Coherent hard X-ray microscopy for mesoscopic materials characterization

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We present a coherent high energy X-ray microscopy brunch of the multimodal instrument which is under the development at the ID06 ESRF beamline. The microscope is developed to study the wide range of mesoscopically structured materials. By employing compound refractive lenses, it is possible to com-bine diffraction and direct space imaging [1-4]. The diffraction pattern of the specimen formed in the back focal plane of the condenser and two-dimensional image of the object generated by objective lens in its image plane [5]. The diffraction mode is used to investigate the structure over the macroscopic distances and to orient the crystals parallel to the low index direction to perform high-resolution imaging on the local scale. The image formation relies on phase contrast due to the interference of several diffracted beams. A coherent illumination is needed in imaging mode to ensure a reasonable contrast. The coherence in terms of the angular source size determines the lens angular resolution (< 1μrad) to get high resolution diffraction patterns.

The microscope was applied for study of natural and synthetic opals, metal inverted photonic crystals and colloidal suspensions [5-6]. The combination of the direct-space imaging and high resolution diffraction provide a wealth of information on their local structure and the long range periodic order. Short acquisition times with modern area detectors allow to extend the microscope to time-resolved studies of the crystallization dynamics, response of the mesoscopic structures to external stimuli such as mechanical strain, temperature jump or temperature gradient as well as external fields.

References

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