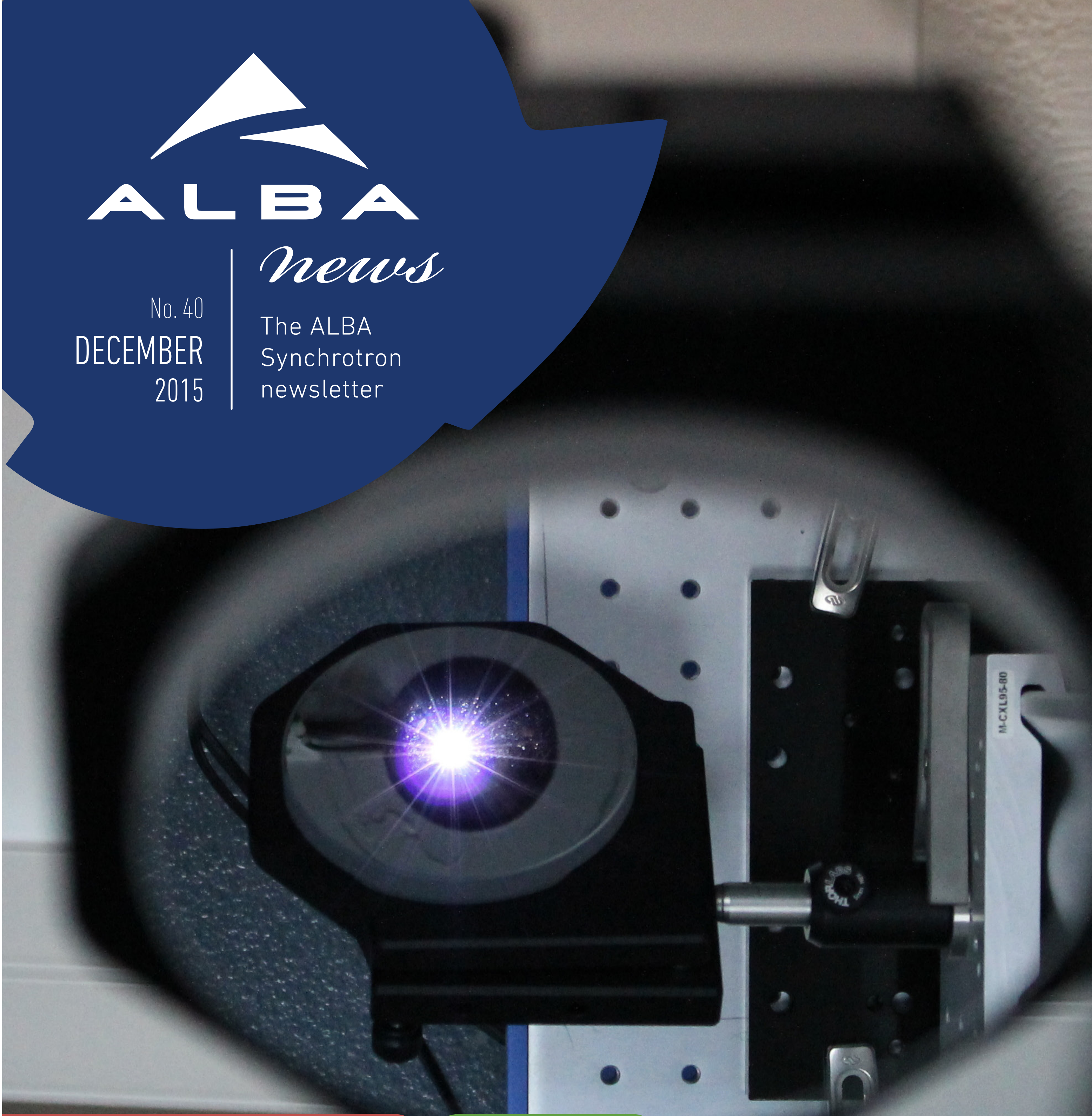
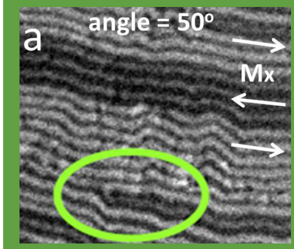
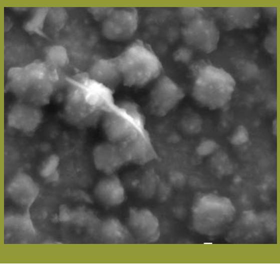
ALBA news

No. 40
DECEMBER
2015

The ALBA
Synchrotron
newsletter







Summary December 2015

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Cover
Synchrotron light observed through the XANADU diagnostic beamline.
Picture taken by Jon Ladrera, Engineering division, for celebrating the IYL2015.
Further information at page 24

Dear reader,

The year 2015, the International Year of Light and Light-based Technologies, has come to its end, and in ALBA it has been celebrated by myriad of activities, more than 1000 user visits, increasing the industrial usage of our instruments, making progress in the two Phase-II beamline projects, several outreach events and collaborations with national and international research institutions.

Operation has been smooth and reliable, with a gradual rise of the electron beam current from the initial 100 mA to 150 mA, thanks to the introduction of transverse bunch by bunch feedback and better reliability of radio frequency systems. Aiming at higher currents is one of the new year objectives.

The construction of the eighth beamline, MIRAS, has proceeded faster than foreseen, and the present schedule forecasts first official users in fall 2016. The experimental hutch is completed and most of the beamline systems will be installed during Christmas shutdown. The design of the ninth beamline, LOREA, is well advanced with first calls for tender already open.

Scientific highlights on bioscience, material science and magnetism, together with technical developments and examples of technological transfer are the backbone of this newsletter issue. Mari Cruz García-Gutiérrez, AUSE president, points out the need of developing new instruments in ALBA to satisfy the Spanish community scientific needs.

This is in line with ALBA priorities for the new year which, together with the facility performances, foresee the starting of the Phase III program.

Caterina Biscari
ALBA Director

Results of the 2016-I Call for proposals

The call for proposals for the period 2016-I was closed last September 7th with a new record of participation: 205 proposals (2,773 shifts). With respect to the 2015-I, the demand increased 5% (196 proposals). 2015-I is the last call comparable to the present one, since the XALOC beamline opens for proposals only once per year.
The evaluation of these proposals has been done and results have been published the 4th December 2015. The oversubscription factor in this call has been 2.18 although in some beamlines, as for example CIRCE, it has surpassed 4.5.The 69% of granted proposals are from Spanish institutions while the 31% of proposals are from international institutions.
According to the research area, the granted shifts are from materials science and structure (23%), followed by macromolecular crystallography (21%), hard condensed matter, electronic and magnetic properties (18%), chemistry (14%), biology (13%), soft condensed matter and biomaterials (8%) and environment and cultural heritage (3%).

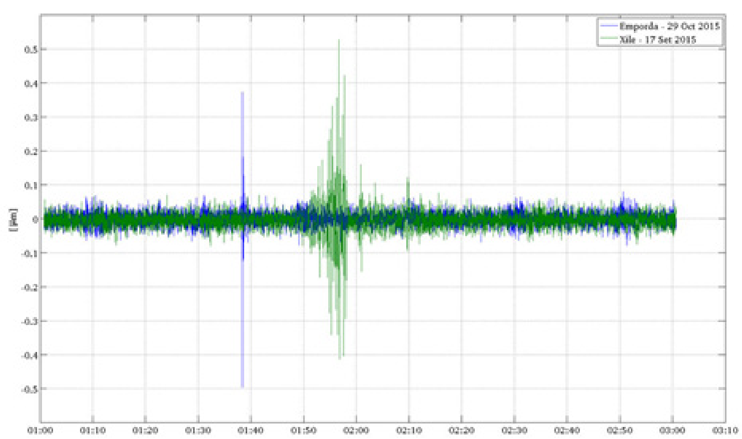
10 young new members of the ALBA staff

On December 2nd, 10 people younger than 30 years old started working at the ALBA Synchrotron thanks to the positive resolution of the grant for young employment in R+D+i launched by the Spanish Ministry of Economy and Competitiveness (MINECO).
During their two-year contract, they will reinforce areas such as the beamlines, the electronics engineering, the mechanical engineering, the process engineering and the infrastructure engineering, the controls systems, the health & safety office, the vacuum engineering, the magnetic measurements in accelerators complex and the user office. They all have different profiles, coming from university scientific or technological backgrounds as well as professional training.
In words of Caterina Biscari, director of the ALBA Synchrotron, “employing ten new young members in our staff is a great opportunity for all of them as well as a positive boost of force, work and new ideas for our institution”.

The new members of the ALBA staff at the experimental hall of the ALBA Synchrotron. © ALBA

Correction of the ALBA electron beam position after earthquakes

On the early morning of the 29th October, the beam position monitors of the ALBA accelerators detected the seismic activity happened in the area of Alt Empordà (Catalonia) and corrected the beam position.
The beam position monitors, that measure the position of the electron beam at 5,000 times per second (5 kHz), detected a sudden movement of the electron beam at 01:38, corresponding with the earthquake registered one minute before at the area of Alt Empordà. The magnitude-4.3 earthquake caused beam oscillations of 800 nanometres, from peak to peak.
This is possible thanks to the high stability of the electron beam generated at ALBA. In natural conditions, the electron beam has oscillations below 100 nanometres because of the orbit feedback system that corrects the electron beam orbit. This feedback system, working at 5 kHz, started operation in ALBA in May 2014, increasing by a factor of 10 the stability of the photon beam reaching the sample.
In September 2015, even though there is a distance of 11,000 kilometers, the ALBA facility also registered the earthquake happening in Chile. The signal was detected approximately at 2 AM, one hour later of the earthquake, being that period the time needed for the seismic waves to go through the inner core of the Earth, from Chile to ALBA.



Graphic showing oscillations at the electron beam during the 29th October (in blue) and the earthquake in Chile in September (in green).

Ultrafast dynamics with attosecond soft X-rays: Time is the key.

Jens Biegert
ICREA Professor of Attoscience and Ultrafast Optics
ICFO - The Institute of Photonics Sciences, The Barcelona Institute of Science and Technology, (Castelldefels, Barcelona)

The Institute of Photonic Sciences (ICFO) and the ALBA Synchrotron are joining forces within the framework of a joint project based on sub-femtosecond time-resolved absorption spectroscopies where the complementary competences of the two parties in the fields of instrumentation, solid state physics, and electron spectroscopies are put together. Interesting subjects being at hand are plenty, ranging from the time structure of magnetic spin transitions in single molecules to insulator-metal-transitions in correlated electron systems. Clearly, this represents an exciting opportunity regarding state-of-the-art time-resolved electron spectroscopies (presently largely non-existent at ALBA) for the unprecedented cutting-edge analysis of attosecond time dynamics in matter, based on a collaboration of institutions from the Barcelona area. In what follows, a brief summary of the project is presented .

It has meanwhile become common knowledge that merely understanding the starting point and the end point of a given process is inadequate for fully understanding and/or mastering the process itself. Thus, our capability of analyzing, understanding, engineering, and controlling the time dynamics *within* processes, as diverse as

- the flow of the electron's charge and spin within complex electronic devices
- exciton formation, transport or decay,
- the dynamics within the wide field of bulk as well as thin film magnetism
- the charge transfer between molecules during chemical reactions
- the charge transfer catalytic reactions at gas-surface interfaces

is key for addressing society's ever-increasing needs regarding the production, transport, and storage of clean energy as well as regarding the continuously growing and accelerating area of information processing, all this whilst not resulting into an undue pollution of the environment or exploitation of ever-dwindling natural resources. Here, photon-based science holds the key to unlocking the access to the required technological developments, which revolve around transformational materials and chemical processes for efficiently converting and directing energy between photons and electrons on one side and chemical, electronic, and magnetic entities on the other side. However, it is also by now accepted that the required functionality and efficiency of these materials have to be developed well beyond todays *empirically engineered* materials, being subject to the inherent limitations resulting from this restricted approach. The basic requirement to understand and control functionality therefore corresponds to our ability for probing and understanding the dynamics of interactions between photons and matter without missing any relevant information, i.e., starting from the fastest "triggering" events, which occur on the attosecond (i.e., 10^{-18} second) time scale.

Various approaches have been developed towards light sources that provide an experimental access to time resolution on the sub-nanosecond time scale, ranging from compact laboratory laser setups to large scale accelerator facilities such as synchrotron and linear accelerators (i.e., X-ray free electron lasers – XFELs) providing photon pulses with duration down to picoseconds or femtoseconds (i.e., 10^{-12} and 10^{-15} seconds), respectively. Also, both laser and accelerator light sources are frequently combined in the framework of so-called pump-probe experiments where matter is analyzed with synchrotron light before and after the excitation with a laser photon pulse.

Fully coherent extreme ultraviolet (XUV) radiation is produced in a process called high harmonic generation (HHG), which is a coherent frequency up conversion process driven by an intense laser field. The laser field ionizes the target gas and accelerates electrons which are then driven back to the atom and emit light upon recombination. With state-of-the-art Ti:Sapphire laser technology, photon energies less than 120 eV are routinely achieved. Isolated attosecond duration XUV pulses are generated with a laser pulse shorter than two oscillations of its carrier field, such that electron recollision can occur only once. This results into the emission of a single attosecond duration burst of radiation. Until now, a long standing challenge has been the low photon energy limit up to which isolated attosecond pulses exist, typically below 120 eV.

The Attoscience and Ultrafast Optics Group at ICFO, led by ICREA Prof. J. Biegert, has been successful in demonstrating, for the first time, single attosecond soft X-ray (SXR) pulse generation at the carbon K-edge in the so-called water window between 284 and 543 eV photon energy [Nature Commun. **6**, 6611 (2015)]. The approach is based on ponderomotive scaling, i.e., wavelength scaling, of HHG. The ICFO group has been pioneering ultrafast and intense long wavelength sources [Nature Photon. **9**, 721 (2015)] and they have developed the first source of intense sub-2-cycle laser pulse with carrier to envelope phase stability, at 1850 nm (instead of 800 nm) and 1 kHz repetition rate [Opt. Lett. **37**, 939-935 (2012)]. A specific HHG target design for high-pressure interaction inside the vacuum environment resulted in emission across the entire water window up to the oxygen K-edge at 534 eV. Figure 1 shows a sketch of the setup and an associated spectrum. Single attosecond emission was realized through wavefront rotation, which resulted in a sub-400-attosecond duration pulse, supporting an astonishing 30 attosecond transform limit. The broadband nature of such a short pulse is ideally suited for dispersive X-ray absorption fine structure (XAFS) as it permits simultaneous measurements across the absorption features of interest and without any photon energy scanning. The setup at ICFO incorporates a home built soft X-ray spectrograph which achieves sufficient resolution of dE/E = 1/1000, i.e. 0.3 eV at 300 eV. We have applied our table-top SXR source to near-edge X-ray fine-structure absorption spectroscopy (NEXAFS) on a polyimide foil as a first test. Figure 2 shows the result, which was obtained with a single 5 minute integration [Opt. Lett. **39**, 5383 (2014); Optics and Photonics News **12**, 58 (2014); Optics in 2014 Highlight]. We can clearly identify the fine-structure peaks of the carbon binding orbitals. The demonstrated ability to generate fully waveform-controlled water-window attosecond emission with sufficient spectral coverage presents a decisive step toward core level soft X-ray absorption spectroscopy in the water window with attosecond time resolution on a table top.

The collaboration between ICFO and the ALBA Synchrotron aims at further developing methodologies for probing the attosecond time dynamics of matter which represents excellent future opportunities for synchrotron light sources and free electron lasers.

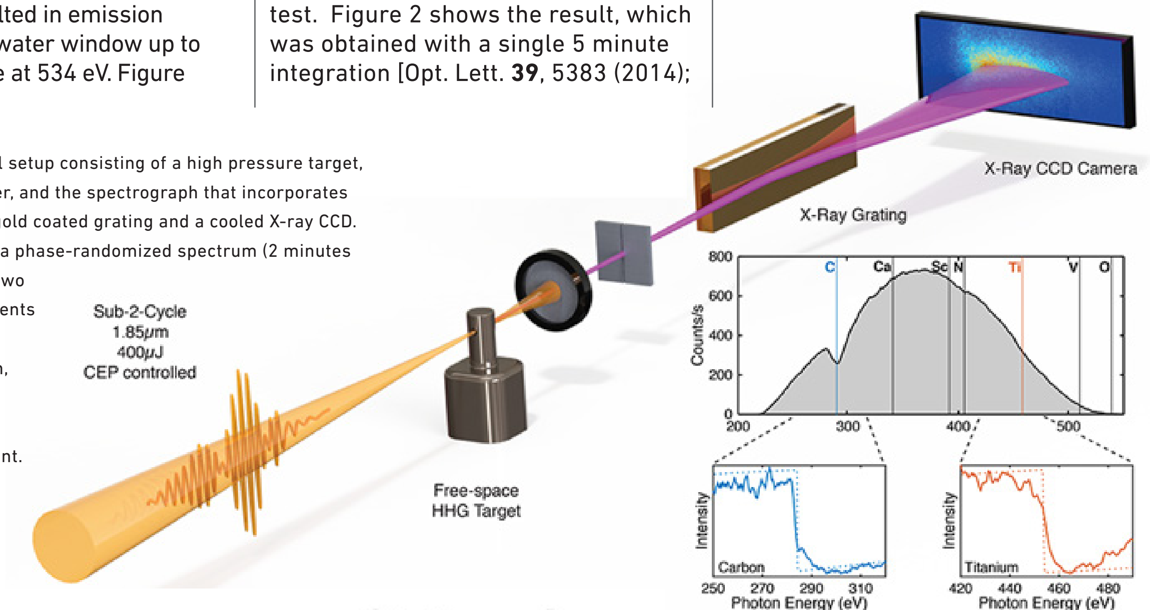


Figure 1: Experimental setup consisting of a high pressure target, a free-standing IR filter, and the spectrograph that incorporates a 2400 lines per mm gold coated grating and a cooled X-ray CCD. The right insets show a phase-randomized spectrum (2 minutes integration time) and two absorption measurements using foils of 200 nm of carbon and titanium, where the K-edges at 284 eV and 456 eV, respectively, are evident.

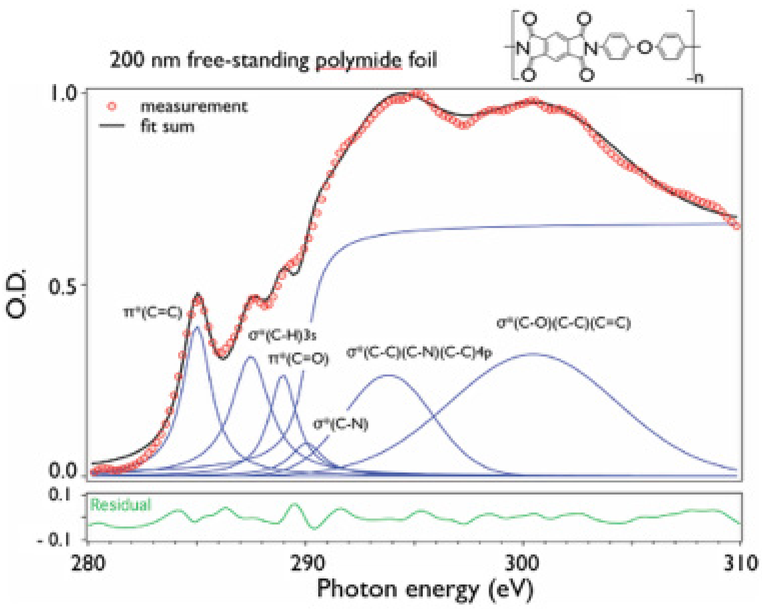


Figure 2: NEXAFS transmission measurement of a 200-nm free-standing polyimide foil using an attosecond soft-X-ray source (red circles). Theoretical peak fit with known transitions (blue) are summed (black curve) showing good agreement with the measurements. Ref.: S. L. Cousin et al., Opt. Lett. **39**, 18 (2014).

ALBA X-rays for the progress of magnetic storage devices

Salvador Ferrer
ALBA Synchrotron

The technology of magnetic storage of digital data has made enormous progress in the last two decades thanks to the scientific advances in nanomagnetism. At present, magnetic bits have dimensions of few tens of nanometers and magnetic devices are based on stacks of ultrathin films of different magnetic characteristics. The fundamental understanding of the magnetic interactions between the layers, their fabrication and the detailed characterization of the magnetic properties are necessary steps to achieve magnetic devices with unprecedented dimensions and performances. Magnetic domain imaging is a major field of activity to visualize magnetic structures from few tens of nanometers down to atomic scale. Most of the imaging methods are sensitive to the topmost surfaces (about 1 nanometer in thickness) but are not suitable to investigate magnetic layers covered with several tens of nanometers of material.

Using MISTRAL beamline, a team of scientists succeeded in analyzing in detail the magnetic characteristics of domains of a magnetically hard material (NdCo amorphous alloy) either "naked" or covered by a magnetically soft permalloy (NiFe alloy) layer. The method used was element sensitive transmission X-ray microscopy which is based in the so-called dichroic contrast achieved for specific X-ray energies that match the electronic levels of the material under study. The thin film samples had stripe domains which consist of alternate bands of up and down magnetizations as shown in figure 3. The films were mounted on a goniometer which allowed varying the angle of incidence of the photon beam relative to the surface of the films. They had their magnetic stripes approximately perpendicular to the rotation axis. By acquiring series of images at different angles at exactly the same location on the films, it was possible to determine the angle of magnetization with the surface.

The angular series of images also revealed local details of the inversion of the magnetization in the films. Preparing samples in an intermediate state of magnetization reversal allowed to map in detail the changes of the magnetization in the plane of the films. Areas with positive or negative in-plane magnetization were found to be separated by magnetic defects similar to dislocations in solids as indicated in figure 3. Detailed analysis of these magnetic singularities revealed that they had the magnetic structure of a meron or ½ skyrmion as depicted in panel b of figure 3. While moving across the dislocation core (from A to B) the magnetization described a single turn helix with a defined chirality. These topological defects are the narrowest possible in-plane reversed domains. They were observed in the uncovered and also in the covered films. Interestingly, in the latter case, it was found, by inspecting the magnetization of Fe atoms in the permalloy film, that the permalloy overlayer only partially replicated the topological singularity. Micromagnetic calculations confirmed the above findings which provide an additional insight of the magnetization reversal in magnetic heterostructrures, contributing to a better use and control of magnetic storage devices in the near future.

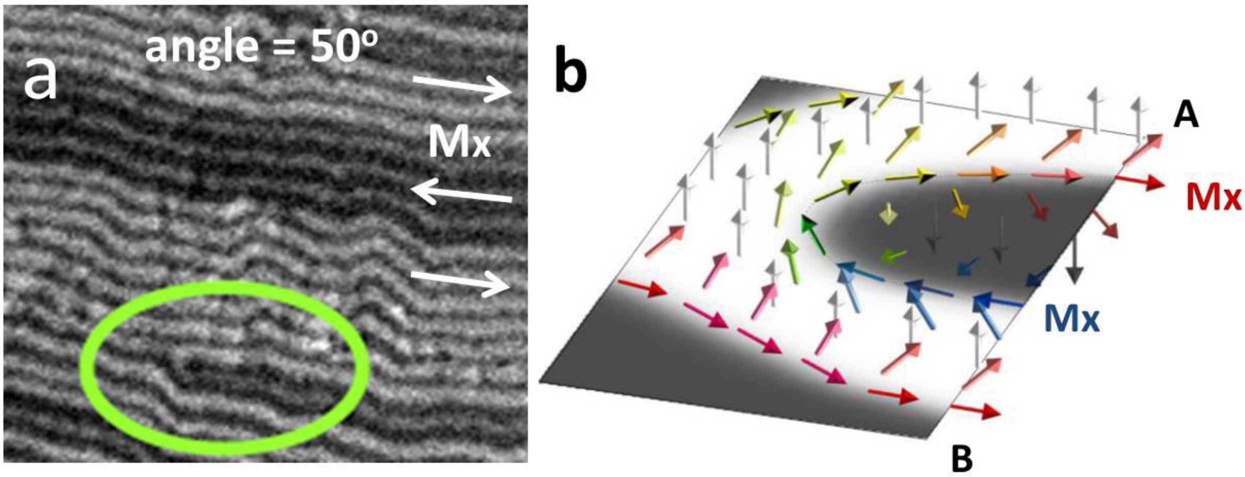


Fig 3: Panel a shows the stripe domains of a NdCo film of 55 nm thickness covered by a layer of 40 nm of permalloy. The green ellipse contains a dislocation having two branches. Panel b schematizes the orientation of the magnetization at the dislocation core: when moving from A to B the magnetization describes a clockwise helical trajectory.

Reference: "Nanoscale Imaging of Buried Topological Defects with Quantitative X-Ray Magnetic Microscopy" C. Blanco-Roldán[1], C. Quirós[1], A. Sorrentino[2], A. Hierro-Rodríguez[3], L.M. Álvarez-Prado[1], R. Valcárcel[2], M. Duch[4], N. Torras[4], J. Esteve[4], J.I.Martín[1], M. Vélez[1], J.M. Alameda[1], E. Pereiro[2], S. Ferrer[2] *Nature Communications* DOI: 10.1038/NCOMMS9196

[1] Universidad de Oviedo, Departamento de Física y Centro de Investigación en Nanomateriales y Nanotecnología (CINN)
[2] ALBA Synchrotron
[3] Universidade do Porto, Departamento de Física e Astronomia
[4] Centro Nacional de Microelectrónica (IBM-CNM, CSIC)

ALBA Fast orbit feedback system in operation

The ALBA storage ring is operating a fast orbit feedback system to correct the electron beam orbit.

● Prior to the FOFB implementation, the orbit was corrected every 3 seconds. Distortions in the orbit faster than 3 seconds (or 0.3 Hz) were not corrected and the residual orbit had an rms value of 400 nm in both planes. Residual orbit refers to the difference between the measured orbit and the defined design orbit.

With the present system, the orbit is corrected up to frequencies of 200 Hz and the rms value of the residual orbit has decreased almost by one order of magnitude. Now it is 80 nm in the horizontal and 40 nm in the vertical plane, respectively.

By sampling the beam position data at 10 kHz, the integrated power spectral density (PSD) has been calculated in both planes. Figure 4a compares the PSD in the horizontal plane with and without the FOFB ON and figure 4b does the same for the vertical plane.

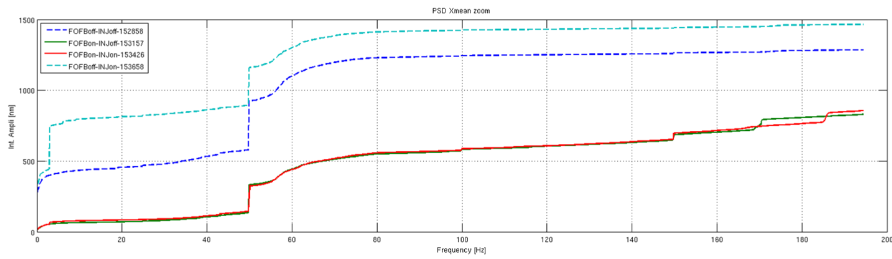


Figure 4a: Integrated spectra for the horizontal plane. Up to 200 Hz the integrated noise is below 1 um when the FOFB is running. The colours correspond to spectra taken under different working conditions.

Blue:	FOFB off, injection off;
Green:	FOFB on, injection off.
Red:	FOFB on, injection on;
Lightblue:	FOFB off, injection on;

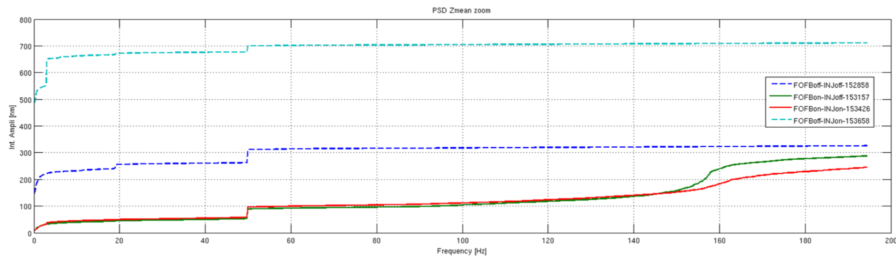


Figure 4b: PSD for the vertical plane. Up to 200 Hz the integrated noise is below 300 nm when the FOFB is running. The colours correspond to spectra taken under different working conditions described in the previous figure.

Notice that the FOFB completely damps the 3 Hz noise of the Booster, when injection is on. The signal at 3 Hz is, together with the 50 Hz signal the largest source of noise on the measured spectrum when the FOFB is off. The distortion at 50 Hz does not disappear completely but it is damped by a factor of 2.

Increase of the electron beam current to 150 mA

● The ALBA accelerators have gradually increased the electron beam current from the initial 100 mA to 150 mA in 2015, answering one of the recommendations given by the ALBA Scientific Advisory Committee. Several tests and performances have been done to achieve it, like the introduction of the bunch by bunch transverse feedback system or reliability improvements of the radiofrequency systems.

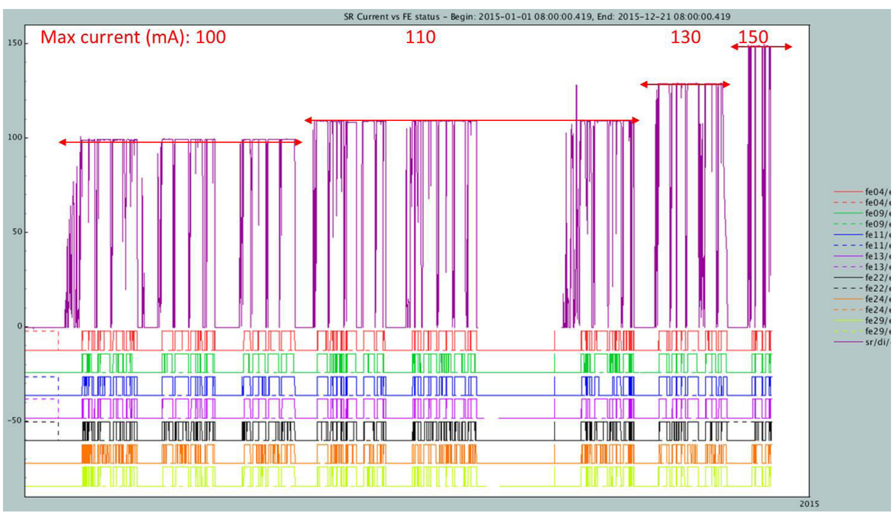


Figure 5: The graphic displays the increase of the electron beam current from January 1st till 21st December 2015.

Also in operation the ALBA Bunch by Bunch transverse feedback system

One of the long-term projects in which the Accelerator Division is working is in increasing the accumulated current in the Storage Ring. But above a certain threshold, coupled bunch instabilities are excited by the interaction of the particle beam with its surroundings producing an undesired transverse beam motion which enlarges the beam size and eventually limits the machine performance.

The Bunch-by-bunch (BbB) feedback system damps the transverse betatron oscillations associated with coupled-bunch instabilities. The BbB system is based on the sensors (BPMs) capability of detecting the unwanted beam motion, the electronics (Libera BBB) that calculate the beam motion correction, and actuators (Fast Feedback Kickers – FFK) that apply the feedback correction to the beam. The software was developed at the Diamond Light Source and they also collaborated during the first start-up. An illustrative sketch is shown in Fig. 6. The BbB system is in operation for the vertical plane since October 2015 and the commissioning of the feedback in the horizontal plane is ongoing.

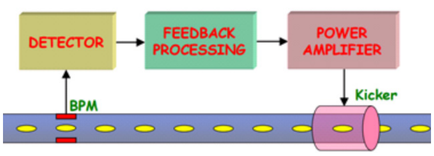


Figure 6: Sketch of the BbB system.

Testing the injector at lower energy

The ALBA synchrotron uses a 100 MeV Linac as the start of the acceleration chain for the injector. It has two main accelerating structures which are fed each with a 35 MW pulsed klystron. Typically the beam energy is 110 MeV and the energy spread is 0.2%.

A recent upgrade of the waveguide system, shown in figure 7, allows the use of a single klystron to power both accelerating structures, or just one independent of the location. Operation with a single klystron produces a beam of 67 MeV with an energy spread typically twice that of a beam at 110 MeV. This beam has been captured in the Booster, accelerated up to 3.0 GeV and successfully injected in the Storage Ring.

The goal of this upgrade is to ensure continuous beam in top-up mode even in the event of a klystron failure. While it may take more than 24 hours to exchange a klystron, the switch to the low energy mode should not take more than 2 hours.

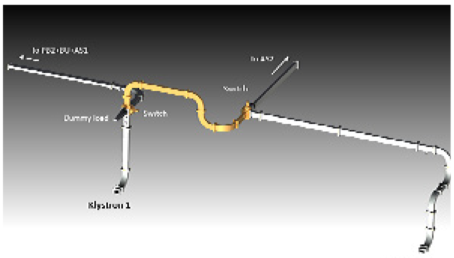


Figure 7: Linac waveguide system. The upgrade is indicated in yellow.

A mini-beta lattice for ALBA

Macromolecular crystallography (MX) represents the largest single group of synchrotron users in Europe. MX is becoming limited by the amount and size of the samples that can be obtained, as today's most challenging samples can only be grown in tiny crystals. To extract useful data, crystallographers resort to micro-focus beamlines with micro sized but highly brilliant X-rays beams.

The ALBA phase-III beamlines contemplates a micro-focus beamline to provide an answer to the problem of tiny samples and the present XALOC beamline is looking forward to higher flux densities.

For this reason, the ALBA Accelerator Division has been testing a new lattice for the Storage Ring that introduces a horizontal mini-beta at the location of the existing XALOC MX beamline which reduces the horizontal beam size by a factor of 2 and will increase the photon flux density at sample.

	Present lattice	Minibeta lattice
Beam size, σ_x	126.0 um	62.0 um
Beam size, σ_y	5.5 um	13.5 um

Tests with the beamline have already been scheduled in order to quantify the benefits in terms of brightness of this new lattice at the sample position.

MATERIALS SCIENCE

New method for fabricating high-quality ultrathin cobalt ferrite nanostructures

BL24-CIRCE

Researchers from the CSIC and the ALBA Synchrotron have synthetized and characterized this material with nanometre thickness. The work, published in "Advanced Materials", has applications in spintronics.

A team of researchers from the Spanish National Research Council (CSIC) and the ALBA Synchrotron has developed a new method to produce and characterise cobalt ferrite nanostructures with higher quality than ever before. The obtained nanostructures consist of ultrathin bidimensional crystals, up to 10 micrometres in lateral size and between 1 and 100 nanometres in thickness. The study, published in Advanced Materials, has implications in spintronics, a technology for developing advanced computing systems.

This new method is applicable to a wide variety of materials that can set the ground for developing nanoelectronic and spintronic devices. In particular, cobalt ferrite is used in the production of spin valves, one of the components of the computers' hard disk read heads.

"The nanostructures or cobalt ferrite islands have a much higher quality than what has been achieved so far, as evidenced by the fact that their magnetic domains are up to 10.000 times larger", says Juan de la Figuera, CSIC researcher from the Institute of Physical Chemistry "Rocasolano".

Growth and initial characterization of the islands were performed at the low-energy electron and photoemission electron microscope of the CIRCE beamline at the ALBA Synchrotron. Cobalt and iron atoms were deposited on a substrate at high temperature, while being exposed to oxygen. The growth was monitored and optimised in-situ, in real space and real time, with the microscope, where the crystals composition and distribution of magnetic domains were also determined. Finally, samples were also analysed at the CSIC Materials Science Institute in Madrid by atomic force microscopy.

Using the movement of the magnetic domain walls for information storage is a current hot research topic, and cobalt ferrite – an oxide with spinel mineral structure - belongs to a family with promising properties in this field.

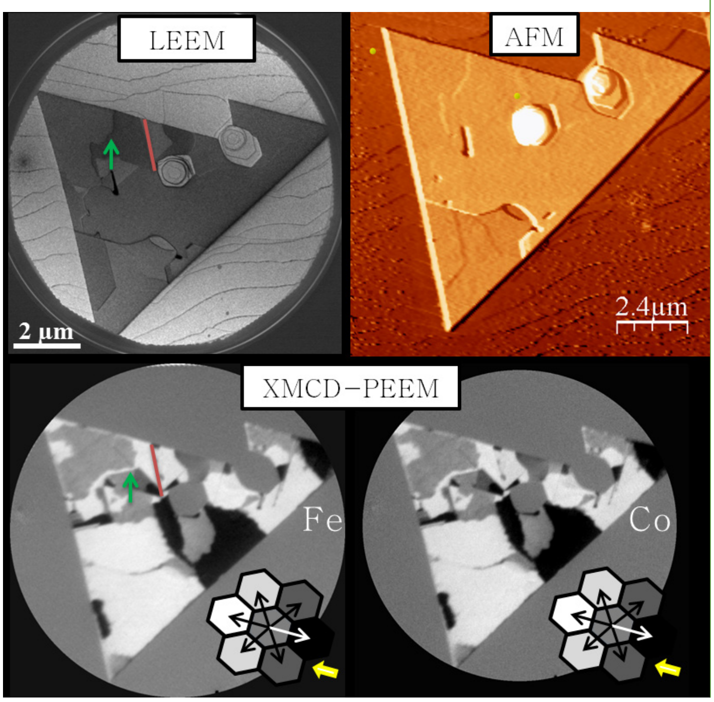


Figure 8: Top left) Low-energy electron microscospy image of a large island; Top right) Atomic force microscopy image of the same island; Bottom) Photoemission electron microscopy (XMCD-PEEM) images of the same island shown in top left image, obtained at the Fe and Co L3 edges respectively, portraying the magnetic domain configuration.

Reference: "Atomically flat ultrathin cobalt ferrite islands" L. Martín-García[1], A. Quesada[2], C.Munuera[3], J.F. Fernández[2], M. García-Hernández[3], M. Foerster[4], L. Aballe[4], J. de la Figuera[1]
. *Advanced Materials* (2015)
27: 5955–5960 DOI: 10.1002/adma.201502799

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[4] ALBA Synchrotron

MATERIALS SCIENCE

Researchers create artificial methane hydrates

BL04-MSPD

X-ray diffraction experiments were performed at the MSPD beamline of the ALBA Synchrotron. Results were published in Nature Communications journal.

A group of researchers has developed a technology for preparing artificial methane hydrates using activated coal materials as nano-reactors. One of the keys of this research was that scientists were able to reduce the process to form methane hydrates, which takes a long time in nature, to just a few minutes.

The group of the University of Alicante worked on design and synthesis of the material. Afterwards, neutron scattering experiments were performed at the Rutherford Appleton Laboratory (Oxford, UK) and X-ray diffraction experiments were also performed at the Materials Science Powder Diffraction (MSPD) beamline of the ALBA Synchrotron. Both studies confirmed the methane hydrate formation and gave insight into the structure of the synthesized nanocrystals.

Results of this research are a step forward to understanding the artificial synthesis process of these natural structures, and a new pathway into the use of fuels such as natural gas for transport (instead of petrol and diesel), or for long-distance transport of natural gas, due to their high energy density and their stability when temperatures are higher than liquid natural gas.

This research has been led by the Laboratory of Advanced Materials of the University of Alicante and has also included the participation of the Instituto de Tecnología Química (ITQ-UPV-CSIC), the Oak Ridge National Laboratory (USA), the Institut Català d'Investigació Química (ICIQ), the Research Center for Exotic Nanocarbons (Japan) and the ALBA Synchrotron.

Reference: "Methane hydrate formation in confined nanospace can surpass nature" Mirian E. Casco[1], Joaquín Silvestre-Albero[1], Anibal J. Ramírez-Cuesta[2], Fernando Rey[3], Jose L. Jordá[3], Atul Bansode[4], Atsushi Urakawa[4], Inma Peral[5], Manuel Martínez-Escandell[1], Katsumi Kaneko[6] & Francisco Rodríguez-Reinoso[1]. Nature Communications (2015) 6:6432. DOI: 10.1038/ncomms7432

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BIOSCIENCES

Crystal Structure and Receptor Binding of a Siadenovirus Fibre

BL13-XALOC

Using ALBA and ESRF X-rays, researchers were able to solve the structure of the fibre head of turkey adenovirus 3 (TAdV-3), which causes fatal hemorrhagic enteritis in turkeys.

Adenoviruses cause mild diseases ("flu" or "colds"), but also more serious afflictions. At the same time, they are under investigation as vectors for gene and cancer therapy, and used as vaccination agents. Adenoviruses are icosahedral, with a trimeric fibre inserted into each pentameric vertex. The fibre protein interacts with the host cell receptor through its distal head domain. The *Adenoviridae* family contains five genera: Mastadenovirus, Aviadenovirus, Atadenovirus, Siadenovirus and Ichtadenovirus. Mastadenoviruses infect mammals, including humans, while aviadenoviruses infect birds. Siadenoviruses have been isolated from frog, tortoises and birds. The genus takes its name from a specific open reading frame similar to bacterial sialidases.

Turkey Adenovirus 3 (TAdV-3) is a siadenovirus. Virulent TAdV-3 causes fatal hemorrhagic enteritis in turkeys, but avirulent strains are suitable vaccines. The TAdV-3 fibre protein has 454 residues, of which amino acids 304-454 make up the head domain. This head domain was expressed, purified and crystallised. Crystallographic data collection for the avirulent version of the TAdV-3 fibre head domain and a selenomethionine derivative was performed at the European Synchrotron Radiation Facility beamline ID14-EH4, with the help of Andrew McCarthy. X-ray diffraction data for the virulent version fibre head crystals were collected at XALOC beamline of ALBA with the help of Jordi Benach, Fernando Gil and Jordi Juanhuix and for the ligand-bound forms at BM30 of the ESRF. All crystals were isomorphous and belonged to space group *I*23. *De novo* structure solution was by single-wavelength anomalous dispersion (SAD). This is the first siadenovirus for which the structure of the fibre head has been determined.

Curiously, the TAdV-3 fibre head structure is more similar to reovirus fibre heads than to other adenovirus fibre heads. Each monomer contains beta-sandwich, in which the C-strand is interrupted by a beta-hairpin "arm" contacting a neighbouring monomer. This arm is a unique feature. The structures of avirulent and virulent forms are virtually identical. To identify possible receptors, glycan microarray profiling was performed by Michelle Kilcoyne and Lokesh Joshi of the National University of Ireland in Galway. Binding to sialyllactose was observed and validated using nuclear magnetic resonance spectroscopy by Álvaro Berbís, Javier Cañada and Jesús Jiménez-Barbero of the Centro de Investigaciones Biológicas (CSIC, Madrid). They also showed that binding to the TAdV-3 fibre head occurs via the sialic acid moiety. Isothermal titration calorimetry (Margarita Menéndez of the Instituto de Química Física Rocasolano, CSIC, Madrid) showed that the fibre head binds sialyllactose with mM affinity.

We also soaked crystals with sialyllactose. A binding site on the side of the molecule, just below the beta-hairpin, was identified and confirmed by site-directed mutagenesis. The binding site is constituted by six residues from one monomer, and three from the beta-hairpin of the neighbouring monomer. Because the binding affinity is low, the natural receptor may well be a more complex sialylated cell surface molecule, interacting more extensively with the fibre head. Knowledge of the structure and receptor-binding properties of the TAdV-3 fibre head may facilitate the design of chimeric adenoviruses and improved vaccination or gene therapy vectors.

This work was performed in collaboration with Monika Ballmann, Mária Benkő and Bálasz Harrach from the Institute for Veterinary Medical Research in Budapest, Hungary.

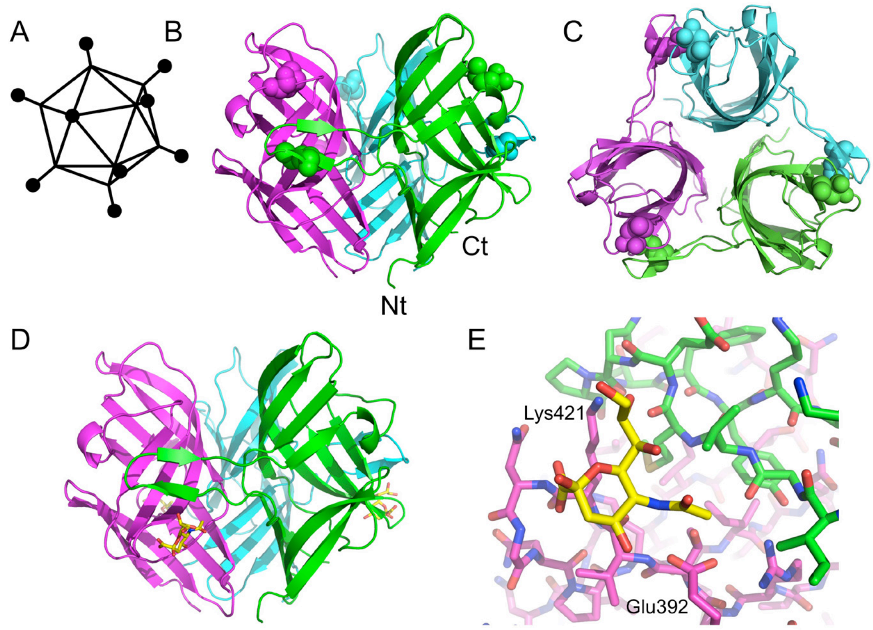


Figure 9: Structure of the TAdV-3 fibre head. A) Schematic structure of an adenovirus. The black balls represent the receptor-binding fibre head domains. B) Side view of the fibre head trimer. C) Top view of the fibre head trimer. D) Structure of the TAdV-3 fibre head protein bound to 3'-sialyllactose (stick model, carbons yellow). E) Close-up of the binding site for sialyllactose on the fibre head. The two interacting residues that were mutated are labelled. Panels B, C, D and E are adapted from figures published in the journal reference.

Reference: "Structure and Sialyllactose Binding of the Carboxy-Terminal Head Domain of the Fibre from a Siadenovirus, Turkey Adenovirus 3" Singh AK[1], Berbís MÁ[2], Ballmann MZ[3], Kilcoyne M[4], Menéndez M[5], Nguyen TH[1], Joshi L[4], Cañada FJ[2], Jiménez-Barbero J[6], Benkő M[3], Harrach B[3], van Raaij MJ[1]. *PLoS One* (2015) Sep 29;10(9):e0139339. DOI: 10.1371/journal.pone.0139339. PMID: 26418008.

[1] Departamento de Estructura de Macromoléculas, Centro Nacional de Biotecnología (CNB-CSIC),
[2] Departamento de Biología Física-Química, Centro de Investigaciones Biológicas (CIB-CSIC)
[3] Institute for Veterinary Medical Research, Centre for Agricultural Research, Hungarian Academy of Sciences
[4] Glycoscience Group, National Centre for Biomedical Engineering Science, National University of Ireland Galway
[5] Departamento de Química Física-Biológica, Instituto de Química Física Rocasolano
[6] Departamento de Biología Física-Química, Centro de Investigaciones Biológicas (CIB-CSIC); Centro de Investigación Cooperativa en Biociencias (CIC bioGUNE).

CHEMISTRY

Sulfur K-edge absorption spectroscopy at CLÆSS: transmission vs fluorescence vs total electron yield modes

BL22- CLÆSS

Due to its chemical reactivity and mobility, sulfur is an essential component of the matter. However due to several experimental constraints related to the energy range of the sulfur absorption edge, direct studies at the sulfur K edge are still challenging. Thanks to its versatility, high photon flux and detection capabilities, CLÆSS provide easy access to the investigation of the electronic and structural properties around this light element in matter.

Sulfur has a particularly interesting X-ray absorption edge spectrum, with chemical shifts spanning more than 14 eV [1]. This permits to easily identify and quantify the presence of different sulfur species in the sample. For example in figure 10 we report spectra acquired at CLÆSS that enlighten the energy shift due to the different sulfur oxidation states. In panel a) are shown the spectra of iron pyrites (FeS_2), iron pyrrhotite ($Fe_{1-x}S$), and sodium sulfate (Na_2SO_4) measured in transmission (T) and fluorescence (F) modes, with integration time of about 5-15 minutes each one.

Apart from the already commonly used transmission and fluorescence detection modes, Total Electron Yield (TEY) has been recently successfully commissioned at CLÆSS. Differently from transmission and fluorescence, were photons are collected, in TEY the absorbed X-ray intensity is measured through the ejected photoelectrons which are proportional to the absorption. Taking into account that the main free path of electrons is limited to the nanometer scale, while photons of that energy penetrate more, around few microns, the TEY is, as a consequence, more surface sensitive. This explains the differences observed in the two spectra collected simultaneously on pyrrhotite and reported in panel b) of fig 10. The main peak in the TEY spectra is located around 2480 eV, exactly in correspondence with the main peak of the sodium sulfate (grey line), suggesting that the sample surface is oxidized.

CLÆSS beamline is dedicated to X-ray absorption and emission spectroscopies. It is installed on a wiggler source and covers an unusually wide energy range: from 2.4 to 63 keV. In addition to different collection modes, several sample environments are available (setups from liquid He to room temperature and from liquid nitrogen to 1000K, as well as in situ catalytic reactors) so that the beamline meets the needs of a very large community of researchers, from fundamental chemistry and physics, to catalysis, cultural heritage, environmental science, food and health science, pharmaceutical science, material science, electrochemistry, energy storage and related fields, etc.

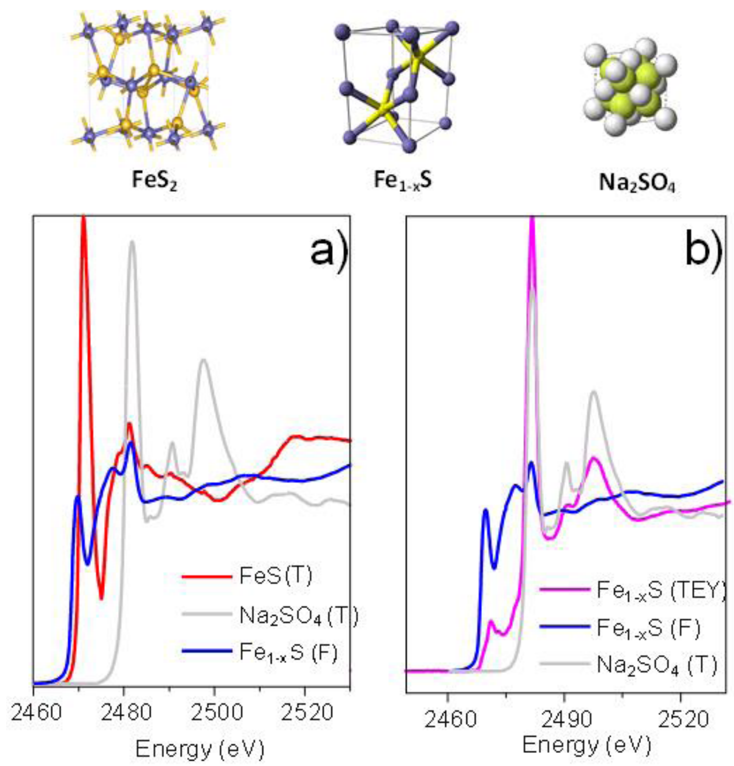


Figure 10: Normalized sulfur K-edge absorption spectra collected in transmission and fluorescence mode (panel a) and in transmission, fluorescence and TEY mode (panel b) on selected references (FeS_2, $Fe_{1-x}S$, and Na_2SO_4).

[1] G.N. George et al., Jor. Am., Chem. Soc, **111**, 3182 (1989) ; Ingrid J. Pickering et al., FEBS Letters 441 (1998) 11-14; Hideo Sekiyama et al., Bulletin of the Chemical Society of Japan Vol. 59 (1986) No. 2 P 575-579.

CHEMISTRY

Visualizing discharge products in lithium-oxygen batteries using soft X-rays spectro-microscopy

BL09-MISTRAL

Energy resolved soft X-rays transmission microscopy studies were performed at MISTRAL beamline to know the morphology and composition of the discharge products in lithium-oxygen batteries.

Lithium-oxygen (Li/O_2) batteries have a theoretical energy density 5-15 times larger than the well-established Lithium–ion batteries. The management of their apparently simple chemistry is challenging and represents a severe hurdle to the viability of this technology. Fig.11 shows a scheme of the operating principles of the Li/O_2 chemistry. In a conventional lithium-ion battery the cathode interface is essentially preserved during operation, in fact the electrochemical reaction is a Li insertion into the active electrode material. Instead, in a Li/O_2 cathode the reaction is rather an electrodeposition process, where molecular oxygen from the electrolyte is reduced and combines with lithium cations to form solid products (mainly peroxide Li_2O_2) that precipitate within the porous electrode:

$$O_2 + 2Li^+ + 2e^- \rightarrow Li_2O_2$$

When the battery is recharged, the reverse reaction should occur and lithium metal atoms and O_2 regenerated. In both reactions the oxygen radicals involved are extremely reactive with the organic environment, and even with the porous electrode (usually carbon), so that parasite reactions will take place. In addition, Li_2O_2 is an insulator that passivates the electrode surface, and in many cases the reaction cannot be quantitatively reverted because of particles that become electrically disconnected from the electrode. The most relevant issues with lithium–oxygen batteries, i.e. their poor reversibility and cycle life, are mainly coming from these two factors. Therefore information on the complex morphology and composition of the discharge products on the porous electrode are important for the identification of the involved processes.

To investigate these issues, measurements were performed at MISTRAL which allows to spatially resolve the chemical state of the oxygen atoms thanks to the spectroscopic imaging capability. A common carbon-coated Au TEM grid was used directly as a cathode and fully discharged in a Li/O_2 battery. On selected areas, 2D absorption images (10 µm × 10 µm) were collected varying the energy across the O K-edge with a spectral sampling of 0.25 eV. In this way, we have obtained 2D maps of the oxygen chemical state of the principal possible reaction products involved, with a full XANES spectrum at each pixel. An example is given in Fig. 12, showing a sample region with Li-O particles of different shape, size and composition. The acquired data have permitted to quantify and localize with spatial resolution of few tens of nanometers the distribution of the oxygen discharge products in these samples (i.e., lithium superoxide, peroxide, and carbonates) and appreciate several compositional, structural, and morphological aspects.

Results confirm the presence of an important amount of carbonates (Li_2CO_3). On one hand, small irregular particles and aggregates with main carbonate character appeared irregularly distributed on the electrode surface. On the other hand, toroidal shaped particles showed a predominating Li–O phase in the core, which is covered with an external carbonate-rich shell. This indicates that a discharge dominated

Reference: "Spatial Distributions of Discharged Products of Lithium–Oxygen Batteries Revealed by Synchrotron X-ray Transmission Microscopy" Mara Olivares-Marín[1], Andrea Sorrentino[2], Rung-Chuan Lee[3], Eva Pereiro[2], Nae-Lih Wu[3], and Dino Tonti[1]. *Nano Letters* (2015) 15 (10), 6932-6938. DOI:10.1021/acs.nanolett.5b02862

[1] Institut de Ciència de Materials de Barcelona, (ICMAB-CSIC)
[2] ALBA Synchrotron
[3] Department of Chemical Engineering, National Taiwan University

by objects with smaller surface to volume ratio could benefit rechargeability, and in general suggests that strategies to control the thickness and mechanical and physical properties of this layer should be implemented. The significant LiO_2-like phase amounts found in toroids strongly suggest that the formation of these characteristic particles can be related to the availability of large superoxide amounts in the solution phase. Tomographic reconstructions show that in our case deposits have a remarkable distortion from an ideal toroidal shape, rather resembling a mushroom cap, with a central hole open on only one side (Fig. 13).

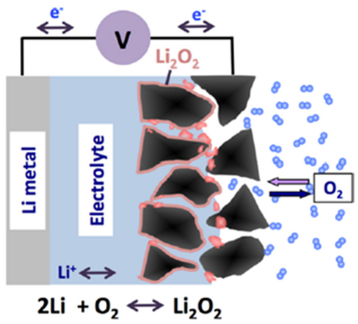


Fig.11: Operating principle of a Li/O_2 battery (non-aqueous electrolyte). The positive electrode consists of a porous support, usually carbon, which enables the reduction of molecular oxygen and accommodates the insulating discharge products.

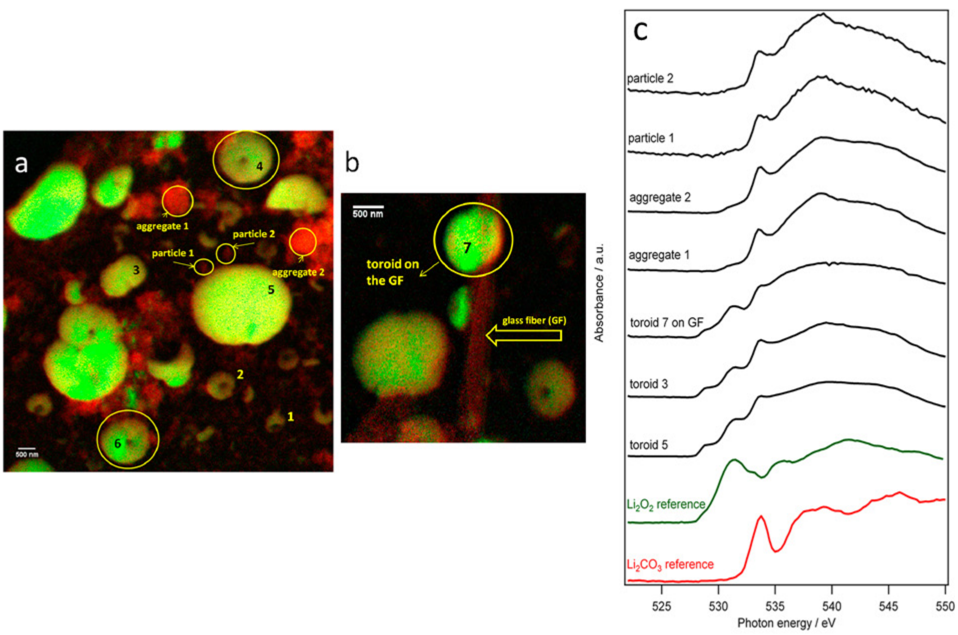


Fig. 12: TXM images (a,b) of a carbon coated Au TEM grid after being fully discharged at 100 mA per gram of carbon in a $Li–O_2$ cell. The images are the result of overlapping three color maps with intensities proportional to the amounts of Li superoxide (cyan), Li peroxide (green), and carbonate (red). c) O K-edge XANES spectra at the selected points indicated by arrows in (a,b) and reference spectra measured for Li_2O_2 and Li_2CO_3.

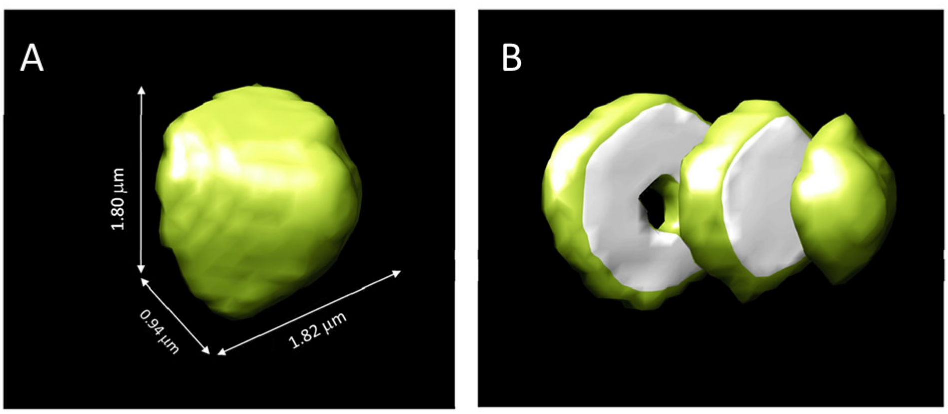


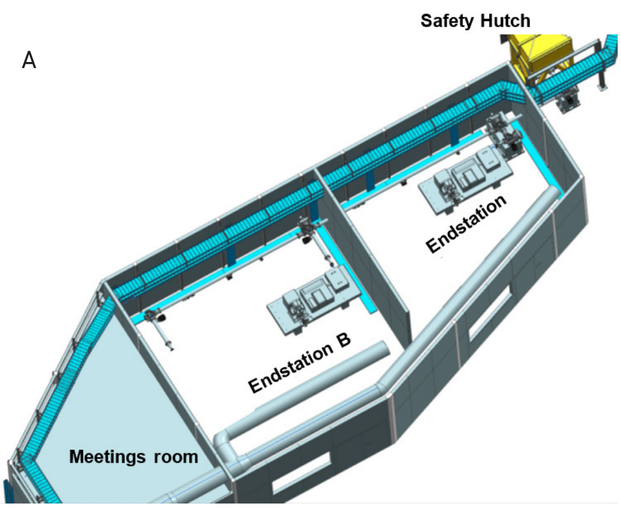
Fig. 13: a) Three-dimensional morphology of a discharged particle showing remarkable deviations from the generally assumed toroidal shape obtained with transmission tomography. b) Sliced view of the same particle shown in a), pointing out that the hole is open only on one side of the particle.

Status of MIRAS: The infrared synchrotron radiation beamline at ALBA

The construction of MIRAS, initiated in 2014, is advancing rapidly, and will enter the commissioning phase in 2016. Here, a brief report of its current status is given.

MIRAS will be dedicated to infrared microspectroscopy, with the aim of delivering world class performance in terms of a bright and highly stable photon beam. The beamline will provide ALBA users with a modern infrared microspectroscopy facility covering a wavelength range from 0.4 to 100 µm. The design of the beamline optimizes performance in the mid-IR range and will give significantly enhanced efficiency, compared to a conventional source, in both far-IR and mid-IR regions. The optical layout of MIRAS includes the option for splitting the extracted infrared beam in two parts, with one containing the edge radiation of the beam [1]. Each of the two parts of the split beam may be used separately at two different endstations [2] or merged together to increase flux. The experimental cabin and transport optics are designed to accommodate two additional endstations as a future upgrade of the MIRAS beamline, one that will be based on a "bring your own equipment" concept (Figure 14 (a)). The microspectroscopy instrument at the first operational endstation will be a Bruker system (Hyperion 3000 microscope coupled to a Vertex 70 spectrometer) equipped with an FPA detector for imaging.

The installation process of the beamline in-tunnel components commenced during the shutdown of the machine, summer 2015. The mechanics of the first extraction mirror M1 have been assembled and several tests were performed, including measurements for alignments and metrology, validation of the system functionality, in term of motors performance and vibration tests (Figure 15). Then, thermocouples were installed on M1, two of them on the body of the mirror and six thermocouples of 1mm diameter were installed on the back of M1 at the slot. The thermocouples will be interlocked with the RF power supply for safety reasons.



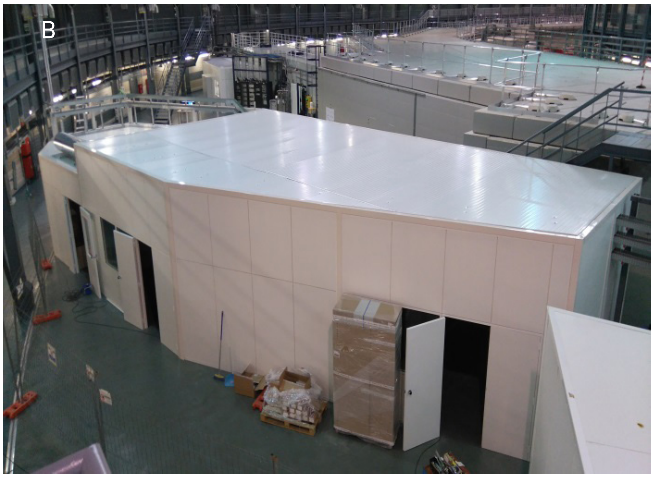


Figure 14: 3D drawings of the experimental hutch. There are two endstations hosting the three branches. Two of these branches will be coupled to a FTIR systems as indicated in the figure, the third branch will be a free station, where the users can bring their own instrument and connect it to this branch.

Figure 15: Assembly of the first extraction mirror mechanics. (a) Alignment procedures, (b) Motors functionality tests, (c) Metrology, Motors repeatability and Vibration tests

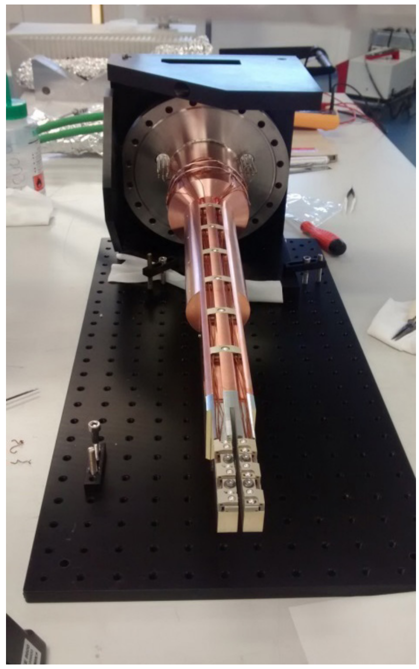


Figure 16: Extraction mirror M1 pre-installation. Installation of thermocouples.

Following the construction of the first mirror mechanics, the whole assembly has been placed inside the dipole chamber implementing a horizontal infrared beam extraction geometry using a laterally inserted M1 (Figure 17). M1 is made from aluminium, with 20 nm of electro deposited gold layer that is tightly clamped onto a copper holder for heat dissipation (Figure 16). After the installation of the first mirror inside the tunnel, several steps will be followed, including the installation of the transport mirrors, chambers, ion pumps etc.

In parallel to the beamline components installation, the construction of the experimental users' hutch has been initiated in September 2015. The full construction of the hutch including cabling, conditioning and light installations were ready by the end of November 2015 (Figure 14 (b)).

After the full installation of the beamline components, the commissioning of the beamline is planned to start in April 2016. Following the successful commissioning of the beamline, the first users can be welcomed officially by November 2016.

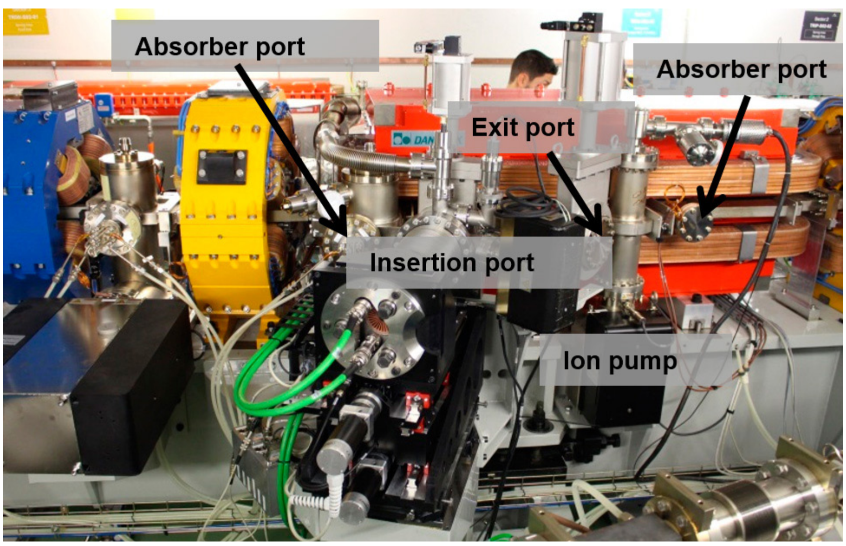


Figure 17: Installation of the extraction mirror assembly inside the tunnel in the dipole chamber.

Viability of calcium rechargeable batteries demonstrated

BL04-MSPD

Calcium can be used as electrode in rechargeable batteries according to a study from Spanish Research Council (CSIC) in collaboration with Toyota Motor Europe (TME) and supported by the measurements performed at the ALBA synchrotron. This work proves that oxidation-reduction of calcium occurs in a reversible way in electrolytes that can operate at high potential.

Calcium, a much more abundant and cheaper element than lithium, can act as negative electrode in rechargeable batteries. This is shown in a study elaborated by researchers of Spanish Research Council (Consejo Superior de Investigaciones Científicas –CSIC) at the Institut de Ciència de Materials de Barcelona (ICMAB) in collaboration with Toyota Motor Europe (TME), and with the support of the results obtained at ALBA Synchrotron.

This study proves that calcium can be used as negative electrode in rechargeable batteries of high energy density and that they are compatible with electrolytes commonly used in lithium ion technology. These results are the basis of two filed patents and from now on researchers will direct their efforts to the development of materials for the positive electrode able to operate at a high potential to achieve high energy density batteries.

This work has been possible by combining different techniques, including electron microscopy and synchrotron powder diffraction, among others. The latter was done at the BL04-MSPD beamline at ALBA Synchrotron and allowed to unambiguously prove that the electrodeposits achieved in conventional electrolytes consist partially of calcium metal.

This research, which has been published in Nature Materials (Ponrouch *et al.*, 2015), opens the door to future technological applications of calcium in the development of batteries.

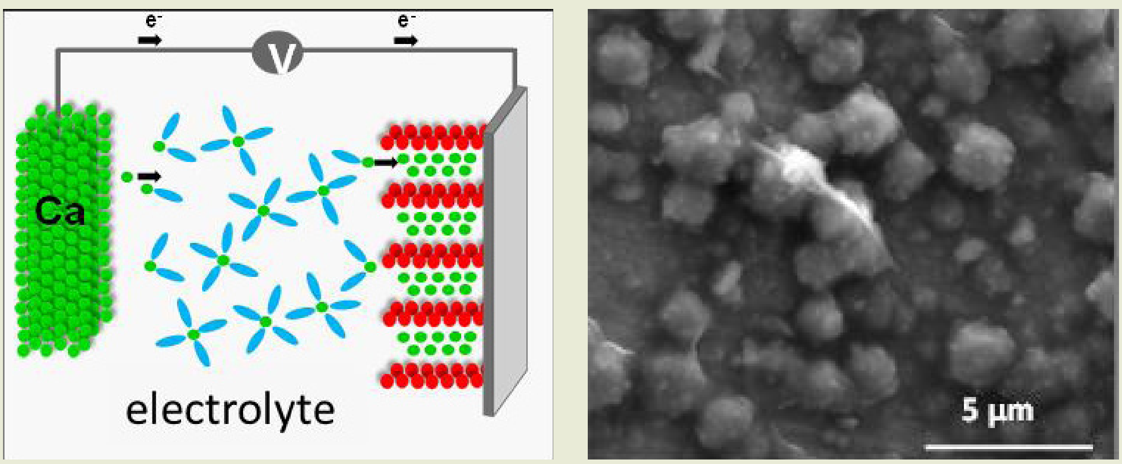
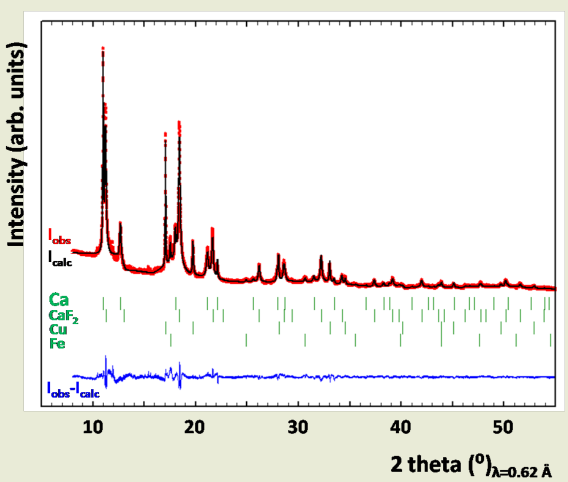


Fig 18: Scheme of the calcium battery, electron microscopy image and powder diffraction pattern of the developed electrodes.



"Towards a calcium-based rechargeable battery" A. Ponrouch[1], C. Frontera[1], F. Bardé[2] and M. R. Palacín[1]. *Nature Materials* (2015) DOI: 10.1038/NMAT4462

[1] Institut de Ciència de Materials de Barcelona (ICMAB-CSIC)
[2]Toyota Motor Europe

The ALBA Synchrotron and the company SENER sign a technology transfer agreement

SENER is devoted to engineering and construction. The agreement enables the commercialization of a technological solution developed at ALBA: a new system to bend X-ray mirrors with high precision at a competitive price.

This system, developed at the ALBA Synchrotron, includes more functions than others available in the market. Its main advantage is that it can reduce mirror's deformation errors, in a stable and controlled way, to values 10 times below the present time existing technologies.

The system has successfully been tested at the ALBA beamlines. The function of the mirrors is to focus the X-rays on the samples under study. The quality of the focusing increases when the shape of the mirrors approach to the perfect ellipses which require accurate polishing methods of the mirror surfaces. The X-ray mirror nanobender developed by the ALBA Synchrotron include correctors that compensate the errors on the mirror's polish. The nanobender developed at ALBA might be applicable also to free electron laser beamlines in addition to synchrotron beamlines.

The signature of this contract confirms the participation and interest of SENER in the market of the synchrotron radiation facilities, with good perspectives for a global demand. Apart from the future needs of mirrors, both from ALBA Synchrotron and worldwide, they are investigating new possible applications outside this market.

The X-ray mirror nanobender is part of the portfolio of high technology optic instrumentation of SENER, which includes projects such as the high performance and resolution camera of the Spanish satellite SEOSAT/Ingenio, where SENER is the main contractor, and opto-mecanic systems for the telescopes T250 from OAJ (Observatorio Astronómico de Javalambre), E-ELT (European Extremely Large Telescope), the Gran Telescopio de Canarias (GTC) and VLT (Very Large Telescope).

Group photo of the agreement signature ceremony. © ALBA Synchrotron

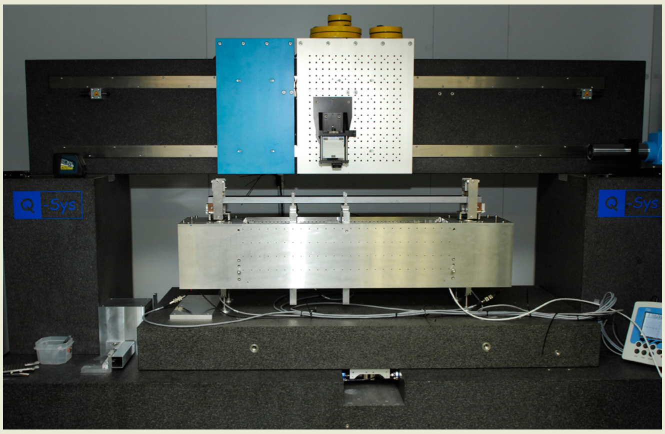


Image of the nanobender at the Optics Laboratory of ALBA. © ALBA Synchrotron

What's on? Agenda of events in 2016

2016 MAY 6th	Industrial workshop
2016 MAY 24th - 26th	5th Workshop on Power Converters for Particle Accelerators
2016 JUNE 6th - 7th	22nd Meeting of the ALBA Scientific Advisory Committee
2016 JUNE 13th - 15th	Workshop on Synchrotron Radiation to study Atomic Layer Deposition
2016 SEPTEMBER 11th - 15th	International Beam Instrumentation Conference (IBIC)
2016 SEPTEMBER 11th - 16th	Mechanical Engineering Design of Synchrotron Radiation Equipment and Instrumentation Conference (MEDSI)

VII AUSE Congress and II ALBA User's Meeting

From June 16th till 19th, the VII AUSE congress (the association of synchrotron users from Spain) and the II ALBA user's meeting were held at ALBA.

During the event, more than 120 researchers from different scientific disciplines and national and international research institutions met to showcase their scientific results and debate synchrotron light capabilities.
The talks of the congress covered topics such as energy – in the search of more efficient batteries -, structural biology – solving cells and protein structures and processes – or magnetic properties of advanced materials or agro food science, among others. This variety of topics highlights the versatility of synchrotron light to face different research problems.
The event counted on the presence of researchers from other European synchrotron facilities like Klaus Lipps from Bessy (Germany), Tilo Baumbach from ANKA (Germany), Gianfelice Cinque from Diamond (United Kingdom) and Germán Castro from the European synchrotron ESRF (France).
On Friday June 19th two parallel workshops were organized to know in detail two of the available techniques in ALBA: photoemission electron microscopy (PEEM), with the participation of scientists and users from CIRCE beamline, and high pressure powder diffraction, organized by the researchers of MSPD beamline, including the involvement of the beamline users.
It is worth mentioning that technological companies PIMicos and MDC Vacuum took also part in the event as sponsors.

Group photo of all the congress delegates at the ALBA experimental hall. © ALBA Synchrotron

Successful industrial workshop for the pharmaceutical industry

On May 7th more than forty people participated at the workshop organised by the ALBA Synchrotron addressed to pharmaceutical companies. During the event the attendees were able to know the available state-of-the-art techniques and the advantages that synchrotron light offers in the development and improvement of drugs.

During the whole day, companies had the opportunity to know more about the access mode for the industry as well as other type of collaborations such as the use of ALBA laboratories, knowledge transfer activities or mid and long term R+D+i projects.
Researchers from MSPD, CLAESS, XALOC, NCD and MISTRAL showed the advantages that synchrotron light techniques offers to the pharmaceutical sector: fast data acquisition and shorter experiments, cost savings and, in the case of X-ray microscopy, the suppression of ethical conflicts because this technique can be a previous step before clinical trials with animals and persons.
The companies Enantia and Almirall, which had already collaborated with the ALBA Synchrotron, commented their own experiences at the facility. The discussion continued with a roundtable where the celebration of the workshop was considered very positively and new forums between ALBA and the pharmaceutical companies were proposed.

Photo taken during the roundtable, including the participation of many attendees. © ALBA Synchrotron

About 2,000 visitors at the ALBA Open Day

On the 21st of November 2015, 1.903 people attended the ALBA Open Day. On its 4th edition, the event has become a successful activity among families and general public. The activities were related to the celebration of the International Year of Light 2015.

The event was a big science party where many different activities were organized for all ages. The visit was organized around a circuit composed by different exhibition areas. The participants had the opportunity to see the different magnets that curve and shape the electron beam since the tunnel was open on that occasion. Besides, several demonstrations were organized to make the experience more interactive and direct: a small electron gun inside a transparent glass vacuum chamber allowed to visualize the effect of the Lorentz force on the trajectory of the electrons, a laser and several gratings illustrated the phenomenon of the diffraction of light, discovering your real height with micrometer precision, etc. The kids could follow a treasure hunt around the facility that ended up with a diploma ceremony. The most prominent surprise was a music band, composed by members of the ALBA staff, who adapted some popular songs for explaining what a synchrotron is. This year, another of the novelties was the celebration of four conferences for giving complementary information about particle accelerators (by Caterina Biscari), the nature of light (Salvador Ferrer), the science behind a synchrotron (Josep Nicolàs) and how a synchrotron works (Montse Pont).

The ALBA Open Day was held thanks to the contribution of 78 volunteers from the ALBA Synchrotron who helped in the coordination of the event and also giving explanations and informing the visitors. It is also worth mentioning the support from Civil Protection, who generously offered their experience during the whole day.

The ALBA Open Day was organized with the support of the Spanish Ministry of Economy and Competitiveness, the Catalan Government and the sponsorship of La Caixa Foundation.

A group of visitors in front of the Accelerators section. © ALBA Synchrotron - Pepo Segura

A girl with her researcher certificate at the photocall. © ALBA Synchrotron - Pepo Segura

ALBA brings science to the city

On Friday 25th September 2015, the 10th European Researchers' Night took place at Cerdanyola del Vallès. Around 650 people enjoyed free outreach activities organized by ALBA in recognition of the International Year of Light.

What is light and what are its properties? And what do we mean by "synchrotron light" and how can we use it in a experiment? These were some questions that ALBA answered during the European Researcher's Night held on Friday 25th September at Cerdanyola del Vallès.

Around 650 people attended the Museum of Art of Cerdanyola to meet researchers and technicians from the ALBA Synchrotron in order to know more about how ALBA works and which its main features are. The mayor of Cerdanyola del Vallès, Carles Escolà, present at the event, highlighted that the city is proud of hosting a facility like ALBA. Caterina Biscari, director of ALBA, insisted on the benefit of organizing this type of events to make people forget fear of science.

The first activity was a hot chocolate party, followed by the shadow theatre play "The pied piper of Hamelin". During the event, there were also available demonstrations and experiments, an exhibition to explain how synchrotron-based research has improved our world and a drawing contest for kids from 6 to 14 years old.

The aim of the event is to bring science to the general public, showing the everyday life of researchers. The event is being held since 2005 in more than 300 European cities the last Friday of September.

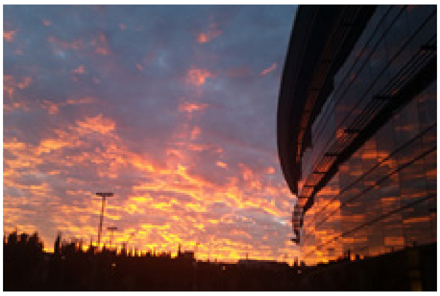
The shadow theatre full of attendees. © ALBA Synchrotron - Teresa Llordés

Explaining the electromagnetic spectrum to kids. © ALBA Synchrotron - Teresa Llordés

The ALBA staff celebrates light in 2015

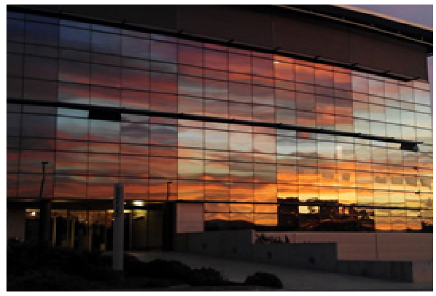
During all the year, members of the ALBA staff have taken light-related images in order to commemorate the International Year of Light 2015. Thanks for the great pictures!

INTERNATIONAL YEAR OF LIGHT 2015

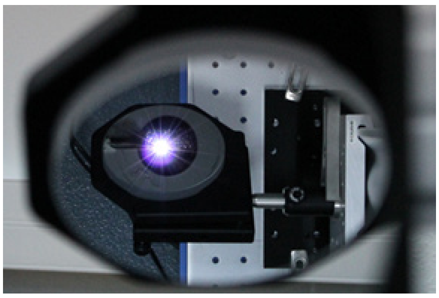


Laura Campos, *Sunlight reflecting on ALBA's building in the evening*

Ibraheem Yousef, *Light at night in the desert of Petra (Jordan)*

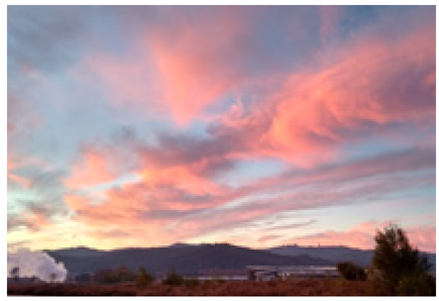


Joan Vilanova, *Sunset over ALBA's main entrance.*



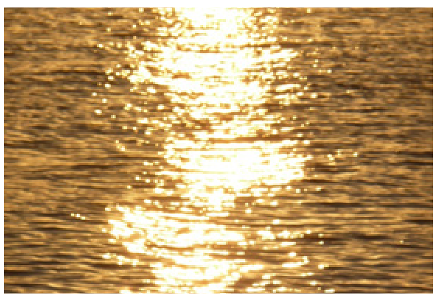
Jon Ladrera, *Synchrotron light observed through the XANADU diagnostic beamline*

Ibraheem Yousef, *the Alhambra (Granada)*



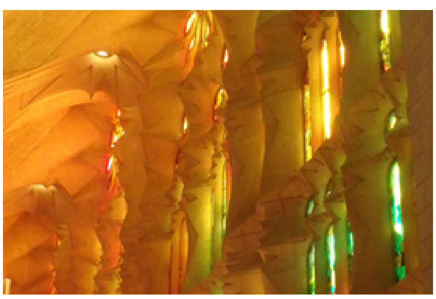
Concepció Girbau, *ALBA Synchrotron skyline.*

Ramon Pascual, *Curious coincidences during the International Year of Light Opening Ceremony in Barcelona. Pictures from R. Josa (ICFO).*



Caterina Biscari, *Light reflecting on Cerdenya's sea.*

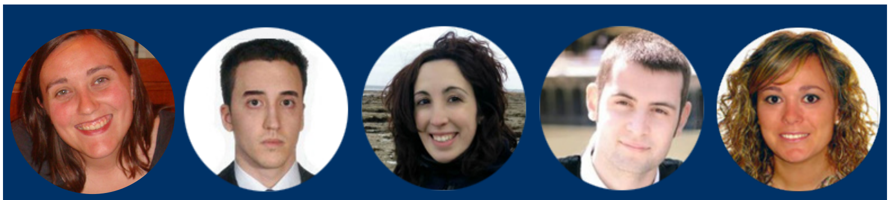
José Aguilar, *Sunlight in the storm in Collserola.*



Caterina Biscari, *Light through the stained glass windows of the Sagrada Família.*

New members of the ALBA staff

From May till November 2015, 8 new members have started working at the ALBA Synchrotron. Besides, two members of the ALBA staff have acquired new positions. A new Health & Safety officer has joined the ALBA team.
Apart from these members, 10 young people started working in ALBA the 1st December 2015 (see complete text in page 4).



MARTA ÁVILA, Former postdoc scientist of CLAESS now researcher at the Industrial Liaison office

IGNASI BELLAFONT, Engineer PhD student for the EuroCircol project

NÚRIA BENSENY, Postdoc scientist at the infrared microspectroscopy beamline MIRAS

ANTONIO CARBALLEDO, Mechanical engineer for phase-II beamlines (MIRAS and LOREA)

INMACULADA HERNÁNDEZ, Secretary at the Experiments division

CRISTINA MASSA, Health & Safety Officer

EMILIO MORALES, Operator of the Accelerators division

HAROLD MORENO, Industrial PhD student

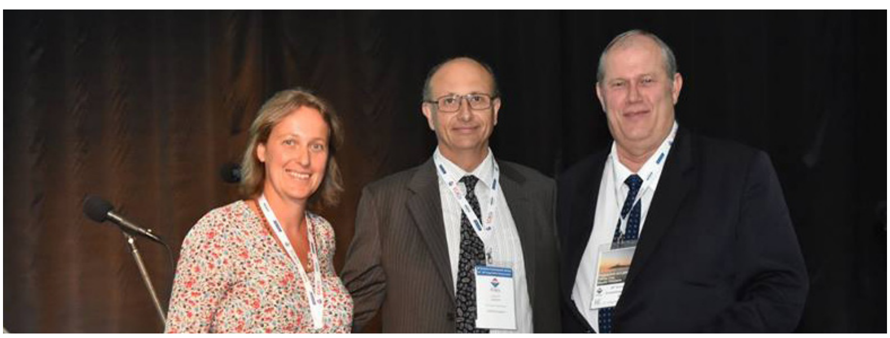
FERNANDO GIL, Former postdoc at XALOC. Now scientist at XALOC

ROGER PASTOR, Technologist for the hall magnetic measurement bench

John R. Helliwell awarded the Max Perutz prize

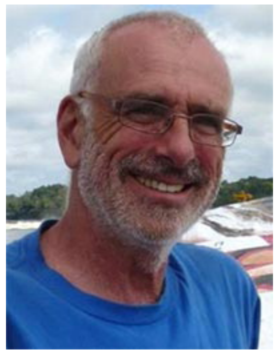
John R. Helliwell - Emeritus Professor of Structural Chemistry at the University of Manchester (UK) - was awarded with this prize for "his long, generous and fruitful dedication to developing all aspects of the use of synchrotron radiation for crystallography and for his boosting support to global development of synchrotron and neutron facilities". He has been the chairman of the ALBA Scientific Advisory Committee till the end of 2014.

The Max Perutz Prize is awarded twice in a three-year cycle in recognition of meritorious achievements in any branch of crystallography by a crystallographer having a clear affiliation with the European Crystallographic Associaction (ECA) region and being an individual member of the ECA.



John R. Helliwell receiving the Max Perutz award at the 29th European Crystallographic Meeting held in Rovinj (Croatia) on 23-28 August 2015.

Pep Fontcuberta named 2016 distinguished lecturer by the IEEE International Magnetics Society



The ALBA Synchrotron and particularly the BOREAS and CIRCE beamlines want to congratulate Prof. Fontcuberta, or Pep Fontcuberta as he prefers to be named, for his recent distinction as IEEE International Magnetics Society lecturer.

Pep Fontcuberta is a research professor at the Institut de Ciència de Materials de Barcelona (ICMAB-CSIC). He was one of the first users of the ALBA Synchrotron and continues being an active user of the ALBA beamlines. He leads the Multifunctional thin films and complex structures group where he has developed a strong research program on functional oxide materials during the last two decades. Oxide systems display a variety of fascinating properties -such as coexistence of magnetism and ferroelectricity, or other remarkable magneto-electric and optical properties-, and the group interest and research efforts both at a basic and applied level, are driven towards the goal of developing oxide-based materials and devices that may contribute to a more a sustainable world. He has co-authored over four hundred scientific articles and he is an editor of Advanced Electronic Materials, Solid State Communications, and the Journal of Magnetism and Magnetic Materials.

Mari Cruz García-Gutiérrez, president of the Spanish Association of Synchrotron Users

Since 2013, the researcher Mari Cruz García-Gutiérrez from the Institute of the Structure of Matter (IEM – CSIC) is the president of the Spanish association of synchrotron radiation users' (AUSE). She has developed her career in the field of soft condensed matter using synchrotron techniques in European and world-wide facilities.
Today we discuss with her about the situation of the users' community in Spain as well as its future challenges.

• AUSE has experienced great growth in the last years. In 2013, the association gathered 550 users while this year 2015 it has 1,200 users. In your opinion, which reasons are behind this progress?

First of all, I'd like to mention that those 1,200 users are registered inside the ALBA's Synchrotron database meaning that 1,200 Spanish users have performed experiments in ALBA from 2012 till 2015. But not all of these users are members of AUSE. However, it is true that both, the number of AUSE members and the number of Spanish users, have considerably grown in the last years. In my opinion, the reasons are the great effort of AUSE getting to know the possibilities of the synchrotron light and attracting students and young scientists and, without any doubt, the start-up of the ALBA Synchrotron.

Synchrotron light will evolve not only including new scientific disciplines, but also improving its techniques.

• Is the Spanish community of users mature enough in comparison with countries like Germany, England or France with more experience?

There are Spanish groups who have used synchrotron light for decades. Those groups, with a wide experience, have been the grounds for AUSE and the ALBA Synchrotron. The Spanish community has been using synchrotron facilities in other countries and the Spanish demand of beamtime has surpassed its quote of the 4% at the ESRF for years. The main difference between Spain and Germany, England or France is that they have one or more synchrotron facilities with about 30 operational beamlines in each of them and, in Spain, we have available ALBA with 7 operational beamlines from 2012. This is the main reason why the Spanish community of synchrotron users grows slower than the community from other countries.

• Synchrotron techniques are available for a wide range of scientific disciplines. However, do you think there are still some unexplored scientific areas with potential to use synchrotron radiation? Which?

I totally agree that synchrotron techniques are applied to a wide range of scientific disciplines: physics, chemistry, biology, materials science, cultural heritage, medicine, environment, geology, nanotechnology, food science, ... just to mention a few. I do also agree that there could be other scientific disciplines with potential to use synchrotron light. However, I see a clearer evolution of the synchrotron light in the seek for improving the techniques, solving the problem of radiation damage of samples and the development of sample environments and the combination of techniques which let investigate processes in real time and real conditions.

• Which are the main needs of the Spanish community of synchrotron radiation users'?

The main need is to have enough investment and planning this investment at medium and long term. Researchers who have proposed new beamlines for the ALBA Synchrotron - that have been positively evaluated by the SAC - will find rewarded their effort with the construction of new beamlines till reaching the nearly 30 beamlines that ALBA can host. This fact, together with an operation planning of SpLine beamline at the ESRF, will guarantee a sustainable growth of the user's community with the access of students and new users.

• Which has been the influence or impact of the ALBA Synchrotron in the Spanish community?

The positive impact of the ALBA Synchrotron inside the Spanish community of synchrotron users is obvious. As we mentioned at the beginning of the interview, the number of users has substantially grown in the last years coinciding with the operation of ALBA. A large facility like the ALBA Synchrotron creates an important synergy in the Spanish scientific community and also in the local industry and the research centres located at the Synchrotron area.

The main need is to have enough investment and planning this investment at medium and long term.

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