Ptychography Based Resolution-enhanced X-ray Fluorescence Microscopy Using Deep Neural Networks

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Accurately resolving elemental distributions inside materials at the nanoscale is critical for understanding their physical and chemical properties. Multimodal hard X-ray scanning probe microscopy has been extensively used to study materials providing multiple contrast mechanisms. For instance, combining ptychography with X-ray fluorescence (XRF) microscopy reveals structural and chemical properties simultaneously. While ptychography can achieve diffraction-limited spatial resolution, the resolution of XRF is normally limited by the X-ray probe size. Here, utilizing the multimodal measurement, we develop a machine learning (ML) model to overcome this problem by deconvolving the X-ray probe from the XRF signal. The enhanced spatial resolution was observed for both simulated and experimental XRF data, showing superior performance over the state-of-the-art scanning XRF method with different nano-sized X-ray probes. Enhanced spatial resolutions were also observed for the accompanying 3D XRF tomography reconstructions.

[1] L. Wu et al, Resolution-enhanced X-ray Fluorescence Microscopy via Deep Residual Networks, submitted.