Mesoscale Priority Research Direction

(Multi-dimensional soft X-ray microscopy of mesoscale behavior)

Opportunity

Full-field soft X-ray microscopes (TXM) record images ((3D spatial + temporal) down to ultimately nm spatial and fsec time resolution with elemental, chemical, and magnetic sensitivity. This allows to investigate the **complexity**, **stochasticity** and **functionality** of mesoscale phenomena in materials, environmental , chemistry and energy related sciences.

Approach

A next-generation full-field TXM provides real-space 2D images over a large field of view with high spectral ($>10^4$), spatial (<10nm) and temporal (<100ps) resolution, allowing for 3D tomographic reconstruction in versatile sample environments. Imaging in reflection gives access to interfaces . The development of next generation X-ray optics is essential and drives the success of this method.

Meso Challenge

Understanding the **properties** and **behavior** of multi-element and mutually interacting nanoscale building blocks of real devices requires characterization across multiple length, time, and energy scales.

Impact

Obtain unique information to research areas, e.g. spintronics, batteries, catalysts, soil sciences, to answer critical questions such as

-how to write magnetic information in real devices reliably and efficiently?

-how to optimize the electrochemical interfaces in batteries?

References:

P. Guttmann et al, *Nanoscale spectroscopy with polarized X-rays by NEXAFS-TXM*, Nature Phot. 6, 25 (2012)

M.-Y. Im, et al., *Direct Observation of Stochastic Domain Wall Depinning in Magnetic Nanowires*, Phys Rev Lett 102 147204 (2009)

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