

HARD X-RAY FULL FIELD 3D IMAGING WITH sub-50 nm RESOLUTION

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One of the key strengths of hard x-ray full-field microscopy is the large penetration depth of hard x-rays into material, which allows one to image the interior of optically opaque objects. Combined with tomographic techniques, the three dimensional interior structure of the object can be reconstructed nondestructively regardless of its state of crystallinity. Projection x-ray microtomography is now routinely available using x-ray microCT scanners with spatial resolution ~ 1 micron, which is limited by the combination of x-ray source spot size and detector imaging resolution. Higher imaging resolution typically requires x-ray magnification using specialized x-ray lenses, such as Fresnel zone plates. This talk will primarily concentrate on operation principles and applications of compact sub-50 nm resolution full field zone plate based x-ray microscopes using both synchrotron and commercially available laboratory x-ray sources¹. These systems employ highly efficient reflective capillary condensers² and high-resolution (<30 nm) objective zone plates³ using x-rays with energy 8 keV and higher. Imaging resolution of such microscopes is independent of the x-ray source parameters and ultimately limited by the ability to manufacture zone plates with finer outermost zone widths (resolution) and high aspect ratio (efficiency). In the past several years substantial progress has been made in manufacturing zone plates with <30 nm imaging resolution and up to 1:40 aspect ratio. Modern state of the art zone plate based full field x-ray microscopes coupled to high brightness synchrotron sources allow data acquisition speeds up to 0.1 s per 2D projection image. At the same time substantial progress has been made in proliferation of sub-50 nm x-ray microscopy to the laboratory environment using commercially available x-ray sources where imaging time per 2D image approaches only a few minutes. Applications of sub-50 nm 3D hard x-ray microscopy will be presented in analysis of internal structures of various nanomaterials.

References:

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