Coherent X-Ray Microscopy & Lensless Imaging

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Coherent Diffractive Imaging (CDI) techniques use coherent sources of radiation - such as x-rays from high-brilliance synchrotrons and free-electron laser sources - to extract information on a specimen from its diffraction pattern [1,2]. This approach can produce high-resolution images of both the absorption and the phase shift within the specimen. However, replacing the lenses with a reconstruction algorithm involves solving the notoriously hard phase problem and imposes strong constraints on the specimens' preparation.
Scanning Transmission X-ray Microscopy (STXM) is an alternative imaging method that can yield high-resolution images through the raster scan of a focused x-ray beam on the specimen. STXM is fast, efficient, and does not require sophisticated data analysis, but it is resolution limited by the spot size at the specimen plane.
This presentation will focus on how CDI and STXM can be combined into one method that bridges the gap between coherent imaging and scanning techniques. We will review the principles of this new Scanning X-ray Diffraction Microscopy (SXDM) approach and show first experimental results obtained with a coherently focused hard x-ray beam [3,4]. For a buried nanostructure test specimen we demonstrate that the resolution can be improved by a factor of more than five beyond the focal size. Our approach can be combined with other x-ray scanning probe techniques such as x-ray fluorescence mapping, microdiffraction or microspectroscopy.
In addition to providing the full complex-valued transmission function of the specimen, the new analysis procedure retrieves the complete structure of the wavefront incident on it. Thus we also expect that SXDM will become a unique wave-sensing tool for the characterization of the fully coherent wavefields produced by projected next-generation x-ray sources.

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