Phase imaging with resonant soft x-ray Fourier transform holography

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We demonstrate quantitative phase imaging using resonant coherent soft x-ray scattering. This lensless imaging technique has the benefits of phase contrast imaging while resonantly tuned to an absorption edge which inherently enhances the absorption and limits the probing depth. The method is illustrated by use of a Co/Pd multilayer sample which exhibits non-periodic magnetic domains. Magnetic contrast is obtained from x-ray magnetic circular dichroism at the Co $L_{2,3}$ absorption edges. The strong energy dependence of the real part (phase) and imaginary part (absorption) of the refractive index is utilized to selectively enhance image contrast at different energies in vicinity to an absorption resonance. An absorption-dominated diffraction pattern is directly obtained at the absorption peak, whereas phase-dominated diffraction is obtained slightly before and behind the resonant peak. Therefore, this method facilitates high contrast imaging while decreasing the radiation dose of the exposed object. The phase and absorption images of the magnetic domains are reconstructed by means of Fourier transform holography[1], where the diffracted wave is encoded by a reference wave in the Fraunhofer regime of the object. The real space image is readily obtained by Fourier transform inversion. The absorption and phase information about the object is separated and retrieved in the respective real and imaginary part of the complex object-reference convolution and cross-correlation in a quantitative manner. In addition, combining the phase and absorption information available in the diffraction patterns will improve current phase retrieval algorithms and the symmetry properties of phase holograms lessen the impact of beam stops.

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