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Centro de Investigación Cooperativa en Biomateriales

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SEMINAR

Thursday 9 January, 12.00 pm, Seminar Room on the 1st Floor

Host: Dr. Ralf Richter

From hard to soft: a journey of chondroitin sulphate proteoglycans (CSPGs) in the regeneration and plasticity of the nervous system

Dr Jessica Kwok

John van Geest Centre for Brain Repair
University of Cambridge, UK

Since the first report in 1913, much of the scientific studies on chondroitin sulphate proteoglycans (CSPGs) have been focused in the field of musculoskeletal research. The significance of CSPGs in the nervous system has only become evident in the last two decades when high concentration of CSPGs was reported in the lesioned area after injury in the central nervous system (CNS). The functions of CSPGs have since evolved from being a pure structural component in the brain matrix, to a strong blocker in regeneration and more recently, as a control of plasticity both during development and regeneration in the CNS. Aggregation of CSPGs, hyaluronan, link proteins and tenascin R into a structure called perineuronal nets (PNNs) control the degree of plasticity after injury. Transgenic mice with attenuated PNNs demonstrated enhanced functional recovery after injuries in two plasticity models. This seminar will take you through the journey of CSPGs in the brain matrix and how the current idea of manipulating the molecular interaction in the PNNs could enhance functional recovery in the CNS after injury.

Biography

Jessica Kwok is a senior research fellow from the University of Cambridge. She obtained her Bachelor Degree in Biochemistry from the University of Hong Kong before pursuing her PhD study with Professor Daisy K.Y. Shum in the same university. Her PhD was focused on the role of extracellular matrix and proteoglycans in the development and patterning of hindbrain network in rodent embryos. Since 2005, she joined Professor James Fawcett's laboratory in the John van Geest Centre for Brain Repair (University of Cambridge) as a postdoctoral scientist, looking into methods to enhance regeneration through modification of the extracellular matrix in the adult central nervous system after injury. She is a scientific advisor from the company AMSBio and has been appointed as a senior research fellow in the University of Cambridge in 2013. Her current research interest is focused on understanding the mechanism of chondroitin sulphate proteoglycans in the perineuronal nets on restricting plasticity in the adult nervous system.

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SEMINAR

Friday 10 January, 12.00 pm, Seminar Room on the 1st Floor

Host: Prof. Luis Liz Marzán

Multi-enzyme systems in solid-phase; The new wave of the synthetic biology

Dr Fernando López Gallego

Departamento de Biocatálisis
Instituto de Catálisis y Petroleoquímica
CSIC Madrid

Nanobiotechnology and synthetic biology are emerging disciplines that merge biology and chemistry to assemble biological machineries onto functionalized nano/micro-structured materials. Nowadays, developing of novel advanced materials is broadening the application of this discipline; however the incorporation of complex biological machineries to such materials is still an unmet need. Integration of advanced biological machineries (i.e. transcription/translation, photosynthetic or CO2 fixation systems) into nano-surfaces (i.e nanoparticles, nanotubes or nanowires) devises more complex functionalities of nanomaterials that will provide new solution for chemistry, medicine or applied life sciences. Inspired by the exquisite **orchestration of biological machineries** found in nature, researchers exploit them in artificial applications. This has become a reality by a multidisplinar approach that combines different areas such as protein engineering, surface chemistry and material science. My research has so far been focused mostly on applying multi-step biocatalytic strategies to synthetic and analytical chemistry by harnessing the exquisite selectivity of enzymes (biological catalysts) for the development of more sustainable and effective chemical processes. I pursue mimicking the spatial organization found inside the living organisms, but using *ex-vivo* systems supported on solid materials. To address such goal, I am interfacing chemistry and biology a) to assemble multi-enzyme cascades on porous carriers by activating such surfaces with different chemical groups that selectively immobilize the different enzymes (i.e. cofactor recycling systems integrated to redox enzymes) **(1,2)** b) to create synthetic scaffolds inspired in biological organizations to assemble biocatalytic cascades inside porous material with fine control of the nanometric localization of each biocatalyst and c) to create novel semi-synthetic proteins with artificial functionalities **(3)**.

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SEMINAR

Friday 17 January, 12.00 pm, Seminar Room on the 1st Floor

Host: Dr Luis Liz Marzán

Designing inorganic nanoparticles for therapy and diagnosis

Dr Jesús Martínez de la Fuente

University of Zaragoza
Instituto de Nanociencia de Aragón
Zaragoza, Spain

In the last decades, inorganic nanoparticles have been steadily gaining more attention from scientists from a wide variety of fields such as material science, engineering, physics or chemistry. The very different properties compared to that of the respective bulk, and thus intriguing characteristics of materials in the nanometre scale, have driven nanoscience to be the centre of many basic and applied research topics. Moreover, a wide variety of recently developed methodologies for their surface functionalization provide these materials with very specific properties such as drug delivery and circulating cancer biomarkers detection. In this talk we describe the synthesis and functionalization of magnetic and gold nanoparticles as therapeutic and diagnosis tools against cancer:

- Pseudo-spherical gold nanoparticles derivatized with with fluorescent dyes, cell penetrating peptides and small interfering RNA (siRNA) complementary to the proto-oncogene myc have been tested using a hierarchical approach including three biological systems of increasing complexity: *in vitro* cultured human cells, *in vivo* invertebrate (freshwater polyp, *Hydra*) and *in vivo* vertebrate (mouse) model. Selection of the most active functionalities was assisted step by step through functional testing adopting this hierarchical strategy.[1] Merging these chemical and biological approaches lead to a siRNA/RGD gold nanoparticle capable of targeting tumor cells in lung cancer xenograft mouse model, resulting in successful and significant c-myc oncogene downregulation followed by tumor growth inhibition and prolonged survival of the animals.[2]

- Gold nanoprisms (NPRs) have been functionalized with PEG, glucose, cell penetrating peptides, antibodies and/or fluorescent dyes, aiming to enhance NPRs stability, cellular uptake and imaging capabilities, respectively.[3] Cellular uptake and impact was assayed by a multiparametric investigation on the impact of surface modified NPRs on mice and human primary and transform cell lines. Under NIR illumination, these nanoprobes can cause apoptosis. Moreover, these nanoparticles have also been used for optoacoustic imaging,[4] as well as for tumoral marker detection using a novel type of thermal ELISA nanobiosensor using a thermosensitive support.[5]

- Magnetic nanoparticles functionalized with DNA molecules and further hybridizing with different length fluorophore-modified DNA have allowed the accurate determination of temperature spatial mapping induced by the application of an alternating magnetic field.[6] Due to the design of these DNAs, different denaturalization temperatures (melting temperature, Tm) could be achieved. The quantification of the denaturalized DNA, and by interpolation onto a Boltzmann fitting model, it has been possible to calculate the local temperature increments at different distances, corresponding to the length of each modified DNA, from the surface of the nanoparticles. The local increments achieved were up to 15ºC, and the rigidity conferred by the double strand DNA allowed to evaluate the temperature at distances up to 5.6 nm from the nanoparticle surface.

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SEMINAR

Monday 3 February, 12.00 pm, Seminar Room on the 1st Floor

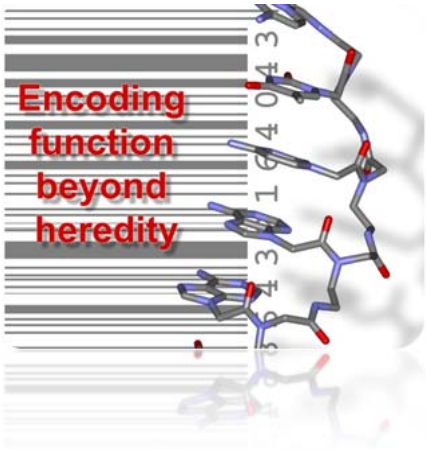
Host: Dr Niels Reichardt

PNA-programmed Self Assemblies in Chemical Biology

Dr Nicolas Winssinger

Department of Organic Chemistry
University of Geneva, Switzerland

The programmable nature of nucleic acid hybridization has inspired a number of applications beyond their natural function in heredity. Peptide Nucleic Acids (PNA) are endowed with attractive properties for this endeavor as they are more robust and form more stable duplex than their natural counter parts. Several applications from our laboratory to program self-assemblies of small molecules into microarrays, template chemical reactions or display multimeric ligands will be presented.



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SEMINAR

Tuesday February 20, 12.00 pm, Seminar Room on the 1st Floor

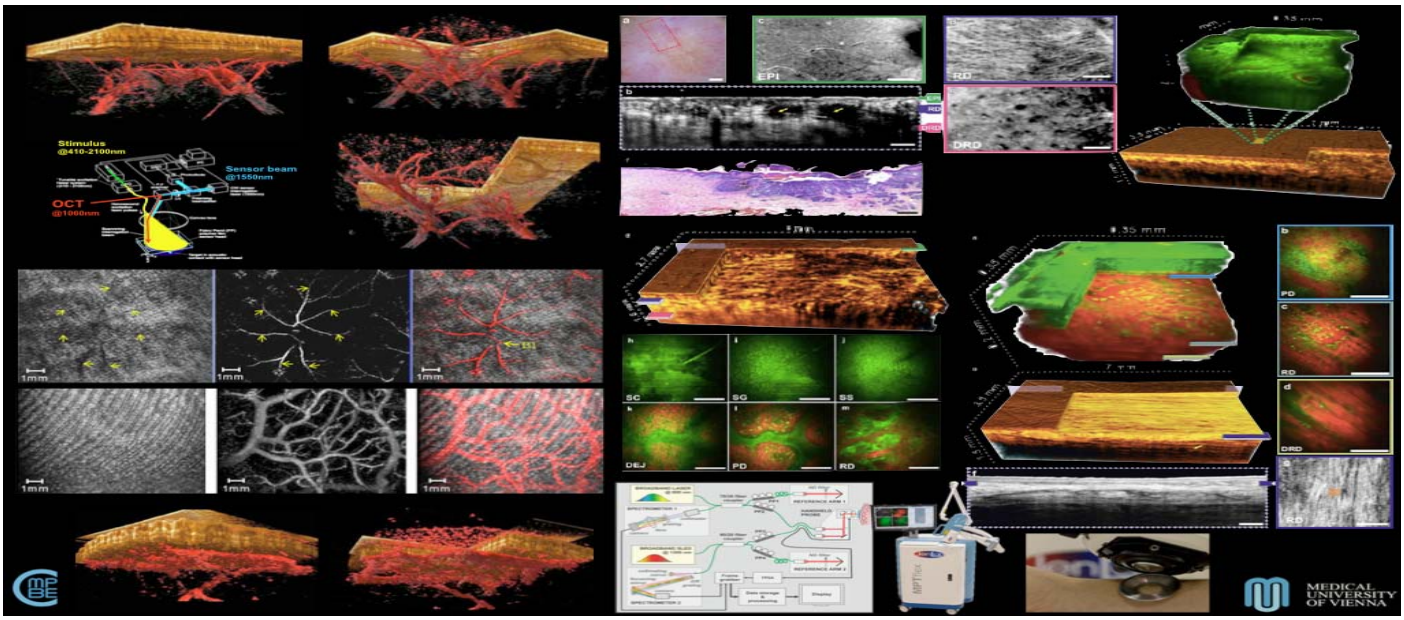
Host: Prof. Luis Liz Marzán

Multimodal Optical Coherence Tomography

Wolfgang Drexler
Center for Medical Physics and Biomedical Engineering,
Medical University Vienna, Austria

Optical coherence tomography (OCT) is one of the most rapidly emerging and innovative optical imaging modalities of the last decades enabling in vivo cross-sectional tomographic visualization of internal microstructure in biological systems [1]. Recent developments in ultrabroad bandwidth laser as well as OCT technology enable three-dimensional ultrahigh resolution OCT with unprecedented axial resolution, approaching resolution levels of conventional histopathology, enabling optical biopsy of biological tissue [2-4].

In addition, multimodal extensions of OCT are recently under development that should provide non-invasive *depth resolved* functional imaging of the investigated tissue, including extraction of spectroscopic, blood flow or physiologic tissue information [5]. These extensions of OCT should not only enable sub-cellular resolution imaging, improve image contrast, but should also enable the differentiation and early detection of pathologies via localized biochemical, molecular properties or functional state. The hypothesis is to provide (sub)cellular level resolution visualization of tissue morphology (optical biopsy) and at the same time localized metabolic, molecular and physiologic tissue information in performing a single volumetric multimodal OCT measurement.



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SEMINAR

Thursday, 20th March, 12.00 pm, Seminar Room

Host: Prof. Luis Liz-Marzán

Theranostics in the Central Nervous System: promises and pitfalls

Pedro Ramos Cabrer
University of Santiago de Compostela,
Department of Medicine.
Clinical Neuroscience

Advances in the field of nanotechnology have enabled the development of a new generation of multifunctional molecular platforms that are capable of targeting specific cell types or functional states, transporting drugs, releasing them in a controlled manner, and enabling visualization of processes in vivo, using conventional imaging systems. Theranostics, the marriage between drug delivery and molecular imaging disciplines, represents the basis of the concept of personalized medicine, opening new and more effective routes to combat disease. However, the application of theranostic approaches in the Central Nervous System remains highly challenging due to its first line of defense, the blood-brain barrier. With these facts in mind, it is necessary to critically discuss the promises and pitfalls on the use of theranostics for the treatment of neurological diseases.

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SEMINAR

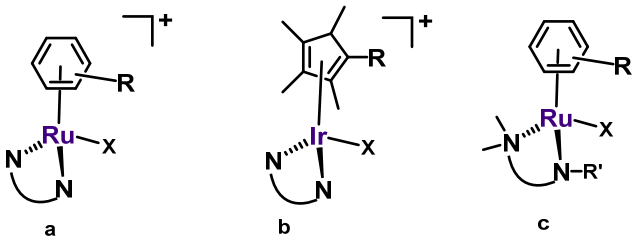
Tuesday, 25th March, 12.00 pm, Seminar Room

Design of organometallic platinum-group metallodrugs for bio-catalysis and photo-activation

Abraha Habtemariam,
University of Warwick, Department of Chemistry, UK
Visiting Ikerbasque professor CIC biomaGUNE,

Organometallic complexes have provided a rich platform for the design of efficient catalysts as well as novel anticancer metallodrugs..[1] Our group has shown that half-sandwich Ru(II) arene complexes (Fig 1a) may have multiple mechanisms of action including the generation of reactive oxygen species and perturbation of the redox balance in cells.[2, 3]
In addition we have shown that some organometallic complexes (Fig1a, b) can act as catalytic drugs and be involved in hydride transfer reactions utilizing NADH as an hydride source.[4]
The Ru compounds have also shown to be photo-activatable when X = pyridine derivatives (Fig1a).[5,6]
Strategies used to anchor this class of compounds to UNCPs (up-converting nanoparticles) and results obtained so far will also be presented.

Figure 1



R = alkyl, ph
X = Py

X = Cl, I

R' = methlensulfonamide (Ms), toluensulfonamide (Ts), triflluomethylbenzenesulfonamide (Tf)

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SEMINAR

Thursday, 3rd April, 12.00 pm, Seminar Room

Application of Plasmonic Nanoparticles in Self-assembly and Photochemistry

Marek Grzelczak
CIC biomaGUNE, Spain; Ikerbasque, Basque Foundation for Science, Spain
mgrzelczak@cicbiomagune.es

A fundamental goal of inorganic nanochemistry is the design and synthesis of materials with tailored shape and size. Tremendous progress over the past decades in the synthesis of gold nanocrystals emerged library of particles with precisely controlled sizes, shapes and surface chemistry. Today the particles serve as chemical ingredients in variety of catalytic transformations or as building blocks for hierarchical self-assembly. In this talk we will discuss the application of plasmonic nanoparticles in the photochemistry and self-assembly.

In the first part of the talk we will show that plasmonic particles can effectively catalyze photoregeneration of biomolecules. Specifically, gold nanorods functionalized with platinum will act as photocatalyst to reduce coenzyme molecule (NADH) under visible light radiation. The presence of gold-platinum heterojunction is of high importance to promote light-assisted regeneration of molecules.

In the second part of this talk we will focus on the role of hydrophobic interactions in the self-assembly of nanoparticles. We will show that polystyrene-stabilized gold nanoparticles dispersed in organic solvent can form monodisersed aggregates upon addition of water, which is a bad solvent for polystyrene. The growth of the clusters can be quenched by addition of a polymeric surfactant comprising hydrophobic (polystyrene) and hydrophilic (poly-acrylic acid) blocks. While micellization of the polymeric surfactant allows for sequestration of clusters inside the hydrophobic core, the hydrophilic outer surface of the micelles (comprising the PAA blocks) ensures stability in polar solvents. This methodology is applied for self-assembly of spherical, rod-, and star-like nanoparticles to form low-symmetry dimers or large spherical clusters.

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SEMINAR

Friday, 4th April, 12.00 pm, Seminar Room

Host: Prof. Luis Liz-Marzán

The power of one: what can be learned by studying individual molecules?

Johan Hofkens[1],

[1] *Katholieke Universiteit Leuven, Department of Chemistry*
Lab. of Photochemistry and Spectroscopy, Celestijnenlaan 200 F, B-3001 Leuven, Belgium,
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Keywords: single molecule spectroscopy, Polymers, Catalysis, Biophysics

Over the last 15 years, single molecule spectroscopy (SMS) has been established as a new tool in the ever expanding range of spectroscopic methods. SMS is especially useful to study inhomogeneous systems. Biological systems are by their nature highly heterogeneous and as such perfect targets for SMS. From this it is clear that, next to biological samples, material science (polymers, catalyst nano-particles) can benefit from single molecule measurements as materials are very often heterogeneous in their behavior. Furthermore, many theories that describe material properties are based on a microscopic picture that now can be evaluated experimentally by applying single molecule techniques. In this contribution, I will give an overview of how we study polymers (reptation, dynamics near glass transition, molecular motors), catalyst particles (heterogeneous catalysis and the problem of diffusion limitations) biophysical processes (recent work on rafts, viruses and DNA mapping) and plasmonic systems with a range of single molecule based techniques.

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SEMINAR

Friday, 11th April, 12.00 pm, Seminar Room

Host: Prof. Luis Liz-Marzán

Nanoparticle-cell interactions: Importance of protein structure

Christine K. Payne, Ph.D.
Associate Professor
School of Chemistry and Biochemistry, Georgia Tech
http://www.chemistry.gatech.edu/faculty/Payne/

Nanoparticles offer exciting new approaches for biomedicine ranging from drug delivery to cellular imaging. In the course of these applications, nanoparticles are exposed to a complex mixture of extracellular proteins that are adsorbed onto the surface of the nanoparticle. This "protein corona" dominates the interaction of nanoparticles with cells. We have investigated how proteins found in blood serum affect the cellular binding of protein-nanoparticle complexes. Using fluorescence microscopy, we find that the cellular binding of cationic nanoparticles is enhanced by the presence of serum proteins while the binding of anionic nanoparticles is inhibited. Competition assays show that these protein-nanoparticle complexes use distinct cellular receptors. Protein-nanoparticle complexes formed from anionic nanoparticles bind to native albumin protein receptors on the cell surface. In comparison, protein-nanoparticle complexes formed from cationic nanoparticles bind to scavenger receptors. This trend is independent of nanoparticle composition; quantum dots formed from semiconductors, colloidal gold nanoparticles, and low-density lipoprotein particles all show the same behavior. Circular dichroism, fluorescence spectroscopy, and isothermal titration calorimetry show that the secondary structure of the adsorbed protein is altered following adsorption on the nanoparticle surface and that these structural changes determine the cellular receptor used by the protein-nanoparticle complex. This link between protein structure and cellular outcomes will provide a molecular basis for the design of nanoparticles for use in biomedical applications.

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SEMINAR

Tuesday, 15th April, 12.00 pm, Seminar Room

Host: Prof. Soledad Penadés

Bestowing chirality to well-defined gold clusters

Prof. Thomas Bürgi
University of Geneva, Department of Physical Chemistry,
30 Quai Ernest-Ansermet, 1211 Geneva 4, Switzerland

Monolayer protected gold nanoparticles and clusters have promising potential applications as building blocks for nanotechnology, as catalysts or as sensors. Very recently, the chirality of these materials has attracted the attention of researchers [1] and application to chiral technologies is an interesting perspective. This contribution deals with the preparation of chiral gold nanoparticles, with their chiroptical properties and with exchange reactions in their ligand shell. We applied Electronic and Vibrational Circular Dichroism (ECD/VCD) to study electronic transitions that are mainly located in the cluster core and to perform conformational analysis of the molecules in the ligand shell. [2] Ligand exchange reactions were performed and monitored by ECD and mass spectrometry. [3]

The chiroptical studies indicate that chirality can be bestowed to gold clusters through the adsorption of chiral thiolates. However, even with achiral ligands chiral clusters can be obtained. In this case a racemic mixture is obtained during the synthesis. Using chromatography we were able to separate the enantiomers of Au_{38} and Au_{40} clusters and study their properties.

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SEMINAR

Thursday, 8th May, 12.00 pm, Seminar Room

Host: Prof. Luis Liz Marzán

Radiological characterization of lung damage, remodeling and response to treatment in respiratory diseases

Arrate Muñoz Barrutia, PhD
Laboratory of Cancer Imaging. Center for Applied Medical Research (CIMA).
University of Navarra
arrmunoz@unav.es

Lung cancer and Chronic Obstructive Pulmonary Disease (COPD) are among the deadliest diseases worldwide. COPD is defined as the finding of nonreversible pulmonary function impairment. Computed Tomography (CT) represents a very convenient technology to obtain three-dimensional images of the lungs with minimum invasiveness. The aim of the seminar is to present the framework we have developed at CIMA devoted to the (transversal and longitudinal) radiological characterization of lung damage, remodeling and response to treatment both in animal models of lung disease and in humans. Moreover, significant contributions in the field of atlas-based segmentation will be presented, with applications in multiple image modalities and segmentation problems.

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SEMINAR

Friday, 16th May, 12.00 pm, Seminar Room

Host: Prof. Luis Liz Marzán

Diffusion of proteins in bicontinuous microemulsion: Anomalous sub-diffusion induced by controlled crowding

Prof. Dr. Thomas Hellweg
Faculty of Chemistry. Physical Chemistry. University of Bielefeld
Germany

The understanding of the diffusive behaviour of proteins in living cells is crucial for the theoretical description of biological processes. As the interior of cells or certain cell organellae is often crowded with molecules, the diffusive behaviour of proteins does not follow the normal Fick type diffusion, where the mean square displacement grows linear in time $\langle x^2 \rangle \propto t$. The diffusion is considered to be 'anomalous': $\langle x^2 \rangle \propto t^{\alpha}$ (with $\alpha < 1$) [1]. However, due to the complexity of the cellular matrix it is very difficult to control the crowding conditions and to make systematic studies inside living cells. Therefore, about 2 years it was pointed out by Saxton that there is a need for the development of media, which don't have these drawbacks.
Hence, to better understand the dependence of the protein diffusion on a confining environment, we study the movement of a fluorescent particle (GFP+) trough a bicontinuous microemulsion via fluorescence correlation spectroscopy. The sponge like network of the microemulsion, which is characterized via small angle neutron scattering, not only slows down the translational movement of the tracer particle with decreasing domain size but also changes the characteristics of the diffusion from 'Fick like' to 'anomalous'.
Additional relevance for such works arises from the fact that microemulsions are used as reaction media for enzymatically catalyzed reactions [2].

[1] T. J. Feder et al., **Biophysical Journal** 70, 2767-2773 (1996)
[2] S. Wellert et al., **Euro. Biophysics J.**, 40, 761–774 (2011)

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SEMINAR

Wednesday, 28th May, 12.00 pm, Seminar Room

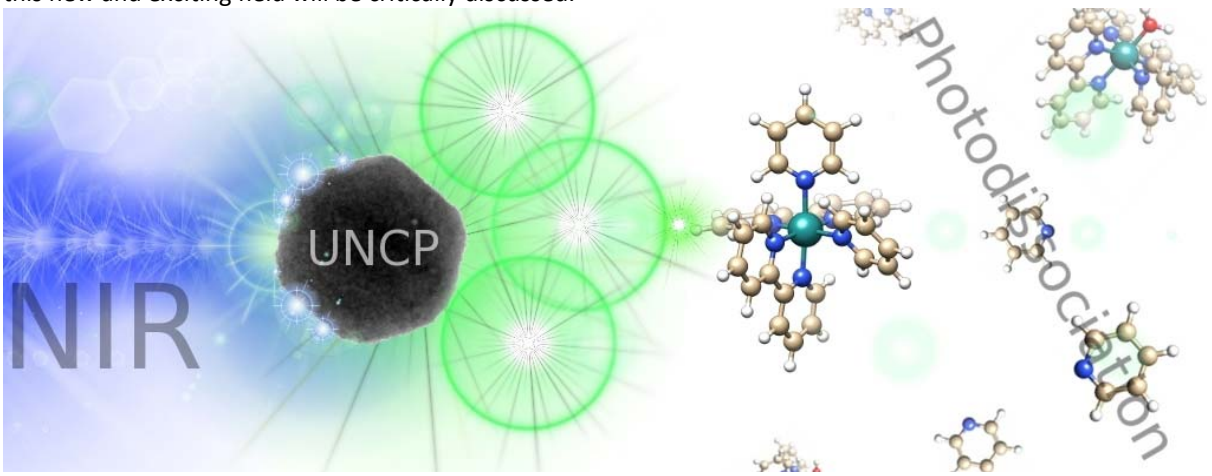
Photoactivation of Anticancer Metal Complexes Using Upconversion Nanoparticles

Luca Salassa

The rich photochemistry of transition metal complexes has been explored for many applications including medicinal chemistry and biology. Several metal complexes displaying light-triggered biological activity have been recently reported and show potential as agents for photodynamictherapy.1 Nevertheless, metal complexes are typically characterized by low extinction coefficients in the 600–1000 nm region, posing a major limitation for their development as practical clinical tools.

Nanoparticles with suitable optical properties can effectively be exploited to extend the range of excitation wavelengths for metal complexes and overcome such fundamental drawback. Moreover, nanoparticles are capable to act as delivery platforms for chemotherapeutic drugs and multimodalimaging agents.

Our recent research is focused on the use of upconversion nanoparticles (UCNPs) for thephotoactivation of anticancer complexes (e.g. Pt, Ru). UCNPs based of a NaYF4 lattice doped with lanthanides ions (e.g. Yb, Er, Tm) can convert 980-nm light to higher energies in the ultraviolet and visible region, hence allowing to trigger the photochemistry of metal complexes2 and potentially their biological effects. In the presentation our advances in this new and exciting field will be critically discussed.



[1] Farrer, N. J.; Salassa, L.; Sadler, P. J. *Dalton Trans.*, **2009**, 10690. [2] Ruggiero, E.; Habtemariam, A.; Yate, L.; Mareque-Rivas, J. C.; Salassa, L. *Chem. Commun.*, **2014**, *50*, 1715.

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SEMINAR

Tuesday, 17th June, 12.00 pm, Seminar Room

Host: Dr. Niels C. Reichardt

The HIV glycan shield as a target for broadly neutralizing antibodies

Dr. Katie Doores
Department of Infectious Diseases, King's College London
School of Medicine at Guy's, King's and St Thomas' Hospitals, Guy's Hospital

Approximately 10-30% of HIV infected individuals generate antibodies that are capable of neutralizing a broad range of HIV isolates and these antibodies have been shown to protect against SHIV challenge in Macaque models. Isolation and characterisation of these antibodies has revealed regions of the HIV envelope glycoprotein, gp120/gp41, that are susceptible to antibody binding and re-eliciting these antibodies may be a key step for a successful HIV vaccine. Gp120 is heavily glycosylated with host-derived N-linked glycans and it was previously thought that these glycans shield conserved protein regions from the immune system. However, we have recently shown that a number of the bnAbs bind directly to these glycans highlighting them as a potential target for an HIV vaccine. This seminar will i) discuss the characterization of glycosylation on virion-associated gp120 and ii) describe how promiscuous glycan-site recognition by bnAbs against the high-mannose patch can enhance neutralization.

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SEMINAR

Monday, 23rd June, 12.00 pm, Seminar Room

Host: Dr. Sergio E. Moya

Fabrication, Surface Engineering, Cellular Uptake and Cytotoxicity of Metallic and Polymeric Nanoparticles

Yuan Qiu

The role of the surface coating of nanoparticles (NPs) and its charge to control the interaction with cells was studied with CeO_2 NPs (CNPs) coated with either positively or negatively charged polyelectrolyte brushes via *in situ* Atomic Transfer Radical Polymerization (ATRP). Polymer brush coated CNPs showed higher colocalization with acidic cell compartments in the cell, meaning that these CNPs were mostly internalized through endosomal and lysosomal involved endocytosis. The different surface charge resulted in different levels of cytotoxicity. The effect of surface modified CNPs on the intracellular generation of reactive oxygen species (ROS) was also examined. Cells with internalized polymer brush coated CNPs showed a much lower ROS level.

The intracellular dynamics of NPs inside cells was studied by means of Fluorescence Correlation Spectroscopy (FCS). Glucose derivative conjugated gold NPs (Glc-Au NPs) were chosen as model NPs for these studies since they have little non specific interactions with proteins due to the glucose derivative coating. To apply FCS intracellularly to measure NP diffusion, a prebleaching strategy was employed. Then, intracellular dynamics, concentration, hydrodynamic radius, etc. of Glc-Au-Hi NPs were measured.

The degradation of poly (lactide-co-glycolide) PLGA NPs was studied under physiological and intracellular conditions by means of flow cytometry (FACS). In a physiological solution,. Degradation was confirmed by Transmission Electron Microscopy, Dynamic Light Scattering and zeta potential measurements. Intracellular degradation of PLGA NPs was followed by FACS measuring the changes in fluorescence intensity per cell over time. An increase in fluorescence intensity was observed during the first 24h for cells with PLGA15 NPs while no changes in fluorescence were observed of PLGA35, meaning that PLGA15 degraded during the first 24 hours while PLGA35 did not. Additionally, Confocal Raman Microscopy (CRM) was used to trace degradation intracellularly at single cell level.

Finally, PLGA NPs incorporating quantum dots (QDs), superparamagnetic iron oxide nanoparticles (SPIONs) and gold NPs (Au NPs) were fabricated via the W/O/W double emulsion method. The uptake of the hybrid PLGA NPs by human neutrophils was studied by FACS and Confocal Laser Scanning Microscopy (CLSM). In addition, ROS in neutrophils after incubation with the hybrid PLGA NPs was assessed. Magnetophoresis experiments showed that neutrophils with internalized hybrid PLGA NPs can be effectively laterally displaced towards the magnetic field.

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SEMINAR

Tuesday, 24th June, 12.00 pm, Seminar Room

Host: Dr. Sergio E. Moya

Impedance studies of transport phenomena in supramolecular polymer assemblies

Teodoro Alonso

This thesis deals with the electrochemical study of transport phenomena and physicochemical aspects of polymer brushes, synthesized by the Atom Transfer Radical Polymerization. Electrochemical Impedance Spectroscopy (EIS) and Cyclic Voltammetry (CV) have been applied to study mass transport and electron transfer processes taking place at the polymer brush and polymer brush/metal interfaces and how these are affected by the structural properties of the brushes.

The effect of the surface density of polymer chains in the molecular transport through a thermoresponsive brush of poly(N-isopropyl acrylamide) ,PNIPAM, supported on Au substrates was studied.

The temperature effects on the diffusion and electron transfer of the electrochemical reaction of the redox couple $[Fe(CN)_6]^{3-/4-}$ in poly(2-(methacryloyloxy)ethyl] trimethylammonium chloride), (PMETAC), brushes were resolved separately Different kinetic constants were obtained for different electrolytes. A quantitative characterization of the charge transfer resistance and diffusion coefficients associated with the electrochemical reactions of the redox couples $[Ru(NH3)_6]^{3+/2+}$ and $[Fe(CN)_6]^{3-/4-}$ for PMETAC brushes was performed.

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SEMINAR

Thursday 3 July, 12.00 pm, Seminar Room on the 1st Floor

Host: Dr Luis Liz - Marzán

Design and synthesis of gold nanoparticles with potential use in 19F-MRI

Dr. Mónica Carril

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Fluorine 19 (19F) based MRI is an emerging field with promising features which complement proton-based traditional MRI. Indeed, the applications of 19F magnetic resonance are steadily growing in clinical and biomedical research. 19F nucleus has a 100% of isotopic abundance and its signal to noise ratio in magnetic resonance is comparable to that of 1H. The most interesting advantage of 19F over 1H is the negligible endogenous 19F MRI signal, for which any detectable signal can only come from an exogenous probe. However, in order to achieve a quality of image similar to that obtained with conventional MRI, a high load of fluorine atoms with the same resonance frequency is required. In this seminar, the use of gold nanoparticles bearing a high number of identical fluorinated ligands as an appealing strategy to increase the local concentration of chemically equivalent fluorine atoms, as an alternative to currently in use fluorine probes (PFCs), will be discussed.

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SEMINAR

Friday, 18th July, 12.00 pm, Seminar Room

Host: Prof. Luis M. Liz-Marzán

Optical forces: a link between classical and quantum mechanics

Mathieu Juan
Research Fellow
Macquarie University, NSW
Australia

Important advances in science have been facilitated by the ability to accurately and noninvasively manipulate small objects. In particular, optical forces, though minuscule, allow for the manipulation of objects ranging from micron-sized beads down to single atoms. Over the past decades, two very distinct applications of optical forces have emerged: a "classical" approach allowing for the manipulation of microscopic objects in water, and a "quantum" approach for the manipulation of atoms.

In the context of the "classical" trapping, I will present recent work based on near-field optics that has enabled trapping ever smaller objects. Our research has led ultimately to the development of the first nano-tweezers allowing for the manipulation of sub-100nm particles with low laser power. Such tweezers will open new opportunities in biology with the potential to manipulate small specimens such as virus or bio-proteins.

Besides this work, I will also present recent work aiming at combining both "classical" and "quantum" aspect of optical trapping. In particular, one project relies on optical levitation, the equivalent of the "classical" optical tweezers applied in vacuum or air. The goal is to manipulate and prepare quantum states of nano-mechanical resonators. The capacity to levitate the resonator offers a much better isolation to the environment, sensibly reducing decoherence sources. In this context the "classical" optical forces merely constitute a link between classical and quantum mechanics.

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SEMINAR

Monday, 21st July, 12.00 pm, Seminar Room

Host: Dr. Jordi Llop

Direct activation of metal oxide nanoparticles: application to biodistribution studies using positron emission tomography

Carlos Pérez Campaña
Radiochemistry and Nuclear Imaging
CIC biomaGUNE

Metal oxides are commonly used bulk chemicals due to their ease of manufacturing, low costs and unique physicochemical properties. Depending on particle size, they are ubiquitously utilized as food or paint additives, in the construction and semi-conductor industries, cosmetic applications, solar cells, and in many other industrial and societal sectors such as electronics, catalysis and medicine. Over the years, new manufacturing processes enabled the transition from fine particle metal oxides, generally in the micron or submicron range, to ultrafine and nanoparticles (NPs).

The unique properties of NPs have promoted a massive growth in the nanotechnology sector leading to increased production of NPs. This, in turn, has raised many concerns because of known and well documented problems associated with exposure of humans to some particulate materials. One particularly problematic aspect in the study of nanoparticle safety is that they are extremely difficult to detect and quantify once distributed in a material or biological system. One alternative to overcome this problem consists of labelling the NPs with radionuclides that can lead to their detection with ultra-high sensitivity using in vivo nuclear imaging.

Herein, we have developed novel, simple and general strategies for the preparation of positron emitter-labelled metal oxide NPs by direct irradiation with protons, based on the activation of the oxygen atom. The activation of the NPs enabled the determination of the biodistribution pattern in rodents up to 8 hours after administration using different routes. Studies for the evaluation of the inflammatory effect after NPs inhalation using nuclear imaging will also be presented.

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SEMINAR

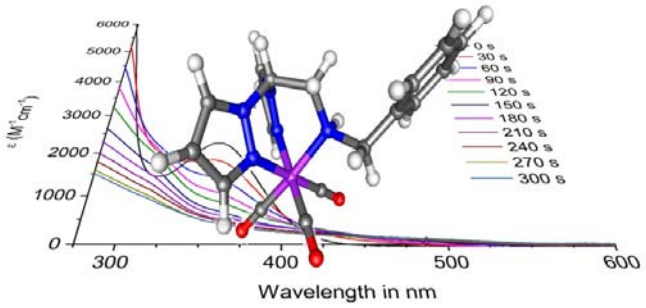
Tuesday, 29th July, 12.00 pm, Seminar Room

Host: Dr. Luca Salassa

One of the smallest possible drugs: biological activity and cellular imaging of carbon monoxide

Prof. Dr. Ulrich Schatzschneider
Institut für Anorganische Chemie, Julius-Maximilians-Universität Würzburg, Am Hubland,
D-97074 Würzburg, Germany, ulrich.schatzschneider@uni-wuerzburg.de

Although to the general public only known as a highly toxic air-pollutant generated by the incomplete combustion of organic matter, carbon monoxide is now well-established as a small signalling molecule, in addition to nitric oxide and hydrogen sulfide. It is endogenously produced, also in humans, by the enzymatic degradation of heme by heme oxygenase (HO) enzymes. It biological function is generally associated with response to oxidative stress and tissue preservation, but localized high concentrations of CO can also be used to eliminate undesired cell sub-populations from the body, such as cancer and pathogenic microorganisms. In order to exploit these beneficial properties for therapeutic applications in human medicine, metal carbonyl complexes, commonly referred to as *CO-releasing molecules* (CORMs), are used as delivery vectors for what is to be considered as one of the smallest possible drugs.



In the present lecture, the basic design principles for CORMs will be discussed and some biomedical applications presented. In addition, the speciation of the metal-carbonyl complexes and the carbon monoxide released from their coordination sphere is an important but currently more or less unresolved question. It will be shown how Raman microspetroscopy can be used to visualized CORMs in living, non-fixed cells and how the CO liberated from the metal coordination sphere can be detected with a fluorescent switch-on probe.

[1] K. Meister, J. Niesel, U. Schatzschneider, D. Schmidt, N. Metzler-Nolte, M. Havenith, Metal-carbonyl complexes as a new modality for label-free live cell imaging by Raman microspectroscopy, *Angew. Chem. Int. Ed.* **2010**, *49*, 3310-3312; [2] U. Schatzschneider, PhotoCORMs: Light-triggered release of carbon monoxide from the coordination sphere of transition metal complexes for biological applications, *Inorg. Chim. Acta* **2011**, *374*, 19-23; [3] S. Pai, M. Hafftlang, G. Atongo, C. Nagel, J. Niesel, S. Botov, H.-G. Schmalz, B. Yard, U. Schatzschneider, New modular manganese(I) tricarbonyl complexes as PhotoCORMs: In vitro detection of photoinduced carbon monoxide release using COP-1 as a fluorogenic switch-on probe, *Dalton Trans.* **2014**, *43*, 8664-8678; [4] U. Schatzschneider, Novel lead structures and activation mechanisms for CO-releasing molecules (CORMs), *Brit. J. Pharmacol.* **2014**, doi:10.1111/bph.12688.

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SEMINAR

Monday, 25th August, 12.00 pm, Seminar Room

Host: Dr. Sergio E. Moya

Designed biomaterials for mediating cell migration and cellular uptake

Changyou Gao, Prof. Dr.
MOE Key Laboratory of Macromolecular Synthesis and Functionalization, Department of Polymer Science and Engineering, Zhejiang University, Hangzhou 310027, China
e-mail address: cygao@zju.edu.cn

The processes of tissue regeneration and remodeling depend strongly on the cell migration and differentiation. It would be very meaningful to study the cell migration behaviors *in vitro* by designing specific materials, especially the materials with gradient chemical, physical and/or biological cues, to understand the factors influencing cell mobility and further develop new strategy for designing regenerative biomaterials. During the past decade, our group has being working on the gradient biomaterials for mediating the cell migration in terms of rate, direction, cell selectivity and differentiation in a spatially controlled manner.

The colloidal particles have been widely used in biological and biomedical fields such as drug/gene carriers, contrast agents, photo-thermal therapeutic materials, etc. However, the interactions between colloidal particles and cells, such as internalization process, intracellular fate and influence on cell functions, should still be clarified in detail.

The current lecture will be focused on (1) the mediation of cell migration by gradient biomaterials, in particular the salt-treated polyelectrolyte multilayers which show continuous change in swelling properties, and (2) the internalization processes and intracellular fate of functional polymeric particles and their influences on cell viability and functions.

For more information, http://polymer.zju.edu.cn/biomaterials/English/

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SEMINAR

Wednesday, 27th August, 12.00 pm, Seminar Room

Host: Prof. Luis M. Liz-Marzán

Surfactant and polymer dispersions with liquid crystalline cores

Prof. Watson Loh
Instituto de Química - UNICAMP – CAMPINAS – SP – Brazil – wloh@iqm.unicamp.br

This communication will present studies on two systems capable of forming particles in which the cores display liquid-crystalline structures. The first system is formed with complex salts prepared with a cationic surfactant and a neutral-anionic block copolymer. In mixtures with water, the surfactant molecules assemble to form aggregates that interact with the oppositely-charged blocks to form mesophases. The whole system forms a core-shell structure in which the neutral blocks compose the particle corona and, probably together with electrostatic contributions, are responsible for the high kinetic stability of the dispersions. These mesophases reproduce the structure and properties of the ones previously studied for complex salts of homopolyions and surfactant. The second system is composed by a bicontinuous cubic phase formed by phytantriol and other surfactants, which is designed to respond to biochemical triggers such as the presence of specific enzymes. Results will be presented on their response to lipases and the phase transition caused by the action of this enzyme.

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SEMINAR

Monday, 8th September, 12.00 pm, Seminar Room

Host: Prof. Luis M. Liz-Marzán

Measuring and understanding order and disorder in nanoscale semiconductors

Prof. Brad Chmelka
Department of Chemical Engineering
University of California, Santa Barbara U.S.A.

The properties of nanostructured materials often depend on their small characteristic dimensions, including the increased importance of surface effects, compared to bulk solids. Advances in syntheses, molecular characterization, and modeling of nanoscale materials increasingly enable their compositions, structures, and morphologies to be adjusted, measured, and correlated at a molecular level with their macroscopic physicochemical properties. Solid-state nuclear magnetic resonance (NMR) spectroscopy, especially two-dimensional techniques, together with X-ray scattering, electron microscopy, and modeling calculations, yield detailed insights on local bonding environments, interactions, and dynamics in nanostructured semiconductor materials. Such analyses provide new understanding of structure-function relationships at the nanoscale, especially on molecular interactions and complicated order-disorder near heterostructure interfaces. Recent results will be presented for Group II-VI or III-V nanocrystals and self-assembled organic or hybrid photovoltaic materials, as representative examples. The influences of surface interactions and distributions of compositional or structural order-disorder will be discussed with respect to the macroscopic properties of nanostructured semiconductors and their optoelectronic properties.

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SEMINAR

Wednesday, 10th September, 12.00 pm, Seminar Room

Brain Imaging of neurologic diseases: focus on Stroke and Multiple Sclerosis

Dr. Abraham Martín
CIC biomaGUNE

Non-invasive molecular imaging has been indispensable for early diagnose, monitoring disease progression and therapeutic of a wide range of cerebral pathologies in both the laboratory and clinic. Molecular imaging methods provide accurate information of pathophysiological features underlying neurological diseases as stroke and multiple sclerosis. Stroke or cerebrovascular accident is the most common neurological disorder and a leading cause of death in western countries and both long-term disability. Likewise, multiple sclerosis is the most demyelinating disease of the central nervous system with a prevalence ranging between 20 and 150 cases per 100.000 inhabitants characterized by inflammation, demyelination, gliosis and axonal injury. In this seminar, several examples of multimodal imaging technology with positron emission tomography (PET), single-photon emission computed tomography (SPECT), Magnetic resonance imaging (MRI), Optical Imaging (OI) and Ultrasound Imaging (UI) to visualize and quantify in vivo biological processes as enzyme activity, cell death, inflammation, cerebral receptor function, angiogenesis and functional recovery during the acute, sub-acute and chronic phases of stroke and multiple sclerosis in rodents will be presented.

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SEMINAR

Monday, 22nd September 12.00 pm Seminar Room

Host: Dr. Juan Mareque

SHARK VNAR DOMAINS – BIOLOGICS WITH BITE.

Dr Caroline Barelle – Research Director,
Shark VNAR Development

Shark VNAR domains – biologics with bite.

Variable new antigen receptors (VNARs) are single chain binding domains that play a key role in the adaptive immune systems of Elasmobranchii (sharks, skates and rays). As the smallest binding sites identified in the animal kingdom (20-30% smaller than technologies of GSK and Ablynx), VNARs provide a simple and highly stable protein scaffold from which novel drugs can be produced. VNAR generation is achieved via our immunisation facilities (UK and US) and/or from our diverse synthetic VNAR libraries (in excess of 100 billion clones). Their simple single chain architecture is amenable to multiple modular formatting and they express well in both prokaryotic and eukaryotic systems. Their small size both minimises the risk of immunogenicity and facilitates easy humanisation. VNARs that facilitate half-life extension and/or are specific for inflammatory and oncology disease will be discussed.

Caroline leads a team of senior scientists at the University of Aberdeen developing shark single chain domains from initial lead isolation through to clinical candidate identification. Having successfully secured substantial pre-commercialisation funding, the aim is to spin out a new biologics company called Elasmogen which will focus on these unique binding domains and continue to strengthen the pipeline portfolio of oncology and anti-inflammatory products currently under development. Prior to setting up this team, Caroline was Head of Shark IgNAR Development in Pfizer and Wyeth where she was responsible for establishing robust platforms for the isolation of these binding domains and progressing pipeline candidates. Her first experience of developing shark domains was during her time with the antibody engineering spin-out company, Haptogen, where she was Programmes and Alliance manager. Caroline obtained her PhD in biochemistry at the University of Aberdeen and is currently completing a MBA at Robert Gordon's University, Business School.

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SEMINAR

Thursday, 2nd October, 12.00 pm, Seminar Room

Host: Prof. Luis Liz-Marzán

Synthesis at the Frontier: Catalytic Methods and DNA Binders

José Luis Mascareñas
Centro Singular de Investigación en Química Biolóxica e Materiais Moleculares (CIQUS) and Departamento de Química Orgánica, Universidad de Santiago de Compostela, 15782, Santiago de Compostela (Spain)
e-mail: joseluis.mascarenas@usc.es

The ability to synthesize molecules is at the heart of the progress in many branches of science.Therefore there is a continuum need of devising practical and efficient synthetic methods. In this context our group has been working in the development of synthetic methodologies, particularly those relying on the use of metal catalysis.[1] On the other hand we have also been interested in the use of our synthetic expertise to construct molecules designed to achieved specific functions. In particular most of our efforts have been centered in the synthesis of non-natural compounds that can mimic the DNA binding properties of natural systems and also incorporate extrinsic components that can give rise to different DNA-mediated functions.[2]

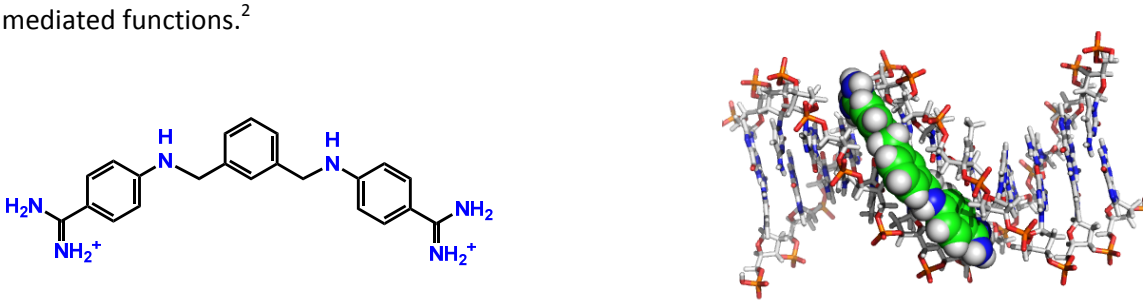

Figure 1. The model (right) shows the structure of the complex between one of our synthetic bisbenzamidines (left) and a dsDNA containing an A/T rich tract, as deduced from NMR studies.

[1] F. López, J.L. Mascareñas *Chem. Soc. Rev.***2014**, 43, 2904.

[2] Pazos, E.; Mosquera, J.; Vázquez M. E.; Mascareñas J. L. *ChemBiochem***2011**,*12* , 1958. Sánchez, M. I.; Vázquez, O.; Martínez-Costas, J.; Vázquez, M. E.; Mascareñas; J.L*ChemicalScience***2012**, *3*, 2383.Sánchez, M. I.; Vázquez, O.; Vázquez, M. E.; Mascareñas; J.L*Chem. Commun.***2011**, *47*, 11107.Sánchez, M. I.; Martínez-Costas, J.; González, F.; Bermudez, M. A.; Vázquez, M. E.; Mascareñas; J.L. *ACS Chem. Biol.* **2012**, *7,* 1276.Jiménez Balsa, A.; Martínez-Albardonedo, B.; Pazos, E.; Mascareñas, J.L.; Vázquez, M. E. *Angew. Chem. Int. Ed.***2012**, 51, 8825.Penas, C; Pazos, E.; Mascareñas, J.L.; Vázquez, M. E. *J. Am. Chem. Soc*. **2013**, 135, 3812.

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SEMINAR

Friday, 10th October, 12.00 pm, Seminar Room

Host: Prof. Luis Liz-Marzán

Nanoporous silicon and alumina technologies in nanomedicine

Prof. Lluís F. Marsal
Department of Electronic Engineering
Universitat Rovira i Virgili
Tarragona, Spain

This talk will explore some recent applications of structured porous silicon and nanoporous alumina in nanomedicine. These porous materials are prepared by electrochemical anodization of aluminum or silicon and their nanostructure such as pore diameter, interpore distance, porosity, film thickness can be tuned by modifying the anodization conditions. Porous silicon and nanoporous alumina can also be used as templates for obtaining replicas of other micro-nanostructured materials (polymers, metals, nanocomposites) and for growing functionalized material arrays. Furthermore, the interaction and confinement of light inside these nanoporous structures make it possible to tune different optical signals (e.g. photoluminescence, reflectance, absorbance, etc) at will by modifying the nanoporous structure. This, combined with other strategies as surface chemistry functionalisation, has made it possible to develop new applications in nanomedicine.

In the first part of this talk, we will introduce the fabrication and properties of structured porous silicon and nanoporous alumina and discuss different electrochemical approaches to modify the nanopore morphology during or after the fabrication process. In a second part, we will present some examples of selective optical biosensors, molecular recognition and controlled release in drug delivery systems and 3D microenvironments for cell culture and tissue engineering.

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SEMINAR

Tuesday, 14th October, 12.00 pm, Seminar Room

Host: Prof. Luis Liz-Marzán

Colloidal Assembly of Surfactant/Oligomer Complexes: Self Assembly, Photophysics and Antimicrobial Activity

David G. Whitten
Center for Biomedical Engineeering
Department Of Chemical and Biological Engineering
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Albuquerque, New Mexico

Given the rise of new and antibiotic resistant pathogens there is a need for new antimicrobials that function via paths or processes that cannot be easily defeated by microorganisms. It is important that new compounds or materials to be used as antimicrobials also must not be harmful to humans or the environment and that they can be readily degraded subsequent to their use. Recent investigations have shown that cationic phenylene ethynylene polymers (CPE) and oligomers (OPE) can be effective antimicrobial agents against Gram positive and Gram negative bacteria, viruses, fungi and spores. In several cases these compounds and materials function both in the dark and under light activation. While their mode of action is at least partially understood, recent work has shown that in some cases unanticipated results have been obtained such as induced germination of bacillus spores. The light-activated mode of action involves generation of singlet oxygen and other reactive oxygen intermediates. For certain of the oligomers, the light activation can also be a pathway for their photodegradation. The photodegradation for the most part involves reaction of the oligomers with oxygen and water and cleavage to give products which are smaller, readily degradable and not likely to be environmental hazards. Complex formation occurs with oppositely charged surfactants or lipids in several cases and it is found that the complexes are often stronger microbials than the OPEs alone.

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SEMINAR

Tuesday, 21st October, 12.00 pm, Seminar Room

Host: Prof. Luis Liz-Marzán

Looking and Listening to Light from Liposome Nanostructures for Cancer Theranostics

Professor Kostas Kostarelos
Chair of Nanomedicine
Nanomedicine Lab
School of Medicine & National Graphene Institute | Manchester Cancer Research Centre
University of Manchester| Manchester M13 9NT | United Kingdom

The discovery of novel diagnosic and theranostic tools against cancer greatly depends on merging progress made in technology development of imaging modalities (hardware, image analysis) and advances in nanomaterial fabrication. Some of the most promising modalities that allow deep tissue imaging are those using optical signal detection at the near-infrared region with minimal background interference. As such optical imaging technologies mature and begin to be adopted in clinical practice, probes with appropriate signals and the capacity to target and accumulate in tumor tissue will be needed. Recently, we have proposed liposomes as clinically-established nanoscale platforms for the design of multi-spectral optical probe systems for multispectral optoacoustic tomography, fluorescence and bioluminescence imaging in vivo. 'Looking and listening' to light emitted from newly engineered liposome systems from within tumor tissue will be shown to allow visualisation of their exact localization, release of their therapeutic cargo (siRNA) and reveal features of the tumor vasculature architecture.

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SEMINAR

Friday 24th October, 12.00 pm, Seminar Room

Host: Prof. Soledad Penades

The Mystery of Starch Granule: A Multiscale Biomaterial

Dr Serge Pérez
Department of Molecular Pharmacochemistry
CNRS & Université de Grenoble-Alpes
Grenoble France

As early as 1858, the botanist Carl von Nägeli stated that "*The starch grain...opens the door to the establishment of a new discipline... the molecular mechanics of organised bodies".* He would be astonished that, more than 150 years later, we are still struggling to understand the complex architecture of starch granules. Recent developments in methods and instrumentation, using X-ray synchrotron radiations, have contributed to major advances in our understanding of the fine structure of amylose and amylopectin, the major macromolecular components of Starch. The presentation will start with a movie that will transport the spectators throughout the different levels of structural organizations over 6 orders of magnitude as seen from different microscopic methods. The molecular and macromolecular descriptions of these levels will be presented and discussed, going from the double helical structures to unique architectures which occur from phyllotactic patterns as a result of the emergence of self-organizing processes in dynamic systems. Distinction between those structural features that have received widespread acceptance and those that are still under debate will be presented with the ambition of being educational and to provide stimulation for further fundamental investigation into the starch granule as a multi-scale macromolecular assembly.

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SEMINAR

Monday, 27th October, 12.00 pm, Seminar Room

Host: Dr. Ralf Richter

A model for the mechanism of protein stabilization by mono- and oligo-saccharides

Ilyas Beg[1], Faizan Ahmad[1], and Allen P. Minton[2]
[1]Centre for Interdisciplinary Research in Basic Sciences, Jamia Millia Islamia, New Delhi, India
[2]Laboratory of Biochemistry & Genetics, National Institute of Diabetes & Digestive & Kidney Diseases, National Institutes of Health, Bethesda MD, USA

The reversible unfolding of α-lactalbumin and lysozyme was characterized quantitatively via measurement of changes in absorbance and circular dichroism as a function of temperature in buffer and in the presence of multiple concentrations of each of three monosaccharides (glucose, fructose, galactose), two disaccharides (sucrose, trehalose), a trisaccharide (raffinose) and a tetrasaccharide (stachyose). It was observed that the temperature at which the proteins were half-unfolded increased linearly with the concentration of each saccharide. The observed dependence of unfolding of both proteins upon temperature and sugar concentration could be precisely modeled by a two-state model, according to which the Gibbs free energy of unfolding increased linearly with sugar concentration at all temperatures. The slope of the dependence of unfolding free energy on sugar concentration was approximately the same for all three monosaccharides and both disaccharides. The slope varied approximately linearly with the degree of sugar oligomerization but the magnitude of the dependence upon sugar concentration was larger for α-lactalbumin than for lysozyme. The dependence of the ability of a particular saccharide to stabilize each protein upon the degree of oligomerization of the saccharide may be accounted for quantitatively by a simple statistical-thermodynamic model, containing only one adjustable parameter for each protein, according to which protein stabilization is attributed to the differential exclusion of sugar by the native and average unfolded state of each protein.

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SEMINAR

Wednesday, 29th October, 12.00 pm, Seminar Room

Host: Prof. Luis Liz-Marzán

Synergies Between Chemistry and Nanosciences: Applications to Nanomedicine

Maurizio Prato
Dipartimento di Scienze Chimiche e Farmaceutiche, Università degli Studi di Trieste, Piazzale Europa 1, 34127 Trieste, Italy, e-mail: prato@units.it

Among the wide range of novel nanometer scale structures available, single-wall carbon nanotubes (SWNT) and multi-wall carbon nanotubes (MWNT) stand as unique materials for fundamental research and potential applications. However, manipulation and processing of carbon nanotubes (CNTs) has been difficult because of their intractability and insolubility in most common solvents. Considerable effort has therefore been devoted to the chemical modification of CNTs, which might open the way to many useful applications.

Our group has been involved in the organic functionalization of various types of nanocarbons, including carbon nanotubes, fullerenes and, more recently, graphene. The organic functionalization offers the great advantage of producing soluble and easy-to-handle CNTs. As a consequence, since biocompatibility of CNTs is improved, many functionalized carbon nanotubes may find useful applications in the field of nanomedicine.

CNT functionalized with bioactive moieties are particularly suited for targeted drug delivery. In fact, not only they exhibit reduced toxicity, but also possess a high propensity to cross cell membranes.[1]

Carbon nanotubes can also act as active substrates for neuronal growth, a field that has given so far very exciting results. Nanotubes are compatible with neurons, but especially they play a very interesting role in interneuronal communication. Improved synaptic communication is just one example.[2]

During this talk, we will show the latest advances of the most exciting results obtained in our laboratory in these fast developing fields.

References

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SEMINAR

Wednesday, 29th October, 16.00 pm, Seminar Room

Host: Dr. Ralf Richter

Electrostatic interactions in biological brushes

Ekaterina Zhulina
Institute of Macromolecular Compounds, Russian Academy of Sciences & Saint-Petersburg State University of Informational Technologies, Mechanics and Optics

We first discuss few examples of natural (biological) brushes. By using scaling concepts we review basic features of synthetic polyelectrolyte brushes. We then focus on one specific example of natural biological brush – the corona of neurofilaments, and discuss how physical theoretical methods can be used to probe the structure and properties of neurofilaments.

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Friday, 21st November, 12.00 pm, Seminar Room

Host: Prof. Luis Liz-Marzán

Controlled Synthesis and Novel Properties of 2-Dimensional Materials: From Doped Graphene to WS_2 monolayers and more

Mauricio Terrones
Department of Physics, Department of Chemistry, Department of Materials Science and Engineering and Center for 2-Dimensional & Layered Materials. The Pennsylvania State University, University Park, Pennsylvania 16802, USA&Institute of Carbon Scienceand Technology,Shinshu University, JAPAN

This talk will discuss the synthesis of large-area, high-quality monolayers of nitrogen- and boron-doped graphene sheets on Cu foils using ambient-pressure chemical vapor deposition (AP-CVD). Scanning tunneling microscopy (STM) and spectroscopy (STS) reveal that the defects in the doped graphene samples arrange in different geometrical configurations exhibiting different electronic and magnetic properties. Interestingly, these doped layers could be used as efficient molecular sensors and electronic devices. In addition, the synthesis of hybrid carbon materials consisting of sandwich layers of graphene layers and carbon nanotubes by a self-assembly route will be discussed. These films are energetically stable and could well find important applications as field emission sources, catalytic supports, gas adsorption materials and super capacitors.

Beyond graphene, the synthesis of other 2-Dimensional materials will be described. In particular, we will discuss the synthesis of WS_2 and MoS_2 triangular monolayers, as well as large area films using a high temperature sulfurization of WOx clusters deposited on insulating substrates. We will show that depending on the substrate and the sizes of the oxide clusters, various morphologies of layered dichalcogenidescould be obtained. In addition, photocurrent measurements on these materials will be presented. Our results indicate that the electrical response strongly depends on the laser photon energy. The excellent response observed to detect different photon wavelengths in MoS_2, WS_2 and WSe_2 materials, suggest these materials could be used in the fabrication of novel ultrafast photo sensors.

From the theoretical stand point, we have found using first principles calculations, that by alternating individual layers of different metal chalcogenides (e.g. MoS_2, WS_2, WSe_2 and $MoSe_2$) with particular stackings, it is possible to generate direct band gap bi-layers ranging from 0.79 eV to 1.157 eV. Interestingly, in this direct band gap, electrons and holes are physically separated and localized in different layers. We foresee that the alternation of different chalcogenide layers would result in the fabrication of materials with unprecedented optical and physico-chemical properties.

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SEMINAR

Thursday, 27th November, 12.00 pm, Seminar Room

Host: Dr. Jordi Llop

Multicomponent and Cascade Reactions: New Opportunities for Natural Product Synthesis and Medicinal Chemistry

Félix Rodríguez
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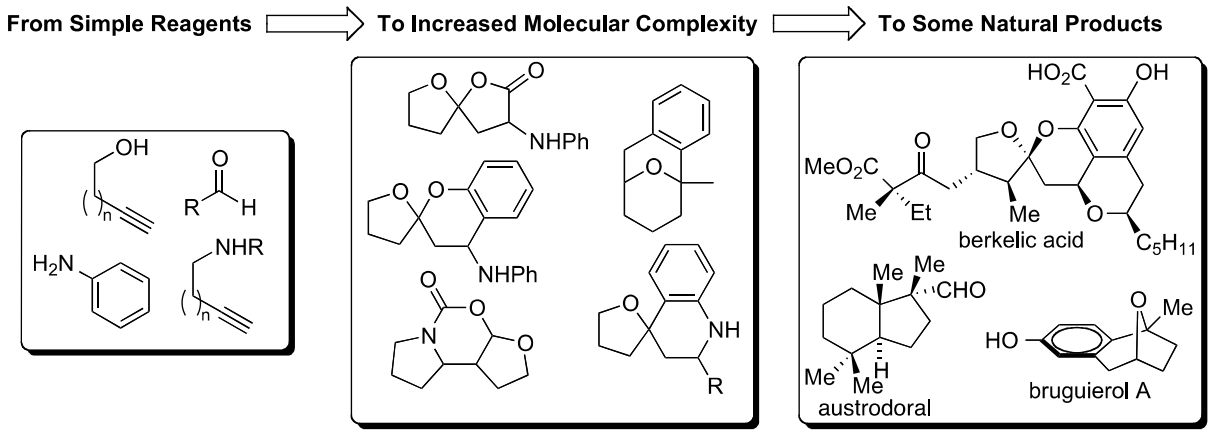
The role played by organic chemistry in the pharmaceutical industry continues to be one of the main drivers in the drug discovery process. More than ever, the industry demands from organic chemists the development of new strategies and technologies to obtain new compounds in a fast, clean and efficient way. Among these procedures multicomponent and cascade reactions offer the opportunity of building up complex molecules with exceptional synthetic efficiency, frequently with high stereoselectivity, from simple and easily available substrates. In these reactions, several bond-forming and/or cleaving events occur in one synthetic operation, thus minimizing the cost and waste associated with one-reaction/one-vessel approaches.

Our interest on the development of new synthetic methods led us to start a project to explore new catalytic cascade reactions. A variety of processes devised for generating molecular complexity will be detailed along with the application of these reactions in the total synthesis of natural products and some other potentially bioactive compounds.



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SEMINAR

Wednesday, 10th December, 12.00 pm, Seminar Room

Host: Prof. Luis Liz-Marzán

Patchy Nanoparticles, Synthesis, Properties and Characterization

Dr. Javier Reguera
CIC biomaGUNE

Patchy nanoparticles are nanoparticles whose surface is composed by several chemical entities that are arranged in domains. These surface domains provide unique properties to the particles, ranging from a different solubility with a structural interfacial energy to cell membrane penetration, enhanced catalytic activity, or selective molecular recognition.[1]

One remarkable way to obtain patchy nanoparticles is with the use of binary Self-Assembled Monolayers (SAMs) where mixtures of molecules can self-assemble at the surface of metallic nanoparticles giving rise to different nanodomains depending on the nature of the ligand molecules. With the use of Scanning Tunnelling Microscopy (STM), the existence of narrow nano-domains (stripes) for different binary mixtures of dislike ligands, have been extensively demonstrated in this work (figure 1a).[2] Additional techniques such as 2D NMR, neutron scattering and theoretical simulation studies have also supported the existence of these stripes.

Last studies have shown also the self-assembly of ligands in Janus morphology (complete phase separation) for nanoparticles with small sizes or with high mismatch between ligands (figure 1b).[3] The anisotropy caused by the Janus formation has an extraordinary potential in a whole set of new applications such as the formation of suprastructures, stabilization of pickering emulsions, drug delivery, etc.

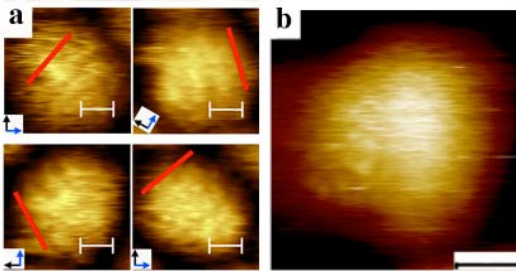

Figure 1: STM images of individual nanoparticles showing different nanostructures. a) Nanoparticle showing narrow nanodomains at different scan angles. b) Nanoparticle showing Janus morphology. Scale bar 2nm.

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3. H. Kim, R.P. Carney, J. Reguera, Q.K. Ong, X. Liu, F. Stellacci, *Adv. Mater.* 2012, **24**, 3857.