Nanometer-scale x-ray holography with 1-2 keV x-rays

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ABSTRACT

X-ray holography is a promising means for imaging biological and materials science specimens with nanometer-scale resolution. Fourier transform holography offers intrinsic phase as well absorption contrast, at a resolution limited only by the precision with which the reference wave is known. It has also been proposed as a starting point for iterative phase retrieval in lenseless coherent diffraction imaging experiments with potentially atomic scale resolution.

Using 1-2 keV x-rays at the 2-ID-B undulator beamline at the Advanced Photon Source, a zone plate lens to form the spherical reference wave, and a direct-detection CCD camera, we recorded Fourier transform holograms of lead micro- and nano-crystals. The zone plate had an finest zone width of 50 nm. The third diffraction order of the zone plate was used for its potentially higher resolution. Hologram exposures were typically 10 s; series of 100-200 exposures were acquired to improve the hologram signal to background. Numerical reconstructions of the individual and summed series of holograms required only a few seconds on a PC-class computer. Fine features in the lead crystal sample were resolved to ~50 nm in the reconstructed holograms. These results give impetus to ongoing efforts to develop high resolution flash coherent x-ray imaging methods using existing synchrotron radiation and future x-ray laser sources.

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