BOOK OF ABSTRACTS

Institut de Nanociència i Nanotecnologia
Universitat de Barcelona

10th ANNIVERSARY

Barcelona, 26th January 2017
Col·legi Oficial de Metges de Barcelona

Institut de Nanociència
i Nanotecnologia

UNIVERSITAT DE BARCELONA

With the collaboration of:

Obra Social
Fundación "la Caixa"

Editorial Board and Scientific Management: Ifigènia Saborit Villarroya
Graphic Design and Layout: Cristina Idoate -- www.idoate.com --

CONTENTS

1. WELCOME 7

2. PROGRAM 8-9

3. INVITED SPEAKERS 10-11
- **CHRISTOPH GERBER:** *Atomic Force Microscopy the ultimate toolkit for Nanoscience and Technology*
- **LORENA REDONDO:** *High-Speed Atomic Force Microscopy as a tool for studying dynamic membrane remodeling processes*

4. ABSTRACTS 12
- **ABSTRACTS** Oral presentations: Research Areas IN²UB 12
- **ABSTRACTS** Oral presentations: ART calls 17
- **ABSTRACTS** Posters 20

5. IMAGES 49

LIST OF ABSTRACTS

INVITED SPEAKERS

- Atomic Force Microscopy the ultimate toolkit for Nanoscience and Technology (C. Gerber) 10
- High-Speed Atomic Force Microscopy as a tool for studying dynamic membrane remodeling processes (L. Redondo) 11

ORAL PRESENTATIONS: RESEARCH AREAS IN²UB:

- **Research area 1: NModels**
  Ultracold gases: a quantum laboratory (A. Gallemí) 12
- **Research area 2: NBioTech**
  Heat capacity change directly measured in single molecule experiments (M. Rico-Pasto) 12
- **Research area 3: NPharma**
  Biodegradable nanoparticulate drug delivery strategies for neurodegenerative and ocular disorders (E. Sánchez-López) 13
- **Research area 4: NElectroMagΦ**
  Plasmonics: light at the nanoscale (A. Conde-Rubio) 14
- **Research area 5: NMaterials**
  Controlling active gels with addressable soft interfaces (P. Guillamat) 15
- **Research area 6: NEnergy**
  Catalytic nanostructures for energy carriers' generation and biomass valorization. Application of photocatalytic processes (A.C. Sola) 16

ORAL PRESENTATIONS: ART (AJUTS A LA RECERCA TRANSVERSAL) CALLS

- Early detection of parkinson's disease (R. Sabaté) 17
- Physicochemical Study of the interaction of Lieshmania parasite with Amphotericine B (Ò. Domènech) 18
- Tailoring gold nanoparticles as agents against the aggregation and the extracellular accumulation of amyloid peptides (A. B. Caballero) 19

POSTERS

- Back-focal plane Mueller matrix microscopy: Mueller conoscopy (O. Arteaga) 20
- Structural and electro-optical characterization of ZnO/p-Si light-emitting devices (O. Blázquez) 21
- Memristive characterization of SiAlON thin films (O. Blázquez) 21
- Rheological studies inside living cells with optical tweezers: from calibration-based methods to direct force measurements (R. Bola) 22

- Therapeutic nanosystems obtained by external gelation of alginate in highly concentrated emulsions (P. Bonilla) 23
- Study of cholesterol enriched monolayers for the development of biomimetic membranes (A. Botet Carreras) 24
- Antifungal activity of a clotrimazole nanoemulsion against Candida Albicans (I. Camarasa) 25
- Direct drag force measurements to detect local sample heating in optical tweezers (F. Català) 27
- Simulation of STEM-HAADF image contrast of Ruddlesden Popper faulted $LaNiO_3$ thin films (C. Coll) 28
- Relative humidity low power consumption sensing with individual gallium oxide nanowire (G. Domènech-Gil) 30
- Microbial enzymes for industrial and environmental applications (M.Estupiñán) 31
- Bacterial Nanocellulose (J. Fernández) 32
- Manipulation of hybrid magnetic nanostructures through exchange bias and interfacial strain (A. Fraile Rodríguez) 33
- Size-dependent electronic and magnetic properties of iron oxide and cobalt ferrite nanocrystals probed by synchrotron-based X-ray imaging and spectroscopy (A. Fraile Rodríguez) 33
- Full structural and chemical characterization of the uniaxial relaxor SBN ($Sr_{0.67}Ba_{0.33}Nb_2O_6$) (L. López-Conesa) 34
- Low temperature Inductively Coupled Plasma Chemical Vapor Deposition of vertically oriented graphene nanowalls for supercapacitor applications (A. Musheghyan-Avetisyan) 36
- Assembly and transport of phoretic colloids by means of liquid crystal- enabled electrosmosis (J.M. Pages-Casasa) 37
- Thin AlN diffusion barrier for carbon nanotubes growth over stainless steel substrate (F. Pantoja-Suárez) 38
- Influence of crosslinking degree on hyaluronan gel properties and in vitro cytotoxicity (F. Roig) 39
- Microwave assisted synthesis and nanostructuration of single-molecule magnets (L. Rosado) 40
- Gelatin-based nanoparticles for the intestinal delivery of proteins (G. Ruano) 41
- SnO2 NWs meshes locally grown for ammonia sensing in dry and humid air (J. Samà) 42
- Evidences of Protein Adsorption in Pegylated Liposomes (M. Sangrà) 43
- Magnetically-actuated mesoporous CoPt nanowires as a means to revolutionize heterogeneous catalysis for both water remediation and hydrogen production (A. Serrà) 44
- Ultrasensitive metal Nano-structures for Plasmonic enhanced Raman scattering for biomedical applications (M. Tahghighi Haji Alizadeh) 45
- Impact of water and oxidation states in the galvanic replacement formation of hollow oxide nanoparticles (P.Torruella Besa) 45
- 2D h-BN Inkjet-Printed Dielectric Inks for Flexible Electronics Devices (G. Vescio) 46
- Understanding the Kinetics of Protein−Nanoparticle Corona Formation (O. Vilanova) 47
- Assessment of zinc oxide nanoparticles toxicity using culture cells and reconstructed tissue (M.P. Vinardell) 48

LIST OF IMAGES

- Sagrada Familia Carbon Nanotubes (I. Alshaikh) 49
- Left Handed Quartz crystal observed by Mueller conoscopy (O. Arteaga) 50
- Graphene 2D crystal growth. On the center of the crystal, a second domain start growing, sharing the same nucleation point (S. Chaitoglou) 51
- Gold nanocups (A. Conde Rubio) 52
- Niu de nanofils d'òxid d'indi (G. Domènech) 53
- Esmèctic (P. Guillamat) 54
- Patrons; microtúbuls al substrat (P. Guillamat) 55
- Cristall líquid actiu: microtúbuls i motors moleculars (P. Guillamat) 56
- Laberints de grafè (J. Martí González) 57
- Schlieren textures of a nematic liquid crystal (J.M. Pages Casas) 58
- Liquid crystal defects in a TEM grid (J.M. Pages Casas) 59
- Radial conformation (ASTER) of a nematic liquid crystal (J.M. Pages Casas) 60
- Efficiency of aluminum nitride diffusion barrier. (L.F. Pantoja Suárez) 61
- Kinetics of Protein adsorption onto NPs (O. Vilanova) 62

1. WELCOME OF IN²UB DIRECTOR

Dear researchers,

On behalf of IN^{2}UB, it is my pleasure to welcome you to the celebration of the 10th Anniversary of IN^{2}UB.

On 2006, IN^{2}UB was born with the will to coordinate multidisciplinary in Nanoscience and Nanotechnology integrating the most active and competitive groups from University of Barcelona in these fields.

Ten years afterwards, it is time to say that this aim has been achieved and that the following step is to consolidate it by keeping on working to favour the most suitable synergies among researchers, by encouraging interdisciplinary activities that shall result in new frontier-knowledge projects and to encourage relationships between researchers. Also boosting those corporations with an interest in the different applications of nanotechnologies, by stimulating the implementation of joint projects that shall suit the technologically challenging requirements of the business sector.

IN^{2}UB researchers have been meeting annually to share their knowledge and know-how and the celebration of the 10th Anniversary of IN^{2}UB is a great opportunity to meet all of us once again. This year we have appointed as speakers the youngest researchers from each area in order to have an overview of the most recent projects just finished or in late development to be accomplished. I hope this will be an interesting exercise for all of us to explore new collaborations and undertake common projects.

I would like to thanks to all participants and specially those who have been asked, and kindly accepted, for an oral presentation. It is an honour four us to have the assistance of Prof. Dr. Christoph Gerber (Swiss Nanoscience Institute SNI and Institute of Physics University of Basel).

Jordi Borrell
-Director-

2. PROGRAM

26th JANUARY 2017,
COL·LEGI OFICIAL DE METGES DE BARCELONA

9.00h - 9.30h
RECEPTION

9.30h - 9.45h
ANNIVERSARY WELCOME:
Manuel Barranco, Amílcar Labarta and Jordi Borrell

SESSION I

9.45h - 10.05h
AREA 1 IN^{2}UB (NModels)
Ultracold gases: a quantum laboratory.
Albert Gallemí

10.05h - 10.25h
AREA 2 IN^{2}UB (NBioTech)
Heat capacity change directly measured in single molecule experiments.
Marc Rico-Pasto

10.25h - 10.45h
AREA 3 IN^{2}UB (NPharma)
Biodegradable nanoparticulate drug delivery strategies for neurodegenerative and ocular disorders.
Elena Sánchez-López

10.45h - 11.30h
COFFEE BREAK, POSTERS and IMAGES SESSIONS

SESSION II

11.30h - 11.50h
AREA 4 IN^{2}UB (NElectroMagΦ)
Plasmonics: light at the nanoscale.
Ana Conde-Rubio

11.50h - 12.10h
AREA 5 IN^{2}UB (NMaterials)
Controlling active gels with addressable soft interfaces.
Pau Guillamat

12.10h - 12.30h

AREA 6 IN^{2}UB (NEnergy)

Catalytic nanostructures for energy carriers' generation and biomass valorization. Application of photocatalytic processes.

Alberto Córdoba Sola

12.30h - 12.55h

ART (AJUT A LA RECERCA TRANSVERSAL IN^{2}UB) AWARDED

Early detection of Parkinson's disease.

Raimon Sabaté

12.55h - 13.20h

INVITED SPEAKER

High-Speed Atomic Force Microscopy as a tool for studying dynamic membrane remodeling processes.

Lorena Redondo (INSERM-Marseille)

13.20h - 14.50h LUNCH

SESSION III

14.50h - 15.50h

PLENARY SESSION

Atomic Force Microscopy the ultimate toolkit for Nanoscience and Technology.

Christoph Gerber (Director of scientific communication Swiss Nanoscience Institute. Institute of Physics University of Basel)

15.50h - 16.15h

ART AWARDED

Physicochemical Study of theinteraction of Lieshmania parasite with Amphotericine B.

Òscar Domènech

16.15h - 16.40h

ART AWARDED

Tailoring gold nanoparticles as agents against the aggregation and the extracellular accumulation of amyloid peptides.

Ana Belén Caballero

16.40h - 17.00h

IMAGE COMPETITION SELECTION and CLOSING CEREMONY

3.INVITED SPEAKERS

CHRISTOPH GERBE

Prof. Dr. Christoph Gerber is a titular professor at the Department of Physics, University of Basel, Switzerland. He was a founding member and Director for Scientific Communication of the NCCR (National Center of Competence in Research Nanoscale Science). He was formerly a Research Staff Member in Nanoscale Science at the IBM Research Laboratory in Rueschlikon, Switzerland, and has served as a project leader in various programs of the Swiss National Science Foundation and in the European Framework 6.

For the past 35 years, his research has been focused on Nanoscale Science. He is a pioneer in Scanning Probe Microscopy, and he made major contributions to the invention of the Scanning Tunneling Microscope and the Atomic Force Microscope (AFM), he is also a co-inventor of Biochemical sensors based on AFM Technology.

Summary of Oral Contribution

Atomic Force Microscopy the ultimate toolkit for Nanoscience and Technology

Nature is the best example of a system functioning on the nanometer scale, where the involved materials, energy consumption and data handling are optimized. The emergence of atomic force microscopy (AFM) 30 years ago in the then fledgling field of nanotechnology led to a shift of paradigm in the understanding and perception of matter at its most fundamental level. It undoubtedly has opened new avenues in physics, chemistry, biology and medicine and still is inspiring researchers around the world testified so far by more than 350’000 scientific articles in peer reviewed journals (according to the web of science).The high flexibility of AFM to image, probe and manipulate materials with unprecedented resolution and to be combined with other technologies made it the most powerful and versatile toolkit in nanoscience and – technology of today. As a consequence, new revolutionary concepts stimulated a number of new technologies for the benefit of mankind.

LORENA REDONDO

Lorena Redondo-Morata carried her PhD in the Physical Chemistry department of the University of Barcelona, concomitantly with the Institute for Bioengineering of Catalonia (IBEC), under the supervision of Prof. Fausto Sanz (2012). Her PhD was devoted to the study of nanomechanics of lipid bilayers mainly using atomic force microscopy (AFM)-based force spectroscopy. In 2013, she joined as a postdoctoral fellow to the Simon Scheuring's laboratory at the Institute de la Santé et la Recherche Médicale (Inserm) in Marseille, France. There, she is currently using High-Speed AFM to study dynamic remodeling of biomembranes. She has been recently awarded by the Spanish Biophysical Society with the Young Researcher Prize (2016) as a recognition for her research achievements.

Abstract

High-Speed Atomic Force Microscopy as a tool for studying dynamic membrane remodeling processes

Atomic force microscopy (AFM) –an imaging technique that allows unlabeled molecules to be visualized at sub-nanometer resolution– has recently undergone significant technological improvements that enable recording of surface topography in the sub-second timescales. This development, termed High-Speed AFM (HS-AFM) is particularly of interest for the study of the dynamics of bio-molecules. It was used with great success to study the structural dynamics of molecular motors such as myosin V[1] and the characterization of membrane protein dynamics in a lipid bilayer[2]. Most recently, we have succeeded to visualizethe Endosomal Sorting Complex Required for Transport-III (ESCRT-III)[3]. ESCRT-III mediates membrane remodeling in cells. When ESCRT oligomerizes, it is able to bud the membrane forming constriction necks that will break resulting in vesicular bodies or the viral envelope, to name a few of its implications. However, how ESCRT-III polymerization generates membrane curvature remains debated. In this work we showed that Snf7, the main component of ESCRT-III, polymerized into spirals at the surface of lipid bilayers (Fig. 1).

We reasoned that Snf7 spirals could function as spiral springs. By measuring the polymerization energy and the rigidity of Snf7 filaments, we showed that they were deformed while growing in a confined area. Furthermore, we showed that the elastic expansion of compressed Snf7 spirals could stretch the lipids they are bound to, generating an area difference between the membrane leaflets and thus curvature. This spring-like activity underlies the driving force by which ESCRT-III could mediate membrane remodeling. This property is in our opinion, new to the field of membrane remodeling, and further investigations will uncover, without any doubt, other unexpected properties for ESCRT-III proteins.

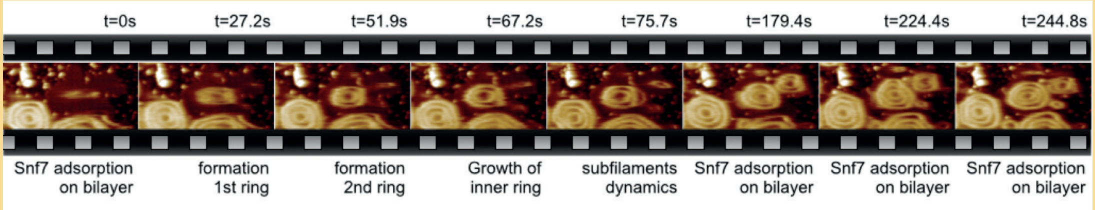


Fig.1: High-speed AFMvisualization of Snf7 assembly maturation

References

[1] Kodera, N.; Yamamoto, D.; Ishikawa, R.; Ando, T., Video imaging of walking myosin V by high-speed atomic force microscopy. Nature 2010,468 (7320).

[2] Casuso, I.; Khao, J.; Chami, M.; Paul-Gilloteaux, P.; Husain, M.; Duneau, J.-P.; Stahlberg, H.; Sturgis, J. N.; Scheuring, S., Characterization of the motion of membrane proteins using high-speed atomic force microscopy. Nature Nanotechnology: 2012; Vol. 7, pp 525-529.

[3] Chiaruttini, N.&Redondo-Morata, L.; Colom, A.; Humbert, F.; Lenz, M.; Scheuring, S.; Roux, A., Relaxation of Loaded ESCRT-III Spiral Springs Drives Membrane Deformation. Cell 2015,163 (4), 866-879.

4. ABSTRACTS

ORAL PRESENTATIONS: IN²UB RESEARCH AREAS

RESEARCH AREA 1: NModels

ULTRACOLD GASES: A QUANTUM LABORATORY

Albert Gallemí

When an ultracold gas is cooled down to ultralow temperatures, a new door to the quantum world opens up: all the atoms form one giant matter wave - the Bose-Einstein condensate. This phenomenon was predicted by Einstein and Bose in 1925, and first experimentally realized in 1995. Since then, many properties of this enigmatic form of matter have been revealed.

RESEARCH AREA 2: NBiotech

HEAT CAPACITY CHANGE DIRECTLY MEASURED IN SINGLE MOLECULE EXPERIMENTS

M. Rico-Pasto[1], M. Ribezzi-Crivellari[2,3] and F. Ritort[1,3]

[1] Departament de Física de la Materia Condensada, Universitat de Barcelona, C/ Martí i Franques 1, 08028, Barcelona, Spain

[2] École Supérieure de Physique et de Chimie Industrielles de la Ville de Paris, 10 rue Vauquelin, F-75231 Paris Cedex 05, France

[3] CIBER_BNN, Instituto de Salud Carlos III, 28029 Madrid, Spain

An accurate knowledge of the thermodynamic properties of nucleic acids as a function of temperature is crucial to predict their structure and stability far away from the physiological temperature. Traditionally, molecular thermodynamic properties, such as free energy, enthalpy and entropy have been determined by bulk experiments, e.g. calorimetry [1] and UV absorbance [2]. Melting temperature experiments have been done to determine the heat capacity change [3]. The melting temperature of a molecule, e.g. a DNA hairpin, is defined as the temperature at which half of the DNA strands in the sample are in the double-stranded DNA (dsDNA) and the single-stranded DNA (ssDNA) forms. In the last 20 years, single molecule experiments have become a powerful, accurate and bulk-complementary methods to characterize thermodynamic parameters such as basepair energy contributions and folding free energies [4].

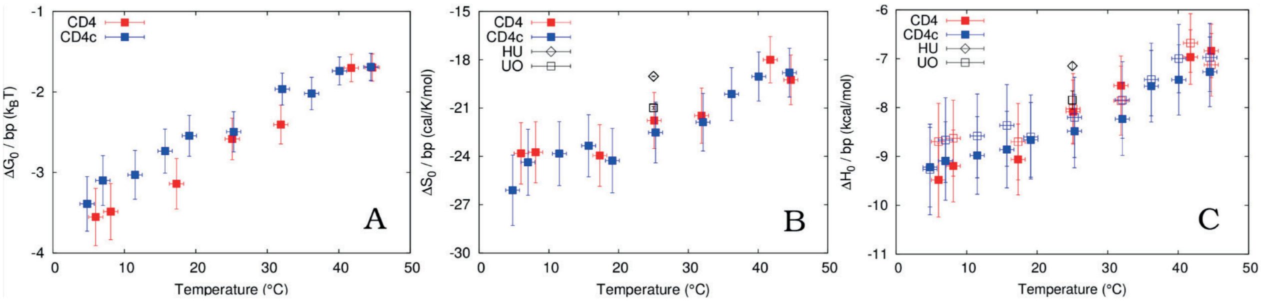


Fig. 1 Folding free energy (A), Entropy (B) and Enthalpy (C) as a function of temperature measured using an Optical Tweezers setup with a temperature controller.

In this work, we propose a novel method to determine the enthalpy, the entropy and the heat capacity change from the force dependence kinetic rates at one unique salt concentration, in contrast with the traditional bulk experiments, where the melting temperature is changed by tunning the salt concentration. From our point of view, this bulk approach left the door opened to an other possible interpretation: It could be that the non zero heat capacity change reported in these previous works was an effect of the salt concentration not to the temperature? With our methodology we overcome this dilemma because keeping constant the salt concentration in all the temperature range we have obtained a non zero heat capacity change.

References

[1] SantaLucia, Jr., J. *A unified view of polymer, dumbbell, and oligonucleotide DNA nearest-neighbor thermodynamics.* Proc. Natl. Acad. Sci. USA. **95**: 1460-1465 (1998)
[2] Plum, G. E., Y. W. Park, ..., K. J. Breslauer. *Thermodynamic characterization of the stability and the melting behavior of a DNA triplex: a spectroscopic and calorimetric study*. Proc. Natl. Acad. Sci. USA. **87**: 9436–9440 (1990)
[3] Rouzina, I. and Bloomfield, V. A. *Heat Capacity Effects on the Melting of DNA.* 1. General Aspects. Biophys. J. **77**: 3242-3281 (1999)
[4] Ritort, F. *Single-molecule experiments in biological physics: methods and applications.* J. Phys. Condens. Matter **18**: 531-583 (2006)

RESEARCH AREA 3: NPharma

BIODEGRADABLE NANOPARTICULATE DRUG DELIVERY STRATEGIES FOR NEURODEGENERATIVE AND OCULAR DISORDERS

E. Sánchez-López1, M. Ettcheto2, M.A. Egea1, A. Camins2, M. Espina1, A. C. Calpena1, M.L. García1
[1] Unitat de Farmacia, Tecnologia Farmaceutica i Fisicoquímica, Facultat de Farmacia, UB
[2] Unitat de Farmacologia i Farmacognosia, Facultat de Farmacia, UB

Biodegradable polyesters have been approved by the Food and Drug administration as nanoparticulate colloidal carriers for drug release. Among other carriers, poly(lactic-co-glycolic acid) (PLGA) possess several advantages such as its biocompatibility, non-toxicity and control and prediction of the degradation kinetics. Coating PLGA nanoparticles (NPs) with poly(ethylene glycol) (PEG) represents an improvement since it increase particles circulation avoiding their recognition by the reticuloendothelial system.

The present research is focused on the multifactorial approach of Alzheimer's disease (AD) treatment. In this sense, Dexibuprofen (DXI) and Memantine (MEM) NPs could reduce brain inflammation and exitotoxic processes. Both drugs are also suitable for ocular diseases treatment (corneal inflammation and glaucoma, respectively).

DXI and MEM loaded PEGylated PLGA NPs, prepared by solvent diffusion and double emulsion methods respectively, were designed to increase drugs delivery reducing systemic side effects after topical and oral administration[1].

NPs exhibited a mean particle size below 200 nm, monodisperse population and negative surface charge. Drug loaded NPs showed a sustained release profile, modifying drug kinetics in vivo. NPs were non-toxic neither in brain endothelial cells, astrocytes or retinoblastoma cells and they did not cause blood-brain barrier (BBB) disruption. NPs design for AD were able to partially cross the BBB and release the drug after co-culture *in vitro* experiments. Behavioral tests for AD performed in APPswe/PS1dE9 mice showed that NPs reduce memory impairment more efficiently than the free drug. Additionally, DXI developed NPs decrease brain inflammation leading to β-amyloid plaques reduction.

By topical administration, DXI NPs reduce and prevent ocular inflammation and MEM NPs were effective for glaucoma decreasing retinal ganglion cells death although they did not contribute to modifications of the intraocular pressure. Therefore, chronical oral DXI PLGA-PEG NPs constitute a suitable strategy for neurodegeneration prevention and NPs topical application could contribute towards corneal inflammation prevention. Additionally, MEM NPs demonstrated to be useful for neurodegenerative diseases such as AD or glaucoma.

References

[1] Sánchez-López, E. et al. PEGylated PLGA nanospheres optimized by design of experiments for ocular administration of dexibuprofen– *in vitro*, *ex vivo* and *in vivo* characterization. *Colloids Surfaces B Biointerfaces* **145**, 241–250 (2016).

RESEARCH AREA 4: NElectroMagΦ

PLASMONICS: LIGHT AT THE NANOSCALE

A. Conde-Rubio,[1] N. Alayo,[2] F. Pérez-Murano,[2] A. Labarta[1] and X. Batlle[1]
[1]Universitat de Barcelona and Institut de Nanociència i Nanotecnologia, Martí i Franquès 1, 08028 Barcelona
[2]Instituto de Microelectrónica de Barcelona (IMB-CNM, CSIC) UAB, 08193 Bellaterra, Barcelona

Plasmonics is the field of optics devoted to the interactions of the electromagnetic waves with the free electrons at the interface between a metal and a dielectric. The collective oscillations of those free electrons reach a maximum at the so-called surface plasmon resonance (SPR). Its intensity and wavelength depend on different factors such as the metal type, size, geometry, structure, composition, embedding medium…

Plasmons give rise to effects such as light confinement or enhanced light-matter interactions which are exploited for different applications. For example, the ability to confine light can be used to image below the diffraction limit. Also, following the idea of radio-wave antennas, nanoantennas are designed by benefitting from the increase of the electromagnetic field in the vicinity of plasmonic materials. Moreover, the enhancement of the electric field can be used to improve phenomena that are not very efficient like fluorescence, Raman scattering or infrared absorption.

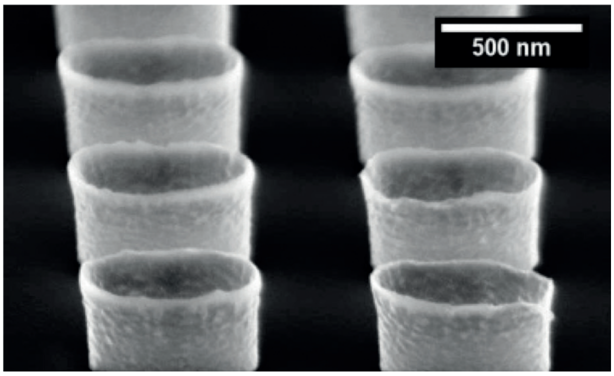


Fig. 1: Hollow cup-shaped nanostructures.

In our research, cup-shaped nanostructures have been fabricated by a process that combines the concepts of stencil and Nanoimprint Lithography (NIL) together with non-directional metallization by sputtering. Besides, it permits to control the interaction between particles as well as their orientation on the substrate [1].

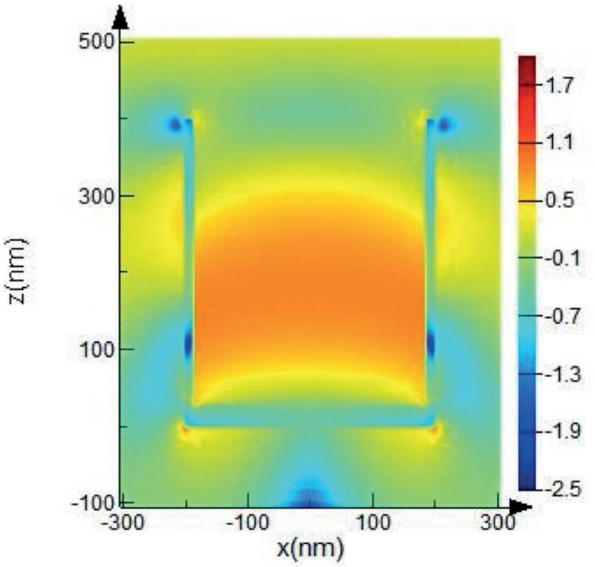


Fig. 2: Log(|E|2) at 620 nm for a 400 nm diameter and 30 nm height, and thickness Au nanocup.

This process starts by preparing a trilayer of PMMA-SiO2-PMMA on a substrate. Then, the top layer is patterned by NIL using stamps with nanometer scale silicon posts. Afterwards, a dry reactive ion etching process is carried out to transfer the pattern to the bottom PMMA layer obtaining an optimal undercut for the final lift-off process. By changing the design of the trilayer, different aspect ratio nanostructures can be obtained. This fabrication procedure also allows for an easy combination of different materials making it possible to obtain multifunctional nanoparticles. Optical absorption experiments and finite difference time domain simulations of Au hollow cylindrical nanostructures of about 400 nm in diameter and height and a wall and base thickness of about 30 nm, demonstrate a great enhancement of the electromagnetic field inside the nanocup, which is promising for fabricating functional devices based on surface enhanced Raman spectroscopy [2].

This work was supported by Spanish MINECO (MAT2015-68772-P), Catalan DURSI (2014SGR220), and European Union FEDER funds (Una manera de hacer Europa). A. Conde-Rubio acknowledges Spanish MINECO for a Ph.D. contract (BES-2013-065377).

References

[1] N. Alayo et al., Nanotech. **26**, 445302 (2015)
[2] M. Kovylina et al., Appl. Phys. Lett. **107**, 033102 (2015)

RESEARCH AREA 5: NMaterials

CONTROLLING ACTIVE GELS WITH ADDRESSABLE SOFT INTERFACES

Pau Guillamat, Jordi Ignés-Mullol* & Francesc Sagués
Institut de Nanociència i Nanotecnologia (IN^{2}UB) and Departament de Química Física, Universitat de Barcelona, Martí i Franquès 1, 08028 Barcelona, Catalonia.
* Corresponding author: jignes@ub.edu

Bacterial colonies [1], cellular tissues [2] or cytoskeletal extract assemblies [3,4] are some examples of recently studied active matter experimental systems. All of them show spontaneous large-scale patterns, which arise from the interaction between their autonomous motile constituents.

Here, ATP-fueled kinesin motors crosslink and drive bundled microtubules (MTs), giving rise to an active network of biofilaments, far from thermodynamic equilibrium [3]. In the presence of a soft interface, the MTs assemble in-plane leading to the formation of a quasi-2d active nematic liquid crystal, which features turbulent flows [3]. Although the morphology and dynamics of these active nematics have been studied in flat [3] and spherical [4] geometries, there was still lack of true control capabilities.

In our experiments [5,6], the active flows are easily commanded by interfacing the active nematic with a thermotropic liquid crystal featuring Smectic-A (lamellar) phase, which self-assemble well-known patterns with marked anisotropic viscosity. Under such rheological constraints, the active nematic is rapidly organized in localized rotating eddies [5] or parallel stripes [6] of aligned MT bundles, revealing its intrinsic length- and time-scales, which have been predicted in recent theoretical works [7].

The demonstrated control strategy should be compatible with other viable active biomaterials at interfaces, and we envision its use to condition bacterial collective motion, cell crawling or tissue growth.

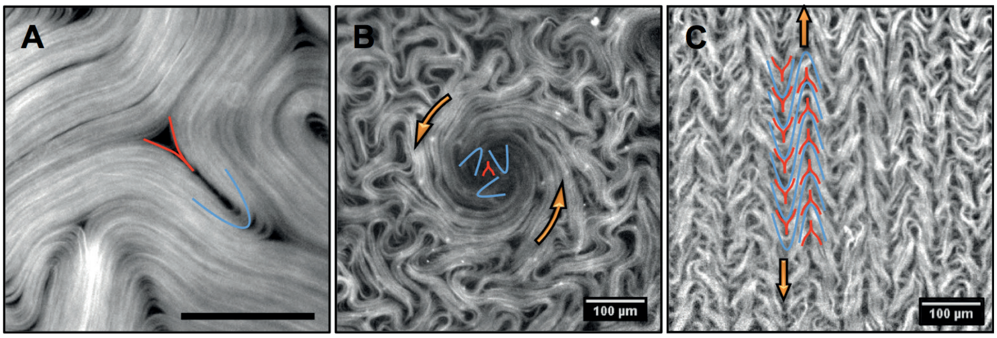


Fig.: Fluorescence micrographs of the active gel. (A) Unbounded active flows. Scale bar, 50 µm. Interfacial coupling with anisotropic viscosity patterns lead to the formation of rotational (B) and laminar (C) flow regimes. Defect disclinations of charge +1/2 (blue) and -1/2 (red) indicate the presence of nematic symmetry.

References

[1] S. Zhou, A. Socolow, O. D. Lavrentovich, I. S. Aranson, Proc. Natl Acad Sci. **111**, 1265 (2014)
[2] T. E. Angelini, E. Hannezobr, X. Trepat et al., Proc. Natl Acad Sci. **108**, 4714 (2014)
[3] T. Sanchez, D. T. Chen, S. J. DeCamp, M. Heymann, Z. Dogic, Nature **491**, 431 (2012)
[4] F. C. Keber, Etienne Loiseau, Tim Sanchez et al., Science **345**, 1135 (2014)
[5] P. Guillamat, J. Ignés-Mullol, F. Sagués. http://arxiv.org/abs/1611.06416 (2016)
[6] P. Guillamat, J. Ignés-Mullol, F. Sagués. Proc. Nat. Acad. Sci. **113**, 20 (2016)
[7] L. Giomi, Phys. Rev. X, **5**, 031003 (2015)

RESEARCH AREA 6: NEnergy

CATALYTIC NANOSTRUCTURES FOR ENERGY CARRIERS' GENERATION AND BIOMASS VALORIZATION. APPLICATION OF PHOTOCATALYTIC PROCESSES

A.C. Sola[a], N.Homs[a,b], P. Ramírez de la Piscina[a]
[a] Inorganic Chemistry section, Department of Inorganic and Organic Chemistry and Institute of ...Nanoscience and Nanotechnology (IN^{2}UB), Universitat de Barcelona,
[b] Catalonia Institute for Energy Research (IREC)

The use of fossil fuels is responsible for two thirds of the world greenhouse emissions [1]. The replacement of fossil fuels with alternative energy carriers is of considerable interest to reduce the emissions. Biomass, including cellulose/hemicellulose, lignin, lipids, chitin and beyond, is currently considered as a renewable and alternative carbon source for fuels and chemicals. However, the effective transformation of biomass components is complicated due to the presence of multiple functional groups and exceptionally high oxygen content [2]. The production of H2 from residual biomass can be considered a feasible medium-term alternative until newer and cleaner technologies are implemented [3]. Catalysis plays a decisive role in the context of generation of energy carriers like hydrogen and hydrocarbon fuels and in the conversion of chemical energy from a fuel into electricity. The efficiency of a heterogeneous catalyst is sensitive to its nanostructure and composition. These properties can modify the activity by altering surface–molecule interactions, the selectivity by reducing by-product formation and the susceptibility of a catalyst to be poisoned and deactivated. Thus, understanding these properties at atomic and molecular level and the reactions that occur on their surfaces are beneficial for the design and development of novel catalysts [4].

Given this background, in this work we present a study of the generation of H_2 through the use of light and ethanol. This alcohol is the bio-fuel produced in the largest quantities worldwide. This comes across as a promising sustainable possibility for H_2 production by using photocatalytic nanostructures. For that purpose, we prepared a series of Pt/TiO_2 and $Pt/M\text{-}TiO_2$ catalysts with different composition, structure and morphology. The production of H_2 and other valuable products are analyzed in the light of the catalyst characteristics. We observed in Pt/TiO_2 catalysts that the crystalline structure determines the H_2 formation rate while the pore structure affects the products selectivity. The promoter effect of M in $Pt/M\text{-}TiO_2$ catalysts is shown in terms of H_2 production and catalyst stability.

References

[1] Van der Hoeven M. Energy and climate change. Int Energy Agency 2015;1–196
[2] Wang Y, De S, Yan N. Chem Commun 2016;52:6210–24
[3] Melchionna M, Beltram A, Montini T, Monai M, Nasi L, Fornasiero P, et al. Chem Commun 2016;52:764–7
[4] Michalak WD, Somorjai GA. Top Catal 2013;56:1611–22

ABSTRACTS

ORAL PRESENTATIONS: ART (AJUTS A LA RECERCA TRANSVERSAL) CALLS

EARLY DETECTION OF PARKINSON'S DISEASE

Alba Espargaró, M. Antònia Busquets, Joan Estelrich and Raimon Sabaté*
Department of Pharmacy, Pharmaceutical Technology and Physical Chemistry, Faculty of Pharmacy and Food Sciences, University of Barcelona
Nanoscience and Nanotechnology Institute (IN^{2}UB), Avda. Joan XXIII, 27-31, 08028 Barcelona, Catalonia, Spain
*Corresponding author: rsabate@ub.edu

In absence of a reliable diagnostic biological marker for Parkinson disease (PD), diagnosis is based on the results of clinical assessment. The accuracy of diagnosis improves with time and repeated assessments. Studies that require only inclusion of early cases of PD present a diagnostic challenge. Importantly, several studies have concluded that initial diagnoses of PD made by general neurologists were incorrect in 24% to 35% of the cases when patients were examined at autopsy. Early diagnosis of Parkinson's disease (PD) by a fast, non-invasive mean benefits its treatment. In this sense, the quantification of α-synuclein (α-syn) oligomers levels in blood and/or saliva may help to identify early-stage PD patients. We will investigate the peripheral blood and saliva from [1] PD patients in stages 1 and 2 (early stage), [2] PD patients in stages 2 and 3 (mid-stage), [3] PD patients in stages 4 and 5 (advanced-stage) and [4] controls (healthy). The α-syn oligomers levels will be measured by bio-barcode assay (BCA) coupled to quantitative real time PCR (rtPCR). We will analyze the association of α-syn oligomers levels with Hoehn and Yahr, and Unified Parkinson's Disease Rating Scale (UPDRS) score. Since α-syn oligomers are the primarily responsible of both toxicity and propagation of the illness, the relative α-syn oligomers levels in blood and/or saliva should be higher the more advanced the illness and inexistent in age-matched controls. The proposed method will allow [1] the unequivocal identification of the illness at an early stage (in still non-symptomatic patients) and [2] the accurate determination of the illness stage as well as the potential disease evolution.

Key words: Parkinson's Disease, Alpha-Synuclein, Amyloid, Oligomer, Theragnostics Agents

PHYSICOCHEMICAL STUDY OF THE INTERACTION OF LIESHMANIA PARASITE WITH AMPHOTERICINE B

Òscar Domènech
Departament de Farmàcia i Tecnologia Farmacèutica i Fisicoquímica, Facultat de Farmàcia i Ciències de l'Alimentació,
Institut de Nanociència i Nanotecnologia IN^{2}UB, Universitat de Barcelona

Leishmaniasis is a parasitic disease found in some parts of the tropics, subtropics and with less incidences in southern Europe. It is classified as one of the Neglected Tropical Diseases (NTD). Leishmaniasis is caused by infection with Leishmania parasites that is transmitted by the bite of some sand flies. About 12 million persons are currently infected and the number of new cases is not fully documented, but is estimated between 1 and 1.5 million infections per year [1]. Common symptoms are skin or mucosal ulceration that heals in months to a year and a half, but in more severe infections it could infect liver, splint or bone marrow causing the death of the host if untreated.

Severe Leishmaniasis can be treated with amphotericin B, which is incorporated between the components of the plasma membrane, releasing the cytoplasmic material out of the cell and finally causing the death of the parasite. Due to side effects, it has been developed new pathways to deliver the antibiotic [2], such as liposomes and nanoparticles, which are promising due to the controlled release of the drug.

With this work we want to bring some light on the nanoscale interaction of the antibiotic amphotericin B reconstituted in nanoparticles with the parasite causing Leishmaniasis. We will study the parasite under biomimetic conditions using Atomic Force Microscopy (AFM) and Force Spectroscopy (FS) before and after the interaction with the nanoemulsion containing the antibiotic. Morphological differences and viscoelastic properties due to the antibiotic effect can clarify the required doses of amphotericin B to produce the death of the parasite. In a parallel way we will study a simplified model membrane simulating the outer membrane of the parasite to evaluate the effect of the nanoemulsion containing the drug on the cell membrane. We will form flat lipid bilayers onto a mica surface, with different proportions of lipophosphoglycan or ergosterol (components of the cell membrane of the parasite) to set up the mechanism in how the antibiotic destabilizes the lipid membrane.

References

[1] CDC - National Center for Health Statistics - Homepage. http://www.cdc.gov/nchs/. November 15, 2015
[2] Shaw, C.D., Carter, K.C. **2014** Nanomedicine 9 (10), 1531-1544

TAILORING GOLD NANOPARTICLES AS AGENTS AGAINST THE AGGREGATION AND THE EXTRACELLULAR ACCUMULATION OF AMYLOID PEPTIDES

Ana B. Caballero,[a] Alba Espargaró,[b] Guillem Vázquez,[a] Raimon Sabaté[b] and Patrick Gamez[a,c]
[a]Department of Inorganic and Organic Chemistry, University of Barcelona, Martí i Franquès 1–11, 08028 Barcelona (Spain)
[b]Department of Physical Chemistry, Faculty of Pharmacy, University of Barcelona, Avda. Joan XXIII 27-31, 08028 Barcelona (Spain)
[c]Institució Catalana de Recerca i Estudis Avançats (ICREA), Passeig Lluís Companys 23, 08010 Barcelona (Spain)

Alzheimer's disease (AD) represents the most common form of dementia. In 2015, the number of people suffering from AD was estimated to 46 million and this number is expected to triplicate within the next three decades. Only five drugs have been approved by the FDA; however they only alleviate the symptoms. The disease is currently incurable. Therefore, the search for novel approaches to lessen the toxicity associated to the prevalence of amyloid deposits in AD brains remains a scientific challenge.

In our IN^{2}UB-supported research, we have started developing potential drugs that are based on gold nanoparticles (AuNPs), with the objective to overcome all-in-one the main drawbacks commonly shown by the traditional small molecules. The new nanoconjugates are intended to exhibit the following properties: (i) permanent slow-down or inhibition of amyloid aggregation, (ii) scavenging and clearance of extracellular amyloid deposits and (iii) permeability through the blood-brain barrier.

In this communication, we will present a discussion of the selected approach to develop anti-AD therapeutics and the synthesis of some of the nanoconjugates. If time allows, the first results on the impact of these conjugates in the aggregation kinetics of amyloid fragments will also be presented.

Acknowledgements
Financial support by MINECO (CTQ2014-55293-P and CTQ2015-70371-REDT), European Comission (Marie Skłodowska-Curie grant of A.B.C) and IN^{2}UB

ABSTRACTS

POSTERS

BACK-FOCAL PLANE MUELLER MATRIX MICROSCOPY: MUELLER CONOSCOPY

Oriol Arteaga, Joan Antó
Dep. Física Aplicada, IN^{2}UB, Universitat de Barcelona, C/ Martí i Franqués 1, 08028, Barcelona, Spain

Microscopy is typically practiced in two, mutually exclusive, observation modes called orthoscopy and conoscopy. In orthoscopy the specimen is viewed directly with parallel ray illumination, while in conoscopy the image is formed in the back focal plane of the objective lens and the observation is made with convergent light. Conoscopy enables the investigator to extract 3D information of the optical properties of a sample from a single measurement, since a cone of light is passing through a sample in the widest range of directions possible, which is determined by the numerical aperture of the objective. Each pixel of a conoscopic image corresponds to a direction of light propagation in the sample.

This work reports the conversion of a commercial polarization microscope (Zeiss Jenaval) into an automatized Mueller matrix microscope based on continuous dual compensator technique [1] capable of orthoscopic and conoscopic measurements. The change between orthoscopic and conoscopic modes is made with the insertion of a Bertrand lens that, as it is placed after the polarization state analyzer, does not perturb the Mueller matrix measurements. Conoscopic interference figures have been traditionally used in mineralogy to identify uniaxial and biaxial crystals or to check their orientation by recognizing well-known patterns such as isogyres. As it was anticipated in Ref. [2], Mueller conoscopy offers a more quantitative and systematic method to gather this information and avoids the need of rotating the specimen. The Mueller conoscopy images shown in Fig. 1 correspond to two thin crystal sections of quartz (uniaxial) cut normal to the optical axis, with the left image corresponding to a left handed crystal and the right crystal a left handed. Despite both crystal plates have the same linear birefringence and orientation, the two conoscopic images are clearly different because Mueller matrix microscopy is sensitive to circular birefringence.

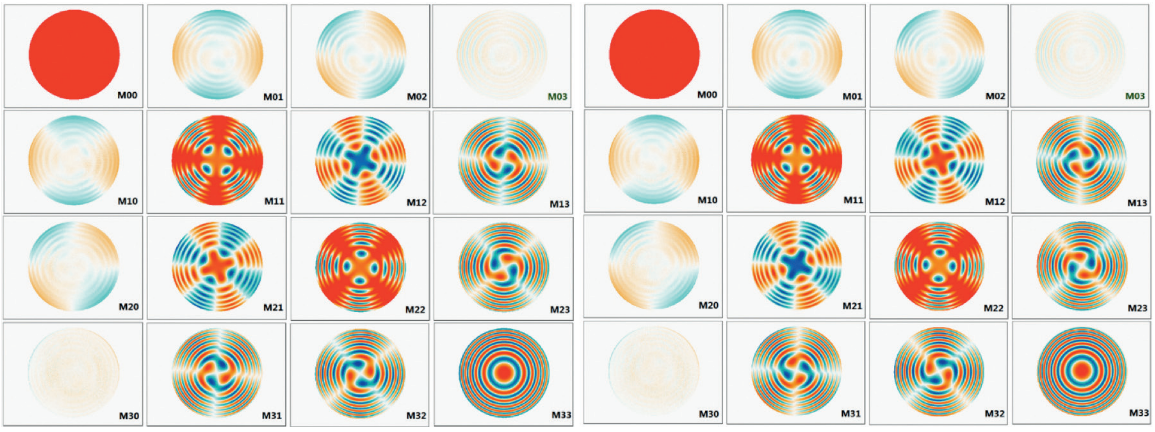


Fig. 1: Mueller conoscopy images collected at 535 nm and with a 0.95 NA objective for a z-cut left-handed quartz plate (left) and for a right-handed plate (right). The plates had a thickness of 1 mm.

We envisage that Mueller conoscopy imaging can be an efficient tool for the metrology of periodic nanostructures as it can work as an extension of Fourier scatterometry using an incoherent light source. It is also particularly well suited to study the surface plasmon polariton modes of plasmonic metamaterials.

References

[1] O. Arteaga, M. Baldrís, J. Antó, A. Canillas, E. Pascual, E. Bertran, Mueller matrix microscope with a dual continuous rotating compensator setup and digital demodulation, Appl. Opt. **53**, 2236-2245 (2014)

[2] B. H. Ibrahim, S. Ben Hatit, A. De Martino, Angle resolved Mueller polarimetry with a high numerical aperture and characterization of transparent biaxial samples, Appl. Opt. **48**, 5025-5034 (2009)

STRUCTURAL AND ELECTRO-OPTICAL CHARACTERIZATION OF ZNO/P-SI LIGHT-EMITTING DEVICES

Oriol Blázquez, Julià López-Vidrier, Pablo Vales, Sergi Hernández and Blas Garrido
Structural and electro-optical characterization of ZnO/p-Si light-emitting devices
MIND-IN²UB, Department of Engineering: Electronics, University of Barcelona, Martí i Franquès 1, 08028 Barcelona, Catalonia, Spain

ZnO is a semiconductor with direct band-gap (Eg = 3.37 eV) and wurtzite crystalline structure. It is an earth-abundant, non-toxic and low-cost material compatible with silicon technology and transparent in the visible range.
This work is focused on the fabrication of light-emitting devices of ZnO onto p-type Si. Thin films of ZnO were deposited on top of (100) p-type Si substrates by e-beam evaporation at 200 ºC, with a thickness around 60 nm. Annealing process was needed for the crystallization the material at 750 ºC for 1 hour in either N2 or air. A vertical structure of the device was completed depositing dots of indium tin oxide (ITO) on top and Al in the back of the substrate. Scanning electron microscopy, X-ray diffraction and Raman spectroscopy were used to determine the structure of the ZnO layers, and photoluminescence measurements for obtain their optical emission. To complete the study, the electro-optical behavior of the devices was analyzed using a probe station and collecting the light with a CCD camera coupled to a monochromator.

Polycrystalline structure was observed, revealing a (002)-orientation and with a mean grain size of 40 nm with a good crystalline degree for all annealed samples. PL measurements exhibited the band-to-band recombination and a wide emission related to defects.

The electrical characterization presents an exponential I(V) curves, revealing higher conductivity in samples annealed in N2, attributed to a higher density of oxygen vacancies. Linear behavior was observed between the integrated electroluminescence (EL) and the injected current. In addition, the spectrum of this emission shows a band related to defect states within the band-gap.

MEMRISTIVE CHARACTERIZATION OF SIALON THIN FILMS

Oriol Blázquez, Eduardo Mariño, Sergi Hernández and Blas Garrido
MIND-IN²UB, Department of Engineering: Electronics, University of Barcelona, Martí i Franquès 1, 08028 Barcelona, Catalonia, Spain

Memristors are devices that can change their resistance depending on the applied current. The reversibility of this process is typically between two different resistive states ON (conductive) and OFF (resistive) and can be done for many cycles. These changes are produced due to the generation of nanofilaments between electrodes, which can be interrupted and reconnected. Silicon aluminum oxinitride (SiAlON) compounds offer good electrical and optical properties, and are abundant materials in the semiconductor industry. In this work, we study the electrical properties of SiAlON as a possible memristive material.

Devices were fabricated with a vertical structure of a SiAlON thin film between two electrodes. Active layer was grown onto a (100)-Si substrate with the pulsed laser deposition technique. Aluminum and indium tin oxide (ITO) were used as bottom and top electrodes, respectively, which were deposited by e-beam evaporation with a shadow mask.
A resistive difference between 1 MΩ in the OFF state and 100 Ω in the ON was obtained, which represents a difference of four orders of magnitude. These states were obtained using a voltage ramp protocol and applying current compliances to prevent irreversible damages in the material. Intermediate states were also observed and their control could increase the capacity of the memories working at more than two levels.

RHEOLOGICAL STUDIES INSIDE LIVING CELLS WITH OPTICAL TWEEZERS: FROM CALIBRATION-BASED METHODS TO DIRECT FORCE MEASUREMENTS

Raúl Bola*, Estela Martín-Badosa and Mario Montes-Usategui
Optical Trapping Lab – Grup de Biofotònica, Departament de Física Aplicada, Universitat de Barcelona, C/ Martí i Franquès 1, 08028 Barcelona, Spain
*Corresponding author: raul.bola@ub.edu

Optical tweezers are tightly focused laser beams capable of exerting pico-Newton forces on micron-sized objects and provide a powerful tool for manipulating organelles and vesicles inside living cells without perturbing the cell membrane or harming the cell itself [1]. Apart from micro-manipulation objects, optical tweezers can be used for measuring external forces, providing information of different dynamic processes, from in-cell biophysics and micro-swimmer hydrodynamics, to single-molecule experiments and micro-rheology. The majority of force measurement techniques rely on a previous calibration of the system, in which the interaction between the object and the optical trap is described as a harmonic potential where the optical trap acts as a micro-dynamometer ($F = -k \cdot x$). Once the spring constant k is known, measuring the relative position between the object and the trap is used to calculate the external force.

However, all these calibration-based methods become useless when dealing with living cells since they need the fulfillment of the fluctuation-dissipation theorem (FDT), which assumes thermodynamic equilibrium between the object and the environment in order to provide a well estimated spring constant k. The presence of biological processes, carried out by the action of molecular motors, breaks down the thermodynamic equilibrium, resulting on an overestimation of the passive spectrum of the trapped vesicles or organelles and then an underestimated measured force. Moreover, these methods need a continuous calibration since the spring constant depends on several parameters such as the refractive index, the geometry of the trapped object, the local viscosity or the local temperature.

In this work we compare and test rheological information of the cell cytoplasm provided by two different force measurement methods: the active-passive method (calibration-based) and the momentum change method. In the active-passive method, the trap stiffness is obtained by comparing the thermal diffusion of the trapped object with its response to an external oscillation [2], while in the momentum change method, the force is obtained in a straightforward way from the changes in the light momentum [3,4].

References

[1] A. Ashkin, J. M. Dziedzic, J. E. Bjorkholm, and S. Chu, Opt. Lett., **11(5)** (1986) 288–290
[2] M. Fischer, A. C. Richardson, S. N. S. Reihani, L. B. Oddershede, and K. Berg-Sørensen, Rev. Sci. Instrum., **81(1)** (2010) 015103
[3] A. Farré and M. Montes-Usategui, Opt. Express, **18** (2010) 11955–11968
[4] A. Farré, F. Marsà, and M. Montes-Usategui, Opt. Express, **20** (2012) 12270–1229

THERAPEUTIC NANOSYSTEMS OBTAINED BY EXTERNAL GELATION OF ALGINATE IN HIGHLY CONCENTRATED EMULSIONS

Pablo Bonilla[1], Eva Arias[1], Conxita Solans[2,3], Elvira Escribano[1,4], MªJosé García-Celma[1,3,*]
[1]Department of Pharmacy and Pharmaceutical Technology and Physicochemistry, Institute of Nanoscience and Nanotechnology (IN^{2}UB). University of Barcelona, Joan XXIII s/n, 08028 Barcelona, Spain.
[2]Institute of Advanced Chemistry of Catalonia (IQAC), Spanish Council for Scientific Research (CSIC), Jordi Girona 18-26, 08034 Barcelona, Spain.
[3]Center for Biomedical Research Network in Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN), Jordi Girona 18-26, 08034 Barcelona, Spain.
[4]CIBER Physiopathology of Obesity and Nutrition (CIBER-OBN), Instituto de Salud Carlos III, Madrid, Spain.
***Corresponding author: mjgarcia@ub.edu**

Highly concentrated emulsions, also known as high internal phase ratio emulsions (HIPRE) are emulsions in which the volume fraction of the dispersed phase is higher than 0.74, the maximum volume fraction of close-packed mono-disperse spheres [1]. Their potential as controlled drug delivery systems has been evidenced [2]. The emulsification of alginate solutions in different oil phases followed by gelation of the alginate droplets in conventional W/O emulsions has been reported [3]. In this research, W/O and W/O HIPREs have been formed in systems consisting of aqueous component/castor oil derivative surfactant/oil. In both kind of emulsions the concentration of disperse phase was 83% and the aqueous component consisted of water, 1% sodium alginate solution or a mixture of sodium alginate solution and calcium chloride solution (crosslinked calcium alginate). Ketoprofen or clindamycine hydrochloride were solubilized in both kind of HIPREs and the influence of the composition of the aqueous phase on drug release was studied. Droplet sizes of the W/O HIPREs formed were in the nanometric range, being smaller than other HIPREs described in the literature. Rheology behavior studies showed an increase in the elastic modulus (G') of the emulsions in the presence of alginate or crosslinked alginate, and the influence of the order of incorporation of alginate and calcium chloride in the viscosity was demonstrated, as an indication of crosslinking efficiency. Drug release was fitted to kinetic models. The results obtained suggest that the formation of a crosslinked alginate matrix in the inner phase of HIPREs is a factor that has to be taken into account to develop controlled drug delivery systems.

References

[1] C. Solans, J. Esquena, N. Azemar, C. Rodríguez, H. Kunieda, in: D.N. Petsev (Ed.), Emulsions: Structure, stability and interactions, Elsevier, Amsterdam, 2004, pp. 511–555
[2] M. Llinàs, G. Calderó, M.J. García-Celma, A. Patti, C. Solans, J. Colloid Interf Sci 394 (2013) 337–345
[3] J. Paques, E. van der Linden, C. Van Rijn, L. Sagis, Adv Colloid Interf Sci 209 (2014) 163-171

STUDY OF CHOLESTEROL ENRICHED MONOLAYERS FOR THE DEVELOPMENT OF BIOMIMETIC MEMBRANES.

Adrià Botet Carreras, M. Teresa Montero, Òscar Domènech, Jordi Borrell
Departament de Farmàcia i Tecnologia Farmacèutica i Fisicoquímica, Facultat de Farmàcia i Ciències de l'Alimentació
Institut de Nanociència i Nanotecnologia IN^{2}UB Universitat de Barcelona

Cholesterol (Chol) is an important and common component of eukaryotic cell membranes. It has been reported as necessary for cell signaling processes [1] and usually it has been studied as part of the matrix where proteins are able to perform their function. The interaction between Chol and phospholipids on cell membranes depends on the different species or groups, which implies a broad range of different interactions with all the different lipids, together with the possible formation of lipid domains or lipid rafts.

In this work we have studied the interactions of three different phospholipids (PSPC, POPC and PLPC), differing only in the number of unsaturation in one of their acyl chains, with different proportions of Chol. We have evaluated the interaction of binary mixtures of theses phospholipids and Chol at the molar fraction where Chol inhibit the phase transition of the pure phospholipids [2]. Langmuir balance was used to investigate the stability of the monolayers trough the values of the free Gibbs energy. The studies indicated that POPC-Chol mixture is the most stable suggesting that an odd number of unsaturation stabilize the molecular structure of the monolayer. Moreover, Atomic Force Microscopy (AFM) was used to visualize the presence of lipid domains in all the monolayers studied after extraction onto a mica surface. We also characterized the adhesion forces with the Force Spectroscopy mode of the AFM (FS-AFM). We found that adhesion forces were different for the Chol enriched domains and for the matrix, except for the PSPC-Chol mixture where differences of adhesion forces values where not significant.

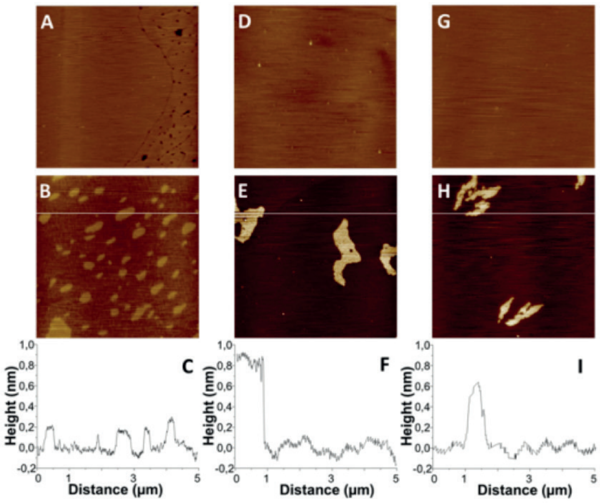


Fig. 1: AFM topography images of: A: PSPC; B: PSPC+30%Chol; D: POPC; E: POPC+15%Chol; G: PLPC; H: PLPC+7%Chol. Cross-section are obtained along white line on each image.

References

[1] Lipid rafts and signal transduction. Simons K, Toomre D. 2000, Nat Rev Mol Cell Biol., 1, pp. 31-39
[2] Heteroacid phosphatidylcholines with different amounts of unsaturation respond differently to cholesterol. Hernandez-Borrell J, Keough KM. 1993, Biochim Biophys Acta, 1153(2), pp. 277-282

ANTIFUNGAL ACTIVITY OF A CLOTRIMAZOLE NANOEMULSION AGAINST CANDIDA ALBICANS

Camarasa I.[1], Suñer Carbó J.[1], Cañadas C.[1], Bozal N.[2], Calpena A.C.[1], Halbaut L.[1]
[1]Department of Pharmacy and Pharmaceutical Technology. Faculty of Pharmacy. University of Barcelona. Spain
[2]Department of Biology, Health and Environment. Faculty of Pharmacy. University of Barcelona. Spain.

Several Candida species are commensal and colonize the skin and mucosal surfaces of humans. *Candida albicans* is the most prevalent species involved in invasive fungal infections [1]. Clotrimazole (CT) is a local imidazole-derivative antifungal agent that is used for the treatment of skin and mucus diseases. It is effective against pathogenic dermatophytes, yeasts and several species of Candida, Tricophyton, Microsporum, Epidermophyton, and Malassezia. It is formulated in creams, gels, pessaries and ovules [2]. However, its use is limited because of its very low water solubility. As a result it is needed to be incorporated into a suitable vehicle [3]. The lipophilicity of CT allows CT to serve as a potential candidate for a lipid-based system such as microemulsion and nanoemulsion [4].

The main objective of this work was to study and compare the antifungal activity of a clotrimazole 1 % nanoemulsion (CT-NE), commercial reference formulation (1% CT cream) and CT solution 1% against C. *albicans* (ATCC 10231) after performing an *ex vivo* drug permeation study using vertical Franz diffusion cells with human skin. The results of the skin permeation of the CT-NE were published in the *Skin Forum Annual Meeting* in Praga [5].

Materials and methods

Materials: a nanoemulsion was elaborated with clotrimazole 1% as Active Pharmaceutical Ingredient and Labrasol®, Labrafac™ Lipophile WL1349, Capryol™ 90 and propyleneglycol as excipients. Characterization and evaluation of this nanoemulsion was published in the IN^{2}UB [6].

Methods: The test was performed in a 96-Well Microtiter plates following the method for the determination of broth dilution MICs of antifungal agents for fermentative yeasts [7]. The method was based on the preparation of working solutions of CT-NE 1%, CT without API, CT cream 1% (commercial reference) and CT solution 1% in 100 µL volumes⁄well with the addition of an inoculum also in a volume of 100 µL. Range of concentrations were from 250 to 0.0019 mg/L. A completely synthetic medium RPMI 1640 was used (ref. 518000-35, INVITROGENT) supplemented with glutamine and a pH indicator, but without bicarbonate. Glucose 2% was added because it is a suitable concentration for the better growth of yeast. pH adjusted to 7 with 1M sodium hydroxide and it was filtered using 0.22 µm filter. To avoid microbial contamination, chloramphenicol (that does not affect the growth of C. *albicans*) [8] was added to a final concentration of 500 µg/ml. The yeast were subcultured on Sabouraud agar at 30ºC. The inoculum was prepared by suspending enough colonies in order to achieve the density of a 2 McFarland. It was obtained a yeast suspension of 1–5·106 CFU⁄mL. A working suspension from a 1 in 10 dilution of the suspension in sterile Ringer to yield 1–5·105 CFU⁄mL which was the inoculum of the assay. Microdilution plates were incubated at 30ºC for 48 h. All plates were analysed by spectrophotometer PINKO model UV/Vis 8500 using λ= 620 nm at times 0, 24 and 48 h.

Results and discussion

Viable counts show that the inoculum used in the antifungal activity was 106 CFU/ml. The table below shows that the MIC of CT-NE is the lowest concentration. It means that the CT nanoemulsion is more effective than the commercial reference formulation.

Product	1st well showing growth	CT concentration mg/L	MIC mg/L
Clotrimazole	10	0.2441	0.4882
Reference	11	0.1220	0.2441
CT-NE	12	0.0610	0.1220
Excipients NE	all	-	-

Table 1. MIC results for Candida albicans ATCC 10231 after 48 h.

Conclusion

CT nanoemulsion has demonstrated higher antifungal activity against *Candida albicans* than the reference formulation. In order to reduce the current commercial dose it could be a good alternative.

References

[1] J. C. O. Sardi, L. Scorzoni, T. Bernardi, A. M. Fusco-Almeida and M. J. S. Mendes Giannini. Candida species: current epidemiology, pathogenicity, biofilm formation, natural antifungal products and new therapeutic options. Journal of Medical Microbiology (2013), 62, 10–24

[2] Fahima M. Hashem, Dalia S. Shaker, Mohamed Khalid Ghorab, Mohamed Nasr, and Aliaa Ismail. Formulation, Characterization, and Clinical Evaluation of Microemulsion Containing Clotrimazole for Topical Delivery. AAPS PharmSciTech, Vol. 12, No. 3, September 2011

[3] Vivek Borhadea, Sulabha Pathakb, Shobhona Sharmab and Vandana Patravalea. Clotrimazole nanoemulsion for malaria chemotherapy. Part II: Stability assessment, in vivo pharmacodynamic evaluations and toxicological studies. International Journal of Pharmaceutics 431 (2012) 149– 160

[4] Prasopchai Tonglairoum, Tanasait Ngawhirunpat, Theerasak Rojanarata, Ruchadaporn Kaomongkolgit and Praneet Opanasopit. Fabrication of a novel scaffold ofclotrimazole-microemulsion-containing nanofibers using anelectrospinning process for oral candidiasis applications. Colloids and Surfaces B: Biointerfaces 126 (2015) 18–25

[5] Cañadas C., Suñer J., Halbaut L., Aróztegui., Calpena A.C. Human skin permeation and retention of a novel antifungical nanoemulsion. Skin Forum Annual Meeting 2014

[6] Suñer Carbó J., Halbaut L., Aróztegui M., Cañadas C., Velázquez N., Saleh E.A. Calpena A. Characterization and evaluation of a (1-2-chlorphenyldiphenylmethyl)-1-4-imidazole nanoemulsion. IN^{2}UB 2014

[7] Subcommittee on Antifungal Susceptibility Testing (AFST) of the ESCMID European Committee for Antimicrobial Susceptibility Testing (EUCAST) EUCAST definitive document EDef 7.1: method for the determination of broth dilution MICs of antifungal agents for fermentative yeasts

[8] Murray PR, Ellen Jo Baron JHJ, Michael A. Pfaller and RHY, eds. Manual of Clinical Microbiology, 8th Edition Washington, D.C; 2004:1199-1200

DIRECT DRAG FORCE MEASUREMENTS TO DETECT LOCAL SAMPLE HEATING IN OPTICAL TWEEZERS

Frederic Català[1,2], Ferran Marsà[3], Mario Montes-Usategui[1,2], Arnau Farré[3], Estela Martín-Badosa[1,2]
[1]Optical Trapping Lab – Grup de Biofotònica, Departament de Física Aplicada, Universitat de Barcelona,
Martí i Franquès 1, Barcelona 08028, Spain
[2]Institut de Nanociència i Nanotecnologia (IN^{2}UB), Martí i Franquès 1, 08028 Barcelona, Spain
[3]Impetux Optics S. L., Trias i Giró 15 1-5, Barcelona 08034, Spain

In recent years, optical tweezing has become one of the most reliable options in micromanipulation and has opened the door to numerous high-accuracy studies in biology. The use of photon-momentum transfer to exert controlled forces on micro-specimens constitutes a non-invasive strategy for handling complex or inaccessible experiments, e.g. those in the interior of a cell. Nonetheless, the high light concentration at the focus of the trapping objective, i.e. at the optical trap, gives rise to notable sample heating, even at the supposedly innocuous laser wavelength of 1064 nm. Importantly, all biophysics and optical trapping experiments require precise control of the local thermodynamic properties, and potential damage on biological samples must be prevented.

In this work, we assess the temperature increase induced by a single-beam optical trap in different experimental conditions. We analyze the effect of the trapped target size and material, the trapping beam numerical aperture, the trap-coverslip distance and the solution medium. The widely assumed heating of ~1ºC/100mW in 1064 nm laser-tweezer set-ups fails in many experimental situations, making it highly recommended to calibrate the particular heating rate prior to precise measurements. As a critical example, we detected heating rates of 4ºC/100mW for certain conditions in watery solutions.

Our measurements were based on the detection of temperature-induced changes in medium viscosity at different laser powers. Drag force measurements on a spherical probe, based on calibration-free beam momentum detection, permitted the accurate determination of the medium viscosity from Stokes hydrodynamics. Additionally, the heat-transfer equation was solved in different layouts, including the micro-chamber wall effect, the presence of the trapped sphere and the trapping beam NA, complementing our experimental observations. In conclusion, beam-momentum-based drag force measurements constitutes an accurate method for the determination of local temperature in optical tweezers set-ups.

SIMULATION OF STEM-HAADF IMAGE CONTRAST OF RUDDLESDEN POPPER FAULTED $LaNiO_3$ THIN FILMS

C. Coll[1], L. López-Conesa[1], C. Magén[2,3], F. Sánchez[4], J. Fontcuberta[4], S. Estradé[1], F. Peiró[1]
[1]Laboratory of Electron NanoScopies, LENS-MIND-IN[2]UB, Institut de Nanociència i Nanotecnologia, Dept. Electrónica, Universitat de Barcelona, Marti i Franqués 1, 08028 Barcelona, Spain
[2]Laboratorio de Microscopías Avanzadas (LMA), Instituto de Nanociencia de Aragón (INA), Departamento de Física de la Materia Condensada, Universidad de Zaragoza, 50018 Zaragoza, Spain
[3]Fundación ARAID, 50018 Zaragoza, Spain
[4]Institut de Ciència de Materials de Barcelona (ICMAB-CSIC), Campus UAB, 08193 Bellaterra, Barcelona, Spain

Perovskite nickelates are interesting candidates to be used as electrode materials or in the research towards artificial superconductors. Among them, $LaNiO_3$ (LNO) is of high interest because of its exceptional transport properties, with a resistivity lower than 100 μΩ·cm, and the potential tuning of electrical and magnetic interactions through appropriated strain engineering. A precise control of the stoichiometry, structural phases, lattice distortions and the presence/absence of dislocations/defects is critical to make LNO electrodes and related heterostructures suitable for electronic applications [1–3].

Frequent defects present in perovskite structures are Ruddlesden Popper (RP) faults which consist on the relative displacement of two perfect defect free perovskite ABO3 blocks a distance of half- unit cell along the (111) direction. The earlier observations of RP faults were based on diffraction results, but they have also been imaged using advanced microscopy tools [4,5]. When observed along the (001) zone axis, this defect appears as a zig-zag arrangement of the A cations with a BO_2 plane lost at the defect boundary.

In the present work we focus our attention on the characterization of RP faults observed in LNO thin films 14 nm and 35 nm thick, grown by pulsed laser deposition on (001) oriented $LaAlO_3$ (LAO) single crystal substrates at an oxygen pressure P = 0.15 mbar and at a temperature T = 700°C. The preliminary characterization of the layers by high resolution transmission electron microscopy (HREM) and electron diffraction, confirmed the good pseudo-cube-on-cube epitaxial growth with atomic-sharp interfaces and the expected (010)LNO(001)//[010]LAO(001) epitaxial relationship, despite the compressive strain driven by the 1% mismatch between LNO (3.838 Å) and LAO (3.795 Å). Nevertheless, defects identified as potential RP faults oriented in both [100] and [010] directions were also observed.

Detailed high angle annular dark field (HAADF) imaging of these defects enabled a better identification of the defects as Ruddlesden Popper type through the appropriated correlation of the contrast of the atomic columns with cationic La(A) and Ni(B) positions as shown in the figure 1.

We will systematically address the interpretation of the contrast of these HAADF images through STEM-HAADF simulations calculated through the multislice procedure [6] from atomistic models based on different arrangements of defect free perovskite blocks with octaetrahedral Ni3+ coordination (Fig. 2). Gradual variation of Z-contrast is interpreted in terms of the average of the atomic numbers of the La and Ni in A and B sites in RP displaced overlapping perovskite crystals [7]. The good agreement between the experimental images and the simulated ones (Fig. 3) validates the proposed geometrical configurations of the RP faulted crystals.

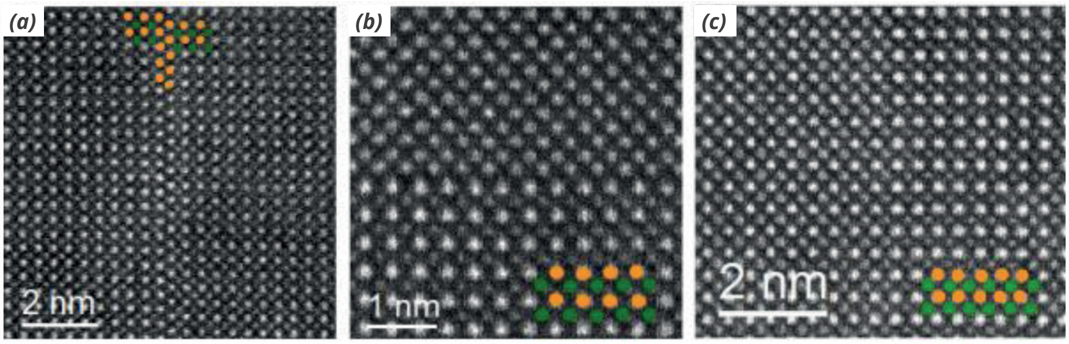


Fig. 1: Experimental HAADF images of the LNO thin films where orange balls corresponds to lanthanum atoms and green ones to nickel. ***(a)*** *LNO film region containing a 2D planar defect with the characteristic zig-zag of the La atoms.* ***(b)*** *LNO film region showing the Z-contrast of a perovskite structure on [100] zone axis in the lower part; in the upper part the contrast is lost.* ***(c)*** *LNO film region showing a gradual loss of perovskite Z contrast moving right to left.*

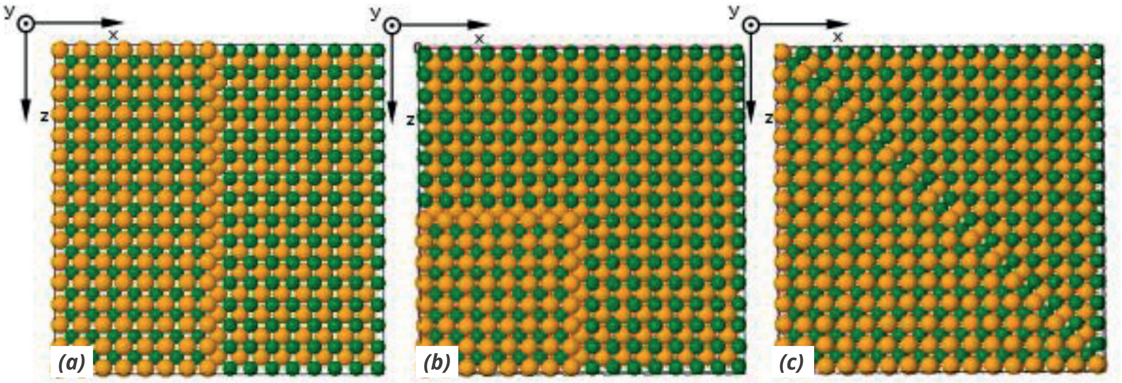


Fig. 2 Atomistic models of RP of different configurations proposed to explain the aforementioned defects found in LNO thin films, where green balls correspond to nickel atoms and orange ones to lanthanum. In the HAADF simulations, the electron been was considered parallel to the z axis.

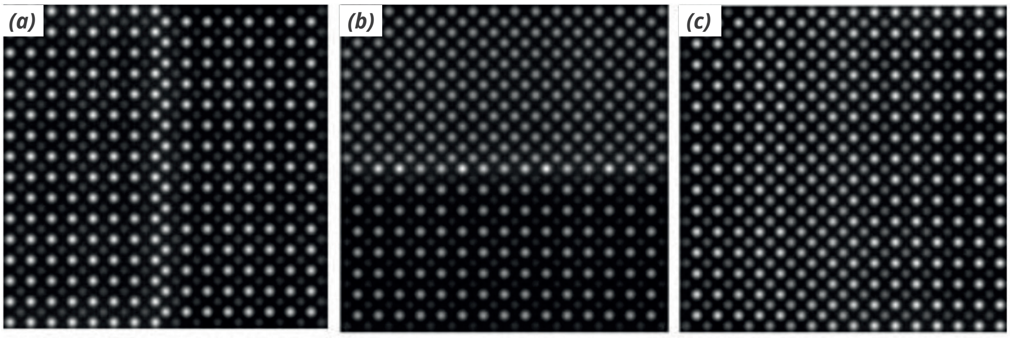


Fig. 3 HAADF simulation results. A good agreement with the experimental images is observed, which validates the proposed models.

References

[1] Scherwitzl, R., Zubko, P., Lichtensteiger, C. & Triscone, J. M. Electric-field tuning of the metal-insulator transition in ultrathin films of $LaNiO_3$. Appl. Phys. Lett. **95**, 10–13 (2009)

[2] Zhu, M. *et al.* Effect of composition and strain on the electrical properties of $LaNiO_3$ thin films. Appl. Phys. Lett. **103**, 141902 (2013)

[3] Detemple, E. *et al.* Polarity-driven nickel oxide precipitation in $LaNiO_3$-$LaAlO_3$ superlattices. Appl. Phys. Lett. **99**, (2011)

[4] Beznosikov, B. V & Aleksandrov, K. S. Perovskite-Like Crystals of the Ruddlesden – Popper Series 1. Crystallogr. Reports **45**, 864–870 (2000)

[5] Ruddlesden, S. N. & Popper, P. New compounds of the K_2NiF_4 type. Acta Crystallographica **10**, 538–539 (1957)

[6] Kirkland, E. J. Computation of Transmission Electron Micrographs. Plenum New York **129**, (1998)

[7] Detemple, E. ***et al.*** Ruddlesden-Popper faults in LaNiO3/LaAlO3 superlattices. J. Appl. Phys. **112**, 1–6 (2012)

RELATIVE HUMIDITY LOW POWER CONSUMPTION SENSING WITH INDIVIDUAL GALLIUM OXIDE NANOWIRE

Guillem Domènech-Gil[1,*], Irmina Peiró Riera[1], Jordi Samà[1], Paolo Pellegrino[1], Sven Barth[2], Albert Romano-Rodriguez[1]
[1]Universitat de Barcelona (UB), MIND-Departament of Electronics and Institute of Nanoscience and Nanotechnology (IN^{2}UB), c/Martí i Franquès 1, E-08028 Barcelona, Spain
[2]Technical University Vienna (TUW), Institut für Materialchemie, A-1040 Vienna, Austria
*Corresponding author: guillemdomenech@ub.edu

In this work gallium oxide (Ga_2O_3) nanowires (NWs) have been synthesized using a chemical vapor deposition (CVD) system via carbothermal reduction and according to a vapor-liquid-solid (VLS) mechanism. To confirm their crystalline nature The grown nanowires have been structurally and optically characterised using X-ray diffraction (XRD), scanning and transmission electron microscopy (SEM and TEM) and related techniques as well as photoluminescence (PL) and X-ray photoelectron spectroscopy (XPS). The nanostructured material was removed from the substrate and deposited on suspended microhotplates with prepatterned electrodes. To study the sensing properties, individual nanowires were contacted by Focused Electron- and Ion-Beam techniques to use them as main element of the gas sensor. Devices have been tested towards ethanol, CO, NO_2, O_2 and water vapor at different concentrations and temperatures in synthetic air.

Motivation and results

The final aim of using nanostructures as principal components of a gas sensing device is to enhance the “3-S” values of the gas sensors: sensitivity, selectivity and stability. The high surface to volume ratio attributed to the NWs has been demonstrated to give rise to sensitivities up to parts per billions (ppb) in different gases [1]. Among these materials, indium and gallium oxides are well-known for their sensitivity towards ethanol, NO2 and O_2. [2-4]

To synthetize Ga_2O_3 NWs a mixture of gallium oxide nanopowder and graphite was used as precursor material. This precursor material was heated up to 950 °C in a quartz tube and the evaporated precursor in gas phase was transported using a flow of pure argon. The heated Si/SiO_2 substrates, covered by a non-continuous layer of sputtered gold that acts like a seed for the NW growth, are positioned downstream and heated at temperatures around 800 °C.

Once the correlation between shape, crystallinity and optical properties of the formed nanostructures was determined by several techniques, gas sensors have been fabricated from individual Ga_2O_3 NWs contacted with Focused Electron and Ion Beam techniques [5]. These devices have been tested towards different air quality monitoring relevant gases like NO_2 and CO in a synthetic air atmosphere as well as towards different O_2 and water vapor concentrations and operating temperatures. Good response towards different relative humidity concentrations was observed using a very low power consumption in a self heating configuration.

References

[1] Y. Dan, S. Evoy, A. T. Johnson (2008): *Chemical gas sensors based on nanowires, Nanowire Research Progress*, Chapter 3, Nova Science

[2] G. Domènech-Gil, J. Samà, P. Pellegrino, S. Barth, I. Gràcia, C. Cané, A. Romano-Rodriguez, Gas Nanosensors Based on Individual Indium Oxide Nanostructure, Procedia Eng. 120 (2015) 795–798. doi: 10.1016/j.proeng.2015.08.826

[3] M. Hai-Lin, F. Duo-Wang, N. Xiao-Shan, Preparation and NO_2-gas sensing property of individual β-Ga_2O_3 nanobelt, Chin. Phys. B 19 (2010) 076102. doi: 10.1088/1674-1056/19/7/076102

[4] Z. Liu, T. Yamazaki, Y. Shen, T. Kikuta, N. Nakatani, Y. Li, O_2 and CO sensing of Ga_2O_3 multiple nanowire gas sensor, Sens. and Act. B: Chem. 129 (2008) 666-670. doi: 10.1016/j.snb.2007.09.055

[5] F. Hernández-Ramírez, A. Tarancón, O. Casals, J. Rodríguez, A. Romano-Rodríguez, J.R. Morante, S. Barth, S. Mathur, T. Choi, D. Poulikakos, V. Callegari, P.M. Nellen, Fabrication and electrical characterization of circuits based on individual tin oxide nanowires, Nanotechnol. 17 (2006) 5577–5583. doi:10.1088/0957-4484/17/22/009

MICROBIAL ENZYMES FOR INDUSTRIAL AND ENVIRONMENTAL APPLICATIONS

Mónica Estupiñán, Pau Soteras, Gerard Margalef, Maddalen Rodríguez, Susana V. Valenzuela, Josefina Martínez, F. I. Javier Pastor, Pilar Diaz
Department of Genetics, Microbiology and Statistics. University of Barcelona, Spain.
Webpage: www.ub.edu/enzimsmicrobians

The group of microbial enzymes for industrial and environmental applications works on the development of enzymes that catalyze the hydrolysis, synthesis and/or biotransformation of natural polymers. Main topics of our research are the study of molecular biology of enzymes which modify the plant cell wall and enzymes which act over lipids, including the identification and design of enzymes for biotechnological applications in pulp bleaching and paper recycling, production of biofuels, synthesis of new compounds from wastes, improvement of textile fibers, food industry and development of new materials based on lignocellulose. The research group is working on the biochemical characterization and genetic manipulation of different enzymes, including cellulases, lipases, lytic polysaccharide monooxygenases (LPMOs) and expansins, from the early stages of sampling, cloning and purification up to studies of structure-function relationship and enzyme engineering.

Lipases are triacylglycerolacyl-hydrolases (E.C. 3.1.1.3) which catalyze the cleavage and formation of ester bonds, using mostly acyl glycerides as a substrate. They are key enzymes due to their applications in biodiesel production, detergency industry, synthesis of chiral products, among others, without cofactor requirements.

Cellulases are modular glycosyl hydrolases, with a catalytic domain that hydrolyzes the β-1,4 glycosidic bond of the cellulose. Apart from the catalytic domain, cellulases have other domains that can modify or potentiate the enzyme.

LPMOs are metalloenzymes that oxidize glycosidic bonds mainly in substrates like cellulose or chitin. They have shown a great potential to biotransform lignocellulosic biomass into high added value products. The catalysis requires the binding of an active oxygen molecule to the copper atom of the enzyme for the oxidative depolymerization of the substrate.

Expansins are accesory proteins that show potential to modify the surface of cellulosic fibres, decreasing the crystallinity of cellulose and therefore increasing the accessible area to other depolymerization enzymes. Both domains of the enzyme, catalytic and binding domain, are required for the expansin activity.

Exploration of biodiversity to expand the sources and number of new enzymes, or the improvement of the enzymes by protein-engineering strategies are our main goals.

BACTERIAL NANOCELLULOSE

Julia Fernández, Ángela Gala Morena, Rubén Reina, Pilar Díaz, F. I. Javier Pastor, Josefina Martínez
Department of Genetics, Microbiology and Statistics, University of Barcelona, Spain.
Corresponding author: jmartinez@ub.edu

Bacterial nanocellulose (BNC) is an emerging nanomaterial with unique properties synthesized extracellularly by some bacteria, mostly members of the family Acetobacteriaceae. Cellulose in BNC has the same chemical composition as that from plants but it is produced in the absence of other polymers (such as hemicelluloses or lignin) which makes it chemically pure. BNC is produced by bacterial cultivation in aqueous culture media containing glucose, and in presence of oxygen. It has a ribbon-like shape (less than 100 nm wide) providing high surface area, and it has high crystallinity index. Due to the replication of bacteria, nanocellulose fibrils in the BNC pellicle form a randomly assembled tangled structure, which has good mechanical properties even in the wet state.

Its conformation and physicochemical properties make it attractive for several applications, especially in the areas of food, separation processes, drug delivery, catalysis and health, due to its biocompatibility. In addition, BNC could meet the needs of research on new biomaterials for its application in nanotechnology. However, a restriction for its production in mass is the expensive cost of the substrate, generally glucose, to support bacterial growth and cellulose production. Another problem is the bacterial low-efficiency production. Therefore, important and challenging aspects of the process are the identification of a new cost-effective culture medium and the finding of new cellulose producing strains that can facilitate the production of high yields within short periods of time.

Nanoscience and nanotechnology provide opportunities for making novel materials for use in industrial, healthcare, energy and environmental applications. In this context, bacterial cellulose is a potential biomaterial for nanoapplications. Our work is focused on the production and study of nanocellulose synthesized by bacteria for its application in obtaining functional biopapers.

MANIPULATION OF HYBRID MAGNETIC NANOSTRUCTURES THROUGH EXCHANGE BIAS AND INTERFACIAL STRAIN

A. Fraile Rodríguez[1], A. C. Basaran[2], I. Valmianski[2], M. García del Muro[1], M. Kovylina[1], R. Morales[3,4], J.G. Ramírez[2], F. Kronast[5], M. A. Marcus[6], A. Scholl[6], I. K. Schuller[2], A. Labarta[1], and X. Batlle[1]
[1]Departament de Física de la Matèria Condensada and Institut de Nanociència i Nanotecnologia (IN²UB), Universitat de Barcelona, 08028 Barcelona, Spain
[2]Department of Physics and Center for Advanced Nanoscience, University of California San Diego, La Jolla, CA 92093, USA
[3]Department of Chemical-Physics, BCMaterials, University of the Basque Country UPV/EHU, 48940 Leioa, Spain.
[4]IKERBASQUE, Basque Foundation for Science, 48011 Bilbao, Spain.
[5]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, 12489 Berlin, Germany
[6]Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

Nanoscale manipulation of thin film magnetic properties can be achieved through proximity effects in hybrid heterostructures. For example, the unidirectional anisotropy induced in FM films by the proximity with an antiferromagnetic (AF) layer upon cooling through the AF Néel temperature (T_N) (the so-called *exchange bias effect*) is crucial in numerous applications. Recently, ferromagnetic/antiferromagnetic (FM/AF) nanostructures exhibiting both negative and positive exchange bias have been proposed as model systems for multistate switching memory units [1, 2]. Furthermore, the proximity of a FM film with a vanadium oxide results in a reversible modification of the magnetic properties due to the magnetoelastic anisotropy caused by the interfacial stress [1]. Recently, large changes in coercivity and noticeable modifications of the magnetization in Ni/V_2O_3 bilayers across the structural phase transition (SPT) of V_2O_3 have been reported [3,4].

In this work, we use synchrotron-based photoemission electron microscopy (PEEM) to analyze the spin configurations of model *exchange* biased Ni/FeF_2 nanostructures and Ni/V_2O_3 nanostructures. For the Ni/FeF_2 case, we show that a progressive spatial confinement of the bilayers, either through FM thickness variation or via antidot patterning the whole FM/AF heterostructure, actively controls the domain configuration of uncompensated spins in the AF. The final spin structure is determined by the balance between the competing FM and AF magnetic energies. The underlying mechanism of the AF domain formation in Ni/FeF_2 may be generic to other magnetic systems with complex non-collinear FM/AF spin structures. For the Ni/V_2O_3 bilayers, we find that the SPT in V_2O_3 induces nucleation of reversed Ni domains, and their fraction grows monotonically with the predominance of one of the coexisting structural phases. The changes in domain structure are fully reversible over the narrow temperature window of the phase transition. The analysis of the domain nucleation and growth indicates a local distribution of T_c across the sample. The lateral domain correlation length allows us to discern the phase transition character.

References

[1] Roshchin *et al.*, International Patent Number: 05803831.6 1214 PCT/US2005025129 **2005**
[2] Morales *et al.*, Appl. Phys. Lett. 2014, **104**, 032401
[3] J. de la Venta, S. Wang, J. G. Ramirez, and I. K. Schuller, Appl. Phys. Lett. **102**, 122404 (2013).
[4] J. de la Venta *et al.*, Appl. Phys. Lett. **104**, 062410 (2014).

SIZE-DEPENDENT ELECTRONIC AND MAGNETIC PROPERTIES OF IRON OXIDE AND COBALT FERRITE NANOCRYSTALS PROBED BY SYNCHROTRON-BASED X-RAY IMAGING AND SPECTROSCOPY

A. Fraile Rodríguez[1], C. Moya[1], N. Pérez[1], C. Piamonteze[2], X. Batlle[1], and A. Labarta[1]
[1]Departament de Física de la Matèria Condensada and Institut de Nanociència i Nanotecnologia (IN^{2}UB), Universitat de Barcelona, 08028 Barcelona, Spain
[2]Swiss Light Source, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland

Iron oxide-based nanoparticles (NP) have outstanding magnetic properties and promising applications for spin-filter devices, biomedicine, and catalysis. In addition to finite-size effects, a key issue for research is how the intrinsic magnetic properties of the individual particles are modified by their own electronic structure, chemistry, surface termination and crystallinity.

By combining synchrotron X-ray absorption spectra (XAS) with photoemission electron microscopy (PEEM), we analyze the electronic structure and chemical bonding of individual, Fe_3-$_xO_4$ and Co_xFe_3-xO_4 NP in the size range of 8 to 24 nm, synthesized by thermal decomposition of organometallic precursors [1,2], and deposited onto Si substrates. All the NP display high crystalline quality and macroscopic bulk-like magnetic properties [3,4]. However, the spectra from individual NP show that the variation of some synthesis parameters significantly alter the cationic distribution and the uniformity of magnetic phases [5]. In particular, In particular, 13-nm NP synthesized using oleic acid as a surfactant and iron oleate (III) as a metallic precursor are very homogeneous in stoichiometry, compatible with an Fe_3O_4 core surrounded by a thin γ-Fe_2O_3 shell. In contrast, 24-nm NP, synthesized with the same precursors but with a different solvent and no stabilizer, are inhomogeneous, composed of either a thick FeO or metallic Fe core surrounded by a thin Fe_3O_4 shell or an Fe_3O_4 core surrounded by a thin γ-Fe_2O_3 shell.

Furthermore, spatially-integrated X-ray magnetic circular dichroism (XMCD) spectra and element-specific hysteresis loops of mono-disperse assemblies of the $Co_xFe_{3-x}O_4$ NP using both electron and fluorescence yields have enabled the deconvolution of the electronic and magnetic contributions of the NP surface from those of the inner core regions.

This work was supported by MINECO (MAT2012-33037), DURSI (2009SGR856 and 2014SGR220), and European Union FEDER funds (Una manera de hacer Europa). A.F.R. acknowledges support from the MICIIN "Ramón y Cajal" Programme.

References

[1] P. Guardia, A. Labarta and X. Batlle, J. Phys. Chem. **115**, 390 (2010)
[2] C. Moya *et al.,* "Crystal domains and magnetic glassy state in Co-ferrite nanoparticles" (in review)
[3] N. Pérez *et al.*, Appl. Phys. Lett. 94, 093108 (2009)
[4] X. Batlle *et al.*, J. Appl. Phys. **109**, 07B524 (2011)
[5] X. Batlle, A. Labarta, and A. Fraile Rodríguez, McGraw-Hill 2015 Yearbook of Science & Technology, pp. 157-163, McGraw-Hill Education, New York, (2015) (0-07-183576-8)

FULL STRUCTURAL AND CHEMICAL CHARACTERIZATION OF THE UNIAXIAL RELAXOR SBN ($SR_{0.67}BA_{0.33}NB_2O_6$)

López-Conesa, L.[1,*], Rebled, J.M.[1,2], Ruiz-Caridad, A.[1], Dezanneau, G.[3], Torres-Pardo A.[4], Ruiz-González, L.[4], González-Calbet, J.M.[4], Estradé, S.[1], Peiró, F.[1]
[1]Laboratory of Electron Nanoscopies (LENS-MIND-IN²UB), Departament d'Electrònica, Universitat de Barcelona, Martí i Franquès 1, 08028 Barcelona, SPAIN
[2]TEM-MAT, CCiT, Universitat de Barcelona, Solé i Sabarís 1, 08028 Barcelona, SPAIN
[3]Laboratoire Structure, Propriétés et Modélisation des Solides (LSPMS), École CentraleSupelec, Grande Voie des Vignes, F-92295 Châtenay-Malabry Cedex, FRANCE
[4]Departamento de Química Inorgánica I, Universidad Complutense de Madrid, 28040 Madrid, SPAIN
*Corresponding author: llopez@el.ub.edu

SBN belongs to the tetragonal tungsten bronze (TTB) family of uniaxial ferroelectric relaxor materials, with a single component polarization vector pointing along the tetragonal c axis. The high dielectric constants observed and polarization controlling around the ordering temperature 'T_m' make of relaxors promising systems for applications such as electrocaloric, pyroelectric, piezoelectric/electrostrictive devices and sensors [1].

The idealized structure of SBN, with the generalized formula $A_2B_4C_4Nb_2Nb_8O_{30}$, has three types of structural channels along the c axis, formed by two types of crystallographically independent NbO_6 octahedra [2]. Disorder due to presence of voids on A cation sites (occupied by Sr atoms) and random distribution of Ba and Sr on B cation sites are thought to be responsible for the relaxor behavior, via the formation of random electric fields and, subsequently, polar nanodomains oriented in the only easy polarization axis c, without a structural change occurring in the phase transition. In this work we present structural and chemical studies of a SBN single crystal by means of Selected Area Electron Diffraction (SAED), High Angular Annular Dark Field (HAADF), Annular Bright Field (ABF) and Electron Energy Loss Spectroscopy (EELS) along the [001] and [100] zone axes. Experiments were carried out in non-aberration corrected (Phillips CM30, JEOL J2100, JEOL2010F) and probe-corrected (Titan^3 G2, ARM cF200) TEMs.

The incommensurate structural modulation in SAED experiments along the [100] direction already points out to structural disorder (Fig. 1). HAADF imaging along the [100] zone axis confirmed the presence of cationic vacancies in A-type sites. Elongation in some atomic columns in HAADF images along the [001] zone axis (Fig. 2) and EELS mapping along the [001] zone axis (Fig. 3) confirmed the mixing of Sr/Ba in the B-type sites. With these results, the causes for local charge disorder in the structure are mapped in direct space with atomic column resolution. ABF imaging allowed mapping the oxygen sublattice in the structure, achieving the full structural characterization of the material.

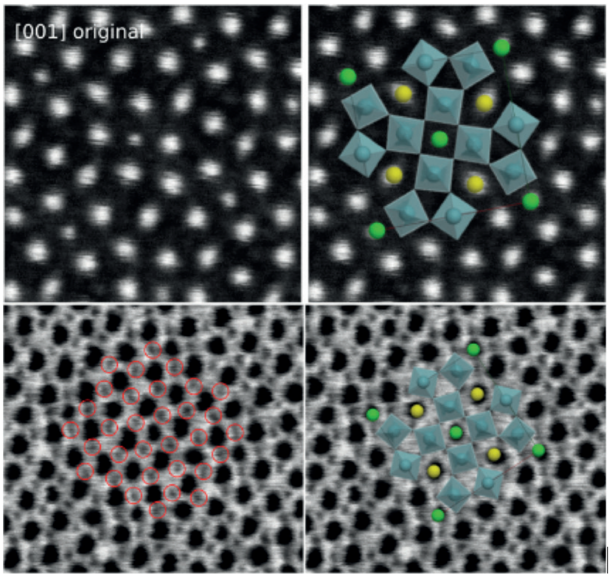


Fig. 1: Top left: HAADF image showing the cation sublattice of the TTB structure of SBN. Top right: the same HAADF image with the superimposed structure with the Nb_2O_6 octahedra drawn in blue. Bottom left: ABF image highlighting the anion sublattice with red circles. Bottom right: the same image with the structure superimposed, showing the oxygen atoms at the corners of the NbO_6 octahedra.

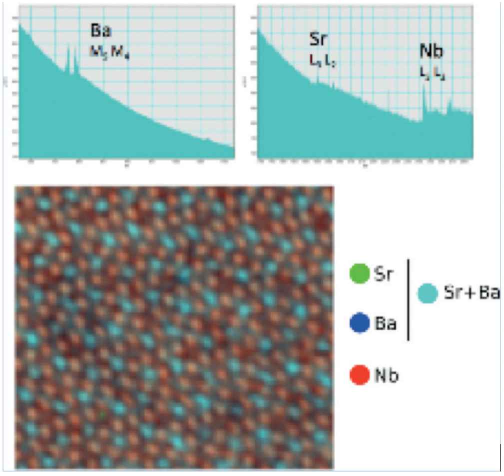


Fig. 2: EELS mapping of the [001] orientation of the SBN crystal, showing the mixing of Sr and Ba.

Acknowledgement: research leading to these results received financial support from the Spanish Ministry of Economy and Competitivity via the projects Consolider-IMAGINE (CSD2009-20013), MAT2010-16407 and MAT2013-41506.

References

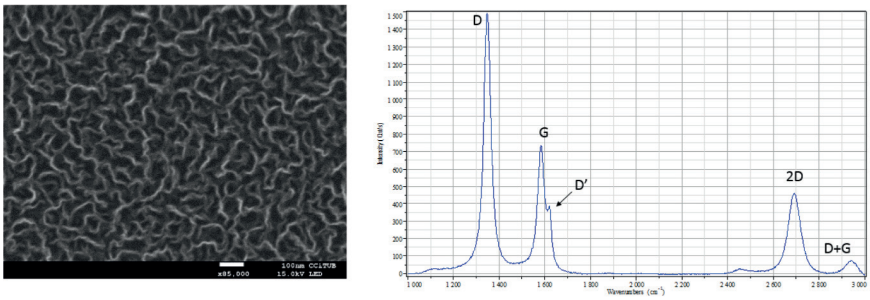
[1] The relaxor-enigma - charge disorder and random fields in ferroelectrics, W. Kleeman, **Journal of Materials Science, 41, 129-136 (2006)**

[2] The modulated structure of Ba0.39Sr0.61Nb2O6, T. Woicke et al., **Acta Cryst., B59, 28-35 (2003)**

LOW TEMPERATURE INDUCTIVELY COUPLED PLASMA CHEMICAL VAPOR DEPOSITION OF VERTICALLY ORIENTED GRAPHENE NANOWALLS FOR SUPERCAPACITOR APPLICATIONS

Arevik Musheghyan-Avetisyan*, Joan Marti-Gonzalez*, Roger Amade, Jose-Luis Andujar, Esther Pascual and Enric Bertran-Serra
FEMAN Group, IN²UB, Dep. Applied Physics, Universitat de Barcelona,
C/ Martí i Franquès, 1, 08028 Barcelona, Spain
***Corresponding authors: amusheghyan91@ub.edu, jmartigonzalez@ub.edu**

Graphene nanowalls (GNWs) are networks of "graphitic" sheets that typically appear vertically oriented on a substrate. Low temperature synthesized and vertically oriented GNWs have some unique characteristics, making them significantly different in many aspects from the conventional horizontal, randomly oriented graphene sheets and great potential for various applications like supercapacitors, lithium-ion batteries, solar cells and sensors. Vertically oriented graphene nanowalls possess a number of unique mechanical, chemical, electronic, electrochemical, and optoelectronic properties that could benefit their potential use in a wide range of applications. For each application, high-quality GNWs should be grown on suitable substrate. For example, GNWs grown on Cu foil becomes an excellent electrode for supercapacitors, meanwhile, GNWs on dielectric (SiO2) substrate could be used to fabricate gas or bio-sensors, also GNWs on semiconductor substrates could be used rather for potential application of solar cells. However, there are still few systematic studies of this promising material. In this study, we have used Inductively Coupled Plasma Chemical Vapor Deposition (ICPCVD) method for growing the graphene nanowalls on polycrystalline Cu foils, c-Si wafers and amorphous silica substrates in the temperature range of 500-750ºC. We have explored the growth parameters: plasma power, gas flow, temperature, pressure or cooling time, and how they affect the morphological and structural properties of the obtained graphene nanowalls. Despite that at present, there is no general agreement on an unified theory to unveil the GNW growing mechanism and to provide guidance for optimum growth condition using different plasma power and temperature, our process and particular technological parameteres can suggest new evidences of the growth mechanisms. The present results of GNWs show new points of view of their morphology (Figure 1).



(a) (b)

Fig.1: (a) SEM image of graphene nanowalls (bar scale of 100nm) (b) Raman spectra of multilayer graphene nanowalls

References

[1] Chongyin Yang, Hui Bi, Dongyun Wan, Fuqiang Huang, Xiaoming Xie and Mianheng Jiang, The Royal Society of Chemistry, Direct PECVD growth of vertically erected graphene walls on dielectric substrates as excellent multifunctional electrodes (2013).

[2] Xuefen Song, Jian Liu, Leyong Yu, Jun Yang, Liang Fang, Haofei Shi, Chunlei Du,Dapeng Wei, Materials Letters,Direct versatile PECVD growth of graphene nanowalls on multiple substrates (2014) 25–28.

[3] Yifei Ma, Haegyu Jang, Sun Jung Kim, Changhyun Pang and Heeyeop Chae, Nanoscale Research Letters a SpringerOpen journal, Copper-Assisted Direct Growth of Vertical Graphene Nanosheets on Glass Substrates by Low-Temperature Plasma-Enhanced Chemical Vapour Deposition Process (2015).

[4] Bo, Z., Mao, S., Han, Z. J., Cen, K., Chen, J., & Ostrikov, K.. Emerging energy and environmental applications of vertically-oriented graphenes. Chemical Society Reviews, doi: 10.1039/C4CS00352G. (2015).

[5] J. Chen *et al.*, Vertically-Oriented Graphene, Springer International Publishing Switzerland, DOI: 10.1007/978-3-319-15302-5_2 (2015).

ASSEMBLY AND TRANSPORT OF PHORETIC COLLOIDS BY MEANS OF LIQUID CRYSTAL- ENABLED ELECTROSMOSIS

Josep Mª Pages-Casasa[2], Jordi Ignés-Mullol[*,1,2] & Francesc Saguésa[2]
[1,2]Departament de Química Física and Institut de Nanociència i Nanotecnologia, Universitat de Barcelona, Martí i Franquès 1, 08028 Barcelona, Catalonia (Spain)
***Corresponding author: jpagescasas@ub.edu**

Transport of solid inclusions in liquid media has opened new perspectives for colloidal self-assembly and dynamic translocation of particle swarms[1]. Of particular interest is the use of colloidal microparticles dispersed in a nematic liquid crystal (NLC) medium. In this situation, inclusions can be driven into self-assembly by means of liquid crystal-enabled electrophoresis (LCEEP)[2]. This process is based on the unbalanced ionic flows at both sides of the inclusions coupled to the local orientational distortions of the nematic matrix. Peanut-shaped colloidal inclusions guarantee a dipolar component in the defect configuration of the local director field. The use of alternating current (AC) is of special interest in this case because ion migration is avoided, while enabling not only solid particle transport but water-based cargoes as well.

In previous work, we prepared hybrid LC cells with plates coated with a transparent electrode. One of them was functionalized with a photosensitive self-assembled monolayer, which can turn the local director field from homeotropic to planar degenerate anchoring of the NLC under UV forcing. The reverse modulation is achieved with blue light. The counterplate was treated with a polyimide resin to achieve a strong homeotropic anchoring of the mesogen. This, finally results in two main LC conformations and corresponding colloidal assemblies: aster (pure splay texture) or vortex (bend-splay texture, which induces a rotating mill). [3]

In this contribution, we address the dependence of the steady-state distance between particles and the amplitude and frequency of the electric field when a colloidal swarm is self-assembled and transported. From these observations we want to study the interactions between particles in different non-equilibrium conditions.

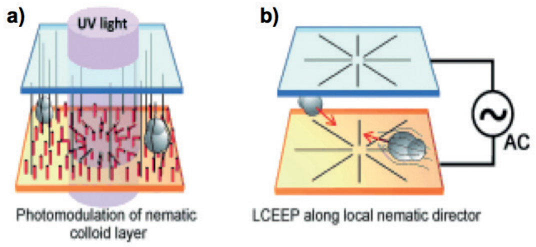


Fig.1: (a) Photomodulation of the colloid-embeddingnematic layer by means of a UV light spot. (b) Particle electrophoresis driven along the planar director.[3]

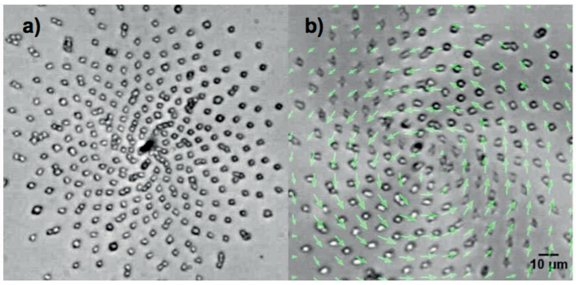


Fig.2: Assembled colloidal conformations: (a) aster (b) vortex. Green arrows indicate the movement direction of the vortex conformation

References
[1] D.G. Grier, Nature 2003, 424, 810-816.
[2] O.D. Lavrentovich, Soft Matter 2014, 10, 1264.
[3] S. Hernàndez-Navarro, P. Tierno, J.A. Farrera, J. Ignés-Mullol, and F. Sagués, Ang. Chem. Int. Ed 2014, 53, 10696-10700.

THIN AlN DIFFUSION BARRIER FOR CARBON NANOTUBES GROWTH OVER STAINLESS STEEL SUBSTRATE

Fernando Pantoja-Suárez, Islam Alshaikh, Roger Amade, José-Luis Andujar, Esther Pascual and Enric Bertran
FEMAN Group, IN^{2}UB, Dep. Applied Physics, Universitat de Barcelona,
C/ Martí i Franquès, 1, 08028 Barcelona, Spain

Nowadays, there are diverse kinds of diffusion barriers (DB) to avoid the migration (diffusion) of catalyst atoms inside the substrate during the annealing process before starting the carbon nanotubes (CNTs) growth using PECVD process. Different oxides and nitrides can be used as a DB. We have compared aluminum oxide (Al2O3) and aluminum nitride (AlN), which act very well over different substrates. These materials have a high melting point, relative low cost, but also a relatively high electrical resistance. One approach to circumvent this disadvantage is the deposition of a thin layer of material that allows the tunneling of electrons. AlN layers of 1 nm of thickness were deposited over austenitic stainless steel 304 (SS304) using DC pulsed sputtering process with an Al target under a N2 / (N2 + Ar) gas flow ratio of 40%, and 3 Pa processing pressure at room temperature. In order to study the effectiveness of the diffusion barriers, a thin layer of catalyst material was deposited on the AlN layer. Iron layers of 1, 2 and 3 nm thickness were deposited and then annealed up to 700 °C. The nucleation of Fe over AlN/Si substrate was optimized adopting the Box-Wilson experimental design. Si substrate was used instead of SS to study the nucleation behavior because it is difficult to observe the nano-islands over SS304 with a roughness of tens of microns. We have chosen the best nucleation conditions for each catalyst layer thickness deposited on our metallic substrate. Then, we started the PECVD process to check whether the CNTs grow or not. In other words, we determined if our diffusion barrier works properly. Scanning electron microscope (SEM) images have been obtained to study the surface morphology of the SS304-AlN-CNTs layered system. The nano-islands formation of iron was successful. Depending on the Fe layer thickness, the diameter of the nano-islands ranges from 5 nm to 30 nm, which was concluded from the diameter of the CNTs observed by SEM.

INFLUENCE OF CROSSLINKING DEGREE ON HYALURONAN GEL PROPERTIES AND IN VITRO CYTOTOXICITY

Ferran Roig[1,2,3], Marta Monge[1,2,3], Conxita Solans[2,3], Jordi Esquena[2,3], MªJosé García-Celma[1,3,*]
[1]Department of Pharmacy and Pharmaceutical Technology and Physicochemistry, Institute of Nanoscience and Nanotechnology (IN²UB). University of Barcelona, Joan XXIII s/n, 08028 Barcelona, Spain.
[2]Institute of Advanced Chemistry of Catalonia (IQAC), Spanish Council for Scientific Research (CSIC), Jordi Girona 18-26, 08034 Barcelona, Spain.
[3]Center for Biomedical Research Network in Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN), Jordi Girona 18-26, 08034 Barcelona, Spain.
*Corresponding author: mjgarcia@ub.edu

Hyaluronan (HA) is a natural polysaccharide widely distributed into the human body that can be used in biomedical and pharmaceutical applications [1]. As HA is degraded in vivo by hyaluronidase [2], the preparation of materials based on chemically crosslinked HA for drug delivery could represent a useful approach for increasing the in vivo resistance to degradation [3]. Hydrogels are crosslinked networks of hydrophilic polymers used as drug delivery systems via several administration routes [4,5]. The aim of this work was to study the crosslinking effect of HA hydrogels on drug release properties and in vitro cytotoxicity. HA hydrogels were prepared with different degrees of crosslinking using butanediol diglycidyl ether (BDDE) as a crosslinking agent. A lipophilic model drug, ketoprofen, and a hydrophilic model drug, theophylline, were incorporated to HA hydrogels and the release properties of HA hydrogels as a function of the degree of crosslinking were studied. The capacity to absorb water decreases dramatically with crosslinker concentration. The results showed that a more sustained release was obtained for HA hydrogels with a high degree of crosslinking. Furthermore, the MTT test was applied to study hydrogels toxicity and the influence of crosslinker concentration on HeLa human cells viability was determined. The results obtained on the release properties of HA hydrogels indicate that there are suitable for controlled drug delivery due to the possibility of modifying the crosslinking degree that influence release kinetics. Likewise, in vitro assays show that these materials could be considered as good candidates for implant developments due to their low cytotoxicity.

References

[1] L. Lapčík, L. Jr. Lapčík, S. De Smedt, J. Demeeste, et al. Chemical Review. 1998, 98, 2663-2684.
[2] R. Stern, M.J. Jedrzejas. Chem. Rev. 2006, 106, 818-839.
[3] T. Segura, B. Anderson, P. Chung, R. Webber, et al. Biomaterials. 2005, 26, 359-371.
[4] N.A. Peppas, P. Bures, W. Leobandung, H. Ichikawa. European Journal of Pharmaceutics and Biopharmaceutics. 2000, 50, 27-46.
[5] F. Roig, C. Solans, J. Esquena, M.J. García-Celma. J. Appl. Polym. Sci. 2013, 130, 1377-1382.

MICROWAVE ASSISTED SYNTHESIS AND NANOSTRUCTURATION OF SINGLE-MOLECULE MAGNETS

L. Rosado[1], A. Broto[1], G. Aromí[1], E. Jiménez[1], Y. Lan[3], W. Wernsdorfer[3], E. C. Sañudo[1]
[1]Inorganic Chemistry Department, Institute of Nanoscience and Nanotechnology (IN²UB), University of Barcelona, Av. Diagonal, 645, 08028, Barcelona, Spain
[2]BM25 Spline, ID-08. ESRF, 6 Rue Jules Horowitz, BP 220, 38043 Grenoble, France
[3]Institut Néel, CNRS, 25 rue des Martyrs, 38042 Grenoble, Cedex 9, France
***Corresponding author: li.rosado.p@gmail.com**

Solvent free microwave assisted synthesis has been used for the synthesis of M_4Ln complexes (Fig. 1) (M = Ni, Co; Ln = Tb, Dy, Gd, La) and other homonuclear compounds with 3d metals. It is proposed as a new and green synthetic tool, low temperatures and short reaction times. We have achieved a controlled synthesis with the possibility of tuning the magnetic properties of the complexes by introducing the desired metal.

These metalorganic structures present characteristic cores that provide them with interesting magnetic properties. Such complexes are called molecular nanomagnets (MNMs) and have been investigated due to their possible application in fields like magnetic coolers or information storage and processing. In order to fabricate devices for this aim, deposition and nanostructuration of these complexes on surfaces is required.

Most of these complexes have surrounding ligands with aliphatic groups like terminal tertbutyl groups that provide them with a major solubility and can favor weak Van der Waals interactions. We can use these interactions to deposit them onto HOPG or gold surfaces with the aim of obtaining an ordered monolayer; in addition these complexes can be linked to the surface of magnetic nanoparticles with aliphatic surfactants like oleates (Fig. 2).

Several basic deposition methods like spin coating, drop casting and deep coating have been used as well as the Langmuir-Blodgett film technique. Functionalized nanoparticles and surfaces have been studied using AFM, DLS, TEM and XMCD.

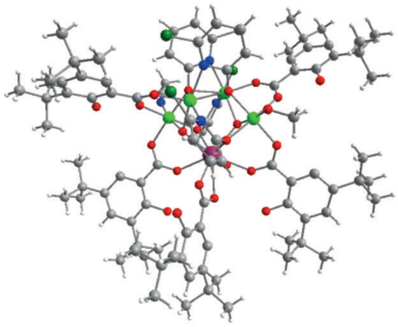


Fig.1: Structure of the M_4Ln complexes with the general formula: $[M_4Ln(OH)_2(chp)_4(tBuSALOH)_5(H_2O)(MeCN)(Solv)]$

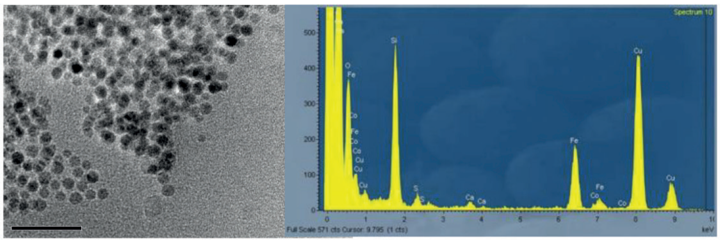


Fig.2: (left) TEM image of oleate functionalized magnetite nanoparticles linked to Co_4Dy complex and (right) EDX spectrum showing the presence of the complex

GELATIN-BASED NANOPARTICLES FOR THE INTESTINAL DELIVERY OF PROTEINS

Guillem Ruano[1] and M. Carmen Morán[1,2]
[1]Departament de Fisiologia – Facultat de Farmàcia, Universitat de Barcelona, Avda. Joan XXIII s/n, 08028 Barcelona, Spain
[2]Institut de Nanociència i Nanotecnologia – IN^{2}UB, Universitat de Barcelona, Avda. Joan XXIII s/n, 08028 Barcelona, Spain

The use of proteins for systemic treatment of certain diseases is now well accepted in medical practice. Oral administration is most preferred because of the various advantages over other routes of drug delivery. The advantages include patient convenience and compliance, which increase the therapeutic efficacy of the drug. However, delivering therapeutically active proteins by the oral route has been a challenge and a goal for many decades. An ideal carrier for intestinal delivery of drugs would remain intact through the stomach and small intestines, providing protection against the harsh acidic conditions of the stomach, but then release its contents in the large intestine [1]. The variety of pH conditions encountered during digestion makes the notion of pH- triggered systems desirable [2]. Among the suitable compounds, the gelification properties of gelatin or carboximethyl cellulose as well as the strong dependence of gelatin ionization with pH makes these compounds interesting candidates to be used to the effective intestinal delivery of active biomacromolecules [3]. This project aims the preparation and physicochemical characterization of new protein-based nanoparticles for the sustainable intestinal delivery. Among the available proteins, Bovine Serum Albumin (BSA) have been chosen. Type B gelatin, carboximethyl cellulose and type A Gelatin have been selected to form particles by interaction of oppositely charged compounds. Particles in the absence (binary systems) and in the presence (ternary systems) of BSA have been prepared. The physicochemical characterization (particle size, polydispersity index and degree of BSA entrapment) have been evaluated as a function of the gel strength or the molecular weight of the components and also the incubation time of the binary and/or the ternary systems. The effect of environmental pH changes from 7.4 to 2 and from 2 to 7.5 (mimicking GI tract pH variation) on the aforementioned parameters has been determined in order to evaluate the efficient intestinal BSA delivery under assayed conditions.

References

[1] Gamboa, J.M.; Leong, K.W. In vitro and in vivo models for the study of oral delivery of nanoparticles. Advanced Drug Delivery Reviews vol. 65(6) p.800-810 (2013)

[2] Evans DF, Pye G, Bramley R, Clark AG, Dyson TJ, Hardcastle JD. Measurement of gastrointestinal pH profiles in normal ambulant human subjects. Vol.29(8) p.1035 (1988) Please do not insert references with the automatic tool nor in the footer.

[3] Elzoghby, A.O. Gelatin-based nanoparticles as drug ande gene delivery Systems: Reviewing threedecades of research. Journal of controlled release Vol.172(3) p.1075-1091 (2013).

SNO2 NWS MESHES LOCALLY GROWN FOR AMMONIA SENSING IN DRY AND HUMID AIR

Jordi Samà[1], G. Domènech-Gil[1], Juan Daniel Prades[1], Olga Casals[1], Carles Cane[2], Isabel Gràcia[2], Sven Barth[3], Albert Romano-Rodriguez[1]
[1]MIND-IN[2]UB, Departament d'Electrònica, Universitat de Barcelona (UB), c/Martí i Franquès 1, E-08028 Barcelona, Spain
[2]Institut de Microelectrònica de Barcelona, IMB-CNM-CSIC, E-08193 Bellaterra, Spain
[3]TU Vienna, Institut für Materialchemie, A-1040 Vienna, Austria

Nanowires have been a topic of intense research the last years due to their optimal characteristics acting as a part of a circuit or as a sensing element due to their reduced size and high volume / surface ratio, and their well-controlled physical and chemical properties. The most challenging issue of fabricating electronic devices based on nanowires as building blocks using bottom-up approaches is the integration, which usually requires many fabrication steps and represents a highly time consuming process.

In this sense, we present the localized growth of SnO2 NWs, on the sensing area of the microdevices in a fast and direct fabrication process, with low power consumption. The synthesis of the NWs has been performed on top of CMOS compatible micromembranes that contain a buried microheater, which provides the growth temperature of the NWs, causing the decomposition of the precursor and allowing the synthesis of NWs, carried out by a localized Chemical Vapor Deposition process using Au as a catalyst. The micromembranes consists, besides the microheater, of interdigitates electrodes that allow the electrical readout of the grown nanowires bridging the space between them. The network of NWs is fabricated on micromebranes without employing a mask and no further steps are required to use the devices as a gas sensor.

The SnO2 NWs-meshes have been characterized as ammonia sensor in dry and humid conditions. The response towards ammonia is diminished and slowed down in presence of water vapour. The sensing kinetics at different temperatures has been analysed, and the concurrent mechanisms related to the ammonia oxidation have been identified. A response time of less than a minute and good repeatability of ammonia response are obtained from the experimental results.

References

[1] Satyanarayana V.N.T. *et al.* (2007) "One dimensional nanostructured materials", Progress in Materials Science 52, 699-913.

EVIDENCES OF PROTEIN ADSORPTION IN PEGYLATED LIPOSOMES

Sangrà, M.; Estelrich, J[1].; Busquets, M.A[1,*]
Department of Pharmacy, Pharmaceutical Technology and Physical Chemistry, Faculty of Pharmacy and Food Sciences, University of Barcelona
[1]Nanoscience and Nanotechnology Institute (IN^{2}UB), Avda. Joan XXIII, 27-31, 08028 Barcelona, Catalonia, Spain
***Corresponding author: mabusquetsvinas@ub.edu**

In order to contribute to a better knowledge of the events involved in the formation of the protein corona when nanoparticles get in contact with proteins, we present an study of the behavior of large unilamellar vesicles (LUVs) and hybrid LUVs containing superparamagnetic iron oxide nanoparticles (SPIONs), so named magnetoliposomes (MLs), in presence of bovine serum albumin (BSA). BSA that binds to nanoparticles changing their physicochemical properties was chosen for their role in enhancing membrane permeability. To analyze the influence of surface composition on the interaction, these systems were decorated with polyethylene glycol (PEG) or the cyclic peptide RGD. Therefore, we report the results obtained with three types of LUVs or MLs: pristine, PEGylated and RGD functionalized. L-α-phosphatydylcholine (PC) and 1,2-dimyristoyl-*sn*-glycero-3-phosphocholine (DMPC) were the main phospholipids chosen for the synthesis of the lipid vesicles for their differences in the acyl chain. The BSA-LUVs or BSA-MLs interactions were characterized by several methods as fluorescence spectroscopy, isothermal microcalorimetry (ITC), dynamic light scattering (DSC), transmission electron microscopy (TEM and Cryo-TEM) and SDS-PAGE. These independent techniques provided similar qualitative results indicating that BSA interactions with LUVs and MLs are strongly dependent on lipid composition. Our findings are in agreement with the reports of several authors that conclude about the difficulty of drawing a general trend and that all the systems need to be studied in a particular way.

MAGNETICALLY-ACTUATED MESOPOROUS COPT NANOWIRES AS A MEANS TO REVOLUTIONIZE HETEROGENEOUS CATALYSIS FOR BOTH WATER REMEDIATION AND HYDROGEN PRODUCTION

A. Serrà[1], S. Grau[2], C. Gimbert-Suriñach[2], J. Sort[3,4], J. Nogués[5], d, E. Vallés[1]

[1]GE-CPN, Departament de Ciència de Materials i Química Física and Institut de Nanociència i Nanotecnologia (IN^{2}UB), Universitat de Barcelona, Martí i Franquès, 1, E-08028, Barcelona, Catalonia, Spain.

[2]Institute of Chemical Research of Catalonia (ICIQ), Barcelona Institute of Science and Technology, Avinguda Països Catalans 16, 43007 Tarragona, Catalonia, Spain.

[3]Departament de Física, Universitat Autònoma de Barcelona, E-08193, Bellaterra, Catalonia, Spain.

[4]ICREA, Pg. Lluís Companys 23, 08010, Barcelona, Spain.

[5]Catalan Institute of Nanoscience and nanotechnology (ICN2), CSIC, The Barcelona Institute of Science and Technology, Campus UAB, Bellaterra, E-08193 Barcelona, Spain.

Industrial contamination of the world's water supply is a growing health and ecological threat in our increasingly industrialized society. Also, the clean and effective energy production is one of the more significant challenges of the scientific community. Thus, novel efficient approaches to catalyze processes for environmental remediation and clean energy generation are of great significance for humans and the environment. The design of novel highly effective micro or nano catalysts (showing a high surface/volume ratio, easy manipulation, high stability, specific chemical and superficial nature) for pollutant elimination and hydrogen production are current paramount scientific challenges.

Herein, we propose a facile synthesis pathway of magnetic mesoporous CoPt nanowires by using an ionic liquid-in-water microemulsion (pore director) and polycarbonate membranes (shape director). Then, we demonstrate that the catalytic activity of magnetically actuated mesoporous CoPt nanowires (Figure 1) for both an ultra-fast degradation of different types of pollutants and hydrogen production is an extremely effective process compared to the state-of-the-art catalytic materials currently being used for such purposes.

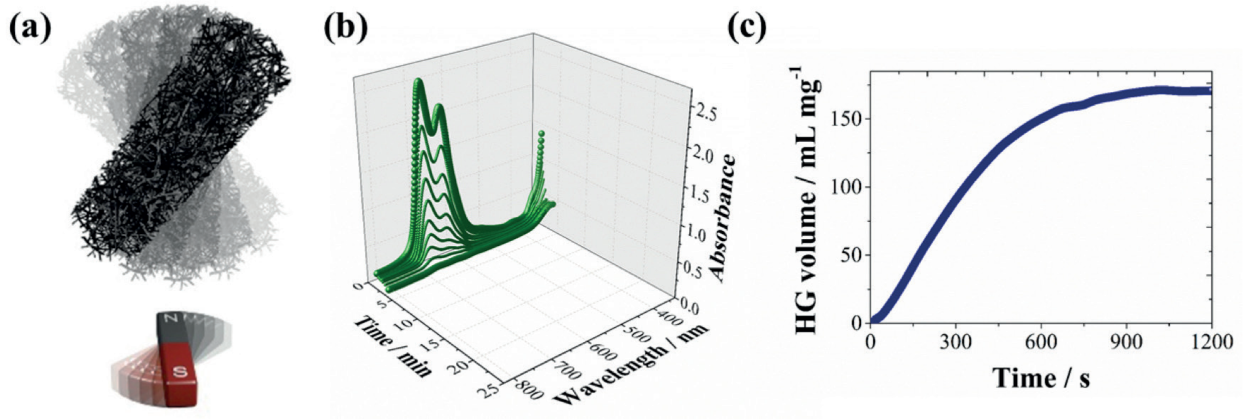


Fig.1: (a) Scheme of magnetic actuation. (b) Time-dependent UV-visible spectra of methylene blue degradation and (c) hydrogen generation volume produced by the hydrolysis of borohydride in magnetic actuation conditions

ULTRASENSITIVE METAL NANO-STRUCTURES FOR PLASMONIC ENHANCED RAMAN SCATTERING FOR BIOMEDICAL APPLICATIONS

Mohammad Tahghighi Haji Alizadeh, Departament de Quimica Fisica, Universitat de Barcelona
Supervised by: Jordi Ignes Mullol, Departament de Química Física, Universitat de Barcelona

Gold nanoparticles play an important role in many branch of science in recent days and many scientists tried to utilize and study their unique characteristics. Monolayers of gold nanoparticles were prepared in the water/air interface from hydrophobic gold particles solution in chloroform. Upon monolayer preparation and after solvent evaporation, monolayers were transferred on glass and silicon wafer with Langmuire-Blodget and Langmuire-Schafer technics which known as horizontal and vertical dipping methods. All samples were characterized by *UV/VIS* spectrophotometer, Atomic force microscope and Surface enhanced Raman Spectroscopy technics. The effect of surface pressure on forming monolayer as a basic parameter which represents the density of gold particles on the surface was examined. There is a direct relation between surface pressure and density of gold on the surface. Presence of gold monolayer was demonstrated by *UV/VIS* spectra and surface topology of monolayers. To study the enhancement effect of gold nanoparticles on Raman spectroscopy, glass samples bind to 4-mercaptobenzoic acid (4-MBA, 99%). Predominant vibrational strong signals were observed in the Raman spectrum of 4-MBA at 1075 and 1586 cm^{-1}. Self-assembling monolayers of gold could be introduced as a noble and economical technic for preparation of gold substrate for utilizing in SERS, Nano biotechnology and Nano electronic sciences.

IMPACT OF WATER AND OXIDATION STATES IN THE GALVANIC REPLACEMENT FORMATION OF HOLLOW OXIDE NANOPARTICLES

Pau Torruella Besa[1, 2], Alberto López-Ortega[3], Alejandro Roca[4], Michelle Petrecca[3], Sónia Estradé[1, 2], Francesca Peiró[1, 2], Victor Puntes[5], Josep Nogués[4]
[1]LENS-MIND, Departament d'Electrònica, Universitat de Barcelona, Barcelona, SPAIN
[2]Institut de Nanociència i Nanotecnologia (IN^{2}UB), Universitat de Barcelona, Barcelona, SPAIN
[3]INSTM and Dipartimento di Chimica "U.Schiff", Università degli Studi di Firenze, Firenze, ITALY
[4]Magnetic Nanostructures Group, Catalan Institute of Nanoscience and Nanotechnology (ICN2), Bellaterra, SPAIN
[5]Inorganic Nanoparticles group, Catalan Institute of Nanoscience and Nanotechnology (ICN2), Bellaterra, SPAIN
Keywords: Nanoparticles, Galvanic Replacement, Iron Oxide, Manganese Oxide

Metal-oxide hollow nanoparticles are appealing structures from the applied and fundamental viewpoints. The synthesis of bi-phase metal-oxide hollow nanoparticles has been reported based on galvanic replacement using an organic-based seeded-growth approach, but with the presence of H2O. Here we report on a novel route to synthesize hollow core-shell MnOx/FeOx nanoparticles by galvanic replacement without the use of H2O. We demonstrate that the role of H2O in the MnOx/FeOx galvanic replacement synthesis is to oxidize the MnO/Mn3O4 seeds into pure Mn3O4 in order to obtain the suitable oxidation state so that the Mn3+→Mn2+ reduction by the Fe2+ ions can occur. Thus, if no H2O is added, onion-like MnO/Mn3O4/Fe3O4 nanoparticles are obtained, while whenMn3O4 seeds are used, hollow core-shell MnOx/FeOx are achieved. Thus, a critical step for galvanic replacement is the existence of proper oxidation states in the seeds so that the chemical reduction by the shell ions is thermodynamically favoured.

2D H-BN INKJET-PRINTED DIELECTRIC INKS FOR FLEXIBLE ELECTRONICS DEVICES

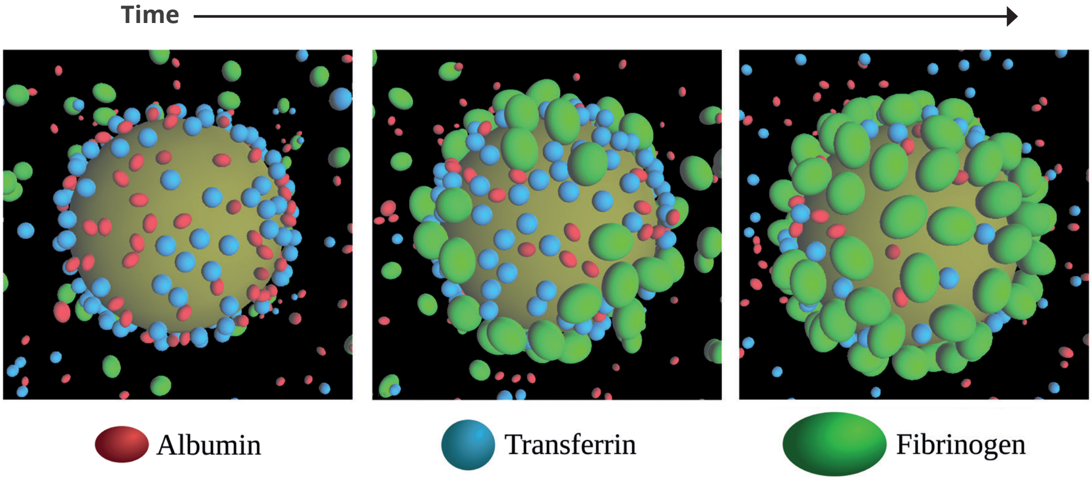
G. Vescio*, Albert Cornet, Albert Cirera
MIND-IN²UB, Departament d'Electrònica, Universitat de Barcelona, C/ Martí i Franquès 1, E-08028, Barcelona (Spain)
***Corresponding author: gvescio@el.ub.edu**

The soaring global demand for flexible, wearable and transparent devices has created an urgent need for the fabrication of new technologies that are both cost-competitive and eco-friendly. Printed electronics is a rapidly expanding research area, enabling low-cost, large-area, light-weight and flexible electronics. Direct drop-on-demand inkjet printing technology is one of the most promising techniques for large area fabrication of flexible electronic devices. Application such as packaging, biomedical devices, and sensors, requires a high degree of biocompatibility and scalability, hence the need of moving from 3D nanoparticle-based to 2D nanosheet-based inks of conductive or insulating elements used for printed electronics devices. In this work, we compare inkjet full-printed metal-insulator-metal capacitors (MIMs) on flexible substrate, where the 3D nanoparticle-based ink of high-k hafnium oxide (HfO_2) and the 2D nanosheets-based ink of hexagonal boron-nitride (h-BN) were selected as the dielectric layer. The HfO_2 has become one of the most remarkable compounds to be employed as an alternative dielectric gate due to its physical properties, such as a relative wide band gap and its higher dielectric constant compared to SiO_2. Among all the two-dimensional materials, h-BN is an insulating analogue of graphite and it is an appealing dielectric biocompatible material for use in improved graphene-based devices. Here, h-BN biocompatible printable inks were prepared with the aid of a biocompatible polymer (Carboxymethyl cellulose) that is a water-soluble polymer widely used as additive in, textiles, food packaging, and biomedical applications. To determine the noteworthy insulator properties of the two deposited thin film materials, the structure and the morphology of the films have been investigated in order to confirm the integrity of these layers within a MIM capacitor structure by microscopy and spectroscopy studies. The full printed capacitors were characterized by field-emission scanning and transmission electron microscopies. X-ray diffraction patterns, as well as Raman scattering and Fourier-transform infrared spectra, revealed the presence of solid layers, without solvent organic ink remains. The good performance of the thin films was proved by the relative permittivity, k = 12.6 for the HfO_2 and k=6.9 for the h-BN, respectively. Finally, the electrical current density-voltage and capacitance-voltage measurements have been studied in the frequency range 10 kHz–1 MHz.

UNDERSTANDING THE KINETICS OF PROTEIN−NANOPARTICLE CORONA FORMATION

Oriol Vilanova, Giancarlo Franzese
Secció de Física Estadística i Interdisciplinària−Departament de Física de la Matèria Condensada & Institut de Nanociencia i Nanotecnologia (IN^{2}UB), Universitat de Barcelona, Marti i Franques 1, 08028 Barcelona, Spain
*Corresponding author: gfranzese@ub.edu

When a pristine nanoparticle (NP) encounters a biological fluid, biomolecules spontaneously form adsorption layers around the NP, called “protein corona”. The corona composition depends on the time-dependent environmental conditions and determines the NP’s fate within living organisms. Understanding how the corona evolves is fundamental in nanotoxicology as well as medical applications. However, the process of corona formation is challenging due to the large number of molecules involved and to the large span of relevant time scales ranging from 100 μs, hard to probe in experiments, to hours, out of reach of all-atoms simulations. Here we combine experiments, simulations, and theory to study (i) the corona kinetics (over 10−3−103 s) and (ii) its final composition for silica NPs in a model plasma made of three blood proteins (human serum albumin, transferrin, and fibrinogen). When computer simulations [1] are calibrated by experimental protein−NP binding affinities measured in single-protein solutions, the theoretical model correctly reproduces competitive protein replacement as proven by independent experiments. When we change the order of administration of the three proteins, we observe a memory effect in the final corona composition that we can explain within our model. Our combined experimental and computational approach is a step toward the development of systematic prediction and control of protein−NP corona composition based on a hierarchy of equilibrium protein binding constants [2].



References

[1] P. Vilaseca, K. A. Dawson, G. Franzese, Soft Matter, 9, (2013) 6978−6985.

[2] O. Vilanova, J. J. Mittag, P. M. Kelly, S. Milani, K. A. Dawson, J. O. Rädler, G. Franzese, ACS Nano, DOI: 10.1021/acsnano.6b04858 (2016).

ASSESSMENT OF ZINC OXIDE NANOPARTICLES TOXICITY USING CULTURE CELLS AND RECONSTRUCTED TISSUE

Vinardell, M.P. and Mitjans, M.

The assessment of skin irritation potential is fundamental on nanotechnology in order to know the potential risk for contact with skin in the manipulation process. Nowadays, there is a common use of zinc oxide nanoparticles in many industrial applications. However, little information is available on its skin toxicity and irritation potential. The objective of the present study is to determine the skin irritation potential of different commercial zinc oxide nanoparticles of 50 and 100 nm and to compare with the non-nanometric zinc oxide. To achieve such objective we have used the human commercial keratinocyte cell line, HaCaT, and a human epidermis equivalent model (Episkin™). We put on contact the different zinc oxides studied with the HaCaT cells for 24, 48 and 72 hours and with the human skin model for 24 hours. After the incubation period, we assessed cell viability by the MTT method. We have characterized the different nanoparticles in different media (water, PBS and DMEM), determining their size by dynamic light scattering (DLS) and transmission electronic microscopy (TEM).

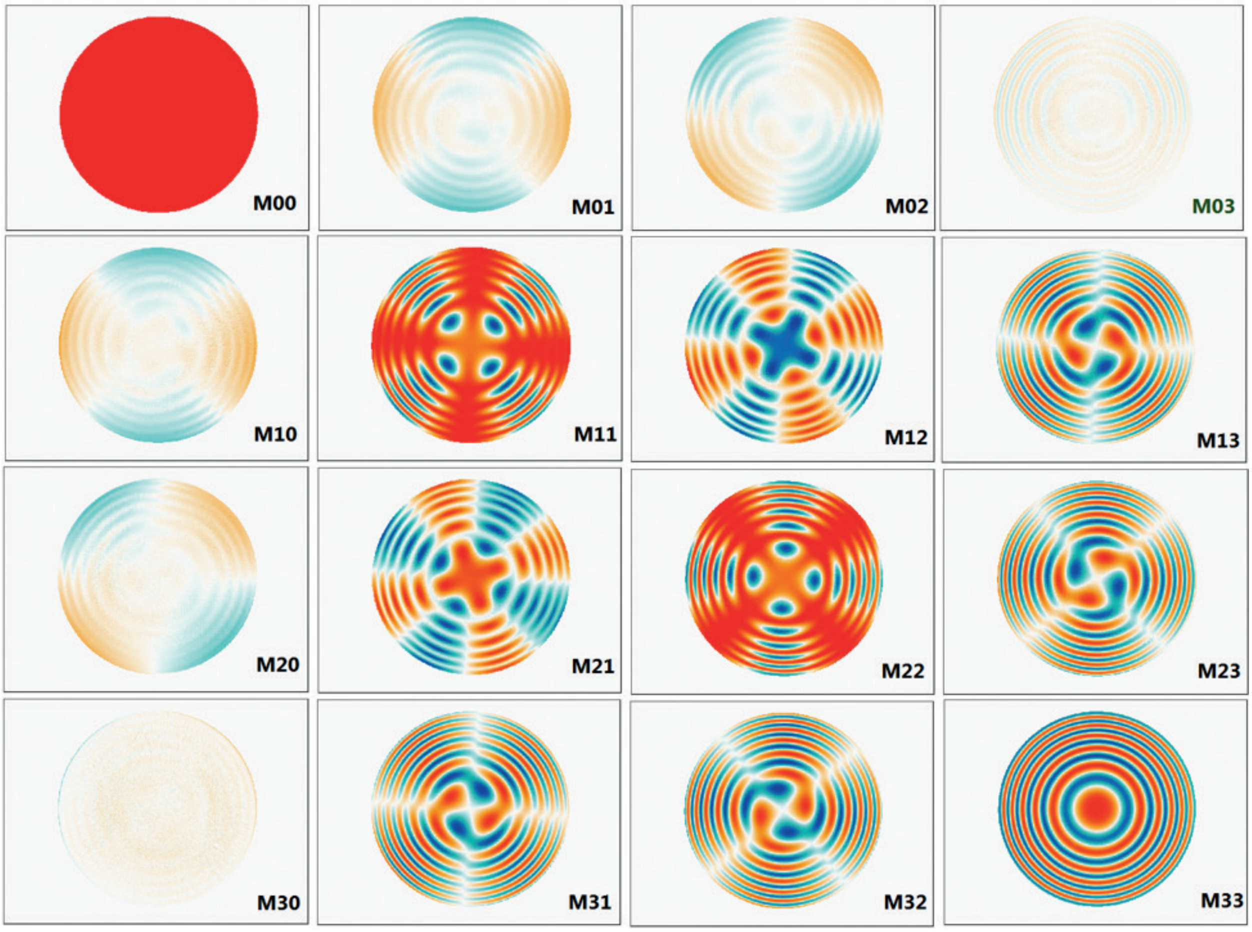
Our data reflected that zinc oxide nanometric and non-nanometric particles reduced cell viability of HaCaT cells in a dose-dependent manner from 0.78 to 100 µg/mL. However, data obtained in skin equivalents revealed no irritation at a high concentration such as 1 mg/mL

This study indicates that zinc oxide nanoparticles do not cause acute cutaneous irritation independently of the size of the particle.

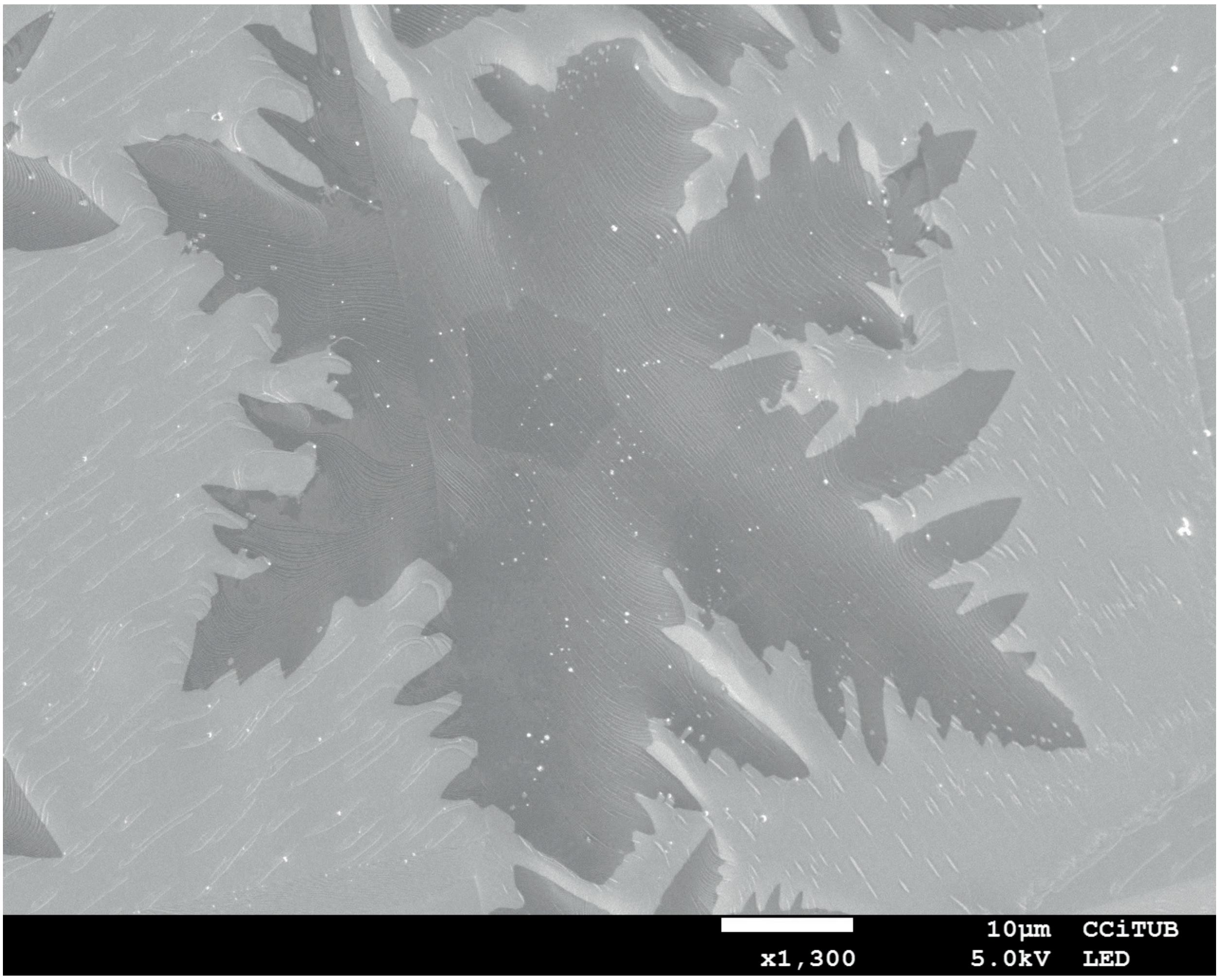
5. IMAGES

SAGRADA FAMILIA CARBON NANOTUBES by I. Alshaikh (E. Bertran)

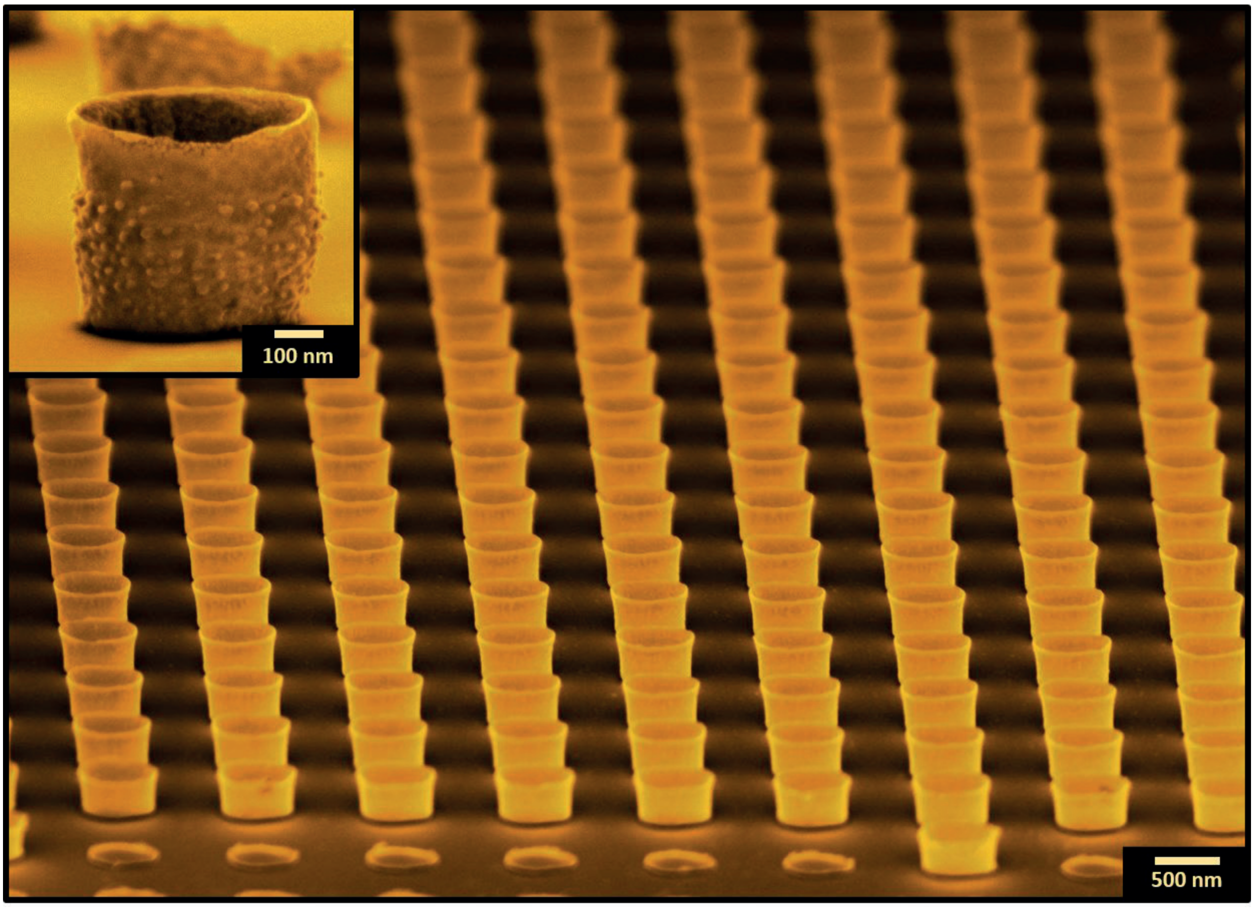
LEFT HANDED QUARTZ CRYSTAL OBSERVED BY MUELLER CONOSCOPY by O. Arteaga (E. Bertran)



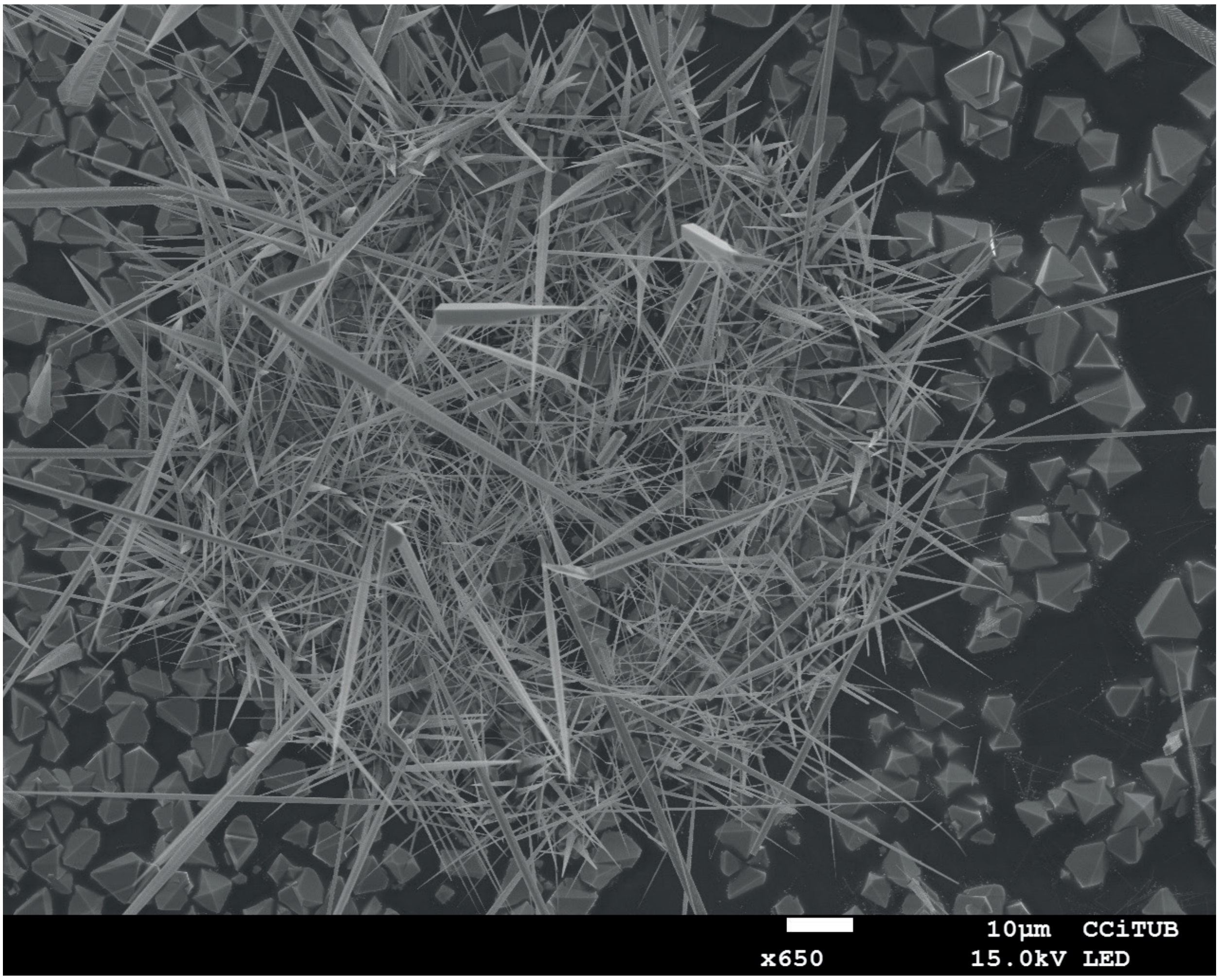
GRAPHENE 2D CRYSTAL GROWTH. ON THE CENTER OF THE CRYSTAL, A SECOND DOMAIN START GROWING, SHARING THE SAME NUCLEATION POINT by S. Chaitoglou (E. Bertran)



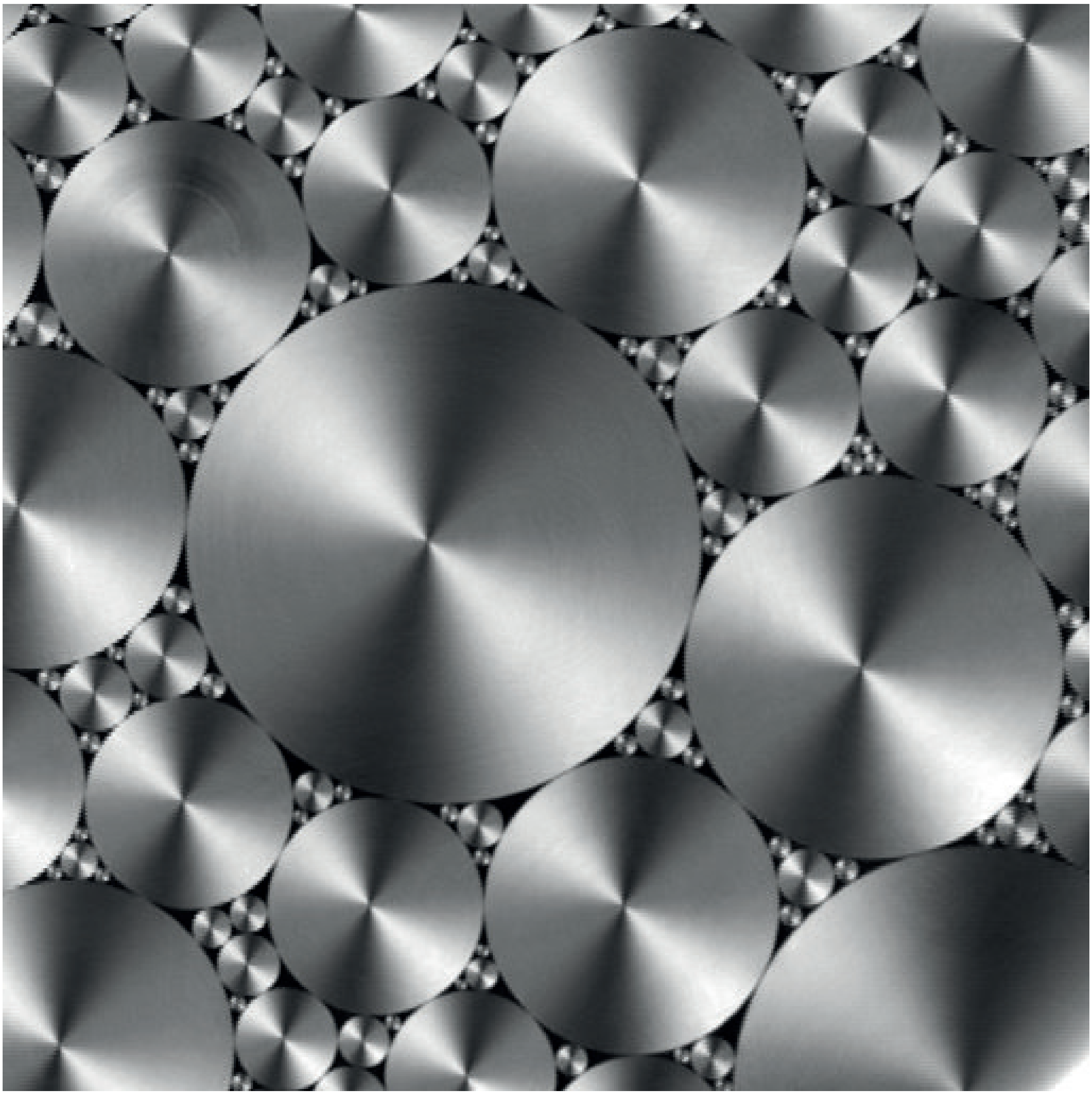
GOLD NANOCUPS by A. Conde Rubio (X. Batlle and A. Labarta)



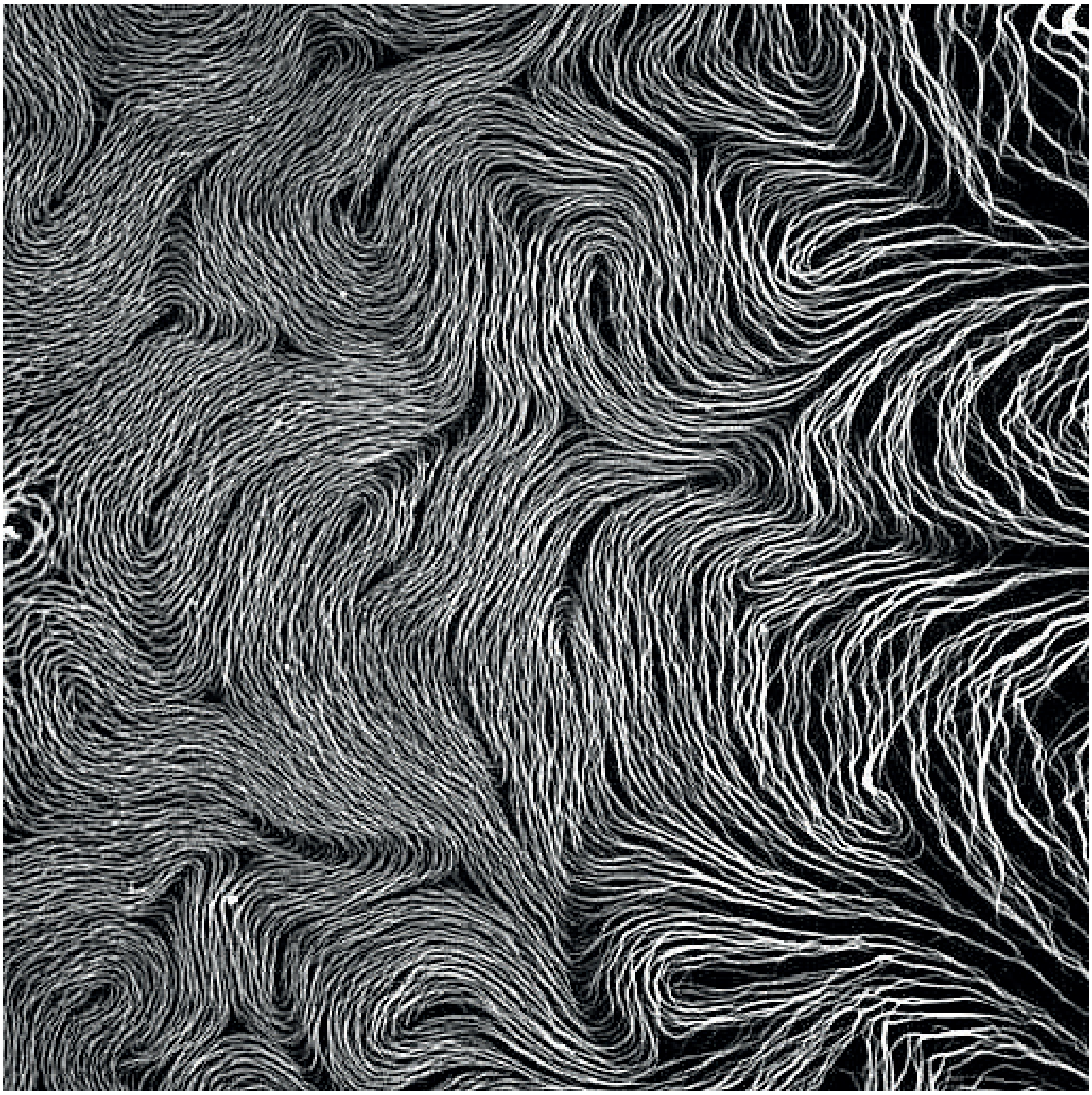
NIU DE NANOFILS D'ÒXID D'INDI by G. Domènech (A. Romano)



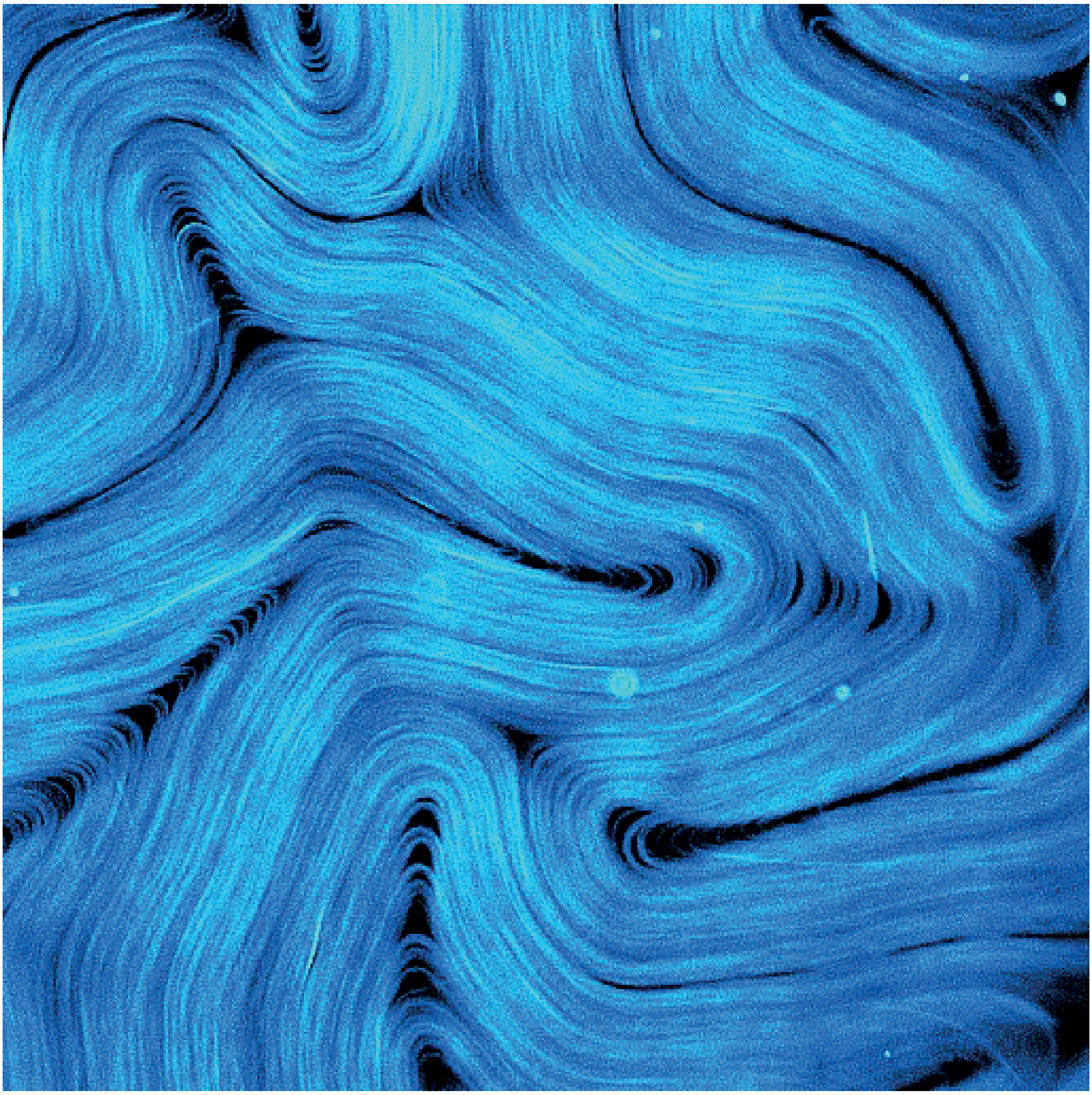
ESMÈCTIC by P. Guillamat (F. Sagués and J.Ignés)



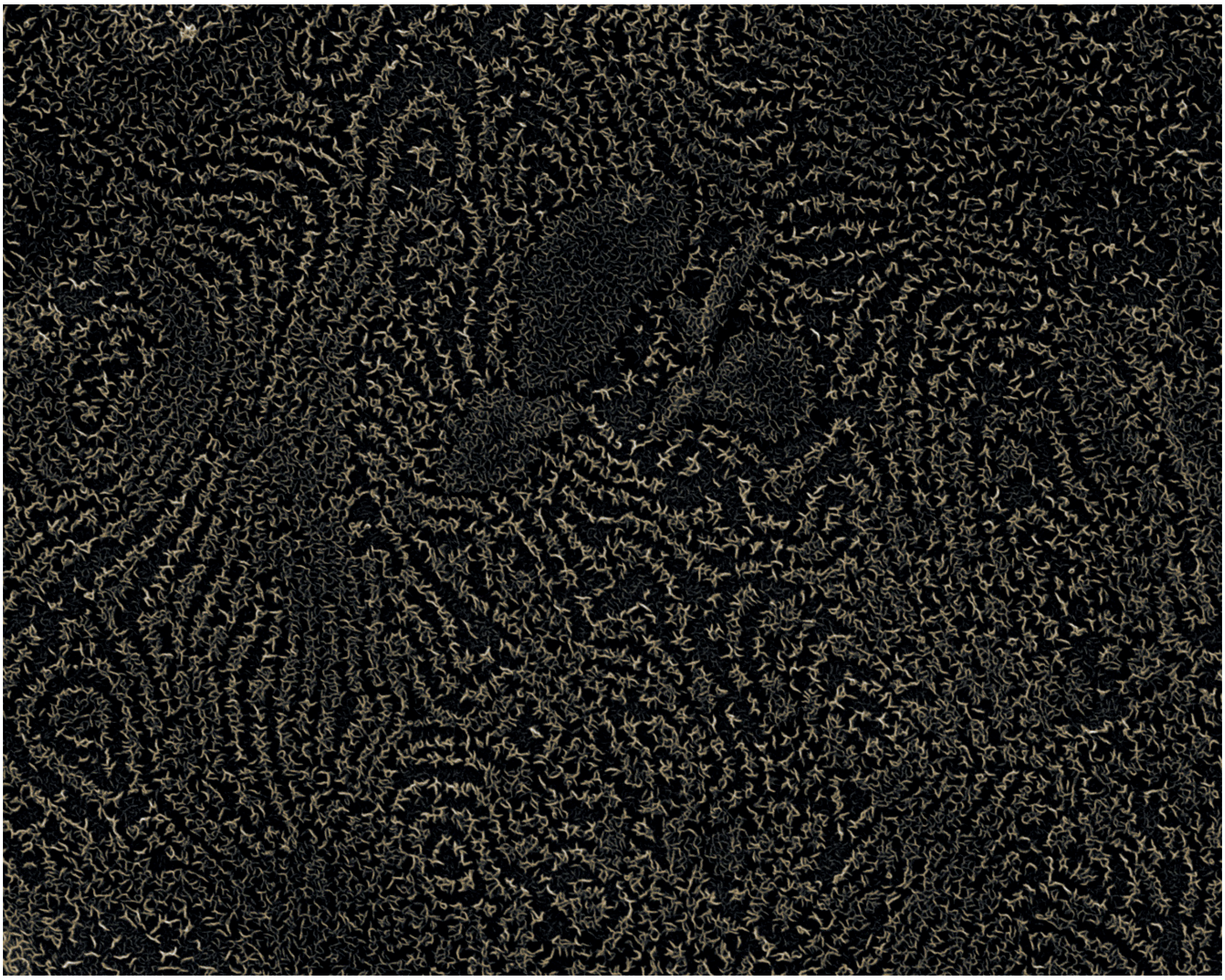
PATRONS; MICROTÚBULS AL SUBSTRAT by P. Guillamat (F. Sagués and J.Ignés)



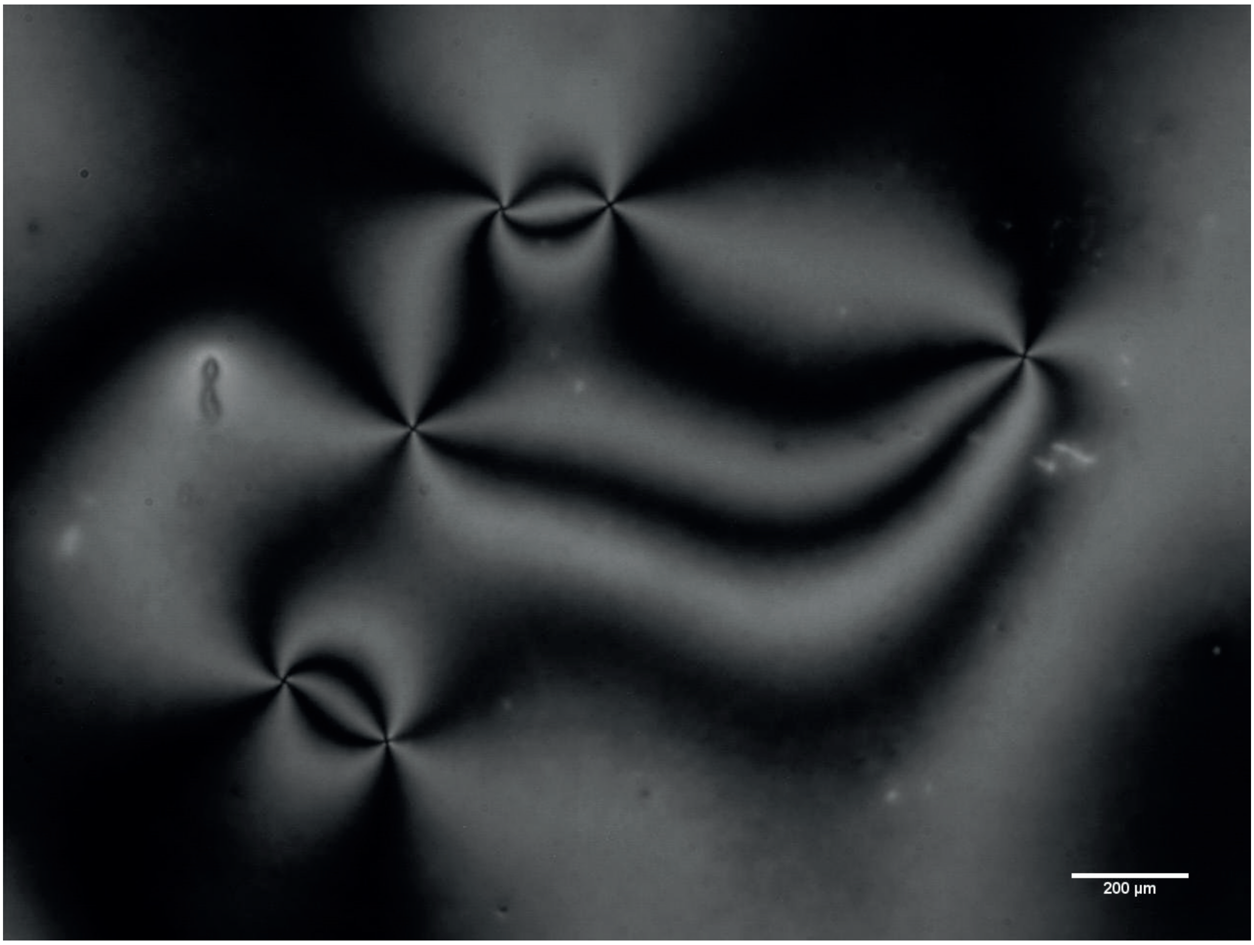
CRISTALL LÍQUID ACTIU: MICROTÚBULS I MOTORS MOLECULARS by P. Guillamat (F. Sagués and J.Ignés)



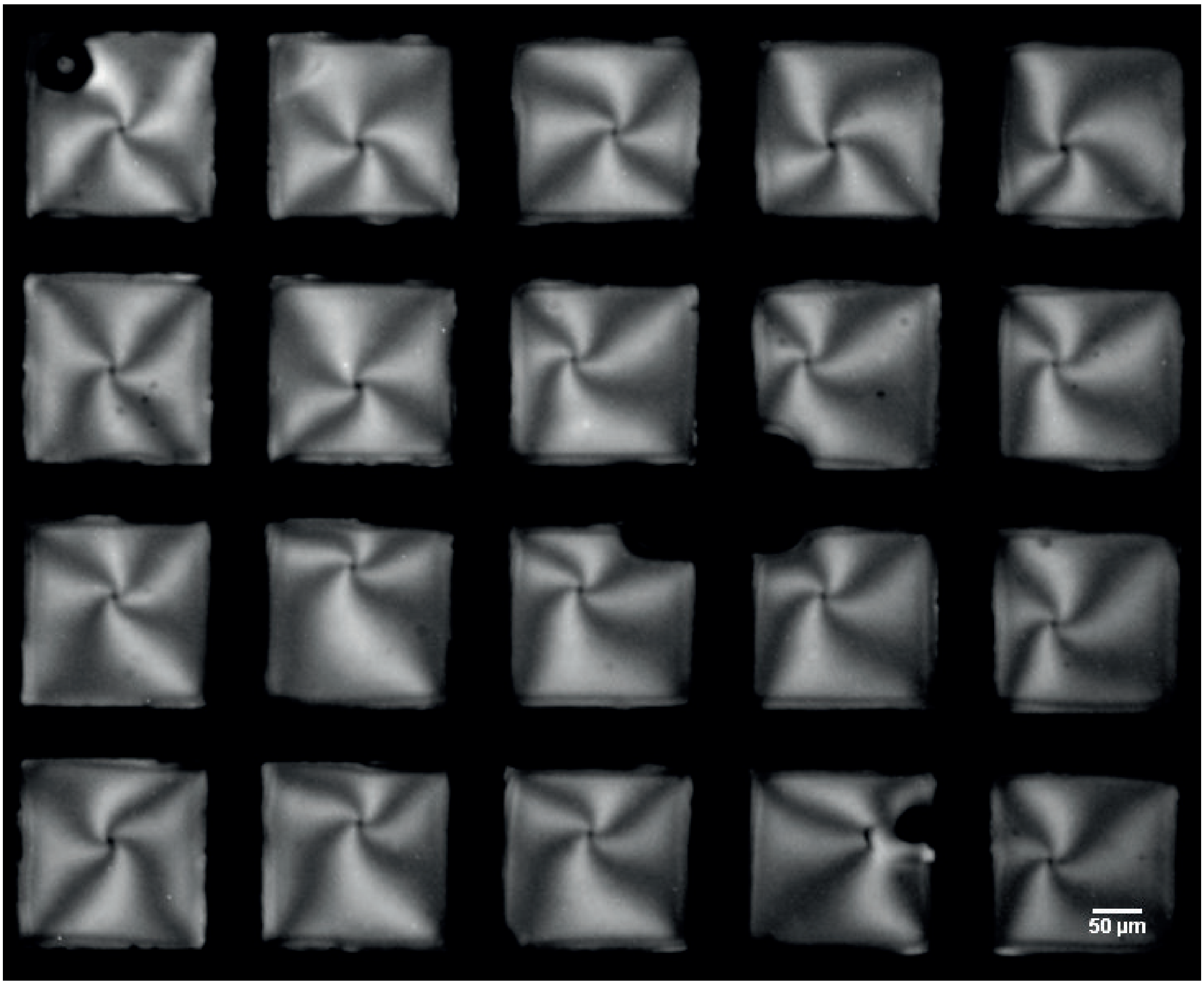
LABERINTS DE GRAFÈ by J. Martí González (E. Serra)



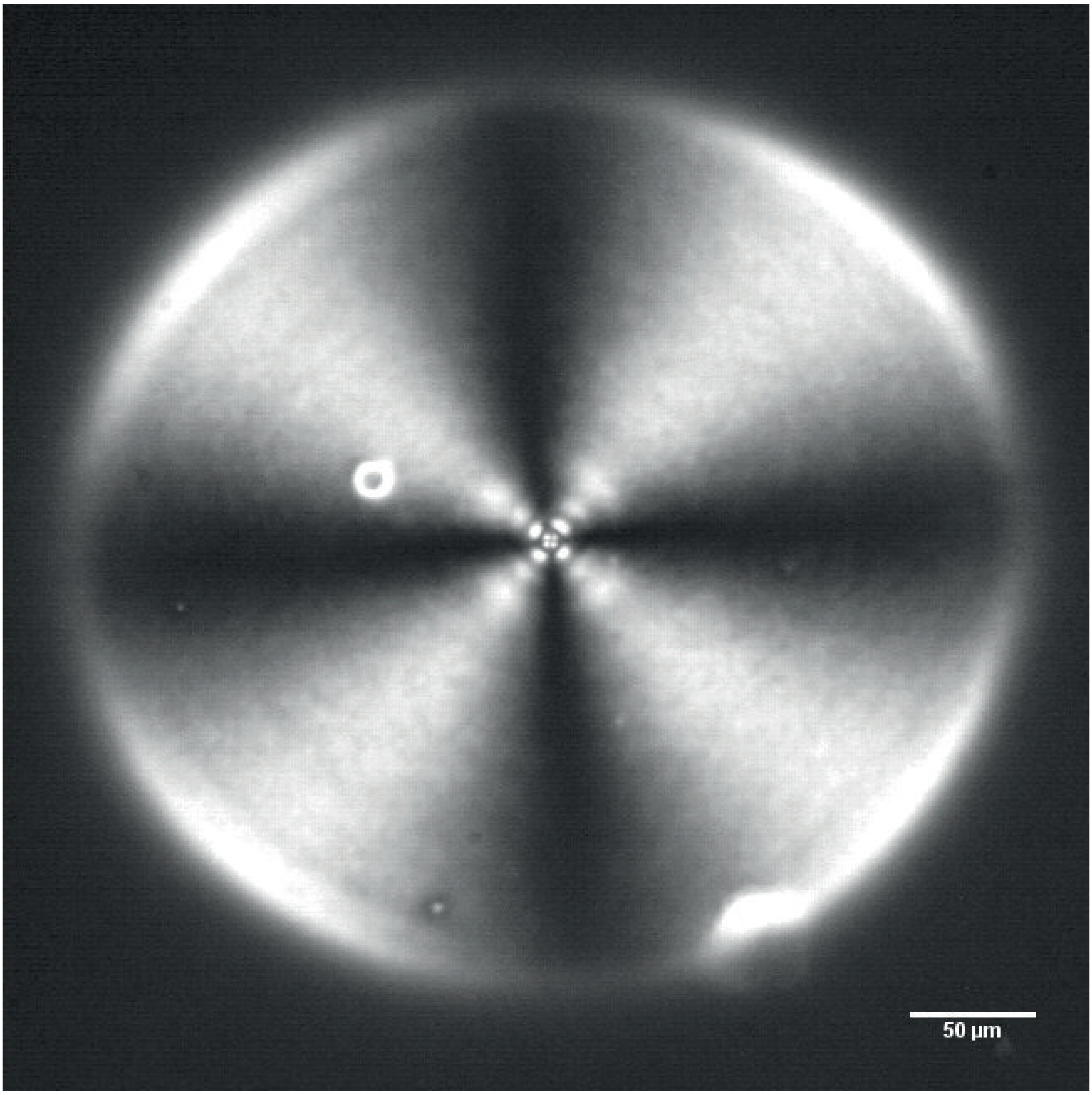
SCHLIEREN TEXTURES OF A NEMATIC LIQUID CRYSTAL by J.M. Pages Casas (F. Sagués and J.Ignés)



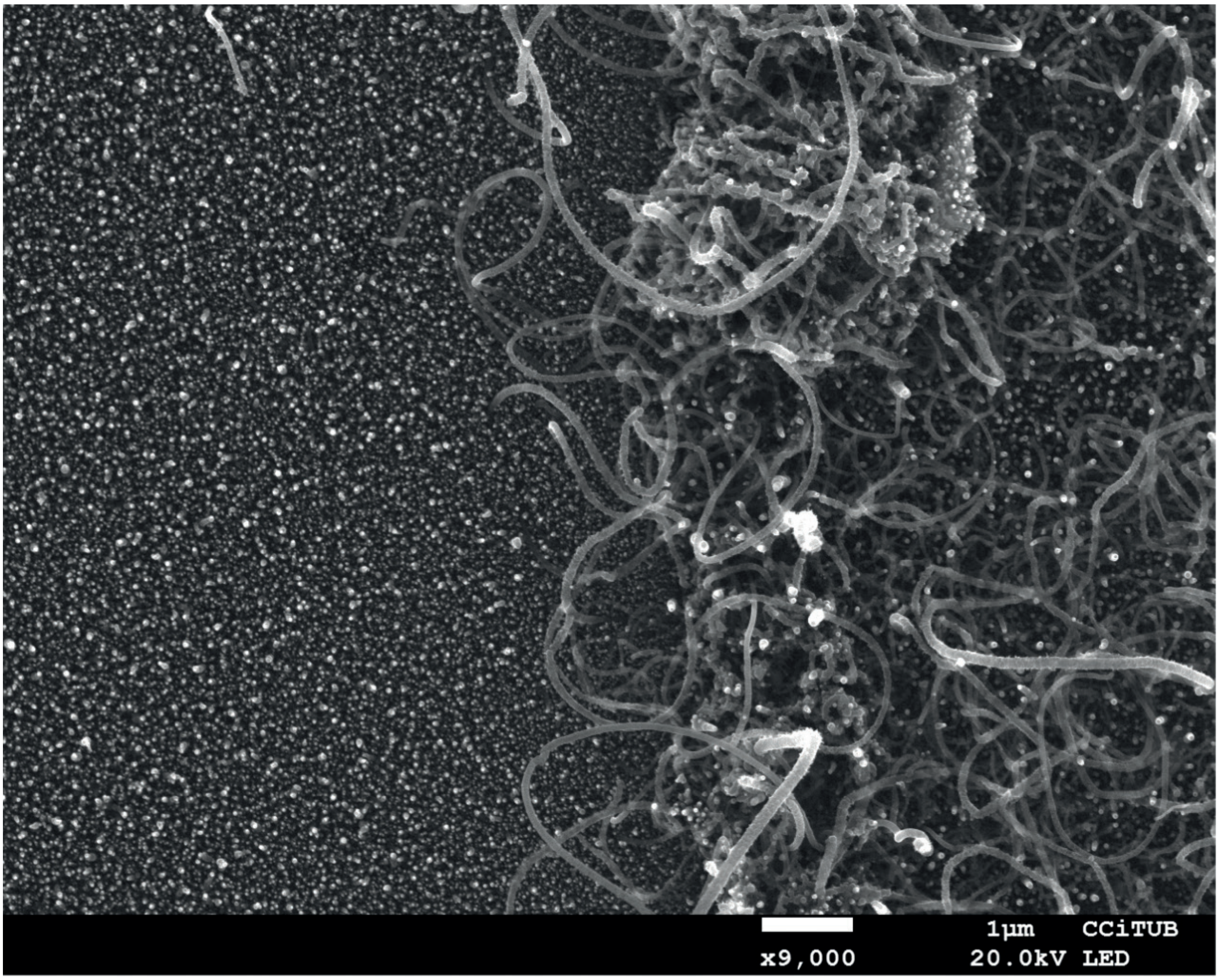
LIQUID CRYSTAL DEFECTS IN A TEM GRID by J.M. Pages Casas (F. Sagués and J.Ignés)



RADIAL CONFORMATION (ASTER) OF A NEMATIC LIQUID CRYSTAL by J.M. Pages Casas (F. Sagués and J.Ignés)

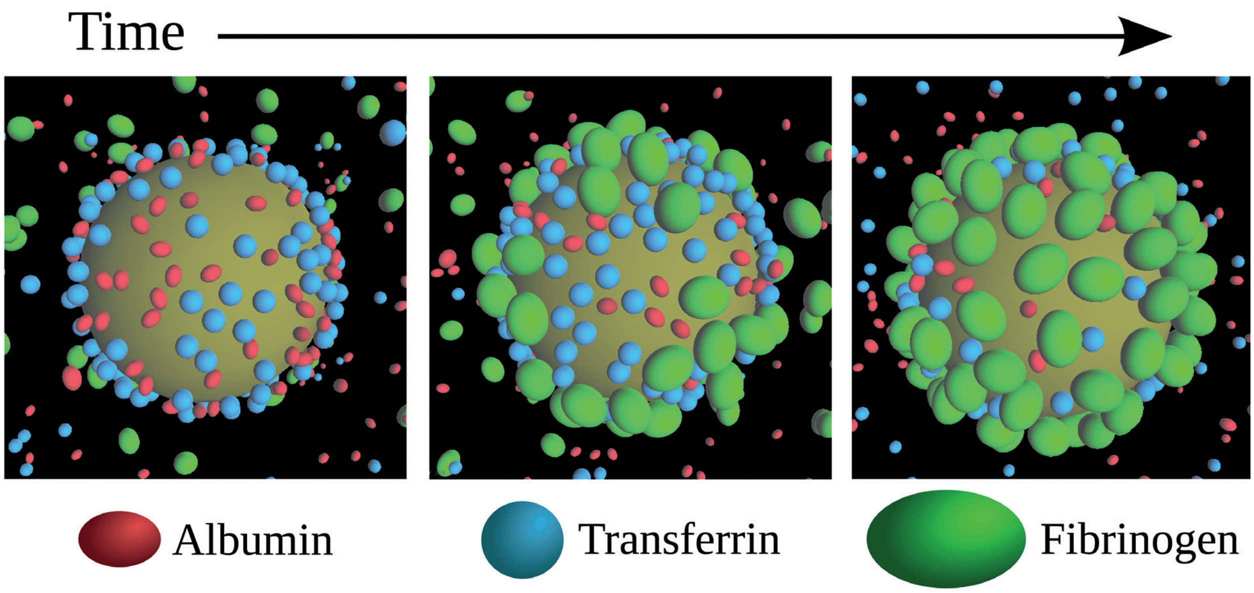


EFFICIENCY OF ALUMINUM NITRIDE DIFFUSION BARRIER by L.F. Pantoja Suárez (E. Bertran)



Top view - forest of carbon nanotubes CNTs
Left side: verticall aligned CNTs
Right side: random distribution of CNTs

KINETICS OF PROTEIN ADSORPTION ONTO NPs by O. Vilanova (G. Franzese)



Institut de Nanociència i Nanotecnologia
Av. Joan XXIII s/n, 08028 Barcelona
phone: +34 93 403 59 85 email:in2ub@ub.edu