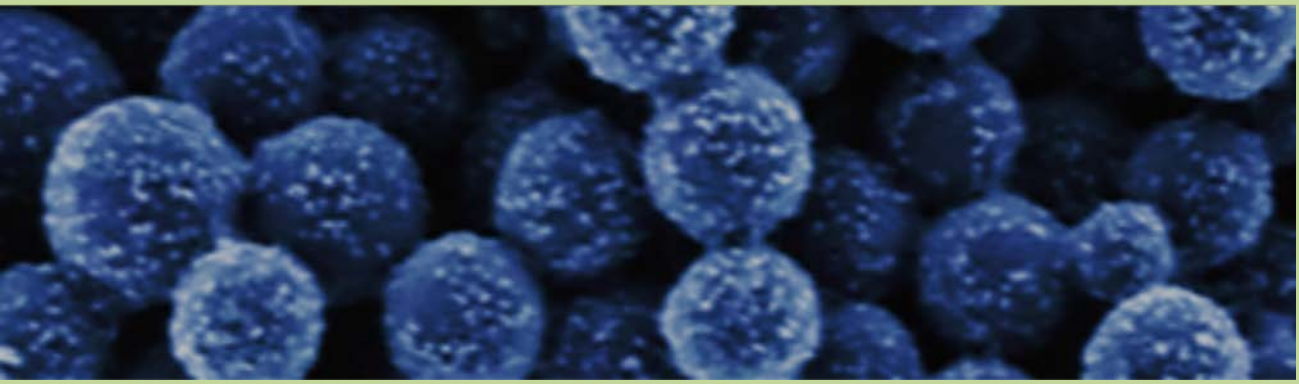
Max Planck Partner Group on
Colloidal Methods for
Multifunctional Materials

(CM³-Lab)



German–Spanish Symposium on Functional Hybrid Nanomaterials

Symposium on the Occasion of the Inauguration of the
Max Planck Partner Group on Colloidal Methods for Multifunctional Materials (CM3-Lab)
at the University of Valencia

April 25–26, 2018

VENUE: "Saló d'Actes dels Instituts d'Investigació"
Edifici d'Instituts d'Investigació
Parc Científic de la Universitat de València
Paterna, Spain

Max-Planck-Institut für Polymerforschung
Max Planck Institute for Polymer Research

ICMUV
INSTITUT DE CIÈNCIA DELS MATERIALS de la Universitat de València

„Wissenschaft fängt eigentlich erst da an,
interessant zu werden, wo sie aufhört.“

“Actually, science only starts
to get interesting where it ends.”

—Justus Liebig (1803–1873)

Presentation

Even if the term “organic/inorganic hybrid nanomaterial” has become incredibly popular in the last years, the combination of organic and inorganic matter at the nanoscopic scale is not really a new invention. Indeed, nature has been fabricating hybrid materials since the origins of life. For instance, bone, nacre, and corals are typical examples of this phenomenon. Inspired by nature, chemists and materials scientists investigate the synergy between different organic and inorganic building blocks to fabricate new materials.

In this bilateral symposium, researchers from Germany and Spain will discuss and share their opinions on the state of the art and future directions in the development of functional hybrid nanomaterials.

The symposium is held in the context of the inauguration of the Max Planck Partner Group on Colloidal Methods for Multifunctional Materials (CM3-Lab), a laboratory at the Institute of Materials Science of the University of Valencia (ICMUV) that works in close collaboration with the Max Planck Institute for Polymer Research in Mainz.

All interested researchers and students are very welcome to join us.

Rafael Muñoz-Espí
Symposium Chair

https://www.uv.es/muesra/symposium2018/

Organization

CHAIR: **Rafael Muñoz-Espí**
ICMUV, University of Valencia, Paterna, Spain

CO-CHAIR: **Katharina Landfester**
Max Planck Institute for Polymer Research, Mainz, Germany

Max Planck Partner Group on Colloidal Methods for Multifunctional Materials (CM3-Lab)

The **Laboratory of Colloidal Methods for Multifunctional Materials (CM3-Lab)** is a Max Planck Partner Group of the Department of Physical Chemistry of Polymers of the Max Planck Institute for Polymer Research, based at the Institute of Materials Science of the University of Valencia (ICMUV). This cooperative project, financed by the Max Planck Partner Group Program of the Max Planck Society, started the activities in June 2017 and is headed by Dr. Rafael Muñoz-Espí. The CM3-Lab is associated to the Unit of Polymer Materials at ICMUV.

The CM3-Lab focuses on the development of multifunctional hybrid systems to be used as platforms for the sustainable use of resources. How to apply the confinement provided by colloidal systems for the control of structure and properties of polymer materials and polymer/inorganic hybrids is the central scientific question.

https://www.uv.es/muesra

Wednesday, April 25, 2018

14:45	OPENING OF THE SYMPOSIUM **María Dolores Real**, Vice-principal of Innovation and Transfer, University of Valencia **Ana Cros,** Director of ICMUV, University of Valencia **Adela Mauri-Aucejo,** Dean of the Faculty of Chemistry, University of Valencia
15:00	**Rafael Muñoz-Espí,** ICMUV, University of Valencia, Paterna (Spain) "Colloidal Strategies for Multifunctional Hybrid Materials" (Presentation of the Partner Group)
15:40	KEYNOTE LECTURE **Katharina Landfester**, Max Planck Institute for Polymer Research, Mainz (Germany) "Polymeric Nanocapsules: from Encapsulation to Selective Release"
16:20	**Coffee Break**
16:45	**María González-Bejar**, ICMol, University of Valencia, Paterna (Spain) "Organic–Inorganic Nanohybrids for Light-Driven Applications"
17:25	**Kai Zhang**, Max Planck Institute for Polymer Research, Mainz (Germany) "Designing Conjugated Porous Polymers for Visible Light Photocatalysis"
18:05	Begin of the Social Program with Tourist Visit of the City Center of Valencia and Dinner

Scientific Program

Thursday, April 26, 2018 — MORNING

09:00	KEYNOTE LECTURE **Helmut Cölfen**, University of Konstanz, Konstanz (Germany) "Mesostructured Organic–Inorganic Hybrid Materials"
09:40	**Juan J. Giner-Casares**, University of Córdoba, Córdoba (Spain) "Air/Liquid Interface as a Versatile Platform for Understanding the Mechanism of Self-Assembly Processes"
10:20	**Olaia Álvarez-Bermúdez**, ICMUV, Univ. of Valencia, Paterna (Spain) & MPI for Polymer Research, Mainz (Germany) "Polyurethane–Metal Oxide Hybrid Microcapsules: Highly Efficient Carriers for Applications in Thermal Energy Storage"
11:00	**Coffee Break**
11:25	KEYNOTE LECTURE **Silvia Gross**, University of Padua, Padua (Italy) "Organically Functionalized Transition Metal Oxoclusters as Versatile Building Blocks for Functional and Structural Hybrid Materials"
12:05	**Dana Medina,** Ludwig-Maximilians-Universität München, Munich (Germany) "Thin Films of Two-dimensional Crystalline Porous Frameworks"
12:45	**Rafael Abargues**, ICMUV, University of Valencia, Paterna (Spain) "Hybrid Nanocomposites: A Step towards Advanced Multifunctional Materials"
13:25	**Lunch**

Thursday, April 26, 2018 AFTERNOON

14:55	**Cristina Flors,** IMDEA Nanoscience, Madrid (Spain) "Hybrid Nanoscopy of Hybrid Nanomaterials"
15:35	**Noemí Encinas**, Universidad Complutense, Madrid (Spain) "Deceiving Bacteria: Low Adhesion Liquid-Repellent Surfaces and Nanocarriers to Overcome Infection"
16:15	CLOSING KEYNOTE LECTURE **Werner E. G. Müller**, Institute for Physiological Chemistry, University Medical Center of the Johannes Gutenberg University, Mainz (Germany) "Polyphosphate, a Smart Bioinspired Nano-/Bio-material, for Regeneratively Active Osteo-Articular Implants: Towards a New Paradigm in Tissue Engineering"
16:55	**CONCLUDING REMARKS**
17:15	**END OF THE SYMPOSIUM**

Max Planck Partner Group on

Colloidal Methods for Multifunctional Materials

(CM³-Lab)

Wednesday, April 25 3:00 p.m.

Colloidal Strategies for Multifunctional Hybrid Materials

Rafael Muñoz-Espí
Institute of Materials Science (ICMUV), University of Valencia, Paterna, Spain
E-mail: rafael.munoz@uv.es

Colloidal synthetic routes involving heterophase systems are very versatile in the preparation of polymer/inorganic hybrid nanoparticles and nanocapsules. Especially interesting are those materials derived from the covalent incorporation of functionalized inorganic building blocks into a polymer matrix through copolymerization with suitable monomers. The variability of the starting building blocks in terms of chemical nature and structure allows a fine tuning of the targeted features.

Nanocontainers produced by colloidal methods are able to protect the encapsulated materials from the external medium and, if required, to deliver them into a specific environment. One possibility is to incorporate the inorganic component in polymer or polymer/inorganic hybrid colloids formed by miniemulsion polymerization. The encapsulation can also be combined with the in-situ surface deposition of further inorganic materials to generate multifunctional nanoparticles. The interaction between the inorganic component and the surrounding polymer is shown to influence the final structure and the segregation of the inorganic components. Our team addresses the structure control in hybrid multicomponent nanomaterials.

Rafael Muñoz-Espí studied Chemistry at the University of Valencia and moved afterwards to Mainz, Germany, for his doctoral studies, as a recipient of a postgraduate fellowship from the German Academic Exchange Service (DAAD) and the Foundation “La Caixa”. He received his doctoral degree in 2006 after working under the supervision of Prof. Gerhard Wegner at the Max Planck Institute for Polymer Research (MPIP). After two years of postdoctoral stay at the State University of New York at Stony Brook, USA (group of Prof. Benjamin Chu), he returned to the MPIP and became group leader of the team “Polymer/Inorganic Hybrid Colloids” at the Department of Physical Chemistry of Polymers, headed by Prof. Katharina Landfester (2009–2015). Since September 2015, Dr. Muñoz-Espí has been a Ramón y Cajal Senior Researcher at the Institute of Materials Science of the University of Valencia (ICMUV). He has coauthored about 70 scientific peer-reviewed publications in high-ranking international journals and books. His current research interests include mineralization processes, the synthesis of polymeric and hybrid nanoparticles, crystallization in colloidal systems, and the study of the interaction of polymers with inorganic matter.

Wednesday, April 25 3:40 p.m.

Keynote Lecture

Polymeric Nanocapsules: from Encapsulation to Selective Release

Katharina Landfester
Max Planck Institute for Polymer Research, Mainz, Germany
E-mail: landfester@mpip-mainz.mpg.de

Control over the nanoscopic scale opens nearly endless opportunities for many scientific areas. In particular polymeric nanoparticles offer the versatility to cover a wide range of mesoscopic properties for sophisticated applications. However, making smart nanoparticles is inevitably linked to a deep understanding of the overall physico-chemical principle of their formation. By means of the miniemulsion process, we design custom-made nanoparticles and nanocapsules for nearly any purpose ranging from self healing (of steel) to biomedical applications. This is facilitated by the enormous versatility of the miniemulsion process that has been developed and conceptually understood by our group. Moreover, the accumulation of understanding the formation process has led to successful and precise control of important nanoparticle parameters such as size, shape, morphology, surface functionalization and modification, degradation, release kinetics. This degree of control is unique and allows us to tune specific properties tailored to particular applications; the successful up-scaling of process is of technical relevance. Furthermore, the encapsulation and release of a great variety of payloads, ranging from hydrophobic to hydrophilic substances has been successfully achieved in a highly controlled manner and with an unmatched high encapsulation efficiency. Additionally, it will be shown how the interaction of the nanoparticles and nanocapsules with synthetic and biological matter is influenced by the characteristics of the nanoparticles and nanocapsules.

Katharina Landfester received her doctoral degree in Physical Chemistry after working in 1995 at the MPI for Polymer Research (MPIP). After a postdoctoral stay at the Lehigh University (Bethlehem, PA), she worked at the MPI of Colloids and Interfaces in Golm leading the mini-emulsion group. From 2003 to 208, she was professor at the University of Ulm. She joined the Max Planck Society in 2008 as one of the directors of the MPIP. She was awarded the Reimund Stadler prize of the German Chemical Society and the prize of the Dr. Hermann Schnell Foundation, followed by the Bruno Werdelmann Lecturer in 2012 and the Bayer Lecturer in 2014. Her research focuses on creating functional colloids for new material and biomaterial applications.

Wednesday, April 25 4:45 p.m.

Organic–Inorganic Nanohybrids for Light-Driven Applications

María González-Béjar
Institute for Molecular Science (ICMol), University of Valencia, Paterna, Spain
E-mail: maria.gonzalez@uv.es

The combination of organic materials (organic molecules, macrocycles and polymers) with inorganic nanomaterials to make new nanohybrids with novel photophysical properties is an interesting and difficult task that requires exceptional control at the nanoscale. Moreover, the effect of light excitation on these nanohybrids and which processes can be derived from these light-nanosystem interactions has to be understood. In the foregoing, special emphasis will be placed in the synthesis of organic-coated gold or upconversion nanoparticles ($NaYF_4$:Yb^{3+},Tm^{3+} or Er^{3+}) to generate new nanohybrids for several purposes such as photodynamic therapy,[1] photocatalysis,[2] thermoresponsiveness,[3] and efficient energy transfer between luminescent nanoparticles.[4] In short, a few examples that illustrate the capabilities of these organic-inorganic nanohybrids will be presented.[5]

[1] a) González-Béjar, M.; Liras, M.; Francés-Soriano, L.; Voliani, V.; Herranz-Pérez, V.; Duran-Moreno, M.; García-Verdugo, J. M.; Alarcon, E.; Scaiano, J. C.; Pérez-Prieto, J. *J. Mat. Chem. B* **2014**, *2*, 4554.; b) Francés-Soriano, L.; Liras, M.; Kowalczyk, A.; Bednarkiewicz, A.; González-Béjar, M.; Pérez-Prieto, J. *Nanoscale* **2016**, *8*, 204.
[2] González-Béjar, M.; Peters, K.; Hallett-Tapley, G.L.; Grenier, M.; Scaiano, J.C. *Chem. Commun.* **2013**, *49*, 1732.
[3] Liras, M.; González-Béjar, M.; Peinado, E.; Francés-Soriano, L.; Pérez-Prieto, J.; Quijada-Garrido, I.; García. O. *Chem. Mater.* **2014**, *26*, 4014.
[4] Francés-Soriano, L.; Gonzalez-Carrero, S.; Navarro-Raga, E.; Galian, R. E.; González-Béjar, M.; Pérez-Prieto, J. *Adv. Funct. Mater.* **2016**, *26(28)*, 5131.
[5] Lanterna, A.; Pino E.; Doménech-Carbó, A.; González-Béjar, M.; Pérez-Prieto, J. *Nanoscale* **2014**, 6, 9550.

Maria González-Béjar holds a Ramón y Cajal contract at the University of Valencia. During the last ten years working in physical and organic chemistry laboratories, she has been engaged with research mainly based on light-driven applications (photocatalysis, photodynamic therapy, time-resolved applications, etc.). She is also extremely interested in the field of upconversion nanoparticles and plasmonics. Dr. González-Béjar earned her PhD in Chemistry in 2007 under the supervision of Prof. Pérez-Prieto at the University of Valencia, with the highest mark (European Doctorate and Extraordinary Prize). From June to August 2005, she worked at the Technische Universität München under the supervision of Prof. Bach. Later on, she got a post-doctoral grant from the Spanish Ministry of Science and Technology to develop new sensors based on quantum dots at the University of Ottawa under the supervision of Prof. Scaiano, where she continued working as Research Associate for another 2 years. After that, Dr. González-Béjar was awarded with a Juan de la Cierva contract and a Marie Curie Career Integration Grant. She has published more than 50 papers and three book chapters.

Designing Conjugated Porous Polymers for Visible Light Photocatalysis

Kai Zhang
Max Planck Institute for Polymer Research, Mainz, Germany
E-mail: kai.zhang@mpip-mainz.mpg.de

Conjugated porous polymers (CPPs) have recently emerged as a new class of organic and heterogeneous photocatalysts for visible light-promoted photoredox reactions. The CPPs have been established as a potential alternative to resolve critical drawbacks of traditional molecular and homogeneous photocatalysts due to their structural durability, non-toxicity, low cost by the absence of noble metals, and high designability. Tremendous attempts have been made for the design and synthesis of CPPs for a variety of visible light-promoted photocatalytic chemical transformations.
In this talk, an overview is given on the recent developments in controlling structural, and photophysical and electronic properties of CPPs, and to extract the underlying design principles with respect to the molecular structure, macroscopic feature, i.e. morphology, porosity and chemical functionality, and processibility of CPPs for the enhancement of photocatalytic activity.

Kai Zhang did his undergraduate at the University of Cologne, Germany, and completed his PhD in 2010 in the group of Prof. Bernd Tieke in Cologne, working also with Prof. Peter Skabara at the University of Strathclyde, Glasgow, UK. After working as a postdoctoral researcher with Prof. Markus Antonietti at the Max Planck Institute of Colloids and Interfaces, Potsdam, Germany, he joined the Max Planck Institute for Polymer Research in spring of 2013 as a research group leader in the department of Prof. Katharina Landfester. His research activity is mainly focused on photoactive porous polymer materials for catalytic studies.

Mesostructured Organic–Inorganic Hybrid Materials

Helmut Cölfen
Universität Konstanz, Physikalische Chemie, Konstanz, Germany
E-mail: helmut.coelfen@uni-konstanz.de

Biominerals teach excellent lessons about advanced materials design. Their structural design is optimized for the specific materials purpose and often, the beneficial properties are generated on several hierarchy levels. This presentation begins with a synthetic mimic of bone as surface coating of bone implants. Covalent linking of gelatin to PEEK or titania implants with subsequent mineralization of calcium phosphate leads to an osseointegrative implant coating on which the osteoblast cells already secrete collagen after a very short time.

The second example introduces the so-called mineral plastics. This is obtained if $CaCO_3$ is precipitated in presence of 100 000 g/mol polyacrylic acid. The precipitated hydrogel is self-healing and forms a transparent film upon drying. The material is non-flammable and can be recycled and reshaped by simple addition of water.

The third example deals with mesocrystals – a product of non-classical crystallization. For the example of magnetite nanocubes, it will be shown which types of superstructures can be formed. The mesocrystals can be dissolved and reprecipitated, which leads to a size fractionation of the nanoparticles. Mesocrystal formation has many similarites to classical crystal growth and these will be discussed.

Helmut Cölfen is full professor of Physical Chemistry and speaker of SFB 1214 at the University of Konstanz. His research interests are in the area of nucleation, classical and non-classical crystallization, biomineralization, hybrid and multifunctional materials, synthesis of functional polymers, directed self-assembly of nanoparticles, and fractionating methods of polymer and nanoparticle analysis (especially analytical ultracentrifugation). He serves on the editorial/advisory boards of several journals, is editor in chief of *Crystals* and co-editor of *Current Nanoscience*, and is member of the German Chemical Society as well as Fellow of the Royal Society of Chemistry. He received several awards, including the listing in the Thomson Reuters and Times Higher Education Index lists of top 100 chemists worldwide for the years 2000–2010.

Air/Liquid Interface as a Versatile Platform for Understanding the Mechanism of Self-Assembly Processes

Juan J. Giner-Casares
Department of Physical Chemistry, University of Córdoba, Córdoba, Spain
E-mail: jjginer@uco.es

The incorporation of exotic molecules, self-assembling chemical groups and inorganic nanoparticles in Langmuir monolayers provides detailed insights in the mechanism of molecular interactions.[1] The Langmuir technique assures a fine control over the self-assembling processes, determining the available surface area and applied surface pressure. The availability of experimental techniques for the in situ characterization of Langmuir monolayers offers exciting possibilities.

Plasmonic nanoparticles serve as excellent building blocks for assembling supramolecular structures that mimic biological behaviour. We have explored mechanosensation, i. e., conversion of applied pressure to defined modification in molecular arrangements. This feature has been achieved through hybridization of the nanoparticles with a purposefully designed self-assembling molecule based on non-covalent intermolecular interactions.[2]

In the research line of biological based materials, Fmoc-functionalized dipeptides are used to build chiral nanowires with different applications. Herein I will discuss on the molecular parameters that lead to an efficient self-assembly of the dipeptides at fluid interfaces.

[1] Giner-Casares, J. J.; Brezesinski, G.; Möhwald, H. *Curr. Opin. Colloid Interface Sci.* **2014**, *19,* 176.
[2] Coelho, J. P. *et al. J. Am. Chem. Soc.* **2017**, *139*, 1120.

Juan J. Giner-Casares graduated in Chemistry at the University of Córdoba (Spain), where he obtained his Ph.D. in 2009, mainly studying Langmuir monolayers under experimental and computational approaches. From 2009 to 2013, he worked as an Alexander von Humboldt fellow in the Department of Interfaces led by Prof. Helmuth Möhwald in the Max Planck Institute for Colloids and Interfaces in Potsdam, Germany. In 2013, he moved to the BioNanoPlasmonics Lab led by Prof. Luis Liz-Marzán at CIC biomaGUNE in Donostia/San Sebastián, Spain, aiming at plasmonic functional materials for biomedicine. Since 2016, he is working under a tenure track position (Ramón y Cajal) at the University of Córdoba (Spain). He has published more than 50 papers, having received more than 600 citations (*h*-index: 13). His main area of research is Langmuir monolayers, which he try to apply to exotic molecules and inorganic nanoparticles (mainly plasmonic nanoparticles) to understand self-assembly processes with a focus on biological applications.

Polyurethane–Metal Oxide Hybrid Capsules: Highly Efficient Carriers for Application in Thermal Energy Storage

Olaia Álvarez-Bermúdez,[1,2] Adrián Aguado-Hernándiz,[1] Inés Adam-Cervera,[1] Katharina Landfester,[2] and Rafael Muñoz-Espí[1]
[1] Institute of Materials Science (ICMUV), University of Valencia, Paterna, Spain
[2] Max Planck Institute for Polymer Research, Mainz, Germany
E-mail: olaia.alvarez@uv.es; alvarezo@mpip-mainz.mpg.de

The unaffordable consumption of energy in our society makes crucial the optimization of the production, storage, and recovery systems in the energetic sector. Phase change materials, and more precisely hydrated salts, have been developed in the last decade as energy storage platforms that allow the storage and recovery of thermal energy during the melting and recrystallization processes, respectively. The thermal and the chemical instabilities inherent to these salts difficult their direct application in bulk, so different encapsulating strategies have been proposed to guarantee their storage capacity. We present the preparation of surfactant-free polymer–metal oxide hybrid microcapsules as traceable systems for thermal energy storage applications. From the synthetic point of view, we establish a versatile colloidal platform in which different surface functionalized metal oxides with magnetic (Fe_3O_4) and/or catalytic (CeO_2 and TiO_2) functionalities are adsorbed at the droplet interface of an inverse miniemulsion conferring Pickering stabilization. The interfacial polymerization process between an isocyanate and a diol results into a hermetic polyurethane shell covered by a surface layer of metal oxide nanoparticles and an inner liquid core containing an aqueous solution of hydrated salts. Stable and magnetoresponsive carriers, highly efficient for thermal energy storage were reached using sodium sulfate decahydrate salt as phase change material and disodium hydrogenphosphate dihydrate salt as a nucleating agent for avoiding supercooling.

Olaia Álvarez-Bermúdez studied Chemical Engineering at the University of Granada, Spain, and the Via University College, Denmark (2005–2011). She received a specializing master in Industrial Biotechnology from the University of Almería (2011–2012). After a short internship in industry, she worked for two and half years as a research engineer at the Institute of Condensed Matter Chemistry of Bordeaux (ICMCB-CNRS). During this time, she investigated composite materials for aeronautic applications. In November 2015, she started her PhD in a joint project between the University of Valencia and the Max Planck Institute for Polymer Research in Mainz. She is currently a member of the Max Planck Partner Group on Colloidal Methods for Multifunctional Materials (CM3-Lab).

Organically Functionalised Transition Metal Oxoclusters as Versatile Building Blocks for Functional and Structural Hybrid Materials

Silvia Gross
Dipartimento di Scienze Chimiche, Università degli Studi di Padova, Padova, Italy
E-mail: silvia.gross@unipd.it

Among organic–inorganic hybrid materials, those deriving from the incorporation of metal-based building blocks (BB) into a polymer matrix are particularly interesting.[1] Typically these BB are functionalised with reactive (generally polymerisable) R' moieties which enable, upon copolymerisation with suitable monomers their covalent incorporation into the polymer matrix. A well explored and versatile class of functionalised inorganic BB are organically modified metal oxoclusters, polynuclear complexes pioneered by Schubert and Hubert-Pfalzgraf, characterised by the presence of O-M-O bonds (M = transition metal, or main group metal, e.g. Sn, Ba) and having the general formula $M_xO_y(OR)_w(OOR')_z$ (R,R'=alkyl groups). In the last years, the synthesis of different early transition and main group metal oxoclusters based on Zr, Hf, Ti, Y, Ti-Hf, Ba, has been extensively explored by our group.[1] The embedding of organically functionalised transition metal oxoclusters into polymers has been proven to be very effective to obtain molecularly homogeneous organic-inorganic hybrid materials, endowed with enhanced structural and functional properties.[1] More recently, we have also explored the use of these oxoclusters as BB for MOF synthesis[2] and as precursors for nanostructured oxides,[3] and the properties of the Zr-based materials as heterogeneous catalysts in oxidation reactions have been assessed.[4–5]

[1] Gross, S. *J. Mater. Chem.* **2011,** *48*, 15853.
[2] Guillerm V. et al. *Chem. Commun.* **2010**, *46*, 767.
[3] Sliem M. A. et al. *Chem. Mater.* **2012**, 24, 4274.
[4] Vigolo, M. et al. *Appl. Catal. B: Environ.* **2016**, *182*, 636.
[5] Benedetti, C. et al. *ACS Appl. Mater. Interf.* **2016**, 8, 26275.

Silvia Gross is currently full professor of Inorganic Chemistry at the University of Padova. Since 2016 she is also a DFG Mercator Fellow at the Justus-Liebig Universität Gießen, where she is regularly visiting professor since 2013. Her current research activity, documented by about 140 scientific publications and 4 books chapters (*h*-index: 30, Scopus 2018) is mainly focused on: (i) the synthesis and characterization of organically modified transition metal oxoclusters and of functional inorganic–organic hybrid materials; and (ii) the green synthesis of crystalline inorganic colloids by wet chemistry and colloidal routes. Born in Padova in 1971, Silvia Gross studied Chemistry at the University of Padova, where she got her master's degree (1996) and her Ph.D. (2001). Afterwards, she spent 18 months at the TU Wien as a Lise Meitner Postdoctoral Fellowship (FWF). In 2002 she was appointed Research Scientist of the Italian National Research Council (CNR), and from 2010 to 2017 she was Senior Researcher at the Institute ICMATE-CNR.

Thin Films of Two-Dimensional Crystalline Porous Frameworks

Dana Medina
Department of Chemistry and Center for NanoScience (CeNS), University of Munich (LMU), Munich, Germany
E-mail: dmepc@cup.uni-muenchen.de

Hierarchical functional materials with properties encoded for a defined functionality are highly desirable targets of numerous synthetic efforts. In the field of reticular chemistry, two-dimensional crystalline, porous covalent and metal organic frameworks (2D COFs and MOFs) are an emerging class of hierarchical materials obtained by dynamic chemical bond formation of molecular building units and metal nodes.[1] Oriented thin films of these materials provide defined host channels for guest molecules and aligned molecular stacks. Therefore, the fabrication of oriented thin films on a suitable surface is a key factor for studying their photophysical properties.[2]

Here, two approaches for the deposition of thin 2D COF and MOF films with preferred crystallite orientation on a variety of substrates are presented. In the first approach, an in-situ growth process results in highly oriented thiophene-containing thin COF films suitable for device fabrication.[3] In a second approach, precursor solutions are converted to a continuous deposit under mild conditions of vapor exposure.[4–5] This vapor-assisted conversion approach yields dense highly oriented thin films allowing for the evaluation of the electrical conductivity of MOF films consisting of aligned triphenylene stacks.

[1] Yaghi, O. M. *J. Am. Chem. Soc.* **2016**, 138, 15507.
[2] Medina, D. D. et al. *ACS Nano* **2014**, 8, 4042.
[3] Medina, D. D. et al. *ACS Nano* **2017**, 11, 2706.
[4] Medina, D. D. et al. *J. Am. Chem. Soc.* **2015**, 137, 1016.
[5] Vermani, E. et al. *J. Am. Chem. Soc.* **2018**, 140, 4812.

Dana Medina obtained her PhD in Chemistry at the Bar-Ilan University (Israel). In 2011, she moved to the University of Munich (LMU, chair of Prof. T. Bein) as a Minerva fellow to conduct postdoctoral research. She is currently leading a young research group. Her research is focused on the aspects of synthesis of novel porous crystalline frameworks. A great emphasis is given to the development of controlled deposition approaches of porous materials on surfaces. Furthermore, she studies the relationship between the on-surface structural physical properties and host–guest interactions.

Hybrid Nanocomposites: A Step towards Advanced Mutlifunctional Materials

Rafael Abargues
Institute of Materials Science (ICMUV), University of Valencia, Paterna, Spain
E-mail: rafael.abargues@uv.es

Hybrid nanocomposites play a significant role in the research on new materials for low-cost fabrication of solid-state micro and nanodevices for optoelectronics, energy generation, photocatalysis and sensing. Nanocomposites are multicomponent materials in which nanomaterials are dispersed into a host matrix. These materials represent an adequate solution to many present and future technological demands, because they combine the novel properties of the nanomaterials with the unique characteristics of metal oxides and polymers. The present talk is concerned with different approaches to synthesize several types of multifunctional materials and their morphological, electrical and optical characterization. In particular, we focus on two types of nanomaterials embedded in polymers (i.e., PMMA, PVA, and polythiophene) and metal oxides (i.e., TiO2, ZnO, and NiO): noble metal nanoparticles (Ag and Au NPs) and metal chalcogenide quantum dots (CdSe, PbS, PbSe…). Emphasis is placed on solution-processed coating and printing techniques such as blade coating, spincoating and inkjet printing for the fabrication and miniaturization of nanocomposite. Examples presented include multifunctional materials with tunable optical and electrical properties for their applications in optoelectronics, sensing, phototocatalysis and thermoelectrics.

Rafael Abargues received his PhD in Chemistry in 2006 (University of Erlangen-Nuremberg, Germany) for a thesis on the synthesis of electrically conducting polymers for electron beam lithography, carried out at Infineon Technologies AG. In 2006 he joined the group of Prof. Juan Martínez-Pastor at the Institute of Materials Science at the University of Valencia as a postdoc , where he launched a new research line in the field of synthesis of new nanomaterials for optoelectronics, photovoltaics, and sensing. At the end of 2009 he co-founded Intenanomat SL, a spin-off company of the University of Valencia, where he was the R&D manager for 7 years. In 2017 he joined again the University of Valencia with a Ramón y Cajal fellowship and started a new research direction in the field of nanomaterials for optoelectronics, photovoltaics, photocatalysis, and sensing. He is currently very much interested in the synthesis and printing of nanocomposites of 2D materials (lead halide perovskites and TMDs) and inorganic nanoparticles (metal nanoparticles and metal chalcogenide quantum dots) embedded in polymers and metal oxides.

Hybrid Nanoscopy of Hybrid Nanomaterials

Cristina Flors
Madrid Institute for Advanced Studies in Nanoscience (IMDEA Nanoscience), Madrid, Spain
E-mail: cristina.flors@imdea.org

Advances in high resolution imaging techniques have led to an increasingly detailed insight into structures and mechanisms in cells and materials. Hybrid approaches that exploit the synergies between two of these techniques can provide an even more comprehensive understanding of many systems. In this talk, I will discuss the benefits and challenges of combining super-resolution fluorescence microscopy with atomic force microscopy (AFM) in situ. The correlation between these techniques provides a high resolution topography image as well as specific chemical information, the latter with a spatial resolution approaching that of AFM. This tool can be used to validate novel super-resolution imaging methods,[1] as well as to obtain complementary information about the structure and properties of (bio)materials.[2] The latter will be exemplified on a hybrid nanomaterial that consists of protein fibrils functionalized with organic fluorophores and quantum dots. [2] The fibrils are made of denatured β-lactoglobulin, a protein that is relevant in the food industry and as an important model for amyloid-like aggregation, with very interesting structural features.[3] Our experiments allow combining information about the topography and number of filaments that compose a fibril, as well as the emissive properties and nanoscale spatial distribution of the attached fluorophores. This technique offers great potential for the characterization of multifunctional hybrid materials, a key challenge in nanoscience.

[1] Monserrate, A. ; Casado, S. ; Flors., C. *ChemPhysChem* **2014**, *15*, 647.
[2] Bondia, P. ; Jurado, R. ; Casado, S. ; Domínguez-Vera, J. M. ; Gálvez, N.; Flors.; C. *Small* **2017**, *13*, 1603784.
[3] Adamcik, J.; Jung, J. M.; Flakowski, J. ; De Los Rios, P.; Dietler, G.; Mezzenga, R. *Nature Nanotech.* **2010**, *5*, 423.

Cristina Flors is a Senior Research Professor at IMDEA Nanoscience in Madrid, Spain. She received her PhD in Chemistry from Institut Químic de Sarrià in Barcelona in 2004, and moved to KU Leuven (Belgium) as a postdoctoral fellow. In 2008 she started her independent research career at the University of Edinburgh (UK) and moved to Madrid in 2012. Cristina's laboratory develops novel tools, typically based on light, to study biology and biomaterials at the nanoscale. Some of her current work involves the combination of super-resolution fluorescence imaging with atomic force microscopy, and the development of novel photosensitizing fluorescent proteins as tags for correlative light and electron microscopy. Her publications have contributed to fields such as photophysics and photochemistry, fluorescence microscopy, biophysics, and materials science.

Deceiving Bacteria: Low Adhesion Liquid-Repellent Surfaces and Nanocarriers to Overcome Infection

Noemí Encinas
Dept. of Chemistry in Pharm. Sciences, Universidad Complutense, Madrid, Spain
E-mail: nencinas@ucm.es

Biofilm formation (i.e., agglomeration of microorganisms on surfaces) on medical devices and implants is a major socioeconomic problem as yields failure and need of replacement, nosocomial infections and high morbidity rate. Despite great advances in antibiotics and vaccination, bacteria have evolved into communities with higher resistances (up to a factor of 103) compared to free-floating cells in the liquid medium. Therefore, battling routes able to hinder or delay irreversible attachment and biofilm growth on solid surfaces is an attractive and reasonable research approach. On this behalf, we used super-liquid repellent surfaces as a suitable platform. Such materials prevent complete wetting of liquids thanks to the existence of a mobile layer (either air or a lubricant) between liquid and solid interphases in the so-called Cassie–Baxter regime. Nano-structured candle-soot based coatings, flexible silicone nanofilaments and poly(dimethyl)siloxane brushes have been the main studied platforms, which we have proved to be able to importantly reduce the ubiquitous and undesirable biofilm formation. One step further, we are working on applying nanotechnology to contribute to the progress of medicine. Mesoporous silica systems have the advantage of a synergy effect between the high surface area of nanoparticles (ca. 1000 m^2/g) and ease of functionalization, with the ability to load and release molecules such as antibiotics. Therefore, a dual system with specific action can be developed.

Noemí Encinas graduated in Chemistry at the Universidad Complutense de Madrid and received her PhD in Materials Science and Engineering from the Universidad Carlos III de Madrid in 2012. Her research was focused on the modification of polymeric surfaces by cold plasma sources to improve the performance of adhesive joints. On 2014, she moved to the Department of Physics at Interfaces at the Max Planck Institute for Polymer Research (Mainz, Germany) to expand her expertise on surface patterning and wetting behavior. On 2015 she was awarded with a Marie Skłodowska-Curie IF fellowship to understand solid–liquid interactions and develop new materials based on super-liquid repellent coatings to prevent protein adsorption and biofilm formation. 0n 2017, she joined the Smart Biomaterials Research Group headed by Prof. María Vallet Regí as a Juan de la Cierva fellow. Her research interests include surface patterning and functionalization of mesoporous materials as a platform to battle infection of medical devices and implants.

Polyphosphate, a Smart Bioinspired Nano-/Bio-material for Regeneratively Active Osteoarticular Implants: Towards a New Paradigm in Tissue Engineering

Werner E. G. Müller
Institute for Physiological Chemistry, University Medical Center of the Johannes Gutenberg University, Mainz, Germany
E-mail: wmueller@uni-mainz.de

Recent developments in the field of biomaterials for tissue engineering open up new opportunities for regenerative therapy and prevention of progression of osteo-articular damages/impairments. A key advancement was the discovery of the regenerative activity of a group of physiologically occurring high-energy polymers, inorganic polyphosphates (polyP). These bio-polymers, in suitable bioinspired formulations, turned out to be capable of inducing proliferation and differentiation of mesenchymal stem cells into the osteogenic or chondrogenic lineages through differential gene expression (morphogenetic activity). Unprecedented is the property of these biopolymers to deliver high-energy phosphate in the extracellular space to promote anabolic processes including extracellular matrix synthesis in bradytrophic tissues such as cartilage and mineralized bone. This presentation summarizes the biological effects of these unique bio-polymers, not yet met by other biomaterials and depending on their specific formulation as smart amorphous nanoparticles/microparticles with different counterions. In addition, polyP in combination with other, hydrogel-forming polymers provide the basis for the fabrication of hardenable bio-inks applicable in additive manufacturing/3D printing and 3D cell bioprinting of regeneratively active patient-specific osteo-articular implants. The future prospects of this innovative technology are discussed.

Werner E. G. Müller is a global leader in the discovery, characterization, and application of enzymes involved in molecular biomineralization and their application in biomedicine and biotechnology. The main objective of his current research is to apply this knowledge for developing nanobiomaterials and bioscaffolds/implants for medical applications. W. E. G. Müller holds an ERC Advanced Grant ("BIOSILICA"; 2011-2017) and three ERC Proof-of-Concept Grants, "Si-Bone-PoC", "MorphoVES PoC", and ArthroDUR (started in 2017). He is author of >1100 publications (*h*-index: 80) and >20 issued patents, and received numerous awards, including the Federal Cross of Merit 1st Class. In addition to his four ERC Grants, he is/was coordinator of around 30 EU Grants and more than 40 international and national projects, including the Centre of Excellence "BIOTECmarin – Biomaterials from the Sea " (2011 awarded as “Selected Landmark” in the national campaign “Germany - Land of Ideas”).

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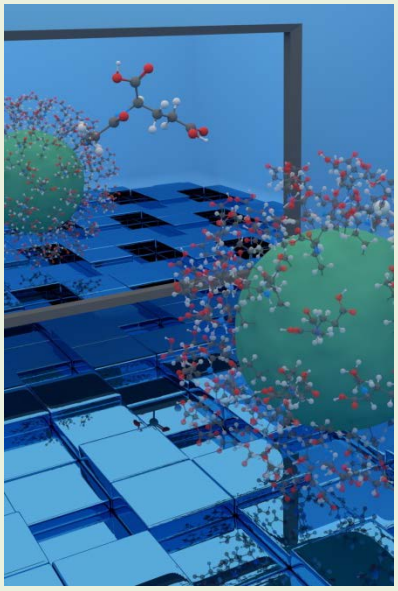

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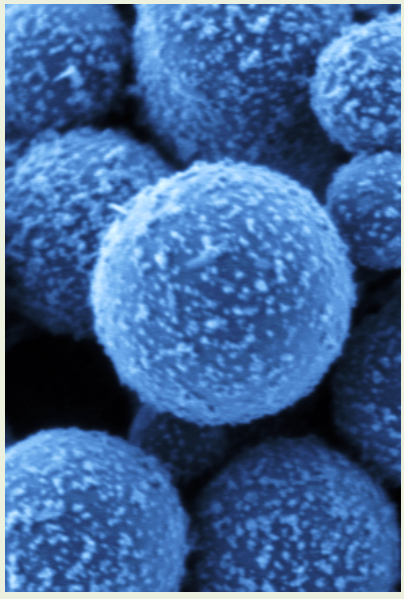

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