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In-situ Correlative facility for Advanced Energy Materials (In-CAEM)

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Within the Complementary Plans Program in Advanced Materials, a correlative facility for in-situ experiments directly linked to the ALBA Synchrotron will be soon launched launched in Catalonia. Its aim is to enable correlative in-situ (S)TEM, AFM/STM and Synchrotron Radiation (SR) experiments to address some of the scientific challenges of the European Green Deal plan, and thus promote a more sustainable EU economy. Its budget is co-financed by the Ministry of Science and Innovation through MRR funds and by the Department of Research and Universities of the Generalitat of Catalonia with its own funds.

The In-situ Correlative Facility for Advanced Energy Materials (In-CAEM) is conceived as a key tool to address the challenges of materials advanced characterization, down to the atomic scale, analyzed in working conditions/in-situ/ operando, and under controlled environment in gas or liquid.

For example, in advanced catalyst materials for energy applications, which are primarily based on metal-based oxides and nanostructures, small surface changes at the atomic level, such as the presence of dopants, vacancies, holes, or slight differences in atomic structure can strongly influence their final behavior. Current state-of-the-art characterization methods are insufficient for the simultaneous observation of atomic structure and measurement of local physical/chemical properties. The combination of chemical and structural characterization at the atomic scale with in-situ measurements at the nanoscale, based on a powerful combination of electron microscopy and synchrotron techniques on the same nanostructure, will allow a much better understanding of these chemical reactions.

The present proposal includes an electron microscope with in-situ detectors, gas and liquid sample holders for in-situ analysis, the adaptation of existing synchrotron beamlines at ALBA for correlative analyses with TEM, STM/AFM equipment to combine improved Raman spectroscopy (TERS), and various advanced STM/AFM on-site equipment. The project also has an advanced computing system for data storage, data processing, and in-situ data analysis using automated protocols based on artificial intelligence.

In-CAEM is part of the Joint Electron Microscope Center at ALBA, a new infrastructure that has been created in the perimeter area of the ALBA synchrotron with an inter-institutional collaboration model. JEMCA currently hosts two instruments (illustrated in the figures) co-financed by FEDER funds from GenCAT and different research institutes, which share their time of use with external users who access through a competitive process. In particular the 200 kV CRYO-TEM, dedicated to life sciences, already open to users, managed by the Barcelona Institute of Molecular Biology (IBMB-CSIC) and METCAM, a monochromated and double corrected 300 kV STEM, in the process of being installed, managed by the Catalan Institute of Nanoscience and Nanotechnology (ICN2). In-CAEM follows the EMCA collaboration model, with the participation of different institutes in the construction, start-up and operation, in particular, in addition to the ALBA synchrotron itself, the ICN2, the Institut de Fisica d'Altes Energies (IFAE) , both CERCA centers and members of BIST, and the Institute of Materials Science of Barcelona (ICMAB-CSIC), which together with the ICN2 forms part of the network of centers linked to the CSIC. In-CAEM is complementary to METCAM. Its usage model foresees LongTerm Projects and competitive access and particular attention to industrial users.

Presenter: ARBIOL, Jordi (ICREA and Institut Català de Nanociència i Nanotecnologia (ICN2), CSIC & BIST)

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