Canadian Light Source | Centre canadien de rayonnement synchrotron

Bringing the power of synchrotron-based tools to advanced materials science and research.

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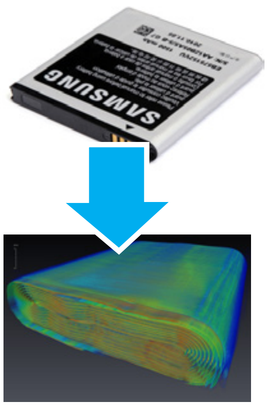
ADVANCED MATERIALS

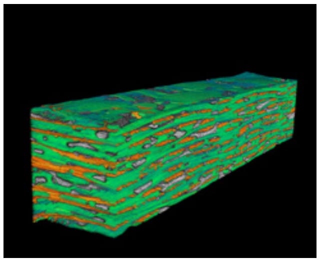
Energy Materials:



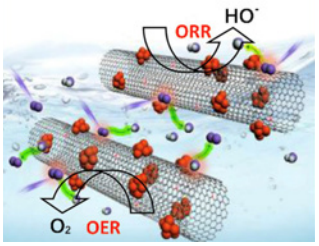
Synchrotron techniques provide a way to observe changes in material properties such as oxidation state or crystalline phase. They also allow the non-destructive, in-situ analysis of complex electrochemical reactions in operating devices. Many synchrotron techniques are element specific, which is especially important for targeted analysis of alloy-based electrode materials.

Engineering Materials:

Uncovering the complex physical and chemical interactions between the components of composite materials is a unique advantage of synchrotron-based techniques. Synchrotron-based X-ray imaging has proven extremely useful for imaging the microstructure of composite materials like carbon fiber, alloys, fiberglass and laminar structures. It is also much faster than conventional techniques, allowing in-situ imaging of defects, damage, stress and manufacturing processes like resin curing.

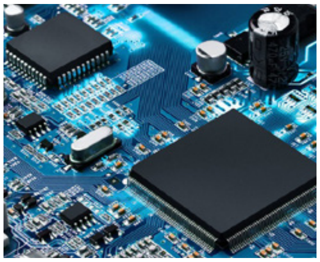


Catalysts:



Catalysis is a well-established application of synchrotron spectroscopy, where experiments can be carried out in-situ or in-operando to monitor changes in metal chemistry and reaction intermediates. Synchrotron-based spectroscopy is uniquely suited for the chemical analysis of catalytic systems, and many techniques are surface sensitive and element specific, allowing targeted analysis of complex catalytic reactions. These techniques provide direct information on important catalytic properties like oxidation state, crystalline phase and coordination chemistry.

Electronic Materials:



The current electronics industry is largely based on silicon but scientists from around the world have been using synchrotron-based tools to explore the novel functions of next generation electronic materials. Advanced technologies allow scientists to design and fabricate new materials at atomic level and to explore the exotic properties that can only exist in thin films or interfaces.

The Canadian Light Source synchrotron is a national research facility located on the campus of the University of Saskatchewan that offers innovative and unique-in-Canada infrastructure and support for research. Synchrotron-based techniques help scientists probe the nature and structure of molecules and materials, making the CLS a valuable tool for both academic and commercial clients.

TECHNIQUES

X-ray Diffraction/Scattering provides detailed information about the identity and structure of crystalline materials.

Computed Tomography (CT) provides internal 3D structures of samples. Synchrotron CT is many times faster and more sensitive than lab-based CT, and is ideal for monitoring dynamic processes under in-situ or in-operando conditions.

X-ray Imaging (including Spectro-Microscopy and X-ray Fluorescence Mapping) provide element specific imaging down to sub-micron level resolution.

X-ray absorption spectroscopy (XAS) is an extremely powerful technique that provides detailed chemical information on specific elements in a sample.

X-ray photoelectron spectroscopy (XPS) has many advantages over lab-based XPS, including variable penetration depth and greatly improved spectral resolution for resolving similar chemical species.

SYNCHROTRON ADVANTAGES

- **Higher resolutions are usually attainable, allowing more detailed structure analysis**
- **High intensity of light allows for short experiment times on small sample sizes**
- **Non-destructive analysis**
- **In-situ experimentation at operational conditions**
- **Trace detection of impurities and their chemical speciation**

SERVICES

Beam time accesses are customized to meet the needs of clients, including experiment design, sample preparation, data collection, analysis and report writing.

Industry Access

Purchased access offers industrial clients quick and accurate solutions to proprietary questions. CLS scientists develop an experimental plan based on the client's needs, and conduct all data collection and analysis, resulting in a detailed report with key answers to critical questions.

Academic Access

Academic clients can submit proposals through peer review process. The beam time is granted based on scientific merit, free of charge. Purchased rapid access is also available for instrument or beam time.

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CASE STUDY

Catalyst with Superior Activity for Energy Conversion

A fundamental understanding of the origin of oxygen evolution reaction (OER) activity of transition-metal-based electrocatalysts, especially for single precious metal atoms supported on layered double hydroxides (LDHs), is crucial for the design of efficient electrocatalysts toward better energy conversion technologies. Single-atom Au decorated NiFe layered double hydroxide (^{s}Au/NiFe LDH) shows a 6-fold OER activity enhancement compared to pure LDH. The single Au-atom was identified through both HAADF-STEM and the Au L_3-edge XANES spectra comparing with the theoretical simulations. The active behavior of NiFe LDH results from the in situ generated NiFe oxyhydroxide from LDH during the OER process.

DOI: 10.1021/jacs.8b00752

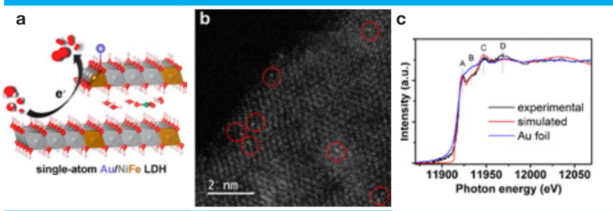

Figure 1 A) Two-layer DFT slab model for the ^{s}Au/NiFe LDH with interlayer CO_3^{2-} anions and water molecules; B) HAADF-STEM; C) Comparison of Au L_3-edge XANES of ^{s}Au/NiFe LDH, Au foil, and DFT guided theoretical modeling.

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