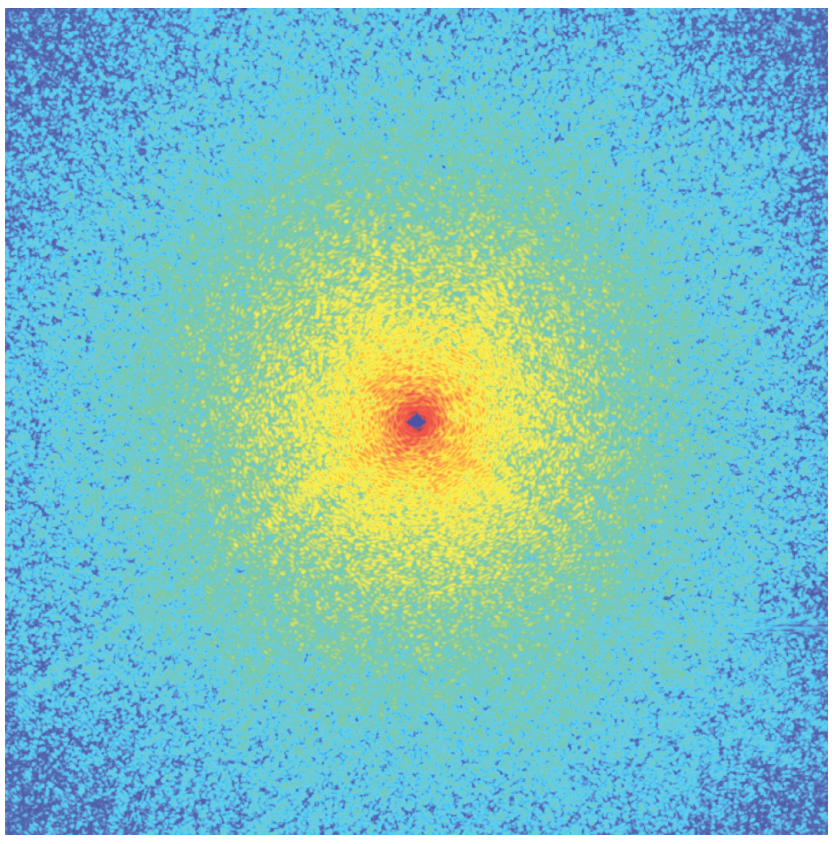
David A. Shapiro

Spectromicroscopy & Tomography of Nanomaterials by Soft X-ray Ptychographic Imaging

Argonne NATIONAL LABORATORY

Elucidating chemical and morphological transitions within active nanomaterials is essential for understanding the current performance limitations and for design of next-generation materials. Though soft x-ray ptychography combined with x-ray absorption spectroscopy has recently become available to study such transformations with the required spatial resolution and chemical specificity, it is intrinsically limited when studying complex architectures by their reliance on two-dimensional projections of thick material. At the Advanced Light Source, Lawrence Berkeley National Laboratory, soft x-ray ptychographic imaging is combined with computed spectro-tomography at the bending magnet beamline 5.3.2.1. This technique achieves about 10 nm spatial resolution in three dimensions with chemical sensitivity. We apply the method to study chemical and morphological changes within agglomerated nano-sized lithium iron phosphate (LiFePO4) plates and hydration products of Portland Cement. We investigate the complex correlation between chemical phase distribution and morphology in single nano-plates with quantitative analysis of oxidation states of transition-metal cations. Our approach enabled both direct observation of the internal chemical structure within crystals as small as 20 nm in their smallest dimension and the evaluation of correlations among a statistically significant number of particles. We are presently moving this capability to the new coherent imaging beamline (7.0.1/COSMIC) which will enable nearly 10X increased spatial resolution or a time resolution of a few minutes.



David A. Shapiro received his B.A. degree in physics from Colgate University in 1998 and his Ph.D. in physics from Stony Brook University in 2004 studying under Professors Janos Kirz and David Sayre. During his doctoral research he developed experimental and computational tools for coherent x-ray diffractive imaging applied to biological cells. He continued this work with Henry Chapman and John Spence while a post-doctoral scholar with the Center for Bio-photonics at the University of California at Davis and later as Seaborg Fellow at Lawrence Berkeley National Lab. This team of researchers achieved one of the first demonstrations of serial protein nano-crystallography. Since 2012, he has been a staff scientist at the Advanced Light Source where he is leader of the x-ray microscopy group, which oversees four scanning x-ray microscopy beamlines that generate nearly 100 publications per year. His research is now focused on bringing advanced imaging technologies like x-ray ptychography to standard use within the U.S. Department of Energy's complex of synchrotron light sources.

Wednesday, March 1, 2017 | 3:00 p.m.

Bldg. 402 | APS Auditorium
Argonne National Laboratory

APS Colloquium