans, and 4) cellular sensors for zinc (II) ion and nitric oxide will be described. We will focus on the photophysical and photochemical properties, cytotoxicity, cellular-uptake, and intracellular functions of these complexes.

References


Notes
Hot and Cold Exciton Dynamics in CdHgTe and HgTe Quantum Dots

Stephen Kershaw
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In previous work [1] we described pump-probe measurements of exciton multiplication (MEG) in organic solutions of Cd$_x$Hg$_{1-x}$Te QDs with MEG QY of 199% +/- 19% when a 4.28 eV (3Eg) excitation pulse energy was used. We have also investigated the MEG threshold in this material in greater detail, making TG measurements at a wider range of pump energies. The previous results at 4.28 eV excitation are confirmed, and below and above 2MEG threshold results are presented. However they are created (hot exciton fission or simply contemporaneous multiple photon absorption), multiple excitons decay very rapidly with the bi-exciton fission lifetime in the alloys typically being around 35-40ps, slightly faster than the 49 ps bi-exciton lifetime seen in pure HgTe QDs (2.9 nm diameter) [2].

On longer timescales, single exciton recovery in II-VI QDs occurs, with average PL decay lifetimes typically around 10 - 200 ns depending on the material and QY. Where radiative recovery can compete with non-radiative processes, high QY results: for CdTe, 80-85% is readily obtained without additional heterostructures. But for the alloys and more so for IR QDs such as HgTe, increasing radiative lifetimes (several hundred ns to over 1 µs) allow non-radiative processes to compete and QYs rapidly fall as the QD bandgap is reduced. For applications requiring QD emission over 2000nm, it is not uncommon to find QD QY much less than 1% [3]. In the light of these results we consider the possible coupling mechanisms between the QD and the surrounding medium, not only as a radiating dipole effect but also as a phonon relaxation process mediated by QD surface-like phonon modes [4].

References


Notes
Cancer is a leading cause of death worldwide accounting for 8.2 million deaths per year and it is expected that annual cancer cases will rise dramatically in the next two decades [1]. To improve the efficiency of cancer treatment and reduce severe side effects there is urgent need for novel drugs and drug delivery systems as well as diagnostic markers.

Synthetic nanoparticles can be applied as “smart drug delivery ferries” for the controlled delivery of drugs, therapeutic nucleic acids and diagnostic markers to specific sites of the human body and are promising tools for cancer therapy. They improve the solubility of incorporated drugs, protect from degradation in biological fluids and enhance the specific uptake and release of drugs into cancer cells. To improve the selective uptake of particles into cancer cells, particles can be functionalized with custom-designed targeting ligands such as peptides or antibodies, allowing personalized medicine. “Intelligent” linkers or molecules that sense and dynamically adapt to their environment can be attached to overcome intracellular barriers and to mediate the triggered release of a drug inside cancer cells.

To improve the efficiency and safety of multifunctional nanoparticles for future clinical application it is important to understand their cellular interactions in detail.

In this talk it will be demonstrated how highly-sensitive fluorescence microscopy can be used to follow the uptake and intracellular trafficking of the described multifunctionalized nanoparticles in living cells. In the acquired movies the cellular attachment, endocytosis and processing of single nanoparticles can be followed in real-time. Due to the high temporal and spatial resolution of this powerful technique [2] mechanistic details of the interaction of nanoparticles with cell components can be revealed. Nanoparticles consisting of DNA complexed by cationic polymers (polyplexes) are investigated [3] as well as mesoporous silica nanoparticles [4] which contain the drug inside the porous network of nanometer-sized channels.

Our data demonstrate that the rational design of “smart” drug delivery ferries can lead to more specific, more efficient and safer drug delivery into cancer cells, in vitro as well as in model animals.

References
Various biological systems in nature orchestrate a high level of adaptability to their environments through the use of smart materials interface. This is exemplified by the lotus leaves which can keep self-cleaning even under dirty water and the beetles living in the dry desert which drink through the collection of tiny droplets in the air, all of which cleverly take advantages of special wettability of their surfaces enabled by their unique micro/nanostructures and low surface energy. On the other hand, by harnessing the slippery lubricant liquid layer, Pitcher plant can easily capture small ants on its surface. The structural and functional integrity in nature provides important insights for the rational design and creation of new classes of functional materials to solve some of the emerging challenges facing us.

In the first part of this talk, I will present the development of various superhydrophobic surfaces that significantly impact thermal-fluid phase transformation processes including dropwise condensation, evaporation and freezing. We show that harnessing the synergistic cooperation between the hierarchical structures, enhancing the droplet nucleation and departure simultaneously, prevent the Cassie-to-Wenzel transition during the evaporation process, and delay the frost/ice formation. Lastly, I will discuss how to significantly promote the droplet detachment from superhydrophobic surfaces through a counter-intuitive pancake bouncing mechanism [6] and novel symmetric-breaking structure.

References
Rhodamine-based dyes have been widely used in the past several decades since the first report on the preparation of rhodamine. It is well-known that many derivatives of rhodamine are in equilibrium between two constitutional isomers with completely different spectroscopic properties. Various rhodamine-based turn-on fluorescent probes for metal cations or oxidative species have been reported in the past few years.

Herein we report a bichromophoric sensory assembly, from the combination of a rhodamine sensing derivative and a luminescent cyclometalated iridium(III) complex [1]. The energy transfer process from rhodamine 6G to the iridium(III) luminophore could be modulated by the ring-opening of the rhodamine 6G through the selective binding of Hg(II) ion (Figure 1). Another novel class of rhodamine derivatives, in which there are two spirolactam groups with five fused six-membered rings will also be discussed [2]. Mercury(II) ion was found to selectively induce ring-opening of the spirolactam groups. In view of the different extent of the π-conjugation upon successive ring-opening processes, different solution color, electronic absorption, and emission responses were found to exhibit in the presence of various concentrations of mercury(II) ions (Figure 2).

References
We have demonstrated plasmonic photocurrent generation from visible to near-infrared wavelengths without deteriorating photoelectric conversion using electrodes in which gold nanorods are elaborately arrayed on the surface of a TiO₂ single crystal [1-3]. We have also reported the stoichiometric evolution of oxygen via water oxidation by irradiating the plasmon-enhanced photocurrent generation system with near-infrared light [4-6]. In the present study, we developed a plasmon-assisted water splitting system that operates under irradiation by visible light; the system is based on the use of two sides of the same strontium titanate (SrTiO₃) single crystal substrate [7]. The water splitting system contains two solution chambers to separate hydrogen (H₂) and oxygen (O₂), respectively. To promote water splitting, a chemical bias was applied by pH values regulations of those chambers. The quantity of H₂ evolved from the surface of platinum, which was used as a reduction co-catalyst, was twice of O₂ evolved from an Au nanostructured surface. Thus, the stoichiometric evolution of H₂ and O₂ was clearly demonstrated. The hydrogen evolution action spectrum closely corresponds to the localized surface plasmon resonance spectrum, indicating that the plasmon-assisted charge separation at the Au/SrTiO₃ interface promotes water oxidation and the subsequent reduction of a proton on the backside of the SrTiO₃ substrate. We have elucidated furthermore that the chemical bias is dramatically reduced by plasmonic effects, which indicate the possibility of constructing an artificial photosynthesis system with low energy consumption.

According to the analogous method of the water splitting system, we have successfully constructed the artificial-photosynthesis system which produces the ammonia by a photofixation of a nitrogen molecule based on visible light irradiation [8]. Unlike the water splitting system, ruthenium is used as a co-catalyst instead of platinum for the ammonia synthesis, and not a solution system but a gas system is used to reduce nitrogen gas. The action spectrum of the apparent quantum efficiency of ammonia evolution showed good agreement with the plasmon resonance spectrum. Therefore, we succeeded in photoelectrochemical synthesis of ammonia by the visible light irradiation through the plasmon-induced charge separation.

References
D printing originally refers to processes that sequentially deposit material onto a powder bed with inkjet printer heads. More recently the meaning of the term has expanded to encompass a wider variety of techniques such as extrusion, sintering and polymerization based processes. So far, 3D printing has been considered as a promising technology for customized manufacturing, mostly for production of macro-scale objects, namely, with dimensions not less than millimeters. In this talk, we will show that laser-based 3D printing at nanoscale is an even more exciting research field. It allows for micro-optical, micro-electronic, micro-mechanical, micro-fluidic, micro-optoelectronics, sensing, biological and biomimetic structures and devices that are otherwise not possible. Laser-nano 3D printing provides a new avenue and a powerful tool for both fundamental research and industrial applications. This talk will focus on the recent progress in my lab along the above line.
For spin qubits in optically active quantum dots (QDs) the hyperfine coupling between the localised spin and the nuclear spin environment is of central importance. The hyperfine coupling to the nuclear spin bath gives rise to a local effective hyperfine field ($B_n$) in which the electron spin evolves coherently over nanosecond timescales [1]. However, the amplitude and direction of $B_n$ changes over time due to the back-action of the resident electron on the nuclear spin bath inducing an irreversible relaxation of the central spin and loss of coherence [2]. The time dependent hyperfine field alone cannot lead to complete relaxation of the central spin [3] and quadrupolar couplings of the nuclear spin bath to the strain induced electric field gradients in strained dots can induce fast dynamics of $B_n$ leading to spin relaxation at low magnetic fields [4].

In this talk, I will present ultrafast optical studies of the dynamics of a single electron spin, optically prepared in an individual InGaAs QD over ultra-long timescales extending into the microsecond range. Hereby, we utilize devices in which a single electron spin can be optically prepared in the dot over picosecond timescales, orientated with near perfect fidelity (~98%) along the optical axis and stored over millisecond timescales. After a well-defined storage time we directly measure the electron spin projection along the optical axis and find that the electron spin at low magnetic fields exhibits two distinct relaxation regimes; (i) a first stage over ~1.4ns arising from the coherent spin dynamics in the randomly orientated, but static Overhauser field with a fluctuation amplitude that we measure to be ~12 mT and (ii) a second stage occurring over a characteristic time of ~300 ns shown to arise from quadrupolar interactions within the nuclear spin ensemble. Comparison with theory that includes hyperfine and quadrupolar interactions provides excellent quantitative agreement, indicating that quadrupolar coupling is twice as strong as the hyperfine interactions. Finally, electron spin coherence timescales are measured using all-optical spin echo techniques as a function of the static magnetic field. The figure shows typical spin echo amplitude versus time for several B-fields, revealing complex oscillatory dependencies and an abrupt transition arising from quadrupolar induced electron spin relaxation. Our methods facilitate measurement of higher order quantum correlations via weak measurements of the electron spin.

References
Two-dimensional layered ‘van-der Waals’ materials are of increasing interest for fundamental research as well as device applications in the areas of electronics, spin- and valleytronics, as well as optoelectronics and sensing. Beyond graphene, the transition metal dichalcogenide (TMDC) family is subject of intense research due to their electronic band gap in the visible range, their stability and inertness in aqueous environment. TMDCs facilitate the realization of purely 2D heterostructures with various functionalities by combination e.g. with graphene and other 2D materials.

We utilize power and gate voltage dependent non-resonant and resonant µ-Raman spectroscopy on dual-gate field-effect transistor (FET) devices to study doping effects, e-ph coupling and excitonic states in mono- and few-layer MoS$_2$ FETs. In non-resonant Raman measurements, a strong power- and gate voltage dependence of zone-center Raman modes is observable \cite{1}. We find that the strength of the doping induced phonon-renormalization of the A$_{2g}$ mode is inversely proportional to the number of layers. We interpret this observation with a homogenous distribution of the free electrons over all individual layers. Under resonant excitation, a rich doping-dependent scattering spectrum emerges with signatures for multistep scattering processes. We further report on photocurrent spectroscopy experiments on mono-layer MoS$_2$. These investigations provide access to the mechanisms for photocurrent generation, charge dissociation and the related charge transport dynamics.

I gratefully acknowledge the cooperation with Bastian Miller, Eric Parzinger, Anna Vernickel, Jakob Wierzbowski, Jonathan Finley, Jessica Lindlau, André Neumann, Alexander Högele and Alexander Holleitner. We acknowledge financial support by the DFG excellence cluster Nanosystems Initiative Munich, the Center for NanoScience (CeNS), the DFG project HO 3324/4-3, and BaCaTec.

References

In this work, we demonstrate a facile but reliable photolithographic technique, which allows the rapid fabrication of highly ordered nanostructure arrays by employing soft transparent polymer films as optical masks for the area-selective exposure of a photoresist upon flood UV illumination. The soft polymer film either contains a monolayer of self-assembled (SAM) colloidal spheres inside at the near surface or has one side replicated from a SAM colloidal layer, in which the confined colloidal spheres or the surface textures can serve as lenses for light focusing. The geometrical feature of the patterns, including the size, pitch, and even the shape, can be finely tuned by adjusting the mask design, exposure time and the thickness of the photoresist layer. Instead of a single usage, the polymer mask can be used numerous times without noticeable distortions in the achieved patterns. The obtained patterns could be used as deposition or etching mask, allowing easy pattern transfer for various applications.
Gels and aerogels manufactured from a variety of nanoparticles available in colloidal solutions have recently proven to provide an opportunity to marry the nanoscale world with that of materials of macro dimensions which can be easily manipulated and processed, whilst maintaining most of the nanoscale properties [1]. The materials carry an enormous potential for applications. This is largely related to their extremely low density and high porosity providing access to the capacious inner surface of the interconnected nanoobjects they consist of. The aerogel materials may be further processed in order to achieve improvements in their properties relevant to applications in optical sensing and catalysis.

The commercialization of polymer electrolyte fuel cells (PEFC) is still hindered by the cathode electrocatalyst for the oxygen reduction reaction (ORR) not fulfilling the criteria of low cost, high performance, and high durability. We recently developed a facile strategy for the controllable synthesis of nanoparticle-based bi-metallic PtPxPdy aerogels with high surface area and large porosity, which act as highly active and stable catalysts for the ORR in PEFC cathodes. In addition to excellent durability the PtPxPdy aerogels show superior electrocatalytic activity towards the ORR with the Pt80Pd20 aerogel exhibiting a five times mass activity enhancement compared to commercial Pt/C catalysts [2].

The reminder of the presentation will be devoted to a) ordered superstructures of nanoparticles [3], and b) nanocrystals incorporated into macrocrystals of varying compositions [4]. The ordered superstructures (mesocrystals) are composed of IV-VI semiconductor nanocrystals (8 – 15 nm in diameter) and stretch to dimensions in the 100 micrometer range. In the latter superstructures the nanocrystals exhibit remarkable photostabilities and enhanced emission quantum yields.

References
Nanostructured materials with novel optoelectronic functionalities play a key role in developing the new generation of solar cells. In particular, the performance of sensitized solar cells and solar fuel generation devices largely determined by suitably designed nanostructures for charge separation, transport and catalysis. This presentation will highlight some of our recent results in understanding, interfacing and assembling different nanomaterials for efficient solar energy conversion. First, I will focus on the construction of novel mesoscopic photoanodes of dye-sensitized solar cells (DSSCs), quantum-dot sensitized solar cells and most recently, perovskite solar cells. Power conversion efficiency (PCE) of over 10% can now be readily obtained by judiciously engineering the interfaces. Second, I will discuss our developments of various nanostructures for solar fuel generation devices, including nanostructures catalysts, photocatalysts and light harvesters.

References


Several approaches to enhance the light absorption and carrier extraction of organic solar cells (OSCs) will be investigated. For the light management, a theoretical and experimental study OSCs with multiple metallic nanostructures is presented in this talk. From theoretical study, the physics of the performance enhancement of OSCs is explained by multiphysics model of plasmonic organic solar cells. Meanwhile, we have also experimentally investigated the plasmonic-optical and plasmonic-electrical effects with various metallic nanostructures such as metallic nanoparticles and metallic nanogratings into different regions of the solar cells. For the plasmonic-optical effects, we demonstrate the enhancement of light absorption in the active layer and thus the improvement of photogenerated current. Regarding the electrical effects due to the incorporation of metal nanostructures, we realize the hot carrier effects and the charge storage effects separately and achieve improvement of the OSC performance. Recently, we also experimentally and theoretically break the space-charge limit of OSCs by a novel plasmonic-electrical concept. Our results show that the power conversion efficiency of OSCs can be enhanced by over 30% and the value of power conversion efficiency can reach about 9.2% depending on the metallic nanostructures, device structures, and the polymer materials. Details of the improvement will be discussed.
Radio Frequency Acousto-Mechanical Tuning of a Photonic Molecule

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We propose and demonstrate a dynamically tunable photonic molecule (PM) formed by two L3 defect cavities defined in a GaAs two-dimensional photonic crystal membrane. To optomechanically tune the resonances of the two cavities forming the PM we employ the dynamic acousto-mechanical deformation induced by an 800 MHz surface acoustic wave (SAW) [1]. For this frequency the cavity separation matches half the acoustic wavelength. Thus, the resulting SAW-driven sinusoidal spectral modulations of the two modes are opposite in phase giving rise to a time-dependent detuning Δ(t). We monitor of the mode spectrum in the time-domain by probing the time-resolved stroboscopic PL emission [2] of off-resonantly coupled quantum dots. For a PM with finite detuning Δ0, we observe for low acoustic amplitudes the established but out-of-phase spectral oscillation of two uncoupled modes. As we increase acoustic amplitudes Δmax ≥ Δ0, we resolve a characteristic anti-crossing of the two cavity modes in the time domain. From the observed splitting we are able to deduce the PM coupling strength. The coupling is further confirmed in spatially and time-resolved PL maps showing delocalization of the modes over both cavities at resonance.

References
The advantages of liquid crystal (LC) nanoscale photoalignment and photopatterning technology in comparison with common “rubbing” alignment methods tend to the continuation of the research in this field. Recently the new application of photoaligned technology in photonics and displays was proposed.

A tunable-focus liquid crystal (LC) lens will be achieved using variable pretilt angle in the LC layer obtained by exposing the photoalignment layer by UV light. The focal length of the LC lens can be worked out according to the retardation profile and it is electrically tunable. The LC lens will be compact, lightweight, low-cost, and highly efficient. The applications in adaptive optics, optoelectronics, machine vision, 2D/3D switchable LCD, and eyeglasses are envisaged. The bulky mechanically adjusted lens system currently used should be replaced by the compact, lightweight, low-cost, and efficient LC lens configuration.

New e-paper displays, based on photo-aligning optically rewritable (ORW) technology will also be developed. The advantages of ORW e-paper: no drivers, no current conducting layer, high thickness tolerance, the technology is very cheap (the price of ORW e-paper is almost equal to the price of the two polarizers). The ORW technology is highly compatible with flexible substrates. New optically rewritable (ORW) LC photonics devices with a light controllable structure may include LC plane waveguides, Fresnel lenses and wave plates, etc.

Fast high resolution ferroelectric liquid crystal devices (FLCD) are obtained through the application of nano-scale photoaligning (PA) layers in FLC cells. The novel photoaligned FLC devices may include field sequential color (FSC) FLC with a high resolution, high brightness, low power consumption and extended color gamut to be used for PCs, PDAs, switchable goggles, and new generation of switchable 2D/3D LCD TVs, as well as photonics elements such as voltage controllable lenses, light converters, beam steering devices, light modulators, diffraction gratings etc. The FSC FLC micro display is now one of the most advanced technologies for pico-projectors.
Photodetectors with short-wave infrared (SWIR) sensitivity are designed specifically for applications such as biomedical imaging and night vision cameras. Presently SWIR photodetectors rely on expensive epitaxially-grown semiconductor structures, such as InGaAs p-i-n photodiodes. The development of low-cost alternatives to such structures would greatly expand the scope of applications for SWIR photodetection. In this talk I will present our recent efforts on developing SWIR photoconductor, photodiode and phototransistor structures based on colloidal HgTe quantum dot (QD) active materials. In particular I will focus on film deposition methods, design and characterization of different device structures, and relationship between the microscopic charge transport and charge trapping properties and the macroscopic photodetector performance.
The next-generation electronic systems are expected to be light, flexible and portable for applications in large area displays, integrated circuits (ICs), light emitting diodes (LEDs), radio frequency identification (RFID) tags, solar cells and so on. Memory is an essential part of advanced electronic systems for data processing, storage and communication. Among many types of memories such as ferroelectric, electret, resistive and floating gate [1, 2] memories, floating gate flash memory devices have gained a great deal of attention due to the simple device structure, non-destructive read-out and controlled charge trap capacity [3-5]. In this presentation, solution processed or printed materials for flash memories on plastic substrates for data storage will be discussed.

References


ZnO is a wide band gap semiconductor which can be grown in a variety of nanostructured morphologies by relatively simple and inexpensive methods. It has a very complex defect chemistry, so that its properties can vary significantly depending on the growth method, growth conditions, and the post-growth treatment. We will discuss the relationship between synthesis conditions, post-synthesis treatment and the properties of ZnO nanostructures. The possible applications in optoelectronic devices (light emitting diodes, solar cells), as well as for photocatalysis (pollutant degradation as well as antibacterial activity) will be discussed in detail. In particular, we will discuss the importance of interface / surface defects on the performance of light emitting devices, the correlation between certain features in photoluminescence spectra and solar cell performance, as well as the effect of defects and surface properties on photocatalytic activity.
Light Emission Mechanism and Excited-State Properties of Low-Dimensional Carbon and Silicon Nanostructures

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14:00

Low dimensional carbon and silicon nanomaterials offer promising applications in photovoltaics, nanoelectronics and thermoelectronics, owing to their tunable physical properties such as size-dependent indirect-to-direct band gap transitions and thus efficient optical transitions in visible ranges. These tunable properties are facilitated by their quantum confinement effects and large surface-to-volume ratios as we have demonstrated over the years based on our computational studies. This presentation will include our work that revealed the size dependencies of energy gaps of small carbon quantum dots [1], zero-dimensional silicon quantum dots, one-dimensional silicon nanowires and two-dimensional silicon nanosheets [2-4]. Interestingly, we also found that, due to their finite size and the significant localization of their electrons upon excitation, silicon nanostructures in excited states generally undergo severe relaxation and thus show a significant Stokes shift at a diameter less than 1.5 nm for quantum dots and 2.6 nm for nanosheets [5]. The effect is much reduced at a larger size due to the improved structural rigidity and also the delocalization of the excited electrons. The latter can also be achieved by elongating the nanostructure in a certain direction. In addition, the boundary or surface could influence the degree of localization of the excited state. Silicon nanosheets are more easily to form self-trapped excitons [6]. Our findings are helpful for designing carbon and silicon nanostructures for optoelectronic applications.

References


Notes
Plasmonic nano-particle dimers are well known to create strongly enhanced electromagnetic fields, localized within nanometer-sized optical volumes within feed-gaps separating the component particles. As such they enhance the local linear and non-linear optical response, a key ingredient for enhanced spontaneous emission dynamics, nanoscale optical switching technologies or frequency conversion in future integrated photonic circuits.

Here, we present detailed numerical, structural and optical studies of the linear and non-linear optical response of lithographically defined bowtie nano-antennas, consisting of two metal triangles arranged in a tip-to-tip configuration. Such plasmonic structures provide very large electromagnetic intensity enhancements of up to >103× in the feed-gap. We fabricated gold bowties on glass and GaAs substrates [1] with triangle sizes and feed-gaps down to 100 nm and 10 nm, respectively. Those structures enable the generation of coherent and incoherent optical fields in the visible region of the spectrum arising from non-linear optical processes. We demonstrate second harmonic generation and two-photon photoluminescence [2] and explore the dependence of the non-linear optical signals on antenna geometry, substrate, fundamental excitation frequency and polarization. This facilitates optimization of the non-linear signal and, moreover, provides a tool to directly quantify the maximum field enhancement in experiments. Simulations suggest local intensity enhancements up to >2300× and an s-3-dependence on the feed-gap size. Moreover, we observe after first fs-excitation of the bowties on a glass substrate a strong increase of the overall non-linear intensity, attributed to structural modifications of the antenna feed-gap due to the short (~100 fs), high power (0.15 GW/cm² per pulse) excitation pulses. This finding is attributed to thermal melting of gold and a subsequent optical formation of metal particles inside the feed-gap. This structural modification and the simultaneous enhancement of the non-linear optical response is supported by high resolution scanning electron microscopy of the bowties after illumination and by theoretical modeling of the plasmonic response of a bowtie with 4 nm sized metal nanoparticles located inside the feed-gap.

Finally, we will also report on first observations of light-matter-coupling between the plasmonic field concentrated in the bowtie feed-gap and near-surface self-assembled InGaAs quantum dots. Here, we observe an increase of the quantum dot photoluminescence intensity by a factor of >5x, accompanied with an enhanced spontaneous emission rate, giving rise to Purcell Factors of >3x, limited by the temporal resolution of our setup.

Our results pave the way towards novel linear and non-linear light-matter-couplings in future semiconductor-plasmonic hybrid nanostructures.

References
I will present recent results of our experiments to demonstrate nuclear magnetic resonance (NMR) on nanoscale samples such as macromolecules, using a single NV center as a detector for nuclear magnetization. This defect center in diamond can serve as a fluorescent nanosensor for magnetic and electric fields, thanks to its ground state electron spin, which is sensitive to magnetic and electric fields and which can be measured and initialized by optical means.

My talk will include a review of the first proof-of-principle experiments employing this novel sensor to detect the nuclear magnetization of nanoscale samples [1,2].

Mainly, however, I will focus on a recent demonstration of magnetic resonance imaging, using a single NV center as a scanning probe to detect nuclear spin ensembles with chemical contrast and a spatial resolution in the 10 nm range [3].

References

The rapidly emerging DNA nanotechnology began with pioneer Seeman’s hypothesis that DNA not only can carry genetic information but also can be used as molecular organizer to create well-designed and controllable nanomaterials for applications in materials science, nanotechnology and biology [1]. DNA-based self-assembly represents a versatile system for nanoscale construction due to the well-characterized conformation of DNA and its predictability in the formation of base pairs. The structural features of nucleic acids form the basis of constructing a wide variety of DNA nanoarchitectures with well-defined shapes and sizes, in addition to controllable permeability and flexibility [2]. More importantly, self-assembled DNA nanostructures can be easily functionalized to construct artificial functional systems with nanometer scale precision for multi-purposes. My talk will focus on the design and self-assembly of DNA-based nanostructures and exploration of their potential applications in targeted drug delivery, therapeutics and diagnostic [3].

Acknowledgement: Financial support by National Science Foundation of China, Hong Kong Research Grant Council and City University of Hong Kong.

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P1. **Template Synthesis of CuInS$_2$ and CuInZnS$_2$ Nanocrystals from In$_2$S$_3$ Nanoplates and their Compositional Tunable Bandgaps**

Bingkun Chen$^{1,2,3}$, Deyao Li$^2$, Liangliang Chen$^2$, Yongtian Wang$^3$, Bingwuo Zou$^{1,2}$, Haizheng Zhong$^2$, and Andrey L. Rogach$^3$

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We report the synthesis of CuInS$_2$ nanocrystals with tunable morphology, chemical compositions and bandgaps through incorporation of Cu$^+$ ions into In$_2$S$_3$ nanoplate templates. The shape of the resulting CuInS$_2$ nanocrystals can be tailored from larger nanoplates to small nanodots by tuning the incorporation temperatures, and the chemical composition can be controlled by the amount of copper ions in the reaction mixture. As a result, bandgaps of CuInS$_2$ nanoplates can be tuned from 1.45 to 1.19 eV with Cu/In molar ratios increasing from 0.72 to 2.89, which was demonstrated by cyclic voltammetry. Furthermore, we have used this template-synthesis method to produce quaternary CuInZnS$_2$ nanocrystals with red emission through injection of both Cu and Zn precursors into a solution of In$_2$S$_3$ nanoplates at high temperature.

P2. **Size Effects on Photocatalytic H$_2$ Generation with CdSe/CdS Core-Shell Quantum Dots**

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Spherical CdSe/CdS core-shell nanocrystals constitute a very convenient model system in which the charge carrier dynamics in photocatalytic applications can be studied due to the possibility to precisely control the structure and favourable optoelectronic properties [1]. In addition, in comparison with well known CdSe/CdS dot-in-rod structures, they allow for significant extension of the usable absorption range beyond the blue region. Accordingly, we have synthesized several types of the nanocrystals, varying the CdSe core size and the CdS shell thickness for several different values of these two parameters. The particles in aqueous dispersion were in situ decorated with Ni nanoparticles [2] and evaluated for photocatalytic hydrogen generation capacity. The highest H$_2$ production quantum yield at 457 nm illumination was 4.7%, while at 530 nm it rose to 9.1%. We have found that ensuring equal absorption at illumination wavelength the H$_2$ formation rate increases with the shell thickness, but decreases with the increasing core size [3]. Interestingly, the same trend was observed for the photoluminescence quantum yield and lifetime for samples without Ni decoration, suggesting that they both compete with the non-radiative recombination pathways and thereby reflect the balance between charge transfer and avoidance of recombination sites.

Optimizing these seemingly contradictory phenomena is crucial for photocatalysis with semiconductor nanocrystals. In this context, the work provides important insights into the photocatalysis with semiconductor nanocrystals and suggests that the photoluminescence QY could be used as a convenient indicator of photocatalytic performance.

References

A novel 3-dimensional polymer nanotube structure decorated with a noble metal nanoparticle monolayer was prepared by polymer melts technique. This unique structure shows dramatically enhanced SERS performance and is promising for chemical detection with high sensitivity and reproducibility.

Herein, we describe a simple and stable method for the decoration of polyethylene nanofibers/nanotubes with noble metal nanoparticles by using the polymer melts wetting technique which has been used for preparing polymer nanofibers/nanotubes. Polyethylene is chosen as the polymer because it is hard to decorate PE with metal nanoparticles through any technique due to its simple repeating units (CH₂) without any functional group. We systematically investigate the preparation, property of the unique 3D structure of PE nanotubes coated with AgNPs and demonstrate their application for highly sensitive surface-enhanced Raman scattering (SERS) detection of 4-ATP and R6G.

References

P4. 2D NANOSHEET-BASED 1D PHOTONIC CRYSTALS WITH GIANT HUMIDITY RESPONSIVENESS
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I 1D photonic crystals (1D PCs), also referred to as Bragg stacks (BSs), are periodic multilayered nanostructures exhibiting optically encoded response to chemical, physical or biological stimuli. Being inherently stimuli-responsive systems which can be fabricated by straightforward wet chemistry methods, these photonic architectures are promising candidates for label-free “smart” optical detectors. The sensing mechanism is based on the manipulation of the photonic band gap - a forbidden spectral range for photons propagating through the nanostructure at certain directions and energies. Due to the tunability of the photonic stop band with respect to its energy as well as transmission and reflection properties, the Bragg stacks can respond sensitively to physical changes such as temperature or chemical stimuli such as the relative humidity. Thus, BSs are capable of translating a chemical fingerprint into an optical read-out by means of a shift of the stop band. Herein, we present 1D PCs fabricated by bottom-up assembly from colloidal ly stable suspensions of phosphate-based 2D nanosheets, which show an ultrasensitive response to local humidity changes caused by the moisture-induced swelling capacity of the nanosheets. The resulting full spectrum color change is indicative of ultrahigh sensitivity towards water vapour, accompanied by fast response times and high reversibility. We demonstrate reversible moistureinduced transparency switching, which make these devices competitive candidates for optical humidity sensors.

References
P5. Design of Iridium(III) Poly(ethylene glycol) (PEG) Complexes as Photoactivatable Cytotoxic Agents

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Photoactivatable molecules are attractive biological reagents for diagnostic and therapeutic applications because they allow exceptionally high spatial and temporal control. In the past decade, transition metal complexes with low ligand lability have been found to display interesting cytotoxic activity due to their molecular structure and chemical properties. Interestingly, we have previously discovered that the cytotoxicity of transition metal complexes can be readily reduced by the incorporation of a cytotoxicity-attenuating group (CAG) such as PEG. In this work, we have designed photoactivatable iridium(III) PEG complexes, such as [Ir(pq)2(bpy-NPE-PEG)]+, that contained a photolabile group between the iridium(III) polypyridine core and the PEG pendant, and studied their photophysical, photochemical, and biological properties. These complexes showed high biocompatibility towards HeLa cells in the dark, but exhibited considerable cytotoxicity upon irradiation. The enhanced cytotoxic potency was due to the photo-release of the iridium(III) polypyridine unit.

We thank City University of Hong Kong (Project No. 7004210 and 9667090) for financial support.

References


**P6. PHOTOCATALYTIC CARBON DIOXIDE REDUCTION ON Cd/Cu SULFIDE NANORODS**

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Copper (I) compounds have the capability to act as both light absorber and co-catalyst and are therefore considered to be the most promising materials for carbon dioxide photoreduction. Therefore, we have used Cu(I) decoration on CdS nanorods to catalyze the reduction of CO2. Novel effects of light-induced cation exchange leading to the creation of Cu2-xS nanostructures from CdS nanorods have been observed under atmospheric conditions and in aqueous environment. The involved copper source consists of a Cu(II) compound, differing from the mostly used Cu(I) ones. The optoelectronic properties of the created materials are very interesting because of the plasmonic features generated from copper vacancies.

The results of the photocatalytic measurements show the possibility to reduce carbon dioxide into methane and carbon monoxide with a compelling connection between the cation exchange processes and the photocatalytic efficiencies. We also show that decoration of CdS nanorods with copper provides high selectivity towards carbon dioxide reduction in competition with H+ reduction from water.

**P7. NEW PHOSPHOROGENIC BIOORTHOGONAL PROBES DERIVED FROM BISCYCLOMETALATED IRIUM(III) BIPYRIDINE NITRONE COMPLEXES**

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Bioorthogonal labeling has been developed as a useful and versatile method for imaging biomolecules of interest in their native environment. Recently, nitrene has been introduced as an alternative to azide for strain-promoted 1,3-dipolar cycloaddition with faster reaction kinetics. With our ongoing interest in the design of phosphorescent transition metal complexes as biological probes and bioorthogonal labeling reagents [1-3], we envisioned that the modification of phosphorescent cyclometalated iridium(III) polypyridine complexes with a nitrene moiety will generate a new class of bioorthogonal probes with interesting photophysical properties. Thus, we have designed and synthesized a series of biscyclometalated iridium(III) bipyridine complexes containing a nitrene moiety. Upon photoexcitation, these complexes displayed extremely weak yellow to red phosphorescence under ambient conditions. Upon reaction with cyclooctyne derivatives such as (1R,8S,9s)-bicyclo[6.1.0]non-4-yn-9-ylmethanol (BCN-OH), they showed substantial phosphorescence enhancement due to conversion of the nitrene moiety to isoxazoline. These complexes can selectively label cyclooctyne-modified biomolecules and the resulting bioconjugates exhibited strong phosphorescence upon photoexcitation. Our results demonstrated that these complexes can be utilized as a new class of bioorthogonal labeling reagents with novel phosphorogenic properties.

References


P8. Surfactant-Assisted Chemical Vapour Deposition of High-Performance Small-Diameter GaSb Nanowires
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Although GaSb NWs have been widely explored as promising active channel materials for various technological applications, the required performance improvement still lags behind the expectation, largely suffering from the uncontrolled radial VS growth during the NW synthesis. In this work, we report the use of sulfur surfactant in chemical vapour deposition to achieve very thin and uniform GaSb nanowires with diameters down to 20 nm. In contrast to surfactant effects typically employed in the liquid phase and thin-film technologies, the sulfur atoms contribute to form stable S-Sb bonds on the as-grown nanowire surface, effectively stabilizing sidewalls and minimizing unintentional radial nanowire growth. When configured into transistors, these devices exhibit impressive electrical properties with the peak hole mobility of ~200 cm²V⁻¹s⁻¹, better than any mobility value reported for a GaSb nanowire device to date. Moreover, this surfactant-assisted CVD scheme might also be employed as a growth platform for other NW material systems, such as other typical III–V semiconductors of GaAs. These facts demonstrate that the use of sulfur surfactant enables the growth of uniform, well-controlled, small-diameter GaSb NWs, with impressive electrical properties and could open up the possibility for many practical applications.

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Metal cluster-semiconductor systems are promising new hybrid materials for combined light harvesting and conversion into chemical energy. In this regard single crystal studies in the UHV are prerequisite for an understanding of the detailed mechanism of such complex hybrid systems. Ethanol is an ideal model system for such investigations, since it is a renewable feedstock for photocatalytic hydrogen production and a precursor for more complex fuels. In this work we present a discrimination between different photocatalytic reaction pathways on TiO₂(110). Ethanol is photocatalytically oxidized to acetaldehyde. In our approach we accumulate the main photoreaction product acetaldehyde at cryogenic conditions and use temperature programmed desorption (TPD) as quantification technique. On the other hand we present isothermal experiments performed at the acetaldehyde desorption temperature to demonstrate a photoreaction by direct detection of product molecules. Our experiments reveal, that the photooxidation does not require O₂ molecules. On the pure TiO₂ single crystal, no molecular H₂ is produced during the photoreaction, but water is identified as a by-product. Our results provide the basis to expand the work on other semiconductor systems (e.g. GaN thin films with different dopant concentrations) and investigations with metal clusters as viable co-catalysts.

References
**P10. DEFECT CREATION AND FUNCTIONALIZATION OF DELICATE SURFACES VIA SURFACE MECHANICAL ATTRITION TREATMENT**

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Defect-based material engineering has found a niche in bandgap modification, photocatalysis and energy storage. Using a process called surface mechanical attrition treatment (SMAT) - normally reserved for deforming the surfaces of bulk material - we propose that this process can also be applied to delicate surfaces, allowing for the creation of strain and defect-based effects through stress concentration, vacancy creation, and/or dopant injection. Furthermore, with the great diversity of processing parameters of SMAT, one can deliver tailored treatment specific to the surface being modified as well as for the functionality being desired.

In this work, we illustrate this concept by implementing SMAT in the modification of titanium dioxide (TiO2) nanotube arrays, leading to improved photocatalytic efficiency under solar radiation. We also suggest that with the further inclusion of surface dopants due to SMAT - when combined with the strain induced by said process - also yield a synergistic effect in light-harvesting in the modified TiO2, which has led to additional long-term operational stability on top of improved photocatalytic behavior being observed. Finally, with the enhanced defect creation via SMAT, the capacitance of the material has been enhanced from its original performance, demonstrating the value of using SMAT as a novel step in the functionalization process, as well as an effective post-treatment on already functionalized surfaces.

**P11. FABRICATION OF (SUPRA)MOLECULARLY PRECISE 2D MATERIAL DEVICE ELEMENTS**

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The recent spotlight on highly crystalline natural-occurring and synthetic two-dimensional materials (2DMs) stands as a unique opportunity to accelerate atomically-precise technology. Here we explore the fabrication and characterization of 2D material devices of supramolecular networks with graphene attaining molecular precise disposition of all elements at interfaces. We present the first technologically relevant, photovoltaic response of a by-design artificial 2DM consisting of a bicomponent supramolecular network on transparent, graphene-passivated HC(100) diamond [1] and employing a gallium droplet as a counter electrode. Our results pave the way toward atomically precise (opto)electronic technology.

References


**P12. Near-to-Mid Infrared HgTe QD Heterojunction Photodiode Photodetectors**

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HgTe colloidal quantum dots (QDs) are a promising material for photodetection applications due to their solution processibility and wide spectral tunability in the near-infrared to mid-infrared wavelength range. HgTe QD photoconductive photodetectors with mid-infrared sensitivity have been reported; however, these devices often suffer from slow temporal response and limited photactive area due to the planar configuration. In this study, we demonstrate and analyze the first HgTe QD heterojunction photodiode that exhibits photoresponse up to 3 µm at room temperature. We compared the HgTe QDs synthesized in aqueous and organic phases, and developed deposition processes for each type of QDs to achieve compact QD film morphology. The device performances of the aqueous QDs and organic QDs were calibrated and compared in terms of temperature-dependent current-voltage characteristics, external quantum efficiency, and transient photocurrent response. The results reveal the effects of trap states and built-in electric field on the responsivity and bandwidth of different device structures and material systems.

**P13. Electric Field Induced Control of Emission and Valley Polarization in Few-Layer MoS₂ Devices**

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The recent discovery of truly two-dimensional direct band gap layered nanomaterials has paved the way for novel optoelectronic and quantum applications. Hexagonal transition metal dichalcogenides (TMDs) such as MoS₂, MoSe₂, WSe₂ and WS₂ exhibit a direct band gap in the monolayer limit and are very promising candidates for studying fundamental new physics. The inherent breaking of inversion symmetry accounts for a giant spin-orbit induced splitting of the valence band up to 450 meV in WSe₂.

Time-reversal symmetry paired with inversion symmetry breaking lifts the Kramer’s spin degeneracy at the corners of the hexagonal Brillouin zone (K-points) leading to coupled spin and valley pseudospin physics. Consequent valley optical selection rules provide access to these quantum degrees of freedom by employing circular polarized light.

Here, we present the electrical control of exciton emission energies and spin-valley photophysics in few-layer MoS₂ crystals embedded within electrically tunable micro-capacitor structures. By tuning the applied gate potential we induce a strong DC Stark shift up to ≈11 meV for monolayer crystals and ≈ 18 meV for five-layer MoS₂. We find effective dipole moments and exciton polarizabilities on the order of $p = 4 \times 10^{-6}$ meV/(kV/cm) and $\beta = 1 \times 10^{-9}$ meV/(kV/cm)², respectively. In low-temperature polarization-resolved µ-photoluminescence studies, we observe a strong electric field tunability of the exciton spin-polarization in bilayer MoS₂ crystals. Due to the inversion symmetry breaking character of the perpendicular applied electric field, we are able to continuously tune the degree of circular polarization of the emission ranging from $\eta = 20\%$ up to 65%. Our results demonstrate the potential for emergent spin- and valleytronic devices based on two-dimensional atomically thin crystals.
**P14. Novel Three-Dimensional Branched Core/Shell Nanostructures for High-Performance Lithium Ion Batteries**

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Lithium ion batteries (LIBs) have attracted significant attention as they show great promise as power sources for portable electronic devices because of their high energy density, flexible light weight design and long cycle life. However, conventional graphitic anodes in LIBs cannot provide high power densities due to slow diffusivity of lithium ions. Thus, seeking appropriate anode materials to replace graphite for high-performance LIBs is of great interest. Nanostructured metal oxides (NMOs), have long been studied as potential electrode materials for LIBs owing to their superior advantages over conventional graphite such as high specific capacities and easy of fabrication in large-scale. On this account, our research goal is to have scrupulous design and smart combination of advanced NMOs electrodes into three-dimensional (3D) branched core/shell heterostructured nanowire arrays that are directly aligned on the current collector by simple but powerful methods to achieve greatly enhanced performance.

**P15. Ultrafast Electronic Readout of Diamond Nitrogen-Vacancy Centers Coupled to Graphene**

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Its superior optoelectronic properties turn graphene into an excellent material to examine near-field coupling to fluorescent emitters [1]. The excitation energy of a nanometer-distanced emitter can be transferred to graphene via a dipole-dipole interaction. This nonradiative energy transfer (NRET) can increase the absorption compared to a bare graphene device and allows to electronically readout the excitation state of the fluorescent emitter.

We apply an ultrafast photocurrent spectroscopy [2,3,4] to detect the non-radiative energy transfer from fluorescent emitters, namely nitrogen-vacancy centers in nano-diamonds, to graphene with a time resolution of picoseconds. The nitrogen vacancy centers are considered to play a fundamental role in new quantum information technologies. On the picosecond timescale the described NRET efficiency is close to 100%. Therefore, our experiments demonstrate that the NRET can be exploited as an electronic read-out process of the electron spin in nitrogen vacancy centers in the nano-diamonds [5].

References


P16. ULTRASENSITIVE PLASMONIC RESPONSE OF BIMETALLIC Au/Pd NANOSTRUCTURES TO HYDROGEN
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Hydrogen is one of the most promising clean and sustainable energy carriers for the replacement of current carbon-based energy sources. For the wide applications of hydrogen energy, hydrogen sensing becomes a very crucial step owing to the highly explosive nature of hydrogen. Conventional hydrogen sensors have been realized typically by detecting the electrical conductivity change of devices. Electrical measurements suffer from possible electric sparks, which are dangerous for flammable and explosive gases. In contrast, optical gas sensors offer advantages of remote and contact-free readout and therefore the avoidance of spark generation. Herein, we report on an optical hydrogen sensing approach based on bimetallic Au/Pd nanostructures. Au nanostructures can support localized surface plasmon resonance, which is very sensitive to the refractive-index change of the surrounding medium. Pd can absorb hydrogen, which gives rise to large refractive-index changes. Bimetallic Au/Pd nanostructures integrate these two properties in single nanostructures and therefore can realize optical hydrogen sensing. We prepared bimetallic Au/Pd nanostructures with continuous and discontinuous Pd shells. The plasmonic response to hydrogen is monitored by directly measuring the extinction spectra of the ensemble Au/Pd nanostructures deposited on glass slides. Introduction of hydrogen induces red plasmon shifts, which become larger for the nanostructures with thicker Pd shells. For the nanostructures with continuous Pd shell, the plasmon shift can reach 56 nm at the hydrogen volume concentration below the explosion limit. The plasmon resonance wavelength displays an excellent linear dependence on the hydrogen volume concentration below 1%. The detection limit in the experiments reaches 0.2 vol%. The nanostructures with discontinuous Pd shell show smaller plasmon shifts than those with continuous Pd shell. The extinction measurements on the ensemble nanostructures supported on transparent substrates and the unprecedentedly large plasmon shifts and detection sensitivity make our results very promising for the development of practical optical hydrogen sensors.

P17. HIERARCHICAL SILICON NANOSTRUCTURED ARRAYS VIA METAL-ASSISTED CHEMICAL ETCHING
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Hierarchically arranged nanostructures, configured in both nanopillars and nanoholes, have been fabricated via a low-cost approach that combines metal-assisted chemical etching (MaCE), nanosphere lithography and conventional photolithography. By manipulating the catalyst morphology as well as the deposition method, different interesting nanostructures like nanowalls and nanograsses were fabricated at the galleries among the nanopillar blocks. Using a similar strategy, hierarchical negative structures (nanoholes) have also been successfully demonstrated. The successful construction of these diversified hierarchical nanostructures illustrates that MaCE could be employed as a feasible, low-cost method for multi-scale silicon micro/nano machining, which is highly desirable for widespread applications, including tissue engineering, optoelectronics, photonic devices and lab-on-chip systems.
P18. Influencing Radiative and Non-Radiative Recombination Channels as a Tool to Improve Luminescence Quantum Efficiencies of CdTe and HgTe Quantum Dots

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Fluorescent marker imaging and other applications of colloidal quantum dots (QDs) require high photoluminescence (PL) quantum yield materials. While improved synthetic methods over the past 30 years have realized promising PL quantum yields approaching 100% in the visible ranges (frequently 80-90% is reported), infrared values are often much lower (20-40% in the 1000-1500 nm range) and one sees a further sharp decrease (often dropping well below 1%) as the fluorescence wavelength extends beyond 2000 nm. Many studies have analyzed the effect of the surface stoichiometry, capping agents and the surrounding media in the PL decay rates of QDs, but the energy coupling mechanism between the QDs and their surroundings is still the subject of both theoretical and experimental investigations. We show some recent progress in surface treatments and solvent exchange of both CdTe (visible emission) and HgTe (infrared emission) QDs to enhance their PL quantum yields. CdTe eQDs with thioglycolic acid as stabilizer in water show an increase of quantum yield as small QD clusters formed during synthesis are broken apart by simple chemical treatments. In addition, by adding form amide to QDs in an aqueous medium, the radiative decay rate increases, partly due to a higher local field factor to promote radiative recombination, and the non-radiative decay rate is lowered due to trap site removal. In yet another approach, both CdTe and HgTe QDs in H₂O show improved PL quantum yields when transferred into D₂O as the solvent. Our results give useful insights into the competing radiative and (several) non-radiative recombination channels that critically govern the PL quantum yield in QDs.

P19. Tunable Quantum Confinement in Ultrathin, Optically active GaAs Nanowires via Reverse–Reaction Growth

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Semiconductor nanowires (NWs) represent a unique architecture that provides the opportunity for both electronic and optical quantum confinement along their axial and radial direction. However, harnessing these powerful physical effects relies on the ability to design NWs with cross-sectional sizes below the de Broglie wavelength.

Here, we demonstrate a “reverse-reaction growth” scheme to produce ultrathin, freestanding GaAs NWs with cross-sections down to ~7 nm that are epitaxially integrated on silicon. We established a two-step process consisting of (i) self-catalyzed, i.e., Ga-droplet assisted, VLS growth of freestanding, vertically [111]-oriented GaAs NWs and (ii) reverse-reaction growth” by subsequent selective thermal decomposition of the [111] side-wall surfaces in situ. This versatile fabrication scheme preserves the bulk-like zincblende crystal phase, in contrast to the frequently observed meta-stable wurtzite phase occurring in catalytic growth of thin NWs. By in situ passivation of the ultrathin GaAs NWs with radial AlGaAs shells, we further produce optical-ly very efficient emitters with strong confinement, evidenced by up to ~100 meV blue-shifts of the energy of photoluminescence (PL). The cross-sectional size dependent blue-shifts are unambiguously verified via correlated microstructure and PL analysis on individual NWs, which are in very good agreement with simulations of the respective confinement energies [1].

References

P20. Two-photon Responsive Three-dimensional DNA Nanostructures
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Since their advent, nanomaterials have always attracted tremendous research interest. Recently, they have also found substantial applications in biological and medicinal sciences. Among their building blocks, DNA strand has emerged as a powerful one in self-assembly of complex nanostructures due to its high programmability and predictability arising from the specific and loyal Watson-Crick pairing of adenine with thymine, guanine with cytosine. Advanced three-dimensional nanostructures built from DNA strands, such as DNA nanotubes, have demonstrated great potential in selective encapsulation and responsive release of cargoes [1]. Meanwhile, the induction of morphological or conformational changes of those nanostructures usually could be counted on some manipulation methods, such as pH adjustment, strand displacement or high-energy excitation [2]. Here, we demonstrated the design and creation of advanced 3D DNA nanostructures and their induced conformational or morphological change behaviors. We hope our nanotools could find potential biomedical applications such as drug delivery and controlled release of drugs.

References

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Covalent organic frameworks (COFs) have recently emerged as a new generation of porous polymers combining molecular functionality with the robustness and structural definition of crystalline solids. Drawing on the recent development of tailor-made semiconducting COFs, we here report on a new COF, TFPT-COF, capable of visible-light driven hydrogen generation in the presence of Pt as proton reduction catalyst (PRC) with quantum efficiencies of up to 2.2%.

The COF is based on hydrazone-linked functionalized triazine 1,3,5-tris-(4-formyl-phenyl)triazine (TFPT) and phenyl building blocks and adopts a layered structure with a honeycomb-type lattice featuring mesopores of 3.8 nm and the highest surface area of 2177 m²/g among all hydrazone-based COFs reported to date.

When illuminated with visible light, the Pt-doped COF continuously produces hydrogen from water in the presence of ascorbic acid as sacrificial electron donor without signs of degradation. While (exfoliation-induced) amorphization is observed during the photocatalytic process, facile recrystallization without significant loss in porosity was achieved by subjecting the COF to the original synthesis conditions. With their precise molecular organization and modular structure combined with high porosity, photoactive COFs represent well-defined model systems to study and adjust the molecular entities central to the photocatalytic process.

Reference
P22. CONSTRUCTION OF PHOTOCATALYTIC FUEL CELLS FOR THE SIMULTANEOUS DEGRADATION OF ORGANICS AND SOLAR ELECTRICITY GENERATION

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Given the rising environmental pollution and energy crisis, it is highly attractive to enhance the generation of clean and renewable energy, such as H₂ or electricity, from the solar energy harvesting by the simultaneous organics degradation [1]. The current work reports the construction of photocatalytic fuel cells (PFCs) that effectively convert the solar energy to the electrical power using a range of anodized photoanodes and organics. The syntheses of the photoanodes (TiO₂, WO₃, and Nb₂O₅) were optimized using the statistical 2ᵏ factorial design. A systematic study was carried out to categorize the influence of studied eleven kinds of organic substrates on photocurrent responses of the photoanodes, which showed the dependence on the organics adsorption as well as their associated photocatalytic degradation mechanisms. More specifically, the strong adsorbates such as carboxylic acids generated higher photocurrent enhancement. Meanwhile, the simple and short-chained molecules, such as formic acid and methanol within the respectively same functional groups, are the most efficient as a result of their fast degradation kinetics. While the current doubling effect was measured during the degradation of alcoholic compounds, the aromatic compounds could form some intermediates that blocked the access of the electrode surface and/or acted as charge recombination centers. Among the photoanodes used for the construction of PFC cells, the TiO₂-based PFC yielded the highest photocurrent and obtainable power, due to its high intrinsic quantum yield compared to WO₃ and Nb₂O₅. The highest open circuit voltage was achieved by Nb₂O₅-based PFC, consistent with its most negative Fermi level [2]. The presence of triethanolamine (TEOA) generated the highest power output relative to other kinds of organics, which was attributed to its high efficiency in holes scavenging. This study reveals the complex relationship between the adsorption and the mechanism of photocatalytic degradation of the organics as important factors affecting the PFC performance.

References

P23. LUMINESCENT OLIGO(ETHYLENE GLYCOL)-FUNCTIONALIZED CYCLOMETALATED Pt(II) COMPLEXES: CELLULAR CHARACTERIZATION AND MITOCHONDRIA-SPECIFIC LOCALIZATION

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Transition metal-organic complexes offer great promise as diagnostic and therapeutic agents due to their modularity, well-defined coordination geometry, and the possibility of visible-light and phosphorescent signaling. We are engaged in the development of functionalized phosphorescent complexes featuring environmentally responsive platinum(II) moieties, with the aim of creating molecular assemblies with unusual photophysical and sensing characteristics that allow the reporting of molecular-level perturbations and events [1]. Herein, we describe the synthesis and spectroscopic properties of a readily tunable family of functionalized oligoethylene glycol-containing Pt(II) complexes, and investigate their application as live cell imaging agents [2]. We demonstrate that suitable structural modification can give traceable mitochondria-specific localization behavior and potent cytotoxic characteristics towards HeLa cells. This work was supported by the Research Grants Council of the Hong Kong, China (CityU 100212).

References
P24. LUMINESCENT HELICAL CONJUGATED METALLOPOLYMERS
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Reports of luminescent polymers with helical structures, especially those containing metals, are relatively sparse in the literature. We are engaged in the design and creation of crowded phosphorescent host structures and assemblies featuring coordinatively unsaturated transition metal-(π-organic) units and rigid, robust supporting scaffolds, with the aim of engendering molecular topologies with unusual photophysical and sensing characteristics [1]. Novel helical polynuclear Pt(II) coordination materials bearing integrated attributes that allow the reporting of molecular-level perturbations and events have been developed, and selective photophysical responses to guest analytes have been observed [2]. In this work, luminescent conjugated metallopolymers bearing chiral moieties have been synthesized. Natural building blocks with different configurations have been employed as substituents to introduce helicity to the polymers. Various spectroscopic methods including 1H NMR, FTIR, UV-vis, fluorescence and CD have been used for characterization, and interesting photophysical properties have been observed.

This work was supported by the Research Grants Council of the Hong Kong, China (CityU 100212)

References

P25. REDUCED GRAPHENE OXIDE FOR ORGANIC FLASH MEMORIES
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The next-generation electronic systems are expected to be light, flexible and portable for applications in large area displays, integrated circuits (ICs), organic light emitting diodes (OLEDs), radio frequency identification (RFID) tags, solar cells and so on. Memory is an essential part of advanced electronic systems for data processing, storage and communication. Among many types of memories such as ferroelectric, electret, resistive and floating gate, nano-floating gate flash memory devices have gained a great deal of attention due to the simple device structure, non-destructive read-out and controlled trap capacity. In this presentation, we will demonstrate recent works based on solution processed reduced graphene oxide for organic flash memories.
The fluorescence anisotropy experiment was adopted to reveal the intrinsic anisotropy in optical properties of CdSe/CdS dot-in-rods (DRs). And such intrinsic optical anisotropy was utilized in aligned DR structures which were achieved by drying DR solution in a capillary tube. Our novel approach to align nanorods allowed us to demonstrate highly polarized spontaneous emission and an anisotropic gain medium from densely packed DR ensemble. The capillary tubes also play a role of cylindrical microcavities to provide optical feedbacks for the DR gain medium coated on their inner wall. The highly polarized whispering gallery mode lasing from this structure demonstrated the anisotropic gain medium originated from our aligned DRs.
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<tr>
<td>Time</td>
<td>Wednesday, May 27</td>
<td>Thursday, May 28</td>
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<tr>
<td>08:40</td>
<td>Opening</td>
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<tr>
<td>09:00</td>
<td><strong>Dmitri V. Talapin</strong></td>
<td><strong>Hiroaki Misawa</strong></td>
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<td>Nanocrystal Assemblies: a Modular Approach to Materials Design</td>
<td>Plasmon-Induced Artificial Photosynthesis</td>
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<td>09:30</td>
<td><strong>Vivian W. W. Yam</strong></td>
<td><strong>Hong-Bo Sun</strong></td>
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<td>Molecular Photonic Materials - From Design to Assembly and Functions</td>
<td>Laser-Nano 3D Printing</td>
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<td>09:50</td>
<td><strong>Alexander S. Urban</strong></td>
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<td>Quantum Confinement in Ligand-Stabilized Perovskite Nanoplatelets</td>
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<td>10:10</td>
<td><strong>Nikolai Gaponik</strong></td>
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<td>Proper Design of surface ligands as a Tool (…)</td>
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<td>10:30</td>
<td>Coffee break</td>
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<td>11:00</td>
<td><strong>Jianfang Wang</strong></td>
<td><strong>Ursula Wurstbauer</strong></td>
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<td>11:20</td>
<td><strong>Kaili Zhang</strong></td>
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<td>CuO nanowires based energetic materials and battery anode materials</td>
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<td>11:40</td>
<td><strong>Abhishek K. Srivastava</strong></td>
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<td>Photo-Aligned Quantum Rods for Application in Modern Displays (…)</td>
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<td>12:00</td>
<td><strong>Yang Yang Li</strong></td>
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<td>Porous Nanomaterials: Electrochemical Fabrication, Simulation (…)</td>
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<td>12:20</td>
<td>Lunch</td>
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<td>13:00</td>
<td><strong>Johnny C. Ho</strong></td>
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<td>Reusable Colloidal-Based Soft Photomask for Rapid Nanoscale Patterning</td>
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<td>13:00</td>
<td><strong>Conference excursion</strong></td>
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<td>Lunch (until 13:00)</td>
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<td>14:00</td>
<td><strong>Jochen Feldmann</strong></td>
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<td>Photocatalytic Hydrogen Generation on Semiconductor Nanocrystals</td>
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<td>14:20</td>
<td><strong>Vladimir Lesnyak</strong></td>
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<td>Partial Cation Exchange as a Route to multinary Copper Chalcogenide-Based Nanoparticles</td>
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<td>14:40</td>
<td><strong>Wey Yang Teoh</strong></td>
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<td>Designing Semiconductor Photocatalysts for Solar Water Splitting</td>
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<td>15:00</td>
<td><strong>Kenneth K. W. Lo</strong></td>
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<td>Development of Luminescent Rhenium(II) and Iridium(III) Polypyridine Complexes (…)</td>
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<td>15:20</td>
<td><strong>Stephen Kershaw</strong></td>
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<td>Hot and Cold Exciton Dynamics in CdHgTe and HgTe Quantum Dots</td>
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<td>15:40</td>
<td>Coffee break</td>
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<td>16:10</td>
<td><strong>Christoph Bräuchle</strong></td>
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<td>Nanoparticles as “Smart” Drug Delivery Ferries (…)</td>
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<td>16:30</td>
<td><strong>Zuankai Wang</strong></td>
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<td>Bio-Inspired Interfacial Materials</td>
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<td>16:50</td>
<td><strong>Keith M.-C. Wong</strong></td>
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<td>Selective Ion-Binding Properties of Rhodamine-Transition (…)</td>
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<td>17:10</td>
<td><strong>Poster session</strong></td>
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<td>17:10 - 19:00</td>
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<td><strong>Conference Dinner</strong></td>
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