CONTACT

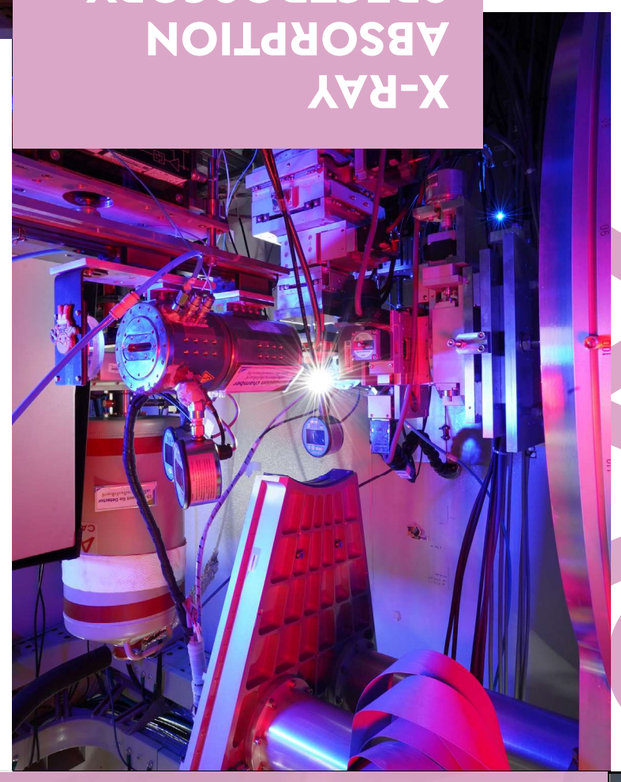
X-ray Spectroscopy Section
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SYNCHROTRON LIGHT RESEARCH INSTITUTE
(PUBLIC ORGANIZATION)

XAS

X-RAY ABSORPTION SPECTROSCOPY (XAS)

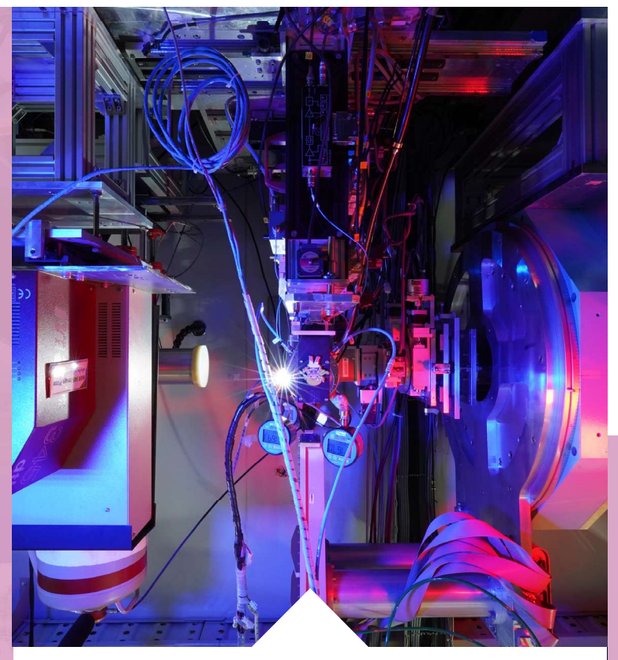


PRINCIPLE INFORMATION

X-ray Absorption Spectroscopy (XAS) is a synchrotron-based analytical technique used to investigate the electronic and local atomic structures of materials with element-specific precision. By measuring the absorption of X-rays as a function of photon energy across the absorption edge of a target element, XAS provides two key types of structural information:

(1) X-ray Absorption Near Edge Structure (XANES), which reveals oxidation states, chemical environments, and electronic configurations; and

(2) Extended X-ray Absorption Fine Structure (EXAFS), which identifies coordination numbers, interatomic distances, and the geometric arrangement surrounding the absorbing atom.



TECHNICAL SPECIFICATION

At SLRI, X-ray Absorption Spectroscopy (XAS) is supported through six experimental beamlines: BL1.1W, BL2.2, BL5.1W, BL5.2, BL7.2W, and BL8

Category	Specification
Beamline	BL1.1W MXT
Photon Energy Range	4 – 18 keV
Photon Flux (Full beam)	10^{10} ph/s
X-ray Beam Size	6 mm (H) × 4 mm (V)
Mode of Measurement	1. Transmission 2. Fluorescence (19-element germanium detector, 19GeD) 3. Grazing-incidence XAS
Sample Environment	**Ex-situ** : Powder, Liquid, Solid **In-situ** : - Octagon furnace for in-situ heating (25-800 °C) - In-situ UV-VIS spectroscopy and octagon furnace heating unit - Dome hot stage for in-situ heating (25-1100 °C) - Electrochemical cell for 3-electrode setup - In-situ cell integrated with Raman spectroscopy

Category	Specification
Beamline	BL2.2 TRXAS
Photon Energy Range	4 – 13 keV
Photon Flux (Full beam)	10^{8} ph/s
X-ray Beam Size	1 mm (H) × 2 mm (V)
Mode of Measurement	Transmission (NMOS linear image sensor, 1024 pixels with scintillator, Hamamatsu)
Sample Environment	**Ex-situ**: Powder, Liquid In-situ: Heating cell (max 700 °C), Electrochemical cell, Gas support: H_2, CH_4, CO_2 **Advanced In-situ**: Cell integrated with GasChromatography (GC) and Mass Spectrometry (MS)

Category	Specification
Beamline	BL5.2: XAS
Photon Energy Range	1.8 – 13 keV
Photon Flux (Full beam)	10^{10} ph/s
X-ray Beam Size	13 mm (H) × 1 mm (V)
Mode of Measurement	1. Transmission 2. Fluorescence (4-element Silicon Drift Detector, 4 SDD)
Sample Environment	**Ex-situ**: Powder form, Liquid form, Solid form **In-situ**: Heating cell (max 1000 °C), Gas support: H_2, CO_2 **Advanced In-situ**: Cell integrated with Gas Chromatography (GC)

Category	Specification
Beamline	BL8: XAS
Photon Energy Range	1 – 13 keV
Photon Flux (Full beam)	10^{11} ph/s
X-ray Beam Size	13 mm (H) × 1 mm (V)
Mode of Measurement	1. Transmission 2. Fluorescence 2.1 13-element Germanium Detector (13GeD) 2.2 7-element Silicon Drift Detector (7SDD) 2.3 13-element Silicon Drift Detector (13SDD)
Sample Environment	Ex-situ: Powder form, Liquid form, Solid form In-situ: Heating cell (maximum temperature 800 °C)

Category	Specification
Beamline	BL5.1W: XAS
Photon Energy Range	5 – 30 keV
Photon Flux (Full beam)	10^{9} ph/s
X-ray Beam Size	3 mm (H) × 3 mm (V)
Mode of Measurement	1. Transmission 2. Fluorescence (1-element Silicon Drift Detector, 1 SDD)
Sample Environment	**Ex-situ**: Powder form, Liquid form, Solid form

Category	Specification
Beamline	BL7.2W: XAS
Photon Energy Range	4 – 22.7 keV
Photon Flux (Full beam)	10^{11} ph/s
X-ray Beam Size	3 mm (H) × 2 mm (V)
Mode of Measurement	1. Transmission 2. Fluorescence (4-element Silicon Drift Detector, 4 SDD) 3. Grazing-incidence XAS 4. Micro-XAS
Sample Environment	Ex-situ: Powder form, Liquid form, Solid form In-situ: - Octagon furnace for in-situ heating (25-800 °C) - Dome hot stage for in-situ heating (25-1100 °C) - Electrochemical cell for 3-electrode setup



XAS END STATION

SDGs SUPPORT





BL1.1: MXT END STATION

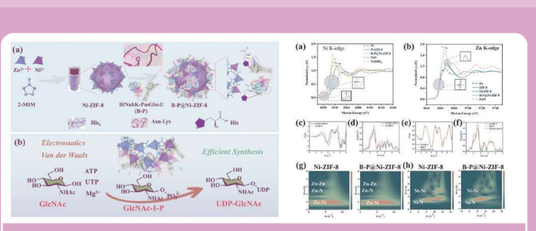


BL2.2: TRXAS END STATION

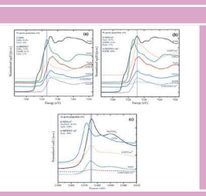


BL5.2: XAS END STATION

Result/Application

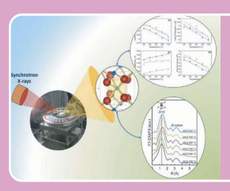


Spatial Organization of an Enzyme Cascade in Ni-ZIF-8 Framework for Efficient Sugar Nucleotide Synthesis (DOI: 10.1039/D5GC06007A)



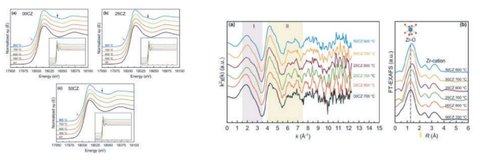
Utilization of Agricultural Waste : Mango Peels and Pineapple Crown Leaves as Precursors for Nanomaterial Production for Arsenate Remediation

(DOI: 10.1007/s11356-025-36534-w)



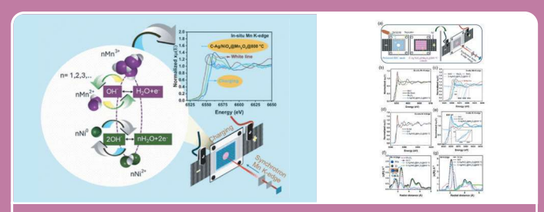
Thermal-Induced Structural Behavior in CaO- Doped ZrO_2 Nanocrystals: A High-Temperature Synchrotron XRD and XAS Study

(DOI: 10.1016/j.nanoso.2025.101470)

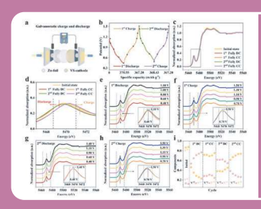


In situ X-ray Absorption Spectroscopy (XAS) at the Zr Kedge was employed to investigate the local electronic and atomic structure of CaO doped ZrO_2 nanocrystals during high temperature treatment.

Result/Application



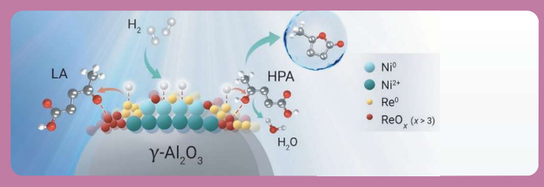
ElucidatingMn^{2+}/Mn^{3+}andNi0/Ni^{2+}RedoxSynergyinHair-Derived Carbon Supported Ag/Ni–MnOx Supercapacitor (https://doi.org/10.1021/acsami.5c07064)



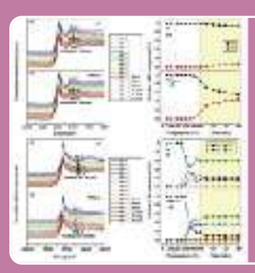
Sulfur-Doped Vanadium Oxide for High-Performance and Stable Cathode Material of Zinc-Ion Batteries

(DOI:10.1002/adfm.202524100)

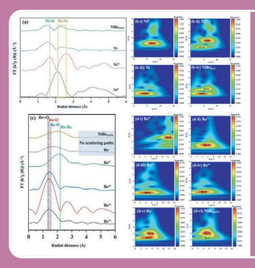
a) Schematic illustration of in situ XAS experiments for Zn-ion batteries. b) The discharging and charging curve of VS-450 during an in situ XAS experiment. (a) XANES spectra of the V K-edges c,d) of the first full 2 cycles of discharge and charge of VS-450, and zoomed in range 5467–5473 eV. e,g) the 1st and 2nd discharge cycles. f,h) the 1st and 2nd charge cycles during the experiment at each voltage. i) The linear combination fitting of V+4 and V+5 of the 1st and 2nd discharge–charge cycle.



Enhancement of hydrogenation activity by synergistically promoting Re booster in Ni/Al_2O_3 catalyst for selectively converting levulinic acid into γ-valerolactone (https://doi.org/10.1016/j.cej.2025.160969)



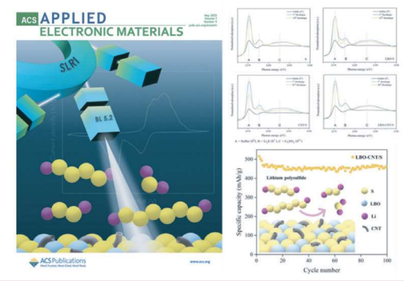
A series of normalized (a and c) Ni K- and (e and g) Re L_3-edge XANES spectra with metal fractions, calculated based on LCF, for the XANES spectra of (b and d) Ni and (f and h) Re detected using temperature-resolved XANES while the catalysts were heated at 10°C min^{-1} in H_2 in the range 50°C–500°C and held at 500°C for 3h.

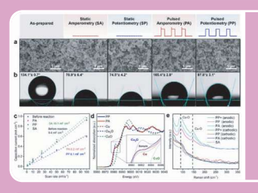


In situ Fourier transform of k^2-weighted (a) Ni K-edge and (c) Re L_3-edge EXAFS spectra and (b and d) wavelet-transform (b-i–b-iv) Ni K-edge and (d-i–d-vi) Re L3-edge EXAFS plots (no phase corrected distance) of the reduced Ni, Re, and Ni–$Re_{0.075}$ catalysts and all the possible Ni and Re standards.

Result/Application

Lithium Borate Glass Ceramics and Multi-Walled Carbon Nanotube Composite as Efficient Sulfur Hosts for Enhanced Lithium–Sulfur Batteries (doi: 10.1021/acsaelm.5c00223)

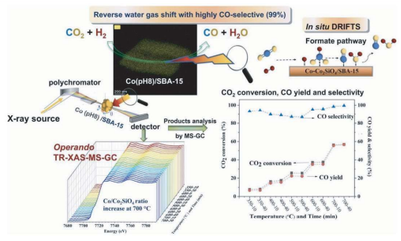




Spikes Effect: Decoding and Redesigning Pulsed Electrochemical CO_2 Reduction for Enhanced C–C Couplingon Oxide-Derived Copper

(https://doi.org/10.1021/acscatal.5c03544)

Tuning Co–Co_2SiO_4 interfacial chemistry on SBA-15 for the reverse water–gas shift reaction: An operando TR-XAS and in situ DRIFTS study (https://doi.org/10.1016/j.cattod.2026.115723)





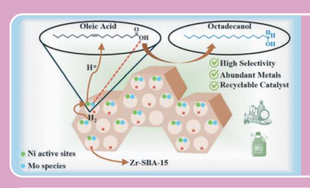
BL7.2W: XAS END STATION



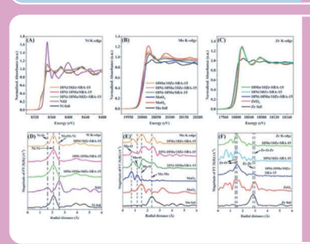
BL8: XAS END STATION

Result/Application

Selective Hydrogenation of Fatty Acids to Fatty Alcohols over Bifunctional Ni-Mo-Based Catalyst Supported on Zr-SBA-15



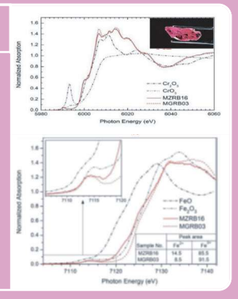
Normalized XANES spectra and Fourier transformed k^3-weight EXAFS spectra



Normalized XANES spectra at the (A) Ni K-edge, (B) Mo K-edge, and (C) Zr K-edge for reduced catalysts (10Ni/10Zr-SBA-15, 10Mo/10Zr-SBA-15, 10Ni-10Mo/10Zr-SBA-15, and 10Ni-10Mo/SBA-15), Ni foil, Mo foil, Zr foil, NiO, MoO_2, MoO_3, and ZrO_2 are used as reference standards. Magnitude of Fourier transformed k^3-weighted EXAFS spectra at the (D) Ni K-edge, (E) Mo K-edge, and (F) Zr K-edge.

Citation: ACS Sustainable Chemistry and Engineering. Vol. 13. DOI: 10.1021/acssuschemeng.5c07097.

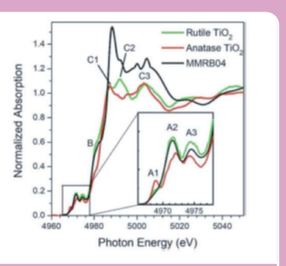
Unveiling Ruby Origins with Synchrotron XANES



Cr K-edge XANES spectra showing reference standards (Cr_2O_3, CrO_3) and natural ruby samples (MZRB16 and MGRB03) collected at Beamline 7.2W, Synchrotron Light Research Institute (SLRI).

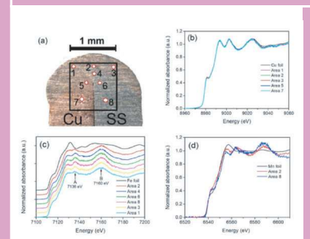
Fe K-edge XANES spectra taken from the reference standards including FeO and Fe_2O_3 and from the natural rubies namely MZRB16 and MGRB03.

Ti K-edge XANES spectra taken from the reference standards including rutile TiO_2 and anatase TiO_2 and from the natural ruby namely MMRB04, thus showing the pre-edges A1, A2 and A3, the characteristic shoulder B and the main crest C1, C2 and C3 features.



Citation: Spectrochemical Acta Part B: Atomic Spectroscopy, Vol. 232. DOI: 10.1016/j.sab.2025.107271.

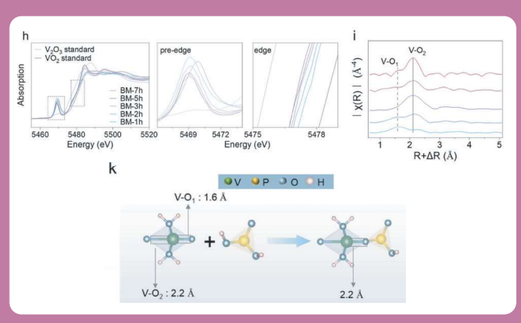
Micro XAS measurements of welding joints of copper and stainless steel



(a) Optical microscope image of a welding joint of OFHC copper and AISI 304 stainless steel, K-edge XANES spectra for (b) Cu, (c) Fe, and (d) Mn.

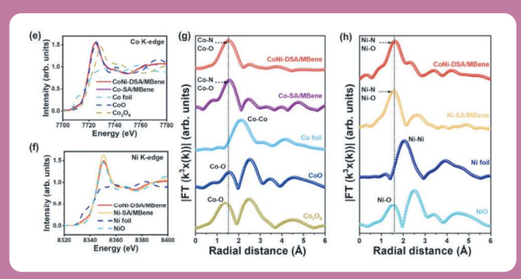
Citation: Radiation Physics and Chemistry. Vol. 206. DOI: 10.1016/j.radphyschem.2023.110768.

One-Step Maturation Pathway of Polyanion-Type $Na_3V_2(PO_4)_3$ Towards Scalable Production and High-Performance Na-Ion Pouch Cells



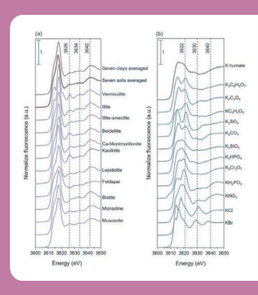
(h) Normalized V K-edge XANES spectra, amplification of corresponding pre-edge and edge. (i) Fourier transform spectra of V K-edge of samples from EXAFS spectra. (k) The schematic diagram illustrates how mechanical force changes the bonding mode of raw materials.

Paradigm for Swift Dual Single-Atom Stabilization on MBene using a CO_2 Laser in Trifecta Energy with Ammonia Production

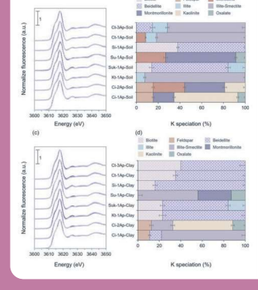


(e, f) XANES spectra at the Co K-edge and Ni K-edge, and (g, h) FT-EXAFS spectra in R-space for Co and Ni in Co-SA/MBene, Ni-SA/MBene, and CoNi-DSA/M Bene.

Dominance of 2:1 clay minerals in soil potassium across aweathering gradient: Insights from K K-edge XANES speciation and sequential extraction



Potassium K-edge XANES spectra of reference K compounds: K-containing primary minerals and clay minerals (a) and K-salts (b).



(a, c) Normalized bulk K K-edge XANES spectra with LCF model fits over the energy range 3588–3668 eV. Pale purple dotted lines symbolize experimental data, and dark purple lines show the LCF model fits. (b, d) K speciation based on XANES LCF of tropical soils.