A full-field KB-FZP microscope for hard X-ray imaging with sub-100 nm resolution

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A full-field X-ray microscope for sub-100 nm imaging and tomography has been built at the UNICAT-beamline 34 ID-C at the Advanced Photon Source (APS). The instrument works with a Kirkpatrick-Baez mirror (KB) as condenser and a micro-Fresnel-zone plate (FZP) as objective lens. 80 nm-features in a Nickel structure have been imaged, operating the microscope at a photon energy of about 9keV.

In sector 34 of the APS, the beam is shared between two hutches. A platinum-coated silicon single-crystal mirror deflects the main cone of the beam into the C hutch, and cuts off the higher undulator harmonics. The double-crystal fixed-exit Si-111 monochromator has an energy bandwidth of $\Delta E/E \sim 10^{-4}$. At 9 keV photon energy, the flux is in the order of 10^{13} photons/s. The intensity drops to a third of this value when the microscope is operated in the so-called "parasitic mode", that means when the undulator is tapered for the experiments in the 34 ID-E hutch. The cross section of the beam is about $1 mm^2$ at 55 m distance from the source. At this location a Kirkpatrick-Baez (KB) system used as a condenser [1] focuses approximately 63% of the incoming intensity onto the sample spot, matching the aperture of the objective lens. For the latter we have a choice of gold micro-Fresnel-zone plates (FZP)[2] having outer zone widths from 40 to 70 nm. Under these conditions the X-ray microscope provides 50-85 nm resolution and short exposure times due to the high efficiency of the KB-system. We will also discuss phase-contrast techniques, applicable with this microscope.

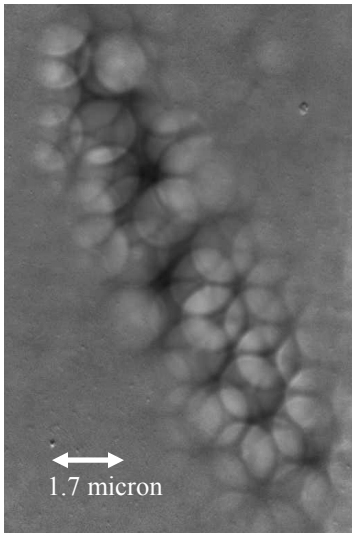

Figure 1: Image of hollow spheres in a Nickel structure, taken with the KB-FZP microscope

References:

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