XXXVI Trobades científiques de la Mediterrània - Josep Miquel Vidal

MICROSCÒPIES I ESPECTROSCÒPIES: ACCEDINT A LA NANOESCALA

October 27-29 of 2021

Maó - Menorca

IME Institut Menorquí d'Estudis

Societat Catalana de Física

SME Sociedad de Microscopía de España

Institut de Nanociència i Nanotecnologia

Universitat de

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INVITED SPEAKERS

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Swiss Federal Laboratories for Materials Science and Technology - EMPA (Switzerland)

PROF. DR. UTE KAISER

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University of Ulm (Germany)

PROF. DR. GIOVANNI VOLPE

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University of Gothenburg (Sweden)

DR. LORENA REDONDO-MORATA

Institut national de la santé et de la recherche médicale - INSERM
Institut Pasteur de Lille (France)

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PROGRAM

Wednesday 27th of October

	11:45	**Welcome**	IME: Camí des Castell, 28, 07702 Maó, Illes Balears
Session Wed1 **Chair: Prof. Francesca Peiró**	12:00	**Invited talk**	**Dr. Marta Rossell - *EMPA***
			PROBING STRUCTURAL DEFECTS IN BIFEO3 THIN FILMS AT ATOMIC RESOLUTION
	12:50		**Xu Han- *ICN2***
			Quasi-Double-Star Nickel and Iron Active Sites for High-Efficient Carbon Dioxide Electroreduction
	13:10		**Ting Zhang - *ICN2***
			Engineering FeN 4 Sites in Fe-N-C Catalysts via Bonded Oxygen-Containing Groups for High-Efficient Electroreduction of Carbon Dioxide
	13:30		**Catalina Coll – *University of Barcelona***
			Understanding of GaInP electronic properties by a combination of DFT and in-situ TEM
	14:00	**Lunch Break**	
			Carrer Sínia des Muret, 23, 07702 Maó, Illes Balears
Session Wed2 **Chair: Dr. Marta Rossell**	16:00		**Dr. Belén Ballesteros - *ICN2***
			Advanced electron microscopy on novel tubular van der Waals Heterostructures
	16:20		**Marc Botifoll - *ICN2***
			Advanced STEM Characterisation of SiGe/Ge Quantum Wells for Quantum Computing
	16:40	(online)	**Dr. Arantxa Fraile Rodríguez – *University of Barcelona***
			Atom- and site- selective spin canting in Co-ferrite nanoparticles with tunable structural disorder
	17:00	**Coffee Break**	
Session Wed3 **Chair: Catalina Coll**	17:20	(online)	**Pritam Banerjee - *IITM***
			Reliable 3D Atomic-Scale Reports of Free- or Amorphous-Standing Nano-Objects: A Cooperation Between IMEYMAT and IITM Institutes
	17:40		**Timothy Craig - *University of Antwerp***
			Determining the 3D morphology of beam sensitive MOF Nanoparticle Composites using Electron Tomography
	18:00		**Antonio Santos – *University of Cádiz***
			Pioneering studies on nanostructured porosity-controlled coatings through scanning-transmission electron microscopy methods
	20:00	**Social**	**Científiques a prop in colab with AMIT-cat**
	Bar Nou, Carrer Nou, 1, 07701 Maó, Illes Balears		

Thursday 28th of October

Session Thu1 **Chair: Dr. Belén Ballesteros**	9:30	**Invited talk**	**Prof. Ute Kaiser – *Ulm University***
		(online)	**PROPERTIES OF LOW-DIMENSIONAL MATERIALS BY LOW-VOLTAGE TEM**
	10:20		**Luisa Maria Valencia- *University of Cádiz***
			Degradation of Polymer-based Materials for Stereolithography by Electron Beam Damage
	10:40		**Daniel del Pozo Bueno – *University of Barcelona***
			Support Vector Machines applied to Electron Energy-Loss Spectra: transition metals classification
	11:00	(online)	**Javier Blanco Portals – *University of Barcelona***
			WhatEELS. A complete software solution for ELNES analysis that combines clustering and NLLS
	11:20	**Coffee Break**	

Session Thu2 **Prof. Gabriel Gomila**	11:40	**Invited talk**	**Prof. Giovanni Volpe - *University of Gothenburg***
			QUANTITATIVE DIGITAL MICROSCOPY WITH DEEP LEARNING
	12:30		**Dr. Andrea Sorrentino - *ALBA SYNCHROTRON***
			Visualize and quantify concentrations in frozen hydrated biological cells using synchrotron- based cryo Soft X-ray Transmission Microscopy
	12:50		**Dr. Allan Johnson – *ICFO***
			Temporally and spectrally resolved coherent X-ray microscopy of nanoscale dynamics in quantum materials
	13:10	(online)	**Dr. M Waqas Khaliq - *ALBA SYNCHROTRON***
			Direct X-ray detection of the spin Hall effect in CuBi
	13:30	(online)	**Dr. Judit Juanhuix Gibert – *ALBA Synchrotron***
			Current capabilities and future plans in bioimaging at the ALBA Synchrotron
	14:00	**Lunch Break**	

	16:15	**Bus tour** Visit: • Torre d'en Galmés talayotic settlement • Ciutadella de Menorca
		Tour guide: Fina Salord from IME
	20:30	**Gala Dinner**
		El Molí des Comte Asador – *Ciutadella de Menorca*

Friday 29th of October

Session Fri1 **Chari: Prof. Giovanni Volpe**	9:30	**Invited talk**	**Dr. Lorena Redondo-Morata – *Insern***
			ATOMIC FORCE MICROSCOPY AS A TOOL TO STUDY CELL MEMBRANE REMODELING PROCESSES
	10:20		**Dr. Neus Domingo- *ICN2***
			Direct and converse flexoelectricity: the effect of strain and electric field gradients on nanoscale electromechanical responses.
	10:40	(online)	**Prof. María Teresa Cuberes – *University of Castilla la Mancha***
			Nanostructural Arrangements and Surface Morphology on Ureasil-Polyether Films Loaded with Dexamethasone Acetate
	11:00	(online)	**Dr. Gemma Martín Malpartida– *UB-CCiT***
			ContactJ: Analysis Method to Identify Lipid Droplets-Mitochondria Contacts by Fluorescence Microscopy images
	11:20	**Coffee Break**	

Session Fri2 **Chair: Dr. Lorena Redondo-Morata**	11:40		**Dr. Giuseppe Battaglia- *IBEC***
			Imaging protein conformational space in liquid water
	12:00		**Prof. Gabriel Gomila- *IBEC-University of Barcelona***
			Mapping the dielectric properties of cells by Scanning Dielectric Microscopy enhanced by Machine Learning
	12:20	(online)	**Prof. María Garcia-Parajo– *ICFO***
			New insights on focal adhesión complexes by super resolution microscopy
	12:40		**Prof. Francesca Peiró – *University of Barcelona***
			Electron Microscopy at the University of Barcelona: past, present and future trends as ELECMI-UB node
	13:00		**Final Remarks**

Abstracts

PROPERTIES OF LOW-DIMENSIONAL MATERIALS BY LOW-VOLTAGE TEM

Ute Kaiser

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Two-dimensional materials exhibit properties, which can differ strongly from those of the bulk counterparts and offer unique opportunities for new and miniaturized electronic and optical devices [1]. In situ electron microscopy nowadays can provide experimental data on the level of the single atom, as it has seen extremely rapid developments in recent years owing to ground-breaking advances in electron optics, electron detectors, sample preparation and manipulation, and highly versatile in situ setups can simultaneously while imaging also functionalizing the material under study. Here we present recent results using our unique chromatic and spherical aberrationcorrected SALVE instrument both in imaging and spectroscopy modes [2].

We first discuss the formation of defects in two-dimensional inorganic and organic crystals. For transition metal di-chalcogenides (TMDs) we present results at electron energies below the knock-on threshold in the range between 20-80kV and understand the role of electronic excitations. We show that the formation of vacancies is possible at electron voltages nearly half of the knock-on threshold and quantify the damage [3,4]. Further, we analyse in-situ structural and chemical modifications of different freestanding transition metal phosphorus tri-chalcogenides (TMPTs). We predict the displacement thresholds, electronic properties, and the displacement crosssection of single vacancy S and P in all materials by ab-initio calculations and using these results, the observed structural changes are understood. As the TMPTs are often very oxygen-sensitive, they were prepared with the help of a newly-developed polymer-assisted sample preparation method [5]. We also present studies on the structure of two-dimensional polymer crystals and characterize on the molecular level the defect structure [6]. Furthermore, we present in-situ studies of a miniaturized electrochemical cell, where reversibly single-crystalline bilayer graphene is lithiated and delithiated in controlled manner using an electrochemical gate confined to a device protrusion [7]. On the more fundamental base we show that differentiating between the bond nature between two metal atoms is now possible [8].

References

[1] A. Hashemi et al. (2017). J. Phys. Chem. C 121, 27207
[2] M. Linck, et al. 117 (2016) 076101. [3] S. Kretschmer, T. Lehnert et al. Nano Lett. 20 (2020), 2865-2870
[4] T. Lehnert et al. ACS Appl. Nano Mater. 2 (2019) 3262-3270
[5] J. Köster et al. (2021). Nanotechnology 32, 075704
[6] H.Qi et al. (2020), Science Advances 6, eabb5976
[7] M. Kühne et al. (2018), Nature 564, 234
[8] K. Cao, (2020), Science Advances 6, eaay5849

PROBING STRUCTURAL DEFECTS IN BIFEO3 THIN FILMS AT ATOMIC RESOLUTION

Marta D. Rossell

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Multiferroic materials that exhibit simultaneous -and strongly coupled- magnetic and ferroelectric order above room temperature offer exciting potential for room-temperature device integration. In particular, magnetoelectric multiferroic films are ideal candidates for applications in next-generation memory devices, which utilize low consuming electric fields to control magnetic order. However, structural defects can dramatically change the way multiferroic materials behave. Crystal imperfections can, for example, induce local polarization reversal, alter the domain kinetics or even modify the phase transition temperatures. Thus, a better understanding of the structure and properties of structural defects is required to help drive multiferroic-based devices toward technological application. To this end, we use advanced analytical imaging methods based on (scanning) transmission electron microscopy (S/TEM) in combination with energy dispersive x-ray (EDX) spectroscopy and electron energy-loss spectroscopy (EELS).

In this talk, we will provide a review of zero-, one- and two-dimensional lattice defects typically found in one of the most widely studied multiferroic systems, BiFeO3 thin films. We will first show the formation of a dopant-controlled polar pattern in BiFeO3 leading to a spontaneous instauration of periodic polarization waves exhibiting giant polarization gradients as large as 70 μC cm−2 across 30 Å thick domains [1]. Further, the influence of edge misfit dislocations on the local electronic properties of BiFeO3 thin films will also be discussed. We will show that small amounts of Fe atoms are present at the BiFeO3 dislocations cores, which result in uncompensated Fe spins along the dislocations giving rise to a magnetic signal [2]. Lastly, we will demonstrate that charged domain walls comprise a core region where most of the screening charge is localized. In particular, an accumulation of oxygen vacancies occurs at tail-to-tail charged domain walls as the leading charge screening process and is responsible for their enhanced conductivity [3].

References

[1] M. Campanini et al. Nano Lett. 18, 717-724 (2018).
[2] P. Agrawal et al. Phys. Rev. Materials 3, 034410 (2019).
[3] M. Campanini et al. Nanoscale 12, 9186-9193 (2020).

QUANTITATIVE DIGITAL MICROSCOPY WITH DEEP LEARNING

Giovanni Volpe

Soft Matter Lab,Physics Department, Gothenburg University, 412 96 Gothenburg, Sweden

Video microscopy has a long history of providing insights and breakthroughs for a broad range of disciplines, from physics to biology. Image analysis to extract quantitative information from video microscopy data has traditionally relied on algorithmic approaches, which are often difficult to implement, time consuming, and computationally expensive. Recently, alternative data-driven approaches using deep learning have greatly improved quantitative digital microscopy, potentially offering automatized, accurate, and fast image analysis. However, the combination of deep learning and video microscopy remains underutilized primarily due to the steep learning curve involved in developing custom deep-learning solutions. To overcome this issue, we introduce a software, DeepTrack 2.0, to design, train and validate deep-learning solutions for digital microscopy. We use it to exemplify how deep learning can be employed for a broad range of applications, from particle localization, tracking and characterization to cell counting and classification. Thanks to its user-friendly graphical interface, DeepTrack 2.0 can be easily customized for user-specific applications, and, thanks to its open-source object-oriented programming, it can be easily expanded to add features and functionalities, potentially introducing deep-learning-enhanced video microscopy to a far wider audience.

ATOMIC FORCE MICROSCOPY AS A TOOL TO STUDY CELL MEMBRANE REMODELING PROCESSES

Lorena Redondo-Morata

INSERM U1019, Institut Pasteur de Lille - CMPI-CIIL, CNRS UMR 8204 Univ. Lille, Lille, France

Atomic Force Microscopy (AFM)-based studies constitute today a fairly established methodology to observe the structure of biomolecules and to measure their mechanical properties. However, biomolecules are dynamic in nature; hence, to understand how they work we need to increase the spatiotemporal resolution of conventional AFM. In the last decade, High-Speed AFM (HS-AFM) was developed [1] and successfully applied to several cellular machineries, either cytoplasmic or bound to membranes [2]. The molecular movies obtained by this method provide insights otherwise not accessible by other means to date.

Recently, we have succeeded to visualize by these means the molecular mechanism of Snf7 assembly formation. Snf7 is the major polymerization component of the Endosomal Sorting Complex Required for Transport-III (ESCRT-III). We observed the formation of spiraling filaments on negatively charged membranes and estimated that these filaments can store sufficient elastic energy to drive membrane deformation [3]. In our most recent work, we studied the molecular role of Vps4, an ATPase that it is known to drive the disassembly of persisting filaments of ESCRT-III [4]. Surprisingly, in the presence of a soluble Snf7 pool, ESCRT-III assemblies shrink under the action of Vps4, liberating free space in the membrane were new ESCRT-III assemblies are growing simultaneously. This results in a high exchange and lateral mobility of ESCRT-III assemblies on membranes. Dynamic exchange provides an explanation for how ESCRT-III filaments gradually adapt their shape during membrane constriction, which has broad implications in diverse cellular processes, differing in size, shape and duration –such as plasma membrane repair, cytokinesis or viral budding.

We are also interested in the dynamic nanomechanical changes of the lipid membrane in the conversion of sphingomyelin to ceramide, particularly the impact of chain length and unsaturation of sphingomyelin and ceramide in the overall membrane nanomechanical properties. Atomic Force Microscopy (AFM)-based Force Spectroscopy is an ideal technique to investigate the mechanical properties of lipid bilayers at the nanoscale, their elastic constants [5] but also their plastic deformation and rupture [6]. However, the viscoelastic parameters of lipid membranes have been less explored by these means. In this work, we systematically studied the enzymatic conversion of sphingomyelin-containing supported lipid bilayers to ceramide by adding sphingomyelinase in situ. The local production of ceramide induces, in turn, local changes in the membrane mechanics that depend on the chain length and degree of unsaturation of the original sphingomyelin (Figure 1). We assess here the elasticity directly from the AFM force-distance curves and discuss possible approaches to evaluate the viscoelasticity of lipid membranes [7], i.e. using fast mapping with bimodal AFM [9]. The different ceramide localization in the membrane and mechanical properties is relevant in several biological contexts as apoptosis or viral infection.

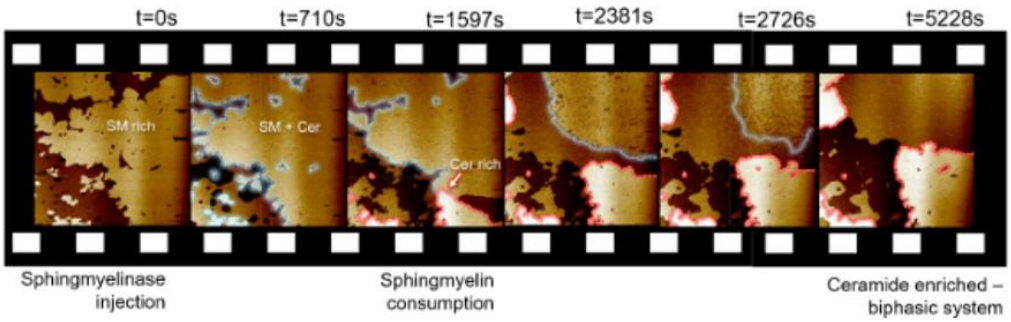

Figure 1. Fast nanomechanical mapping of a biphasic lipid membrane. After injection of sphingomyelinase to the solution, sphingomyelin-enriched domains evolve to ceramide-enriched domains, which impacts the lipid order, domain distribution and local mechanics.

References:

[1] Kodera, N.; Yamamoto, D.; Ishikawa, R.; Ando, T. Nature, 2010, 468:72-76.
[2] Casuso, I.; Khao, J.; Chami, M.; Paul-Gilloteaux, P.; Husain, M.; Duneau, J.-P.; Stahlberg, H.; Sturgis, J. N.; Scheuring, S. Nat. Nanotech., 2012, 7:525-529.
[3] Chiaruttini*, N.; Redondo-Morata*, L.; Colom, A.; Humbert, F.; Lenz, M.; Scheuring, S.; Roux, A. Cell, 2015, 163:866-879.
[4] Mierzwa*, B.E.; Chiaruttini*, N.; Redondo-Morata*, L.; Moser von Filseck, J.; König, J.: Larios, J.; Poser, I.; Müller-Reichert, T.; Scheuring, S.; Roux, A.; Gerlich, D.W. Nat. Cell Biol., 2017,19:787-798.
[5] Redondo-Morata, L.; Sanford, R. L.; Andersen, O.S.; Scheuring, S.; Biophys. J., 2016, 111, 363-372.
[6] Redondo-Morata, L.; Giannotti, M.I.; Sanz, F.; Langmuir, 2012, 28, 12851-12860.
[7] Al-Rekabi, Z. and Contera, S.; Proc. Natl. Ac. Sci. USA, 2018, 115, 2658-2663.
[8] Benaglia, S. Amo, C.A.; Garcia, R.; Nanoscale, 2019, 11, 15289-15297.

Advanced electron microscopy on novel tubular van der Waals Heterostructures

Belén Ballesteros[a]

[a]*Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC and BIST, Campus UAB, Bellaterra, 08193 Barcelona, Spain*

One dimensional van der Waals heterostructures are attracting a great interest for both fundamental research and advanced applications. [1] Theoretically any layered inorganic material could roll up into a cylinder, forming inorganic nanotubes that will combine the characteristics of both 2D and 1D materials.

Carbon nanotubes (CNTs) have been extensively used as platforms for the template assisted growth of nanomaterials, taking advantage either from their internal space or their outer surface. Here I will present our advances on the formation of novel high quality, single-crystalline single-layered inorganic nanotubes using carbon nanotubes as templates [2-4]. The produced tubular van der Waals heterostructures combine two different tubular materials: single-layered halide nanotubes and CNTs. The configuration of such structures can be tailored by controlling different synthetic parameters in the melt filling procedure, such as growth temperature, morphology of CNT templates or the metal halide composition. Moreover, high selectivity has been achieved by using a laser-assisted methodology. Aberration corrected electron microscopy characterization of these heterostructures allows us to unequivocally prove the formation of the tubular structure, get insights on the composition of the tubes and to study the dynamics under the electron beam radiation.

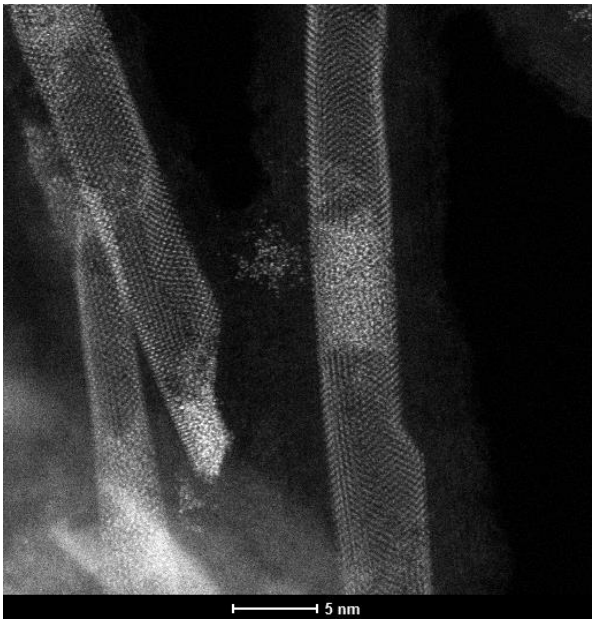

FIGURE 1. Aberration-corrected HAADF-STEM image showing a single-layered PbI_2 nanotube encapsulated within a multiwalled carbon nanotube

References

[1] Science 367(6477), 537 (2020)
[2] Adv. Mater. 26, 2016 (2014)
[3] Carbon 123, 129 (2017)
[4] ACS Nano 12(7), 6648 (2018)

Direct and converse flexoelectricity: the effect of strain and electric field gradients on nanoscale electromechanical responses.

Neus Domingo[a]

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Surface electromechanics at the nanoscale are typically studied by Piezoresponse Force Microscopy (PFM), based on the inverse piezoelectric effect. As a first approach, generally only homogeneous responses are taken into account, but it has been realized that the effect of gradients in electro-mechanical phenomena at the nanoscale can become dominating: the generation of electrical signals after the application of mechanical strain gradients with an AFM tip has been proved, and it has been shown that it is possible to write ferroelectric domains [1] or to move oxygen vacancies and charges.

In this talk, I will review how gradient-based electro-mechanical effects couples and affects the quantification of PFM measurements. I will start by demonstrating the asymmetry in mechanical properties induced by the coupling of flexoelectricity to ferroelectricity leading to ferroelectrics as smart mechanical materials [2], and opening new opportunities to mechanically read ferroelectric polarization states [3] in both, thin films and single crystals, on the base of Contact Resonance Frequency AFM mode. Then, I will put the light in another new aspect: I will demonstrate how converse flexoelectric effect [4] due to the presence of strong local electric field gradients at the tip end can induce a mechanical strain of the sample in dielectric centrosymmetric materials with magnitudes comparable to piezoelectric d33 coefficient.

References

[1] H. Lu, C.-W. Bark, D. Esque de los Ojos, J. Alcala, C. B. Eom, G. Catalan, A. Gruverman, Mechanical Writing of Ferroelectric polarization, Science 336 (2012) 59.

[2] K. Cordero-Edwards, N. Domingo, A. Abdollahi, J. Sort, G. Catalan, Ferroelectrics as Smart Mechanical Materials, Advanced Materials,29 (2017) 1702210.

[3] Stefani C, Langenberg E, Cordero-Edwards K, Schlom DG, Catalan G, Domingo N. Mechanical reading of ferroelectric polarization. Journal of Applied Physics. 130 (2021) 074103.

[4] Abdollahi, A.; Domingo, N.; Arias, I.; Catalan, G., Converse flexoelectricity yields large piezoresponse force microscopy signals in non-piezoelectric materials. Nature Communications 10 (2019) 1266

Determining the 3D morphology of beam sensitive MOF Nanoparticle Composites using Electron Tomography

Timothy M. Craig[a] and Sara Bals[a]

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Traditional electron microscopy techniques offer valuable insight into nanomaterial morphology. However, these techniques only provide 2D projections which can be misleading. Electron tomography allows the reconstruction of 3D structures from an acquired series of 2D projections. Unfortunately, materials such as metal nanoparticle (NP)/metal-organic framework (MOF) composites remain challenging to characterize. This is due to high contrast between the two materials and sensitivity to structural damage during imaging which causes a loss of detail. Herein, tomographic characterization of NP@MOF samples is explored using multi-detector STEM and real-time optimization of collection parameters.

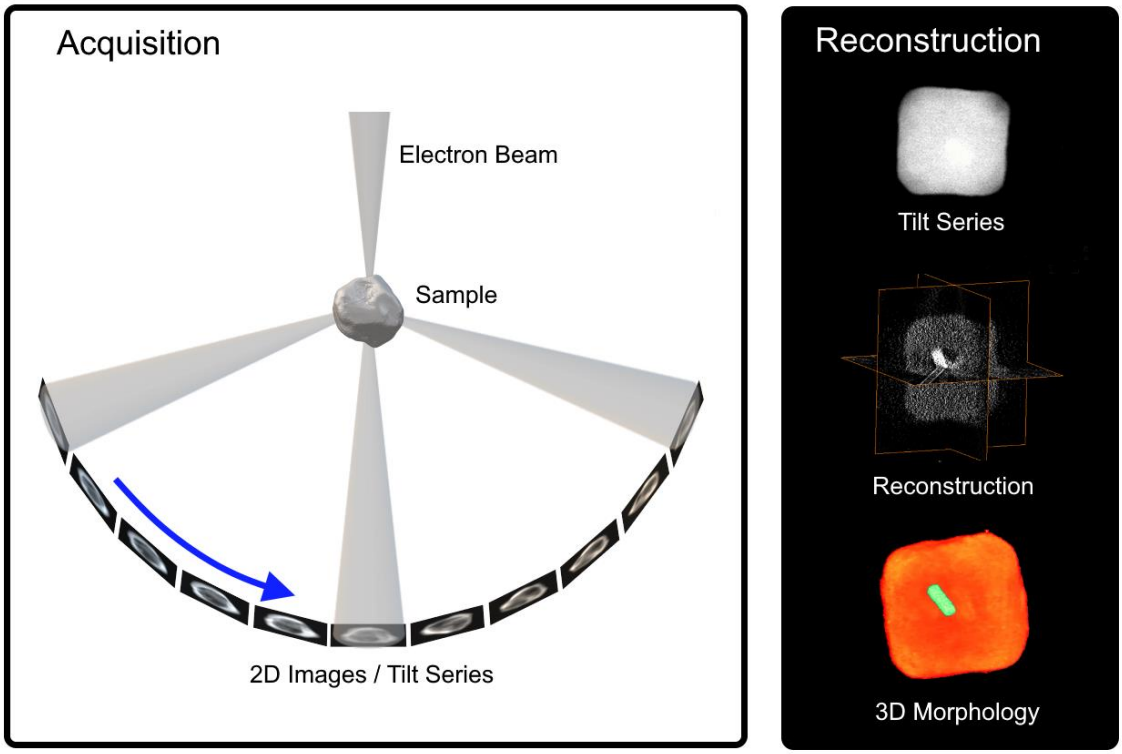

FIGURE 1. Electron tomographic acquisition and reconstruction of NP@MOF composite.

Pioneering studies on nanostructured porosity-controlled coatings through scanning-transmission electron microscopy methods

Antonio J. Santos[a,b], Bertrand Lacroix[a,b], Florian Maudet[c], Simon Hurand[c], Cyril Dupeyrat[d], Víctor J. Gómez[e], Diana L. Huffaker[e], Fabien Paumier[c], Thierry Girardeau[c], Rafael García[a,b] and Francisco M. Morales[a,b]

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Nanostructured films offer the ability of modifying surface properties, even more, when they can generate layers with controlled porosity. The lower implicit integrity of these (multi)layers when compared to their compact counterparts, hinders the attainment of electron-transparent sections of submicron thicknesses (lamellae), which becomes one of the main reason for the scarcity of studies thorough (scanning-)transmission electron microscopy ((S)TEM). Aware of this opportunity, this work provides an overview of the possibilities offered by the application of a variety of (S)TEM techniques for the study of nanostructured and porous photonic surfaces. A few working examples are presented to illustrate the type of information that can be obtained in the case of mesoporous films prepared either by at oblique angles physical processes [1-5] as well as nitride nanowire arrays prepared by epitaxy methods [6,7]. It will be demonstrated that this approach enables the realization of several pioneering works, which are essential to complete the characterization of such porosity-controlled coatings. Topics as diverse as the preparation of electron-transparent specimens and the advanced characterization of their structures, morphologies, interfaces and compositions are addressed thanks to the implementation of new breakthroughs in (S)TEM, which allow to obtain high-resolution imaging, spectroscopies, or tomography, at both microscopic and nanoscopic levels. Finally, establishing (S)TEM as a reference tool for the advanced structural, chemical and morphological characterization of porous nanostructured skins, will open new horizons, providing better and new insights and thus allowing the optimization of the fabrication and design of such architectures.

References

[1] A. J. Santos *et al*., Appl. Surf. Sci. 493, 807-817 (2019)
[2] F. Maudet *et al*., Appl. Surf. Sci. 470, 943-950 (2019)
[3] F. Maudet *et al*., Acta Mater. 188, 386–393(2020)
[4] F. Maudet *et al*., Appl. Surf. Sci. 520, 146312(2020)
[5] B. Lacroix *et al*., J. Phys. Chem. C. 123, 22, 14036-14046 (2019)
[6] V.J. Gómez *et al*. Cryst. Growth Des. 19, 2461-2469 (2019)
[7] A.J. Santos *et al*. J. Phys. Chem. C. 124, 2, 1535–1543 (2020)

Current capabilities and future plans in bioimaging at the ALBA Synchrotron

Judith Juanhuix, Tanja Dučic, Barbara L Machado-Calisto, Alberto Mittone, Eva Pereiro, Ana J Pérez-Berná, Nicolas Soler, Andrea Sorrentino, Núria Valls, Ibraheem Yousef and Klaus Attenkofer

ALBA Synchrotron, carrer de la Llum 2-26, 08290 Cerdanyola, Catalonia, Spain

The ALBA synchrotron came into operation in 2012 to provide a readily accessible X-ray photon source to the Catalan and Spanish scientific communities, while being fully open to the worldwide community and to industry. Since then the number of beamlines has increased steadily and currently nine beamlines are in user operation and three more will follow in the near future.

Bioimaging techniques have been a main focus of the research activities at ALBA. Two bioimaging beamlines, MIRAS and MISTRAL, are providing routine service to external research groups. MIRAS is devoted to Fourier transform infrared (FTIR) spectroscopy and microscopy to identify the vibrational signatures and therefore map the chemical composition of the sample with a few-microns resolution. The full-field transmission X-ray microscopy beamline MISTRAL can provide the 3D structure of whole cells in cryo-preserved condition at a resolution of 40nm. One more beamline dedicated to micro-tomography in the hard X-ray range, FAXTOR, will enter in operation in 2024.

Since December 2020, ALBA synchrotron is preparing for a major upgrade which will extend the services portfolio with new instruments and capabilities beyond X rays, particularly in bioimaging. The Life Sciences section is developing a strategic plan to provide holistic solutions for life sciences research. Several strategies are followed: specializing and optimizing existing instruments, adding new beamlines, combining these instruments with optical- and electron-based tools in a multi-modal approach, providing new sample preparation infrastructure and developing the necessary computing services. A key to this ambitious project is the development of strategic partnerships which guarantee not only the necessary know-how but also integrate ALBA's services into the surrounding research ecosystem.

The upgrade of ALBA is now in the design phase, and it is fully open to the feedback from the scientific community. In this talk we will review the existing instruments currently in operation and will give an overview of the current plans with the aim to receive the input of the Life Sciences community, and in particular bioimaging, to better adapt the ALBA Strategic Plan for the upgrade to the community needs.

Visualize and quantify concentrations in frozen hydrated biological cells using synchrotron- based cryo Soft X-ray Transmission Microscopy

A. Sorrentino[a], Francesca Rossi[b], Giovanna Picone[b], K. Kahil[c], E. Malucelli[b], A.J. Perez-Berna[a], J.J. Conesa[a], A. Gal[d] A. Scheffel[e] S. Weiner[c], L. Addadi[c], S. Iotti[b] and E. Pereiro[a]

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Full field transmission cryo soft X-ray tomography (cryoSXT) allows the 3D morphological characterization of whole cells in their native state with a spatial resolution of few tens of nm [1]. Using synchrotron radiation, cryo soft X-ray spectromicroscopy (cryoSXS), i.e. energy resolved microscopy, can be also performed. It allows, if concentrations or volumes are big enough, the chemical characterization of objects in the field of view, providing pixel-by-pixel X-rays absorption spectrum [2]. In this work we will describe how we can estimate elemental concentrations combining cryoSXT and cryoXSM on the same cell. Recent results about the quantitative characterization of Ca – rich organelles in different biological cells will be presented as an example of application [3-4].

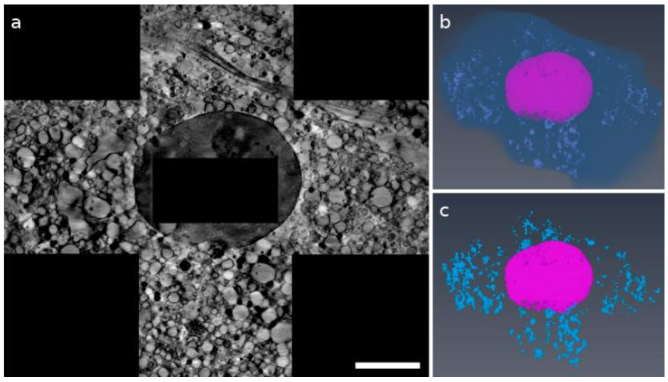

FIGURE: 1a) Central slice volume of a bone mesenchemial stem cell 4 days after osteoblastic induction obtained by stiching togheter 4 tomographic reconstruction collected at 520 eV. Scale bar is 6.9 µm. (b,c) Corresponding color-coded 3D rendering (with the nucleus in pink and the dense objects inside the cell in light blue). In (b), the cellular membrane is also showed. Ca-rich bodies can be distinguished from carbon dense structures and chemically charchterized varyng the energy of the incident photons across the Ca L edge (≈ 350 eV).

References

[1] Pereiro E.; et. al. . J Synchrotron Radiat. 2009, 16:505–512.

[2] Sviben, S.; et. al. Nat. Commun. 2016, 7.

[3] Kahil, K.; et. al. Proc. Natl. Acad. Sci. USA 2020, 117, 30957–30965.

[4] Sorrentino, A.; Malucelli, E. et.al. Int. J. Mol.Sci. 2021, 22, 4939.

Direct X-ray detection of the spin Hall effect in CuBi

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The spin Hall effect (SHE), and its inverse, are important spin-charge conversion mechanisms widely investigated due to their fundamental importance in the development of spintronics devices. Its measurement has been mostly related to electrical detection schemes involving an interface with another magnetic material and thus, a combination of the properties of both materials as well as the interface are measured. Only recently, optical measurements for Pt and W have been reported[1].

We propose the use of Photoemission Electron microscopy with X-ray magnetic circular dichroism (XMCD-PEEM) for direct, interface-free determination of the SHE in metals. In particular, we report the observation of spin separation due to SHE in a single layer of Bi-doped Cu ($Cu_{95}Bi_5$), a material in which giant SHE has been already reported [2,3]. We have performed x-ray spectroscopy measurements at the Cu $L_{3,2}$ absorption edges while applying electrical current to the sample. The sign of spin accumulation depends on the direction of the current (Figure 1.a) and the amplitude of the XMCD signal scales with the density current (Figure 1.b). The induced magnetic moment is (2.7 ± 0.5) x $10^{-12}\mu_B$ A^{-1} cm_2 per Cu atom averaged over the probing depth.

Our results constitute the proof of concept for the direct, interface free and elementselective measurement of the SHE in a single material by means of X-ray spectromicroscopy and highlight the potential of CuBi for spin-charge conversion applications [4].

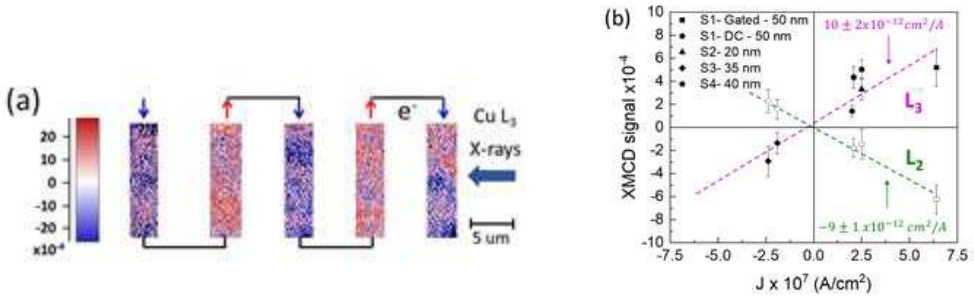

FIGURE 1. (a) Visualization of the spin accumulation in a $Cu_{95}Bi_5$ electrode. The graph shows the pixelwise up-down asymmetry of an XMCD image taken at the Cu L_3 edge. (b) XMCD signal as function of current density for measurements at the Cu L_3 and L_2 absorption peak energies

[1] C. Stamm et al. Phys. Rev. Lett. 119, 087203 (2017)
[2] Y. Niimi et al. Phys. Rev. Lett. 109, 156602 (2012)
[3] S. Ruiz-Gómez et al. APL Materials 6, 101107 (2018)
[4] S. Ruiz Gómez et al. arXiv:2107.02620 (2021)

Reliable 3D Atomic-Scale Reports of Free- or Amorphous-Standing Nano-Objects: A Cooperation Between IMEYMAT and IITM Institutes

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This work summarizes the results of recent colaborations between the Indian IITM and the Spanish IMEYMAT Institutes on transmission electron microscopy reseach of InN quantum dots, Ag and TiO_2 nanoparticles. The special capabilities of the aberrations-corrected FEI Titan^3 Themis at the University of Cádiz were required to carry out high resolution focal series images of nanostructures. Atomic-scale 3D reconstructions using STEM based tomographic methods have proved to face hurdles due to high electron irradiation damage and "missing-wedge". Instead, inline 3D holography based tomographic reconstructions from single projection TEM images registered at low electron doses proved to be the more suitable technique for defining atomic positions of these nano-objects. In addition, in cross-section preparations of QDs, or in lacey grids hold particles, glue or carbon films, add overlapping amorphous contributions that lead to ambiguity to the reconstructions. To neglect this issue, the effect of amorphous portions was quantitatively studied using simulations and experiments. It was revealed that increasing their thickness and/or density enhances distortions in the exit surface geometry of tomograms, so an error correction method was proposed and applied. As an output, reliable morphological analyses of 3D shape and dimensions for materials agregations below 20 nm were possible for the first time.

References

[1] Banerjee, P.; Roy, C.; Santos, A.J.; De, S.K.; Morales, F.M.; Bhattacharyya, S.; Unrevealing the atomically resolved nanocuboid structure of high energy {111} faceted anatase TiO2 sized below 20 nm. Materials Today Nano (In press).
[2] Banerjee, P.; Roy, C.; De, S.K.; Santos, A.J.; Morales, F.M.; Bhattacharyya, S.; Atomically resolved tomographic reconstruction of nanoparticles from single projection: Influence of amorphous carbon support. Ultramicroscopy 221, 113177 (2021).
[3] Banerjee, P.; Roy, C.; Jiménez, J.J.; Morales, F.M.; Bhattacharyya, S.; Atomically resolved 3D structural reconstruction of small quantum dots. Nanoscale 13, 7550 (2021). Articled featured in the Inside Front Cover- Nanoscale, 13, 7416 (2021).

New insights on focal adhesion complexes by super resolution microscopy

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Focal Adhesions (FA) are mechanosensitive complexes that connect the extracellular matrix (ECM) with the actin cytoskeleton. This is achieved through clustered integrins, their ligands in the ECM, and an internal dynamic protein complex linking the cytosolic domain of integrins with the actin cytoskeleton. In contrast to the established view that FAs are homogenous micron-scale protein assemblies, recent super-resolution imaging and single molecule dynamic approaches are challenging this view. These studies suggest that FA molecular components are highly organised in the axial direction establishing segregated layers of functional activity. Recent data also indicates that similar type of nanoscale modularity might exist in the horizontal plane of FAs. Here, we present a set of experiments aimed at dissecting the lateral nanoscale organisation of different proteins as a function of FA maturation.
By combining quantitative multicolour super-resolution approaches, such as STED and STORM nanoscopy we demonstrate that a subset of adhesion proteins (the integrins α5β1 and αvβ3, and the adaptor proteins paxillin, talin, and vinculin) form spatially segregated nanoclusters at the cell membrane. Moreover, the characteristics of these nanoclusters remain unchanged as a function of the cell spreading time and are not influenced by the region of the basal membrane they are populating, FAs, fibrillar adhesions (fAs) or the membrane regions outside adhesions. These data indicate a highly complex spatiotemporal organisation within FAs with different proteins forming nano-hubs of activity. The duration and strength of the protein interactions inside these hubs are highly regulated not only in the axial direction but, importantly, also in the horizontal plane of FAs. Remarkably, we find that α5β1 integrin nanoclusters and main adaptor proteins have an inherent nanoscale distribution that keeps them organised within a lateral spacing of 50-60 nm, for different spreading times investigated. Such a lateral nanoscale spacing is maintained in both, focal and fibrillar adhesions. Interestingly, αvβ3 integrins develop similar organisation at later spreading times, correlating this defined distribution with their increased expression and focal adhesion stabilisation in time. Our results are fully consistent with earlier observations suggesting the existence of an integrinligand spacing threshold below 70 nm that regulates the dynamics of cell spreading, adhesion and migration. Based on our results we postulate that this spatial sensing of integrin ligands is, in fact, dictated by the inherent nanoscale spacing of integrins nanoclusters inside adhesion complexes. The nanoscale clustering and lateral spacing of integrins thus play an essential role in controlling the dynamics and fate of the adhesive response.

Imaging protein conformational space in liquid water

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Recent developments in electron-transparent materials have paved the way for liquid-phase electron microscopy (LPEM) leading to an unprecedented understanding of the structure and dynamics of specimens in their liquid environment. Image reconstruction in liquid-state poses several challenges, and most importantly, it undermines the single-particle analysis assumption that the three-dimensional objects captured on the image sensor are identical. We propose the combination of all-atom simulations with LPEM to complement structural studies with dynamic investigations. In this work, we exploited LPEM to image the dynamics of particles undergoing Brownian motion, using their natural rotation to access the particle structural landscape for reconstructing its architecture in 3D using tomographic techniques. We have selected two test cases for our approach according to prior data accessibility and physiological environment factors: apoferritin and archaeal RNA polymerase. We show that the adopted approach allows to achieve sub-nanometer spatial resolutions of protein structures, either imaging proteins one by one and assessing different conformational states or combining several proteins into one statistical conformational ensemble.

Mapping the dielectric properties of cells by Scanning Dielectric Microscopy enhanced by Machine Learning.

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The nanoscale dielectric properties of cells play an important role in different biological phenomena such as the response of cells to external electromagnetic fields, the propagation of action potentials along axons, the transport of ions across the cell membrane or the electroporation properties of cells. In addition, these properties can be used to obtain nanoscale composition maps of the cells without the use of exogenous labels. Here, we present a method based on Scanning Dielectric Microscopy in force detection mode to map the nanoscale dielectric properties of cells. The method is based in the use of the force volume acquisition mode coupled to finite element numerical simulations incorporating the actual measured cell topography [1]. In addition, we developed a machine learning algortithm to overcome the long computational times involved in the finite element numerical calculations, reducing them from weeks or months to just a few seconds [2]. Examples of application to bacterial cells and eukariotic cells will be presented [1]-[3].

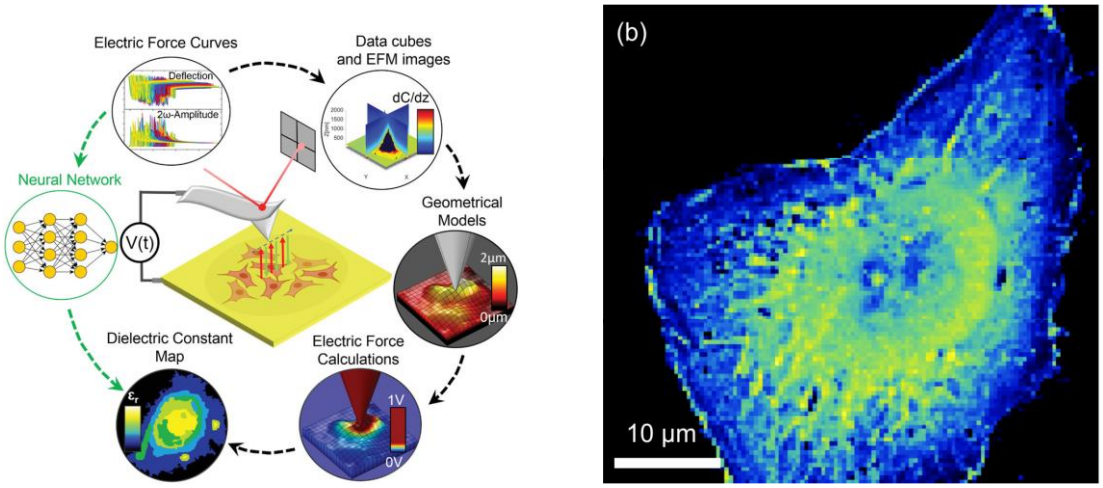

FIGURE 1. (a) Schematic representation of the Scanning Dielectric Microscopy method developed to map the nanoscale dielectric properties of cells, including both the use of finite element numerical calculations and of machine learning algorithms. (b) Example of a nanoscale dielectric constant map obtained on a fixed HeLa cell in dry conditions.

References

[1] M. Checa, et al. Mapping the dielectric constant of a single bacterial cell at the nanoscale with scanning dielectric force volume microscopy. Nanoscale 11, 20809 (2019).
[2] M. Checa et al. Fast label-free nanoscale composition mapping of eukaryotic cells via scanning dielectric force volume microscopy and machine learning. Small Methods 2100279 (2021).
[3] M. Checa et al. Dielectric Imaging of Fixed HeLa Cells by In-Liquid Scanning Dielectric Force Volume Microscopy. Nanomaterials 11, 1402 (2021).

Atom- and site- selective spin canting in Co-ferrite nanoparticles with tunable structural disorder

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Cobalt ferrite nanoparticles (NP) are attractive in a number of applications due to a suitable combination of high chemical stability, surface active sites, and ease of synthesis and functionalization, together with a high anisotropy constant, a high coercivity, and a moderate saturation magnetization. Yet, to control the functional response of Co-ferrite NP asks for unravelling the dependence of the overall magnetic response on the composition, structure, or surface chemistry.

Here, we address the key role of the structural defects on the magnetic properties of Co-ferrite NP investigated by X-ray magnetic circular dichroism (XMCD) combined with high-resolution transmission electron microscopy (HRTEM) of individual NP [1]. We studied a series of samples of monodisperse 8 nm NP, prepared by chemical routes [2,3], with similar stoichiometry but with a tunable number of defects. XAS and XMCD spectra and element-specific hysteresis loops reveal that the collinear alignment of Co^{2+} (O_h) cations is much more affected by the structural disorder than that of the Fe^{3+} cations. This is due to the effective local anisotropy axes caused by the structural defects, giving rise to prevalent Co^{2+} spin canting through the spin–orbit coupling due to the relatively large value of the partially unquenched moment of these cations. The Fe^{3+}(Td) cations are the least sensitive to defects due to the smaller number of next-nearest neighbors in the T_d-sublattice. Our work highlights the importance of combining advanced synthesis with the use of complementary local probes with element, valence, site, and structural sensitivity to enhance the performance of nanomagnets.

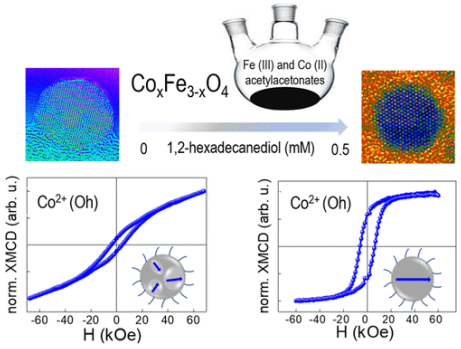

FIGURE. 1. HRTEM images for Co-ferrite nanoparticles with increasing crystalline quality. Bottom panel shows XMCD hysteresis loops measured at 2 K for Co^{2+} cations in Oh sites for highly-defective (left) and highly-crystalline (right) nanoparticles.

References

[1] C. Moya, A. Fraile Rodríguez, et al., J. Phys. Chem. C, 125, 691 (2021).

[2] C. Moya et al., M.D.P. Morales, et al. Phys. Chem. Chem. Phys. 17, 13143 (2015).

[3] C. Moya, G. Salas, M.D.P. Morales et al., J. Mater. Chem. C 3, 4522 (2015).

Nanostructural Arrangements and Surface Morphology on Ureasil-Polyether Films Loaded with Dexamethasone Acetate

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Organic-inorganic ureasil-polyether hybrid matrices for drug delivery prepared by sol-gel are formed by highly correlated siloxane nodes, separated ~2nm, linked by polyether chains [1]. Ultrasonic Force Microscopy (UFM) has revealed a new nanoscale structure in ureasil-poly(propylene oxide)400 films: clusters of correlated siloxane nodes form beads, which align into strands, imaged by Atomic Force Microscopy (AFM) on the film surface gathered into hybrid polymer ropes. This structure impacts the behavior of the film matrix as host (see Fig. 1). When incorporating dexamethasone acetate, the drug molecules form aggregates in locations depleted from ureasil nodes, aligned along the direction defined by the polymer ropes in the unloaded matrix [2].

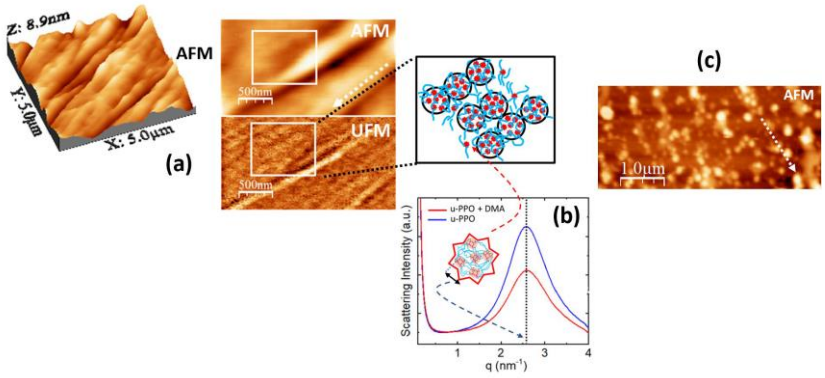

FIGURE 1. (a) AFM and UFM on ureasil-Polyethyelene Oxide (u-PPO400). (b) SAXS on AFM on u-PPO400, unloaded and loaded with Dexamethasone Acetate (DMA). (c) AFM on DMA-loaded u-PPO400

References

[1] C. V. Santilli, L. A. Chiavacci, L. Lopes, S. H. Pulcinelli, and A. G. Oliveira, "Controlled Drug Release from Ureasil–Polyether Hybrid Materials," *Chemistry of Materials,* vol. 21, no. 3, pp. 463-467, 2009, doi: 10.1021/cm801899u.

[2] J. A. Oshiro, A. Lusuardi, E. M. Beamud, L. A. Chiavacci, and M. T. Cuberes, "Nanostructural Arrangements and Surface Morphology on Ureasil-Polyether Films Loaded with Dexamethasone Acetate," *Nanomaterials,* vol. 11, no. 6, 2021, doi: 10.3390/nano11061362.

Engineering FeN_4 Sites in Fe-N-C Catalysts via Bonded Oxygen-Containing Groups for High-Efficient Electroreduction of Carbon Dioxide

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Regulating the local environment of active sites via neighboring subgroups can effectively enhance the catalytic performance of catalysts. Here, we report a facile route to in-situ introduce bonded oxygen-containing subgroups on FeN_4 sites through simple pyrolysis of Fe-doped Zn-based MOFs. Due to the different Z contrast among Fe, N, O and C elements, the obtained Fe single atom catalyst has been directly characterized by AC-HAADF STEM, showing the isolated starry spots densely planted in the oxygen/nitrogen-doped carbon matrix, which confirms that Fe has been successfully introduced in the D-Fe-N-C sample as an atomic dispersion. In addition, multiple areas of the D-Fe-N-C sample are examined by HAADF STEM, revealing a few Fe nanoparticles could be observed, which is accordance with the XAS results. Therefore, in order to further reveal that the excellent CO_2 RR performance of the D-Fe-N-C catalyst is attributed to the highly dispersed Fe single active sites rather than Fe nanoparticles, EELS mapping and HRTEM characterizations are further utilized to corroborate that the Fe clusters are rigorously encapsulated by a few layers of carbon, which would encumber the interaction between the Fe nanoparticles and the electrolyte, resulting in an inactive performance of these Fe nanoparticles. This result is consistent for the electrochemical results, suggesting that in fact the catalytically active sites are due to the presence of single Fe atoms. Benefiting from these advantages, this highly dispersed D-Fe-N-C catalyst exhibits a high CO Faradaic efficiency (95 %) at −0.50 V vs. RHE.

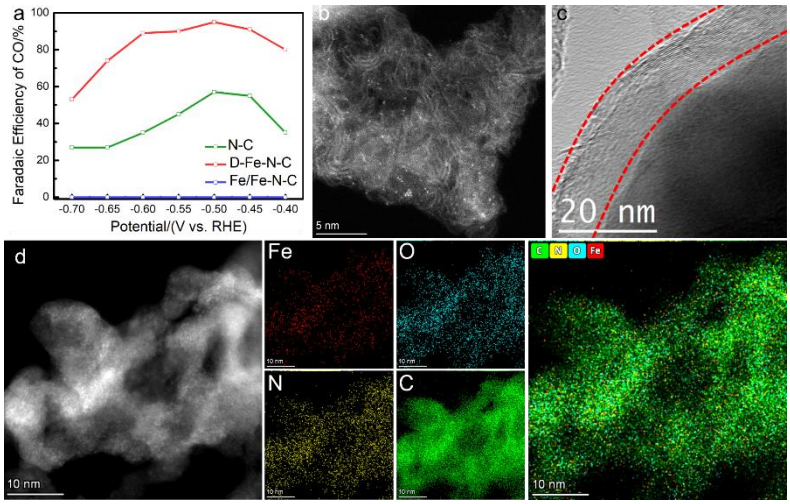

FIGURE 1. (a) FE of CO at various potentials on different samples. (b) High magnification aberration-corrected HAADF STEM image, (c) HRTEM image, (c) HAADF STEM image and representative EDS chemical compositions of D-Fe-N-C sample.

Quasi-Double-Star Nickel and Iron Active Sites for High-Efficient Carbon Dioxide Electroreduction

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Although the Faradaic efficiencies (FEs) obtained on most of the Ni based single-atom catalysts (Ni-N-C) are satisfactory (generally > 90 %) for electrochemical transfer CO_2 to CO, the practical application is still limited by their high overpotentials (> 600 mV vs. RHE), which implies a higher consumption of energy to drive the CO_2 RR.[1] In this work, we have prepared a quasi-double star catalyst composed of nearby Ni and Fe active sites through a simple pyrolysis of Ni and Fe co-doped Zn-based MOFs in order to achieve a high selectivity at a low overpotential during CO_2 RR. Due to the different Z contrast among Ni, Fe, N, O and C elements, the obtained Ni/Fe-N-C catalyst has been directly characterized by AC-HAADF STEM, showing the homogenously dispersed spots in the substrate, which confirms that Ni and Fe are atomically dispersed in the Ni/Fe-N-C sample, which is accordance with the XAS results. Benefiting from the nearby Ni and Fe active sites, the optimized Ni/Fe-N-C catalyst shows an exclusive selectivity (a maximum FE (CO) of 98 %) at a low overpotential of 390 mV vs. RHE, which is superior to both single metal counterparts (Ni-N-C and Fe-N-C catalysts) and other state-of-the-art M-N-C catalysts, which is further supported by DFT results.

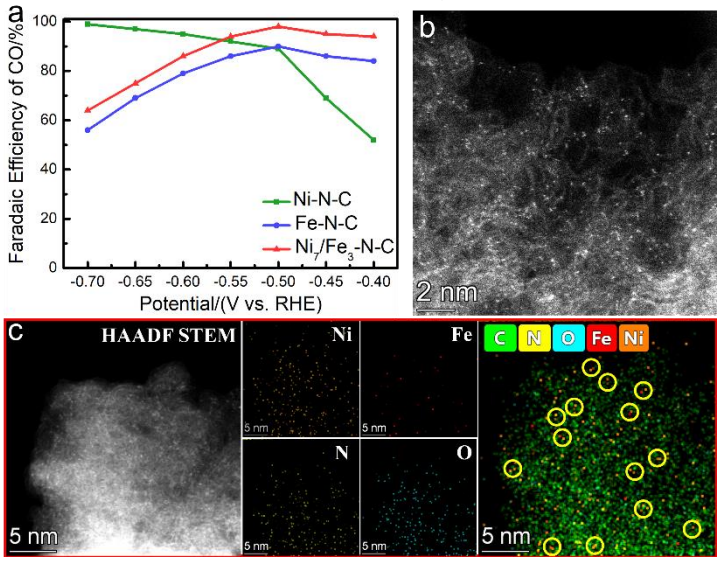

FIGURE 1. (a) FE of CO at various potentials on different samples. (b) High magnification aberration-corrected HAADF STEM image, (c) HAADF STEM image and representative EDS chemical compositions of Ni_7/Fe_3-N-C sample.

References

[1] T. Zhang, X. Han, H. Liu, M. Biset-Peiró, X. Zhang, P. Tan, P. Tang, B. Yang, L. Zheng, J. R. Morante, J. Arbiol, *Energy Environ. Sci.* 2021, *14*, 4847-4857

Degradation of Polymer-based Materials for Stereolithography by Electron Beam Damage.

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Nowadays, Additive Manufacturing (AM) technologies, such as Stereolithography (SLA), find applications in countless fields. The continuous growth of these technologies promotes the development of new materials meeting the requirements of the fabrication methods while providing enhanced properties to the polymer matrix. Among these materials, it is worth highlighting the polymeric nanocomposites in which nanoadditives are added to the matrix [1]. The incorporation of metallic nanoparticles within photocurable acrylic resins is a widely employed strategy to get SLA nanocomposites [2]. However, analyzing polymer-based materials by TEM techniques is challenging due to electron beam damage which may induce chemical and structural changes in the specimen [3]. Consequently, the resolution limit achievable depends, among other parameters, on the total electron dose to which they can be exposed before the damage [4]. It is well-known that the chemical changes on a specimen during TEM analyses can be monitored by using Electron Energy Loss Spectroscopy (EELS), where it is possible to observe thickness variations of the specimen due to degradation or contamination during the measurements, changes at the characteristic peaks of constituents due to alterations of the chemical structure, etc [5].

In this work, we examine the effect of electron beam damage in acrylic resins by studying the variations on the core-loss EELS signals when increasing the exposure time and, consequently, the accumulated dose. In particular, the material of interest consists of a composite formed by an acrylic resin working as matrix and inorganic nanoparticles, such as WS2, as additive, to be used in SLA. Preliminary studies show variations on the σ-π transitions observable on the fine structure at the carbon K-edge of core-loss signal.

References

[1] A. P. Kumar, D. Depan, N. Singh Tomer, and R. P. Singh, “Nanoscale particles for polymer degradation and stabilization-Trends and future perspectives,” *Prog. Polym. Sci.*, vol. 34, no. 6, pp. 479–515, 2009, doi: 10.1016/j.progpolymsci.2009.01.002.

[2] S. J. Leigh, C. P. Purssell, J. Bowen, D. A. Hutchins, J. A. Covington, and D. R. Billson, “A miniature flow sensor fabricated by micro-stereolithography employing a magnetite/acrylic nanocomposite resin,” *Sensors Actuators, A Phys.*, vol. 168, no. 1, pp. 66–71, 2011, doi: 10.1016/j.sna.2011.03.058.

[3] R. F. Egerton, “Radiation damage to organic and inorganic specimens in the TEM,” *Micron*, vol. 119, no. January, pp. 72–87, 2019, doi: 10.1016/j.micron.2019.01.005.

[4] N. Jiang and J. C. H. Spence, “On the dose-rate threshold of beam damage in TEM,” *Ultramicroscopy*, vol. 113, pp. 77–82, 2012, doi: 10.1016/j.ultramic.2011.11.016.

[5] P. K. Singh, B. R. Venugopal, and D. R. Nandini, “Effect of electron beam irradiation on polymers,” *J. Mod. Mater.*, vol. 5, no. 1, pp. 24–33, 2018, doi: 10.1063/1.4710140.

ContactJ: Analysis Method to Identify Lipid Droplets-Mitochondria Contacts by Fluorescence Microscopy images

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Lipid droplets (LDs) are the major lipid storage organelles of eukaryotic cells and together with mitochondria key regulators of cell's bioenergetics. In order to achieve their functions, LDs communicate with mitochondria and other organelles forming membrane contact sites1, "metabolic synapses", to ensure that lipid provision occurs where and when necessary [1]. Whereas Electron Microscopy allows accurate and precise characterization of contacts, their analysis on a large number of cells and conditions can become a long-term process. On the other hand, confocal fluorescence microscopy combined with advanced image analysis methods enable to extend contact analysis to hundreds of cells and multiple conditions.

In the present work, we describe a novel and straight image analysis method to identify and quantify contact regions between LD and mitochondria in fluorescence microscopy images allowing the automatic analysis of hundreds of cells and multiple conditions. We have developed ContactJ, a macro script for the open-source image analysis software ImageJ. This image analysis workflow combines colocalization7 and skeletonization methods, enabling the detection of LD-Mitochondria contacts together with a complete characterization of organelles and cellular parameters (morphometry and distribution).The correlation and normalization of these parameters contribute to the complex description of cells response under different experimental conditions such as metabolic or pathogenic states. The macro automatically detects and measures LD-mitochondria linear contacts by combining standard and machine learning8 segmentation processes and the novel use of colocalization together with skeletonization methods from a large number of fluorescence images. Finally, along the execution of the macro all the data is stored in arrays (cell, LD and mitochondria areas and perimeters, contact perimeter, number of contacts, etc). Moreover, this data is stored in a .txt database file allowing the traceability of the results for each cell and each image.

The described image analysis workflow unveils a wide range of possibilities in the automatic quantification of LD and mitochondria contacts. Obtaining contact regions together with multiple cell and organelles parameters allow building descriptive statistics of the cells response. Moreover, its application in a large number of images enables the use of High Content Screening and Analysis, highly increasing the quality and statistical confidence of the results.

References

[1]Bosch, M.; Parton, R. G.; Pol, A. Lipid Droplets, Bioenergetic Fluxes, and Metabolic Flexibility. Seminars in Cell and Developmental Biology. Elsevier Ltd December 1, 2020, pp 33–46. https://doi.org/10.1016/j.semcdb.2020.02.010.

WhatEELS. A complete software solution for ELNES analysis that combines clustering and NLLS.

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The analysis of energy loss near edge structures (ELNES) in electron energy loss spectroscopy (EELS) is a powerful approach for a precise characterization of elemental oxidation states at the nanoscale. Non-linear least squares fitting (NLLS) is a compelling technique for ELNES analysis due to the large amount of information encoded in each of the individual curves included in the fitted model. However, as a result of its inherently large convergence times it is oftentimes dismissed in favour of other analysis techniques. To tackle the shortcomings of NLLS and still access its superior capabilities, we propose the inclusion of an unsupervised segmentation step via centroid-based clustering analysis, that would divide the EELS dataset by its spectral characteristics[1]. As a direct result, the control over the model parameters for each of the separated regions is increased in the posterior NLLS analysis. Also, a dramatic reduction in convergence times can be achieved in cases where multiple elements contribute to the region of the EELS dataset under consideration.
This combined approach is implemented in a self-contained and expandable modular Python-based software solution called WhatEELS. It presents a fully interactive design that allows users without any previous programming knowledge to access its capabilities. The layout is designed to facilitate a fast and iterative operation for an improved workflow. Alongside the clustering analysis and NLLS fitting modules, WhatEELS includes natively a set of tools to characterize white-lines (WL ratio and WL centre position analysis) and elemental quantification.

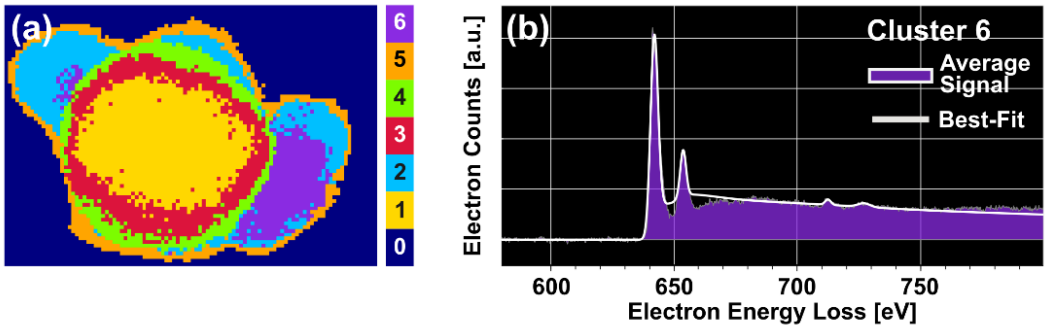

FIGURE 1. (a)K-means cluster map foran EELS spectrum image of aniron-manganeseoxide core-shell nanoparticle.(b)Best-fit model for thecentroid signal of cluster 6showninpurple in(a).The dataanalysis and the resulting figures shown here were done using WhatEELS.

References

[1] P. Torruella et al, Ultramicroscopy 185 (2018), p. 42-48.

Understanding of GaInP electronic properties by a combination of DFT and in-situ TEM

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Density Functional Theory (DFT) based calculations are the most used quantum method to obtain and analyze the electronic structure of a huge number of compounds at the atomic level. Its importance increases when the studied material has a particularity in its crystalline structure (defects, vacancies, superstructure, etc.). These anomalies are the key to unveil the properties of novel materials where non previously reported data exist. In this scenario, DFT, in combination with Transmission Electron Microscopy (TEM), becomes a very powerful tool.

In this work, the potentiality of DFT in combination with TEM characterization is illustrated with a detailed study of the properties of GaInP semiconducting samples exhibiting an ordered superstructure. As it is well known, GaInP is one the materials used for the fabrication of III-V semiconductors based tandem solar cells due to its high electron mobility and its bandgap tunability. With the proper synthesis conditions, GaInP presents an alternation of Ga-rich/In-rich {111} planes known as CuPt type B ordering, which has a direct effect on their optoelectronic properties, such as a bandgap reduction.The comparison between experimental in-situ electrical measurements and the DFT calculations allowed to distinguish between the proper effect of the ordering from other structural features present in the samples, in particular the antiphase domain boundaries between the ordered domains[1].

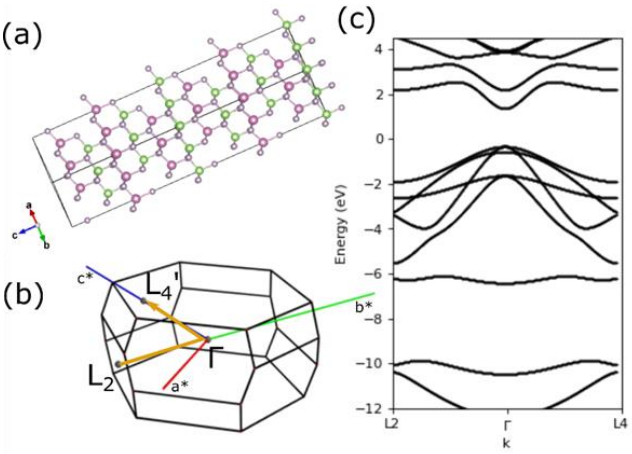

FIGURE 1 (a) Crystallographic model of GaInP with CutPt type B ordering. (b) Scheme of the first brillouin zone where the selected k-path is highlighted. (c) Bandstructure of GaInP with order along the highlighted k-path.

References

[1] C. Coll et al., "The effect of Sb-surfactant on GaInP CuPtB type ordering: Assessment through dark field TEM and aberration corrected HAADF imaging," Physical Chemistry Chemical Physics, vol. 19, no. 15, pp. 9806–9810, 2017, doi: 10.1039/c7cp01125c.

Support Vector Machines applied to Electron Energy-Loss Spectra: transition metals classification

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Electron Energy-Loss Spectroscopy (EELS) is a powerful and functional spectroscopic technique to study locally the composition and properties of materials at the nanoscale. The technological improvement of the Scanning and Transmission Electron Microscopes (S/TEM) technique leading to higher spatial and energy resolution results in an enormous increase of the total amount of data acquired in STEM-EELS measurements. Thus, currently the EELS technique offers better energy and spatial resolutions making possible a better nanometric characterization, at the cost of producing large spectral datasets, hindering the spectra analysis for the spectroscopist.

The machine learning methods provide a large variety of tools to properly deal with these large amounts of spectral data in an automated manner, at the same time that allow for extracting valuable physical information. In this sense, a promising machine learning strategy for identifying EELS data is the Support Vector Machine (SVM) [1], in particular the soft-margin SVM, which is a supervised machine learning algorithm allowing the multiclass classification, even with non-linear data, and that can be used as a probabilistic classifier.

The soft-margin SVM algorithm has shown promising results identifying the oxidation state in transition metal (TM) oxides, manganese and iron oxides, through the study of their EELS spectra, concretely, their white lines (L3 and L2) [2]. The algorithm has been implemented in Python programming language from the library Scikit-learn [3], concretely, the LIBSVM library [4]. It has presented a performance above 90 % classifying the TM oxidation state, and additionally, it has exhibited a good performance classifying these EEL spectra considering the usual level of noise and additional instrumental energy shifts in the spectrum.

Finally, the SVM applied to EEL spectra makes the most of the simplicity (it presents few parameters to optimize) and short computation times of it to identify the oxidation state of the transition metals correctly and automatically. Furthermore, although it presents fast computing times for large spectral datasets, they can even be reduced by implementing additional algorithms, as the Stochastic Gradient Descend (SDG), which is an iterative method that optimizes, and so, accelerates model training enabling also faster parameter optimization.

References

[1] C. Cortes and V. Vapnik, Machine Learning 20 (1995), pp. 273–297.
[2] D. del-Pozo-Bueno, F. Peiró and S. Estradé, Ultramicroscopy 221 (2021), p. 113190.
[3] F. Pedregosa et al., Journal of Machine Learning Research 12 (2011), pp. 2825–2830.
[4] C. C. Chang and C. J. Lin, ACM Trans. Intell. Syst. Technol. 2 (2011), pp. 1–39.

Temporally and spectrally resolved coherent X-ray microscopy of nanoscale dynamics in quantum materials

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We present results on coherent lenless X-ray imaging of phase dynamics in the quantum material VO_2, including the first femtosecond-temporal and nanometer-spatial resolution imaging of a light induced phase transition. We first show coherent X-ray diffractive imaging spectroscopy can be used to return the full complex refractive index across the oxygen K- and vanadium L-edge of all constituents of a phase-mixed sample simultaneously, with 25 nm spatial resolution and 0.25 eV spectral resolution [1]. Then, using resonant X-ray holography [2], we studied the ultrafast light-induced insulator-to-metal phase transition in VO_2 at the Pohang Accelerator Laboratory X-ray free electron laser. Femtosecond 800 nm pulses were used to drive a thin film sample through the phase transition, which was then probed using ultrafast X-ray pulses. Domain growth and nucleation dynamics monitored by coherent X-ray scattering at the vanadium $L_{2,3}$ and oxygen K edges with 140 fs and 50 nm resolution. Prompt changes in the domain structure were observed, along with further dynamics over picoseconds and hundreds of picoseconds. Coherent diffractive imaging-spectroscopy performed at 20 ps time-delay reveals no sign of a proposed monoclinic metallic state in the ultrafast phase transition [3,4].

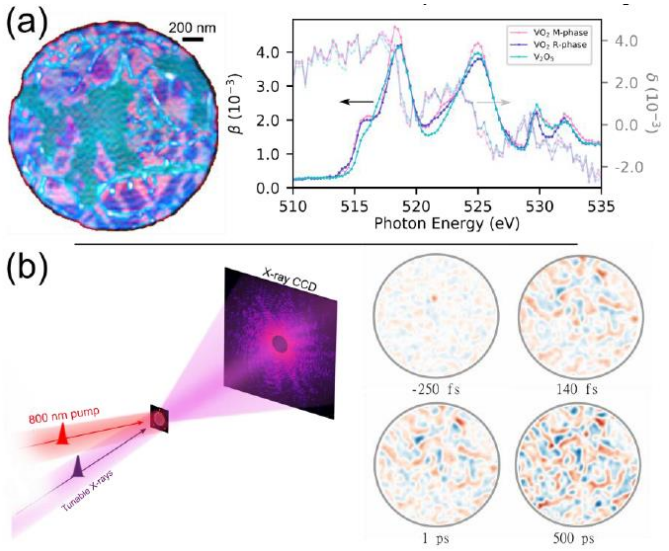

FIGURE 1 (a) Coherent X-ray imaging spectroscopy of phase co-existence in VO_2. (b) Time-resolved X-ray nanoscopy of the light-induced phase transition at the PAL XFEL.

References

[1] A.S. Johnson *et al.,* Science Advances **7, eabf1386 (2021)**
[2] L. Vidas *et al*., Nano Letters **18, 3449−3453 (2018).**
[3] M.R. Otto et al., Proceedings of the National Academy of Sciences of the United States of America **116**, 450-455 (2019)
[4] L. Vidas et al., Physical Review X, **10**, 031047 (2020)

Advanced STEM Characterisation of SiGe/Ge Quantum Wells for Quantum Computing

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Quantum computing is thought to be one of the main technological revolutions to occur in the current century. It will become ubiquitous in our society providing with powerful tools to solve scientific problems in diverse fields such as chemistry and drug design, biomedical research and personalised medicine, and engineering, among others. Towards achieving quantum processing units, germanium is an outstanding platform to create well-controlled quantum dots given its high hole mobility and low effective mass. In this study, we have explored the materials science implications behind the creation of a Ge-based Josephson field-effect transistor (JoFET) [1] and a singlet-triplet hole spin qubit [2].

HAADF-STEM was used to get atomic resolution micrographs of the misfit dislocation-free Ge quantum wells (QW) and their interfaces with the SiGe surrounding layers, and crystalline Al and Nb metallic contacts, when present. We computed the elastic strain by a correlative study between geometrical phase analysis (GPA) and quantitative-EELS and X-ray diffraction (XRD). We proved the feasibility of extracting reliable quantitative compositional information by means of core-loss EELS despite plural scattering when complementary reference values are provided (e.g. XRD). We used this precise compositional information to correlate the relative lattice displacements unveiled by GPA to the strain to which every region of the device has undergone.

In conclusion, we have applied a systematic structural-compositional correlative characterisation to state-of-the-art Ge-based devices for hole spin qubits generation in an ongoing study aiming for an optimised quantum performance.

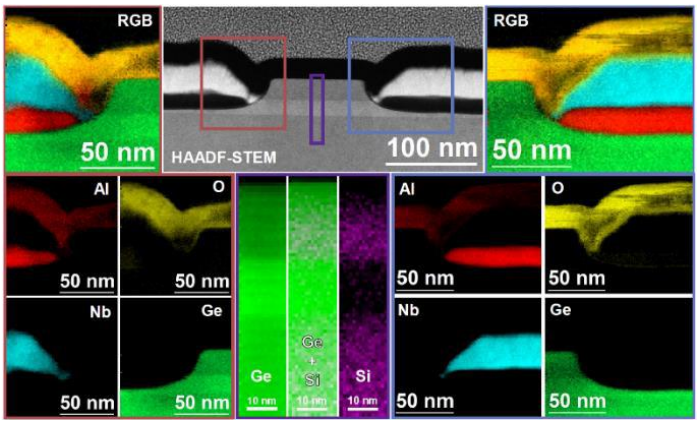

FIGURE 1. Electron Energy-Loss Spectroscopy (EELS) compositional maps of the JoFET device and its germanium quantum well and surrounding Al-Nb contacts. The EELS maps were taken at 200kV, with a spatial resolution of around 1nm.

References

[1] Aggarwal, K et al, Physical Review Research, **3**(2), (2021) L022005 [2] Jirovec, D. et al. Nature Materials, (2021) doi.org/10.1038/s41563-021-01022-2

Electron Microscopy at the University of Barcelona: past, present and future trends as ELECMI-UB node

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ELECMI (http://elecmi.es/en/) is the Spanish Infrastructure for Electron Microscopy of Materials, a Unique Scientific and Technical Infrastructure (ICTS) within the current Map of National Facilities in Spain. ELECMI is made up of four nodes: the Laboratory for Advanced Microscopies (LMA) of the University of Zaragoza; the National Center for Electronic Microscopy (CNME) of the Complutense University of Madrid; the Division of Electronic Microscopy (DME) of the University of Cádiz and the Unit of Electronic Microscopy Applied to Materials (UMEAP) of the Scientific and Technical Centers of the University of Barcelona (CCiTUB). ELECMI has a wide range of top-level equipment and know-how in electron and local probe microscopy dedicated to the observation, analysis and characterization of materials at atomic and molecular scale, constituting a large infrastructure at the service of researchers, universities, research centers and Industry, with the ability to address the most relevant challenges in the field of new materials.
In this talk, after looking back to the beginning of electron microscopy at UB, we will get a glimpse to the synergy stablished between the UMEAP-CCITUB unit and the LENS group to develop innovative instrumental methodologies and data treatment procedures. Pushed by strong collaborations with the material science community at local, national and international level, LENS vision on combination of electron beam precession, energy loss spectroscopy and electron tomography paved the way to pioneer work on chemical and valence state 3D volume rendering. Further significant achievements steamed from this strong activity and the long track of the CCITUB as central research facility, open to academic and research institution users and private companies, deserved the recognition of the UMEAP unit as ELECMI node in 2018. We will review the current capabilities of the UB node and the future plans to update the available instrumentation to the state of art equipment.

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