



The Hard X-ray In-Situ Nanoprobe Beamline at APS: Enabling Multimodal, In-Situ and Operando Studies

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The hard X-ray In-situ Nanoprobe (ISN) beamline at 19-ID is a new APS Upgrade (APS-U) feature beamline designed for multimodal studies of complex materials and devices under in-situ and operando conditions. Using Kirkpatrick–Baez mirrors, ISN delivers a diffraction-limited spot of ~25–30 nm at 25 keV with a 55 mm working distance across an energy range of 4.8–30 keV, enabling realistic sample environments without compromising spatial resolution. Key measurement modes include X-ray fluorescence (XRF) imaging for elemental and trace-impurity mapping, X-ray diffraction (XRD) for local structural and phase information, X-ray beam induced current/voltage (XBIC/XBIV) for electronic property mapping, X-ray excited optical luminescence (XEOL) for optical response, and ptychography for high-resolution coherent imaging. The unique combination of these modalities enables correlative, nanoscale linking of elemental, structural, electrical, and optical properties, particularly relevant to energy and quantum materials, batteries, catalysis, and microelectronics. ISN supports in-situ environments including inert/vacuum operation, 40 K–1000 °C temperature control, and gas/liquid flow, and will benefit from APS-U brightness gains to enable faster, higher signal-to-noise measurements.