ALBA SYNCHROTRON

Food and packaging under synchrotron light

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ALBA Synchrotron in a nutshell

1st SCIENCE FACILITY IN SOUTH-WEST EUROPE

210M€ PUBLIC INVESTMENT (2011)

220 STAFF (~20% INTERNATIONAL)

2200 RESEARCHERS PER YEAR

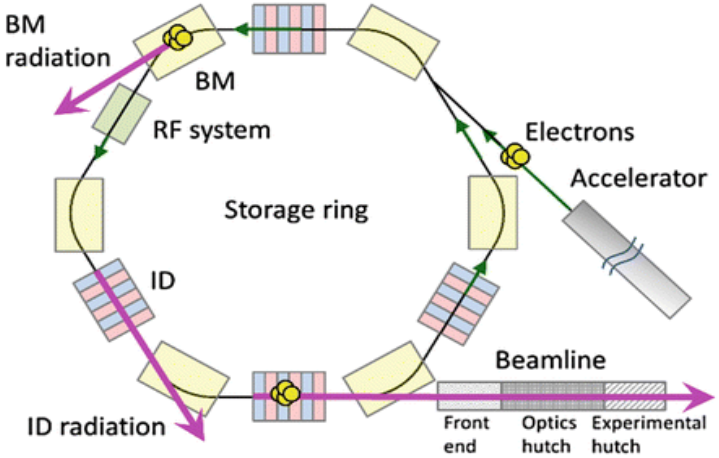
500 EXPERIMENTS PER YEAR

A large facility to study the structure at atomic scale of materials in:

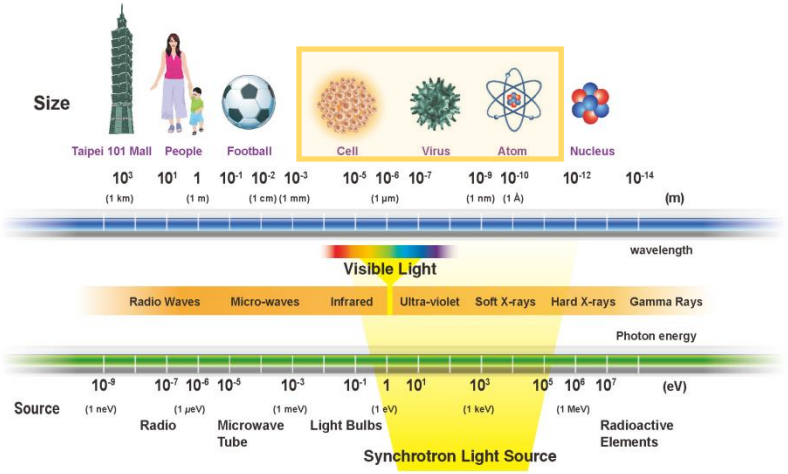
- CHEMISTRY
- PHARMACEUTICAL
- ADVANCED MATERIALS
- ENERGY
- HEALTH
- NANOTECHNOLOGY
- AUTOMOTIVE AND AEROSPATIAL
- FOOD AND PACKAGING
- ENVIRONMENT
- CULTURAL HERITAGE & FORENSIC SCIENCES

What is a synchrotron?

- A synchrotron is a particle (electrons) accelerator
- Electrons in a synchrotron travel to nearly the speed of light and generate synchrotron light (IR, UV, soft and hard X-rays)
- Synchrotron light can be used to study materials up to atomic scale like cells, viruses, proteins, drugs…



Schematic representation of a synchrotron



Synchrotron light range in the electromagnetic spectrum

- Synchrotron light outperforms conventional light sources: higher resolution, better detection levels, faster measurements…

WHY ?

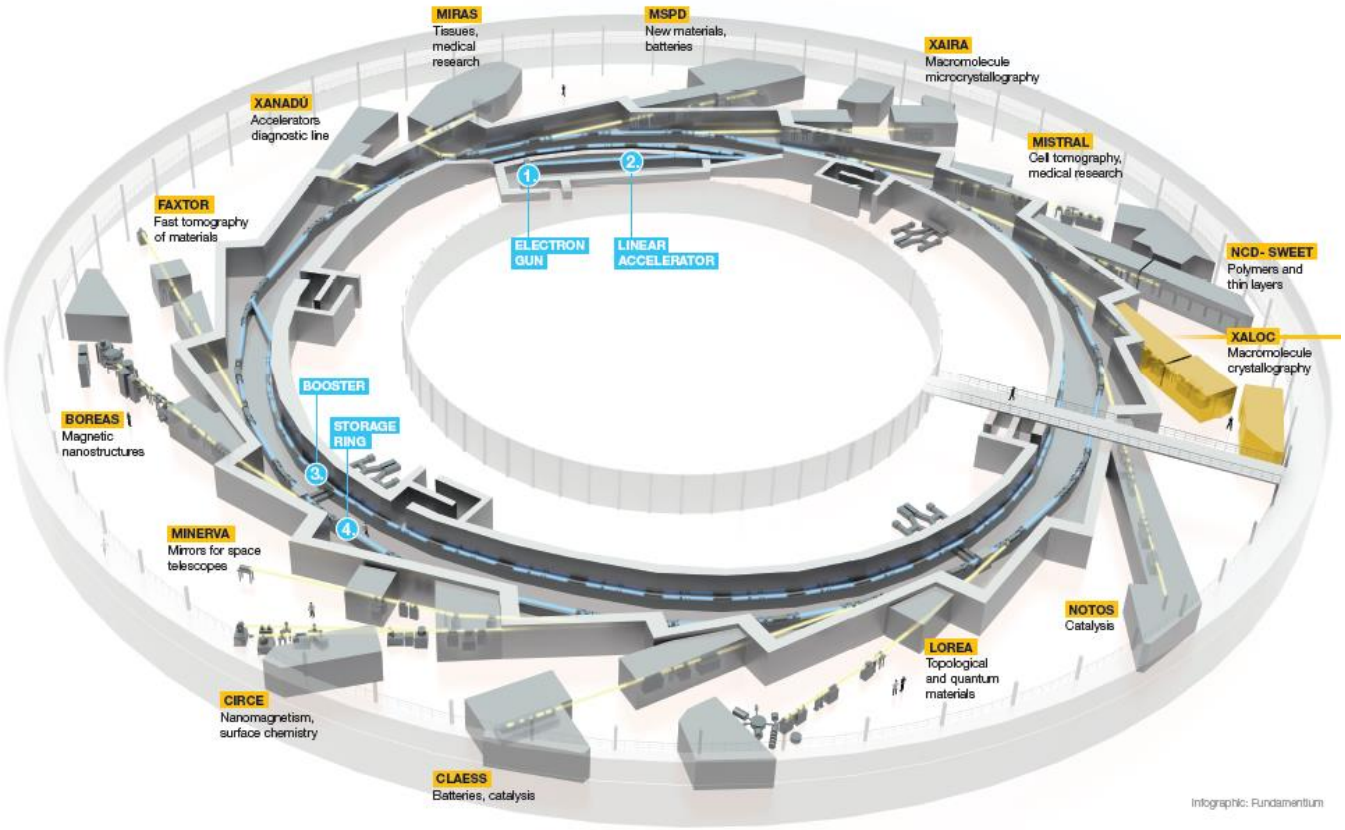
DO COMPANIES USE ALBA SYNCHROTRON?

ALBA Synchrotron techniques provide **outstanding results** that cannot be achieved with other equipment and techniques and which are very valuable in boosting a company's competitiveness.

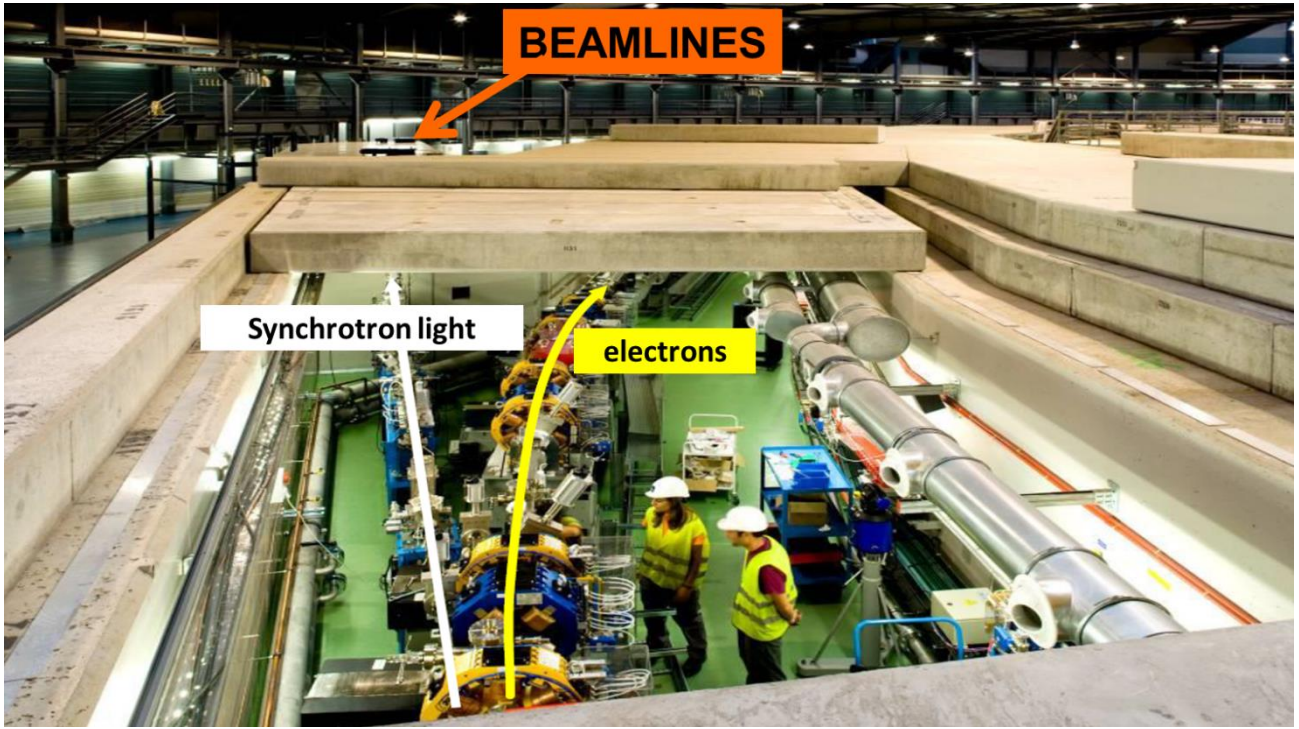
- LOWER DETECTION LEVELS
- CHEMICAL MAPPING
- OXIDATION STATE DETERMINATION
- HIGHER RESOLUTION
- FASTER EXPERIMENTS
- WIDE VARIETY OF SAMPLE ENVIRONMENTS

The ALBA Synchrotron

10 beamlines (X-ray laboratories) with different techniques



This is how it actually looks



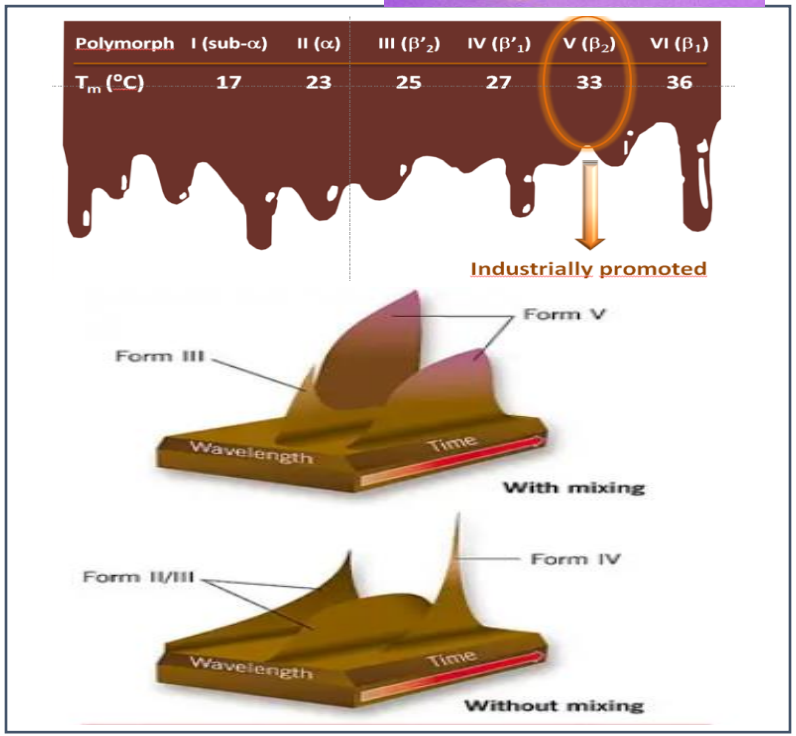
ALBA

SAXS-WAXS

Making better chocolate

Cadbury, one of the first very important industrial applications, 1998 (SRS-Daresbury, UK)

- The taste of chocolate depends on the predominant crystalline forms generated when the chocolate cools down in the factory.
- Six different crystalline forms: Form V produces good taste (smooth texture). Form III produces poor taste (brittle)!
- Synchrotron measurements at different cooling temperatures and mixing conditions were done.
- Form V is predominant when cocoa butter is mixed and the temperature is above 23.86 °C.
- The data obtained helped Cadbury to determine the optimum conditions for good tasting chocolate manufacturing.
- Cadbury lowered tempering temperatures significantly, bringing energy and cost savings, and optimized a complex process, with subsequent benefits to profits.



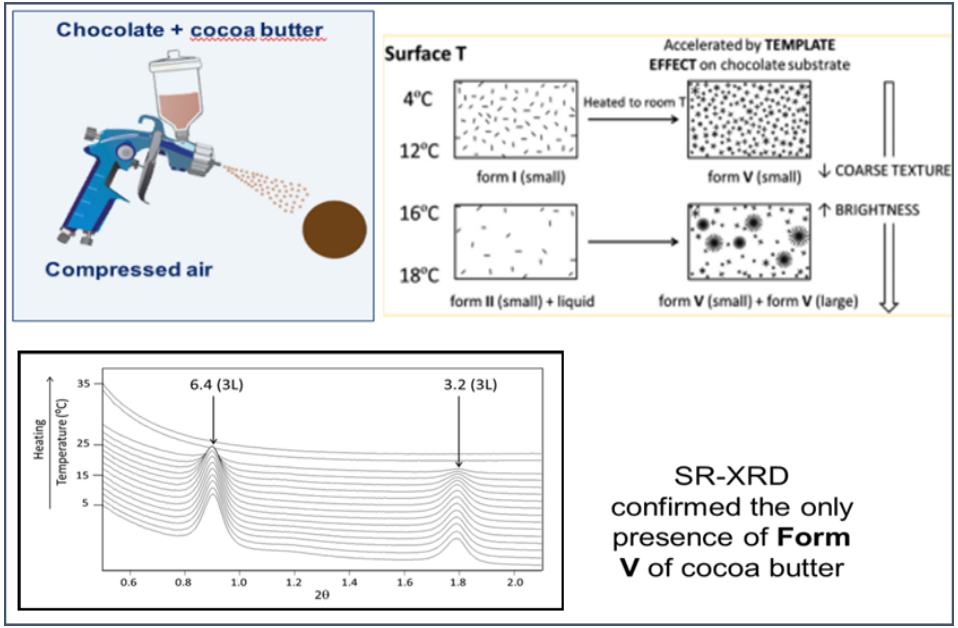
Source: www.newscientist.com/article/mg15821331-100-cool-chocolate/

SAXS-WAXS

Chocolate with velvet texture

Characterization of the velvet effect (Enric Rovira chocolates)

- ❑ Experiment performed at NCD BL (ALBA)
- ❑ Characterization of the velvet chocolate with soft mouthfeel.
- ❑ Thin layers of cocoa butter crystals were formed using a compressed air gun.
- ❑ Different temperatures of crystallization: 4ºC, 12ºC, 16ºC, 18ºC and different substrates.
- ❑ Influence of the surface temperature(supercooling).
- ❑ The velvet effect is caused by the formation of large and small crystals of form V.
- ❑ The velvet effect is enhanced when using low temperature and low cooling rates.



Source: Bayés-García, L. et al. Cryst. Growth Des. 2015, 15, 4045.

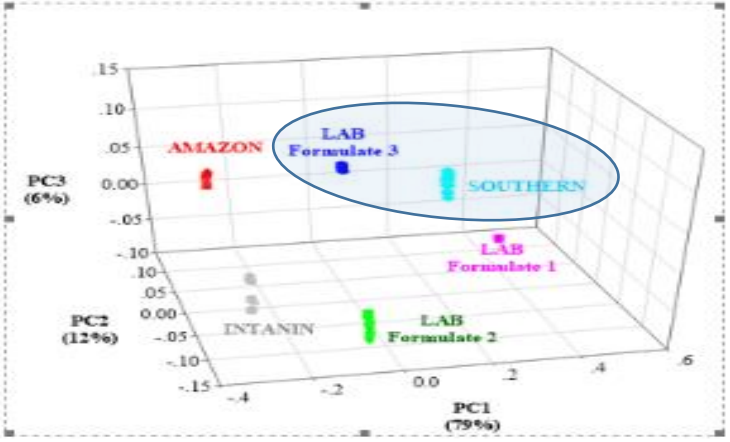
Fresh ready-to-drink coffee

Fresh coffee and ready-to-drink coffee

SR-FTIR

- Southern Coffee Co. wanted to produce fresh ready-to-drink coffee in sealed packaging with a quality closest to fresh coffee and a shelf life of over 3 months at room temperature.
- Suranaree University and Thailand Synchrotron co-studied and developed fresh coffee in 150 ml glass to keep the freshness and fragrance of coffee.
- Synchrotron FTIR spectroscopy was used to examine the components of ready-to-drink coffee samples and compare them with fresh coffee with higher details than conventional FTIR.
- Coffee from the modified formulation (Lab Formulate 3) was more similar to Southern coffee than the other formulas tested.
- The technique was used as "Biomarker" to detect small differences/similarities between fresh and ready-to-drink coffee.

Ready-to-drink coffee formulations



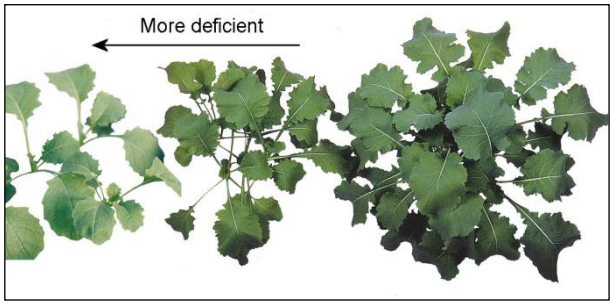
https://www.slri.or.th/en/list-research/472-formula-development-of-fresh-ready-to-drink-coffee-with-synchrotron.html

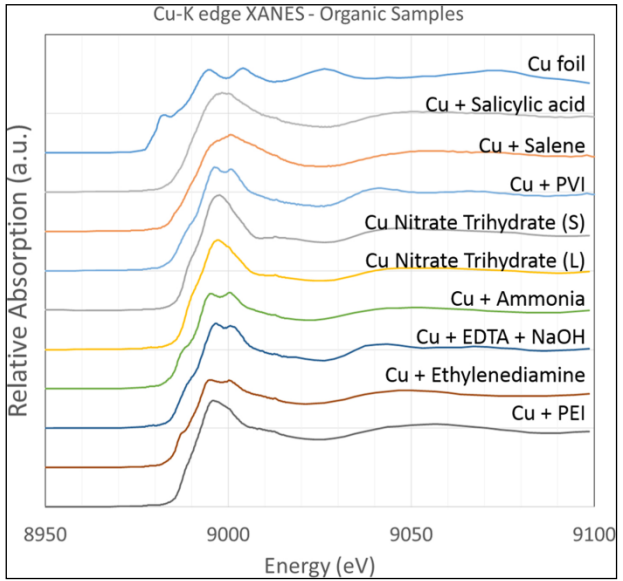
Agricultural products

Copper complexes for slow release in plants

XANES

- Copper (II) is an essential micronutrient that acts as a growth stimulator.
- Sometimes Cu(II) is complexed with different chelating agents for its slow delivery to plant tissue.
- X-ray absorption spectra is different for different oxidation states and species and therefore can determine the amount of Cu-chelated and Cu-free.
- The results may help agricultural industry to understand the release of Cu(II) in plants and will allow the production of improved Cu(II) products for its slow release on plants.
- X-ray absorption is a very powerful technique to determine oxidation states and chemical species/complexes. Very important for agricultural products.





Mechanical deformation of bionanocomposites

Poly(lactic acid) mixed with montmorillonite as bionanocomposites

SAXS-WAXS

- Poly-Lactic Acid (PLA) is a thermoplastic polyester derived from renewable sources such as sugar, corn, potatoes, etc.
- PLA is transparent, biocompatible and biodegradable, and has potential in packaging. But is brittle and mechanically weak.
- The mechanical properties of PLA blended with natural rubber (NR) and nanoclay (C15A) were studied and correlated with structural properties using SAX/WAXS.
- PLA is a brittle material due to failures through crazes. PLA/NR is ductile as it forms voids when stretched. PLA/NR/C15A bionanocomposites generate crazes that allows polymer chain orientation and elongation.
- By SAXS/WAXS measurements the structure of polymers can be understood and thus modified to tune the properties of plastics and polymers.

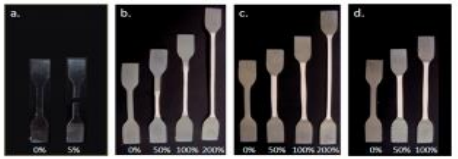
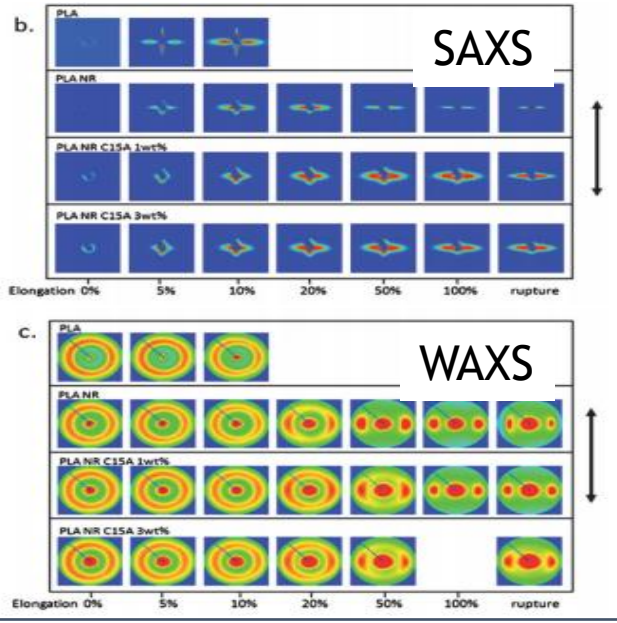


Fig. 4 Samples stretched at different elongations (a) PLA, (b) PLA/NR, (c) PLA/NR/C15A 1 wt%, (d) PLA/NR/C15A 3 wt%.



Source: N. Bitinis et al. Soft Matter 2012, 8, 8990-8997.

Food analysis

Identificación de especies químicas características de la denominación de origen

Transiciones de fase en grasas, actividad reológica de pastas alimenticias

Dinámica y estabilidad de emulsiones de alimentos

JAMÓN

- Técnica XAS (BL22-CLAESS).
- Cambios en los estados de oxidación de los iones de hierro y zinc en la carne de cerdo
- Comparación entre jamones curados de distintas DO y distinto tiempo de curación
- Se identificaron posibles biomarcadores

TRIGLICÉRIDOS

- Técnicas SAXS y WAXS (BL11-NCD).
- Microestructura de los cristales de lípidos
- Composición en ácidos grasos: polimorfos
- Adaptación de propiedades fisico-químicas a aplicaciones farmacéuticas, cosméticos y alimenticias

ALIMENTOS SACIANTES

- Técnicas SAXS y WAXS (BL11-NCD).
- Glucomannan: fibra con gran capacidad de incharse.
- Se debe mezclar con otro componente que le de estabilidad: quitosano
- Los resultados indicaron que las mezclas que funcionaban mejor al pH del estómago eran las que contenían mayor contenido de glucomannan.

Food analysis

Cambios estructurales de botellas de plástico, embalajes

Mapeado químico de plantas, semillas, granos, algas, etc.

Toxicidad de carnes, pescados, verduras, legumbres y hortalizas

POLÍMEROS

- Técnicas SAXS y WAXS (BL11-NCD).
- Estudio de la formación de estructuras con distinto grado de cristalización
- Medidas en tiempo real y a temperatura variable de a formación de mesofases en varios polímeros
- Tunear la rigidez o plasticidad de polímeros para gran variedad de aplicaciones

ALIMENTOS FUNCIONALES

- Técnica XAS (BL22-CLAESS).
- Estudio de trigo enriquecido con Selenio
- Caracterización de la absorción de Se en raíz, tallo, hoja y grano
- Determinación de las mejores prácticas para enriquecer los cultivos de trigo

OSTRAS

- Técnica XAS (BL22-CLAESS).
- Estudio de los metales pesados en ostras de distinto origen
- Caracterización de las distintas especies químicas presentes en ostras
- Determinación de la toxicidad de ostras de la ribera del mediterráneo

Long term contract between HENKEL and ALBA

BASF, UPC and ALBA propose a methodology for producing better additives for concrete technology

SAMTACK benefits from synchrotron light for improving food packaging

The company is analysing nanoparticles contained in a new food packaging system that will prevent food oxidation and extend its lifetime.

ESTEVE, UAB and ALBA Synchrotron join efforts to investigate the mechanism of action of new inhibitors against pain

TOYOTA and CSIC proved viability of calcium-based batteries

The Spanish Research Council (CSIC) in collaboration with TOYOTA Motor Europe (TME) demonstrates the viability of Calcium rechargeable batteries using ALBA techniques.

ENANTIA uses ALBA's X-rays to detect crystalline impurities in drug products

CALIPSOplus – H2020 European Project

Convenient Access to Light Sources Open to Innovation, Science and to the World

SME free analysis at ALBA Synchrotron

- ***Free measurements can be granted at ALBA to SMEs through CALIPSOplus funding.***
- ***Rapid access for Covid-19 projects***
- ***ALBA (industrialoffice@cells.es) will help.***

CALIPSOplus has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730872

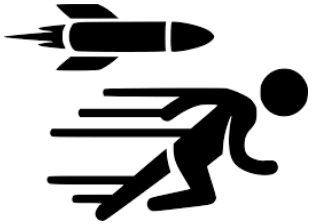
ALBA seeks actively ways to support clients

- ***Supporting Small and Medium Enterprises (SME) free access to synchrotrons following the European rules:***
  - ***CALIPSOplus project***
  - ***LEAPS-INNOV project***
- ***Sharing experiences with other synchrotrons to improve the services provided to the clients:***
  - ***SYLINDA project (with SOLARIS synchrotron at Poland)***
  - ***European Industrial Liaison Offices networking***

- ✓ Synchrotron light is very powerful to characterize in depth agrifood products.
- ✓ ALBA Synchrotron is at the service of the scientific and industrial community
- ✓ ALBA provides results focused on the company's specifics needs.
- ✓ The industrial office of ALBA provides easy access to industry through one-stop shop.
- ✓ Free analysis are available for SMEs through TamaTA project.

HOW

TO CONTACT ALBA ?



FAST

CONFIDENTIAL

FULL SERVICE

industrialoffice@cells.es

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THANK YOU!