Holographic X-ray Imaging Methods

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When studying diffraction data of non-periodic structures in the nanoscale, the inversion of the detected intensity distribution into real-space information is a challenging task due to the loss of phase information. Attempting to solve the phase problem triggered the development of ptychographic and holographic imaging. A single hologram encodes the full complex wave field information of the sample, which allows 3D-reconstruction and image enhancement using subsequent computational processing. Furthermore, since a holographic setup is ideally void of image-forming lenses, it is well-suited for the "diffract and destroy" approach using intense pulses of X-ray free-electron lasers. One class of holographic imaging is Fourier transform holography (FTH) that intrinsically preserves the phase information owing to the presence of a reference feature. In its simplest form, FTH includes a point scatterer in the vicinity of a sample resulting in two images of the specimen by a simple Fourier transform. In addition, a refined method known as differential holographic encoding provides further improvement on contrast, noise, and resolution by utilizing extended reference features.

From the classic Gabor holography to differential encoding, we will discuss holographic imaging and its application with coherent x-rays at I13.