Probing matter at the nano-to-mesoscale in the real and reciprocal space with chemical and bond-orientation sensitivity

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ALBA II Long Beamlines Workshop

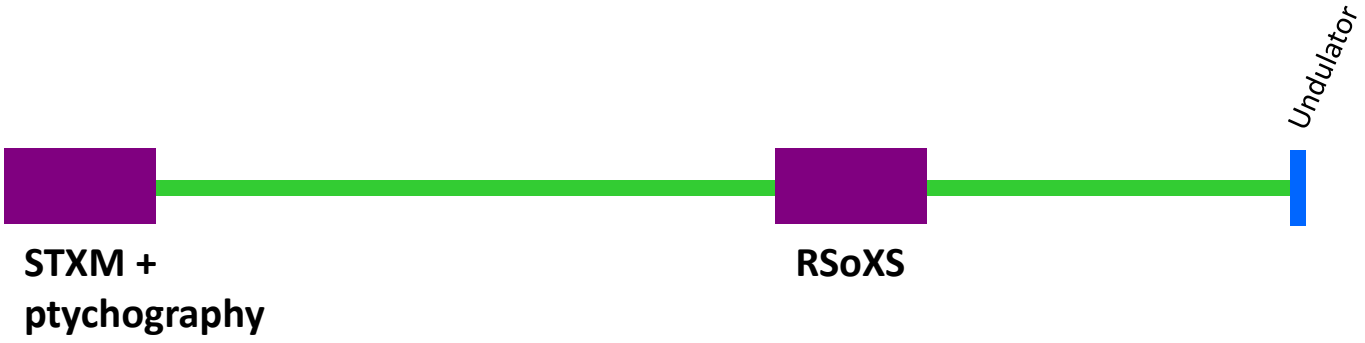
Barcelona, Spain

14th – 15th November 2022

Techniques

Beamline technique(s): Resonant Soft X-ray Scattering (RSoXS) & Scanning Transmission X-ray Microscopy (STXM) + ptychography

Two endstations:



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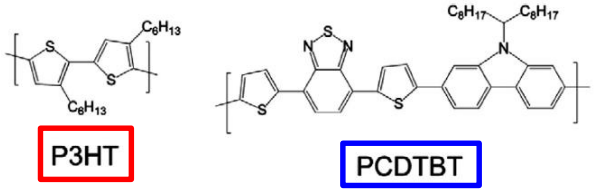
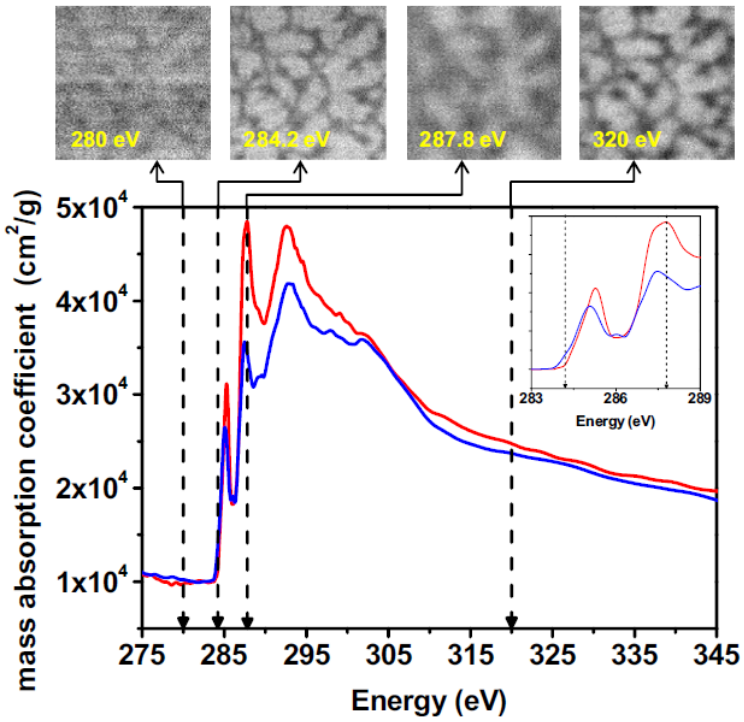
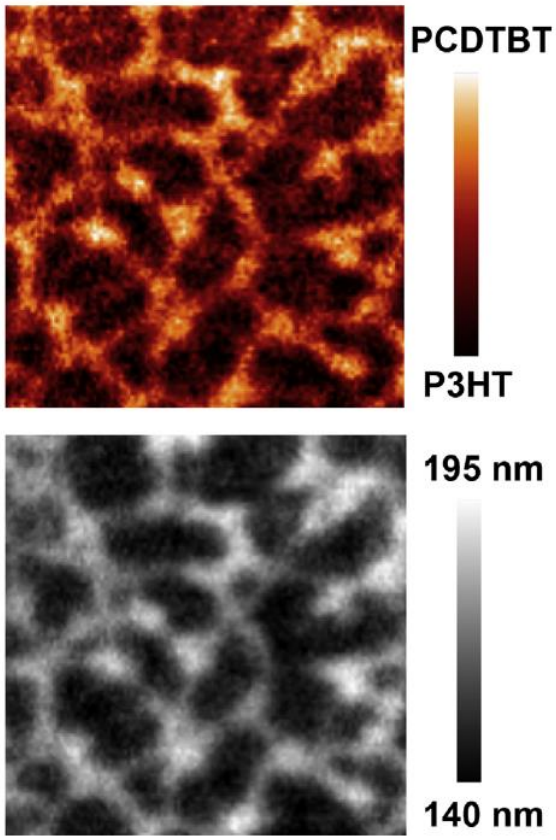
Techniques: Transmission X-ray Microscopy (STXM)

Organic electronics:



NEXAFS





6 μm x 6 μm

A. Rodríguez-Rodríguez, et al. *Polymer* 77 (2015) 70-78

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Techniques: Transmission X-ray Microscopy (STXM) + ptychography

Spatial resolution

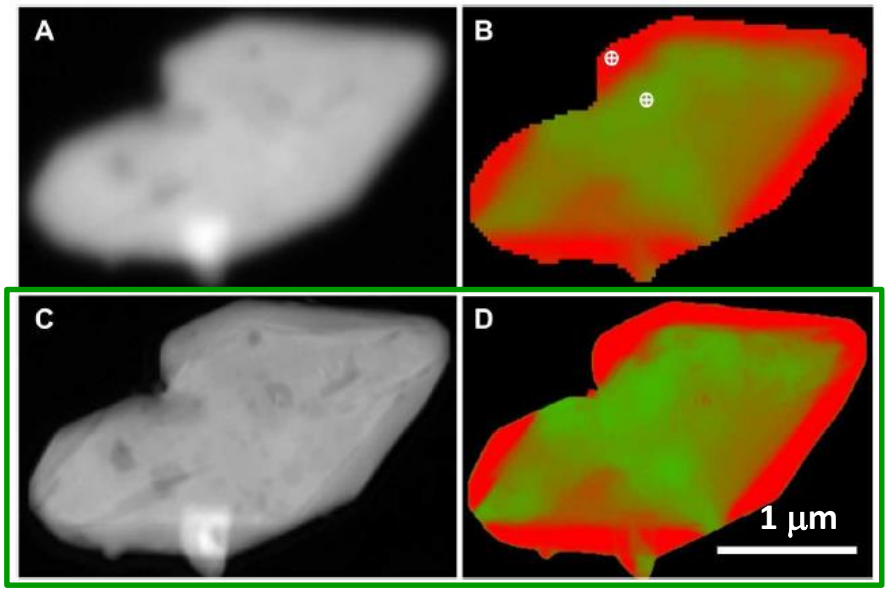
Conventional STXM: around 25 nm.

Limitations: the spot size on the sample ⟷ the quality of the X-ray focusing lenses.

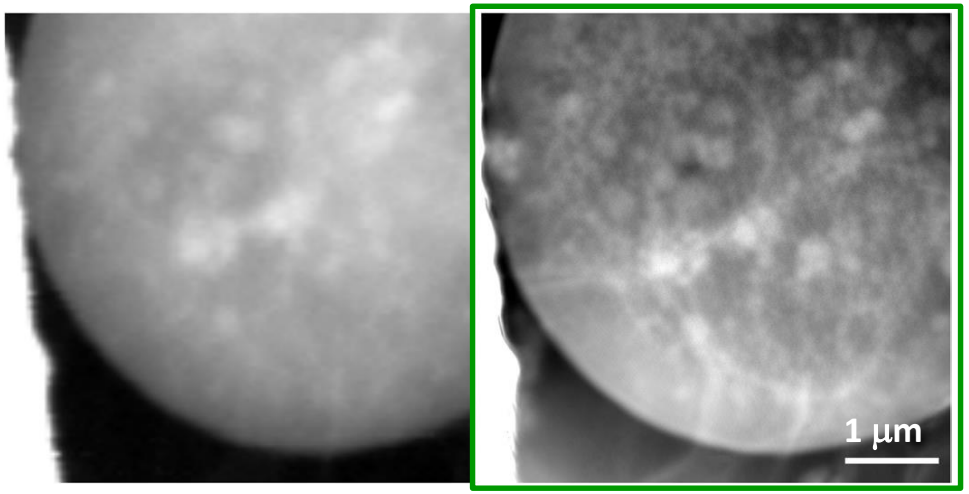
STXM + ptychography: 6 to10 nm.

Spectromicroscopy of a LixFePO4 microplatelet (battery cathode material)

Average optical density | Chemical composition map



Cryogenic microscopy of a frozen hydrated yeast cell.



D.A. Shapiro et al. *Science Advances* 6 (2020) eabc4904.

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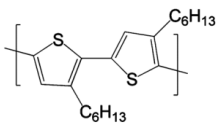
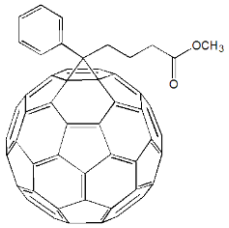
Techniques: Resonant Soft X-ray Scattering (RSoXS)

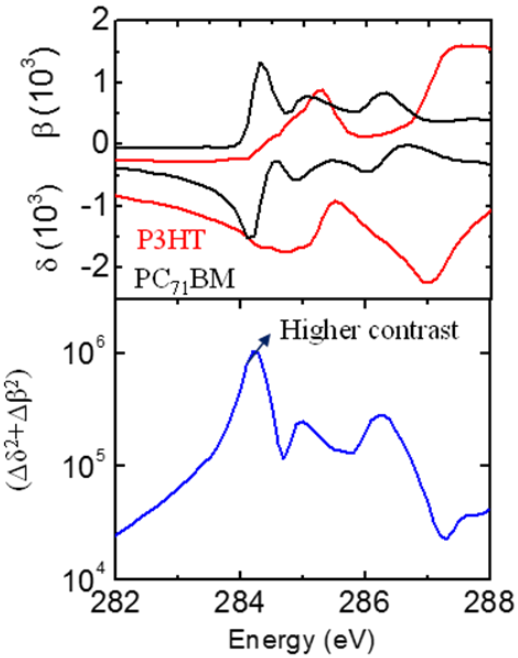


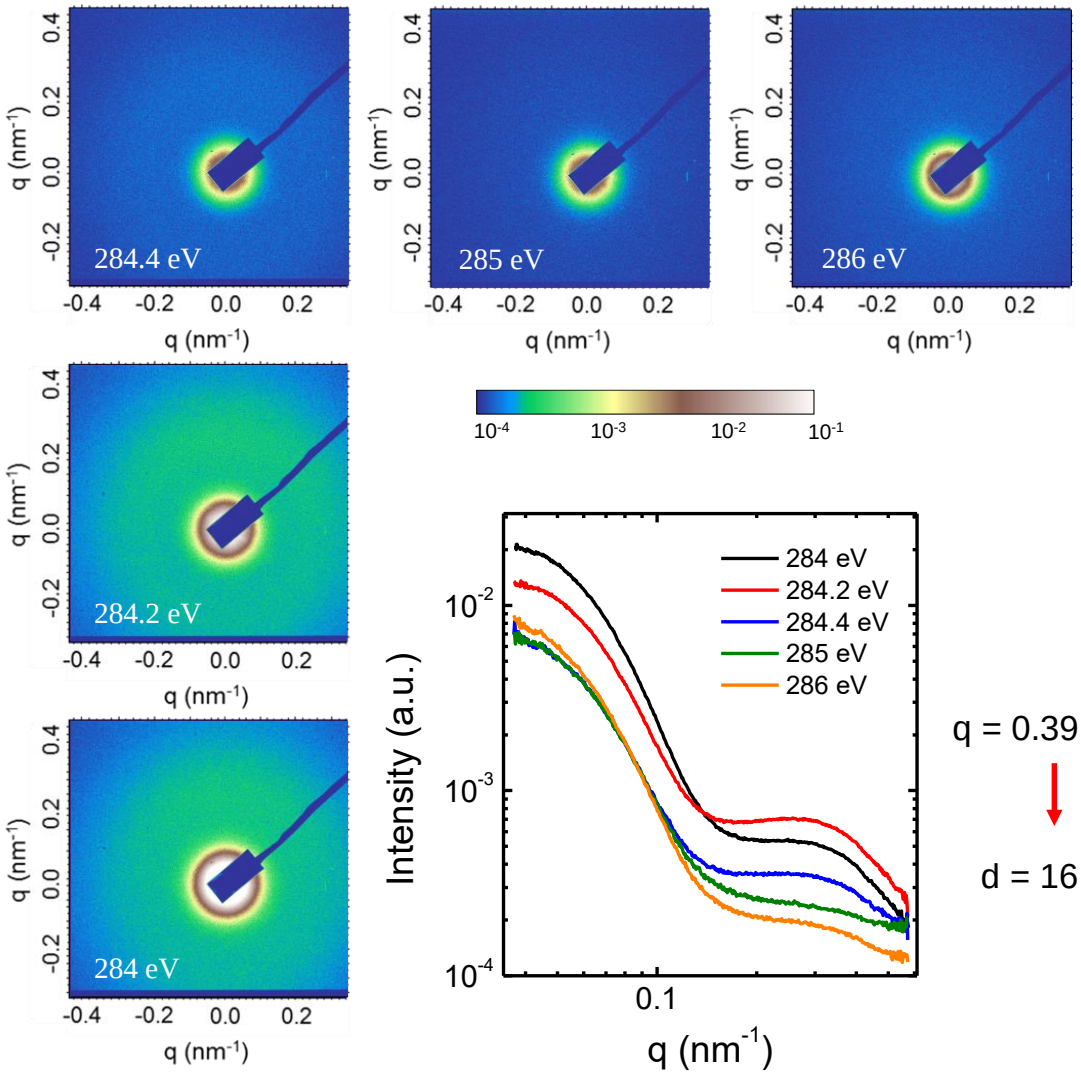
P3HT



$PC_{71}BM$

Scattering contrast





q = 0.39 nm^{-1}

d = 16 nm

A. Rodríguez-Rodríguez, M.C. García-Gutiérrez, et al. *Physical Review Materials* 2 (2018) 066003.

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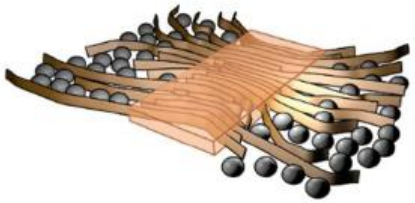
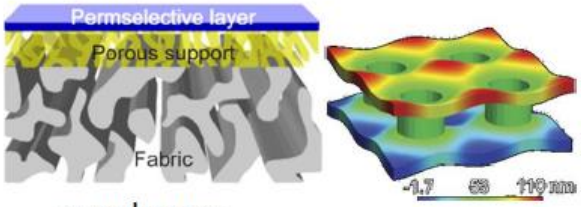
Science case



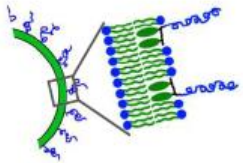
Organic Electronics



membranes

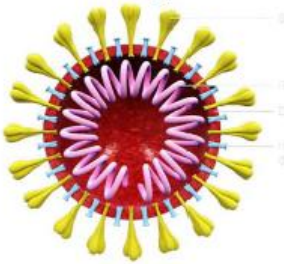
Liquid crystals

Polyelectrolyte Solutions & Gels



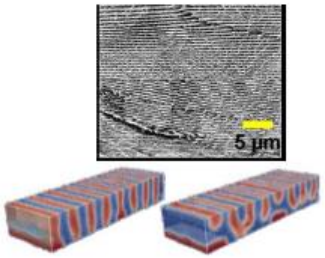
Low Z catalysis

Biology

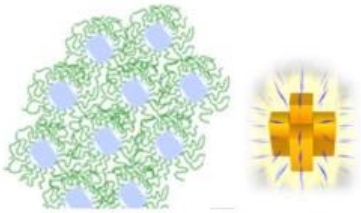


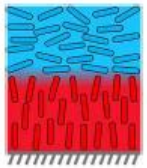
Structural Polymers

Self directed assembly



nanocomposites





Interfacial structures

Which scientific or community need will be addressed:

Soft matter in general, including: Organic electronics, liquid crystals, polyelectrolyte solutions and gels, membranes and porous materials, self direct assembly, polymers, nanocomposites, interfacial structures, low Z catalysis, biology, etc. In summary this beamline will provide solutions for the ALBA priority areas: energy, health and sustainable information technology.

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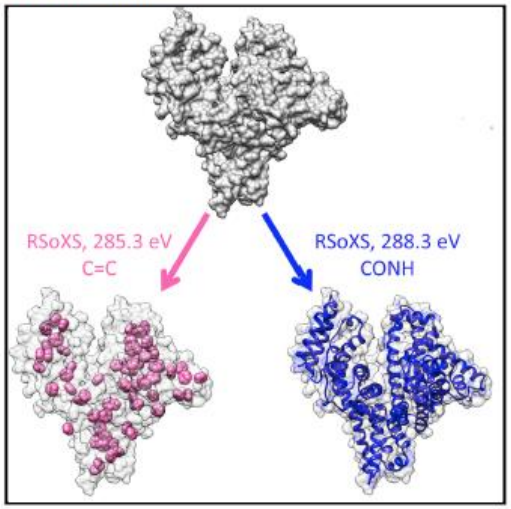
Article

Structure

Resonant Soft X-Ray Scattering Provides Protein Structure with Chemical Specificity

Graphical Abstract



Highlights

- Soft X-ray scattering provides structural information with chemical specificity
- Scattering in the soft X-ray regime enhances contrast by orders of magnitude
- Reconciling scattering at various energies leads to refined structural models
- Radiation damage is mitigated in the soft X-ray regime

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In Brief

Ye et al. de
scattering
and size of
at X-ray ab
opportunity
structure a
chemistries
promising
complex bi

Ye et al., 2018, Structure 26, 1513–1521
November 6, 2018 © 2018 Elsevier Ltd.
https://doi.org/10.1016/j.str.2018.07.018

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Research Article

In Situ X-ray Microscopy Reveals Particle Dynamics in a NiCo Dry Methane Reforming Catalyst under Operating Conditions

Abbas Beheshti Askari, Mustafa al Samarai, Bruno Morana, Lukas Tillmann, Norbert Pfänder, Aleksandra Wandzilak, Benjamin Watts, Rachid Belkhou, Martin Muhler,* and Serena DeBeer*

Cite This: *ACS Catal.* 2020, 10, 6223−6230

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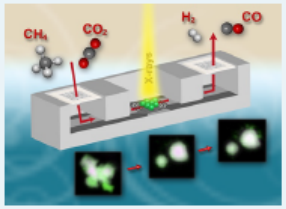
ABSTRACT: Herein, we report the synthesis of a γ-Al_2O_3-supported NiCo catalyst for dry methane reforming (DMR) and study the catalyst using in situ scanning transmission X-ray microscopy (STXM) during the reduction (activation step) and under reaction conditions. During the reduction process, the NiCo alloy particles undergo elemental segregation with Co migrating toward the center of the catalyst particles and Ni migrating to the outer surfaces. Under DMR conditions, the segregated structure is maintained, thus hinting at the importance of this structure to optimal catalytic functions. Finally, the formation of Ni-rich branches on the surface of the particles is observed during DMR, suggesting that the loss of Ni from the outer shell may play a role in the reduced stability and hence catalyst deactivation. These findings provide insights into the morphological and electronic structural changes that occur in a NiCo-based catalyst during DMR. Further, this study emphasizes the need to study catalysts under operating conditions in order to elucidate material dynamics during the reaction.



KEYWORDS: *in situ, heterogeneous catalysis, nanoreactor, methane reforming, X-ray spectroscopy, microscopy*

Science case

JACS
JOURNAL OF THE AMERICAN CHEMICAL SOCIETY
pubs.acs.org/JACS
Communication

Operando Resonant Soft X-ray Scattering Studies of Chemical Environment and Interparticle Dynamics of Cu Nanocatalysts for CO_2 Electroreduction

Yao Yang, Inwhan Roh, Sheena Louisia, Chubai Chen, Jianbo Jin, Sunmoon Yu, Miquel B. Salmeron, Cheng Wang,* and Peidong Yang*

Cite This: *J. Am. Chem. Soc.* 2022, 144, 8927–8931
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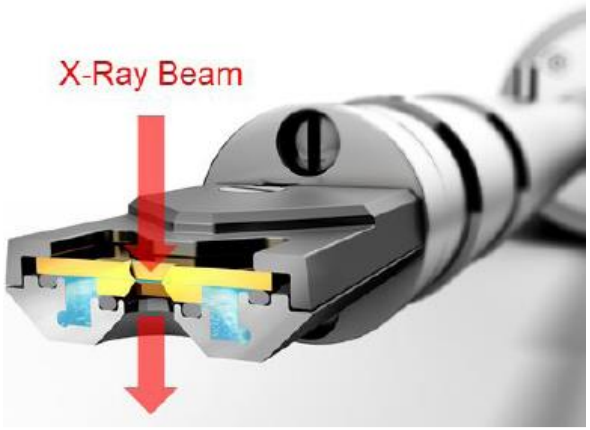

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Science case

nature COMMUNICATIONS

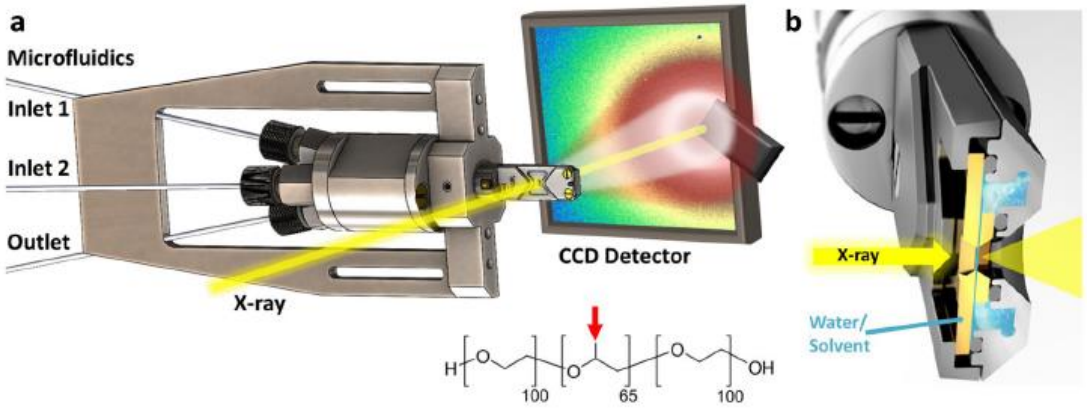
ARTICLE

https://doi.org/10.1038/s41467-021-23382-8 OPEN

Check for updates

Label-free characterization of organic nanocarriers reveals persistent single molecule cores for hydrocarbon sequestration

Terry McAfee[1,2], Thomas Ferron[1], Isvar A. Cordova[2], Phillip D. Pickett[3], Charles L. McCormick[3], Cheng Wang[2]✉ & Brian A. Collins[1]✉



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Beam properties

Beamline type: **Long; ID (elliptically polarized undulator)**

Energy range : **Soft ~ (0.1-2 KeV)**
Beam size and specific conditions: **250 μm for RSoXS and ~ 0.02 μm for STXM. Polarized beam. Coherent beam for ptychography.**

Expected benefit from ALBA II:

- Increase of total flux will be useful for decreasing exposure times and increasing speed for operando experiments.
- Decrease of beam size will improve resolution in the real space.
- Increase of beam coherence will enable ptychography as a high resolution extension of conventional STXM imaging.

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User community

Potential or existing user community (communities or also institutes):

- Soft and Polymeric Matter Group (SOFTMATPOL) Instituto de Estructura de la Materia (IEM-CSIC)
- Lasers, nanostructures and materials processing (LANAMAP) Instituto de Química Física Rocasolano (IQFR-CSIC)
- Nanostructured Functional Surfaces Group, IMDEA Nanociencia
- Chemistry of low dimensional Materials Group, IMDEA Nanociencia
- Organic Photophysics and Photonics Group, IMDEA Nanociencia
- Biomolecular Nanotechnology Group, CICbioMAGUNE
- NEMS and Nanofabrication Group, Instituto de Microelectrónica de Barcelona (IMB-CNM-CSIC)
- Multifunctional Nanocomposites Group, IMDEA Materiales
- Nanostructured Polymers and Gels Group, Instituto de Ciencia y Tecnología de Polímeros (ICTP-CSIC)
- Macromolecular Engineering Group (ICTP-CSIC)
- Functional Nanoscale Devices for Energy. Instituto de Nanotecnología de Madrid (INM-CNM-CSIC)
- Nanostructured Materials for Optoelectronics and Energy Harvesting Group (ICMAB-CSIC)
- Laboratory of Colloidal and Supramolecular Chemistry. Departamento de Química Física I, UCM
- Innovative Polymers Group, POLYMAT UPV/EHU
- Nanomidas Group, Universidad de Zaragoza
- Liquid Crystals and Polymers Group. Universidad de Zaragoza
- Martin Fabiani's Group, Loughborough University (UK)
- Laboratory for X-ray Nanoscience and Technologies (LXN), PSI
- Nano4energy

International competition:

- There are only two RSoXS facilities devoted to soft matter investigation worldwide, both of them in the States: one at ALS and a new one at NSLS-II.
- Several STXM beamlines are available around the world included Europe, but few in the Soft range with ptychography.

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