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COHERENT X-RAY OPTICS AND MICROSCOPY FOR ADVANCED MATERIAL RESEARCH APPLICATIONS

A. SNIGIREV

Immanuel Kant Baltic Federal University, 238300 Kaliningrad, Russia

With appearance of new Megascience facilities - fourth generation X-ray sources (synchrotrons and free-electron lasers) materials research will strongly benefit from the increased spectral brightness, small source size and divergence. New ultimate parameters of the beam provided by the diffraction-limited sources – new synchrotrons with the reduced horizontal emittance will open up unique opportunities to build up a new concept of X-ray diagnostics including diffraction, spectroscopy and microscopy techniques based on the beam transport and conditioning systems using in-line refractive optics [1]. The refractive optics can provide the various beam conditioning functions in the energy range from 3 to 200 keV: condensers, micro-radian collimators, low-band pass filters, high harmonics rejecters [2], and beam-shaping elements [3-4]. The implementation of the lens-based beam transport concept will significantly simplify the layout of new beamlines, easily expanding their microscopy capabilities in different fields including biomedical science [5-6] and material research under extreme conditions [7-10].

The versatile beam conditioning properties of refractive optics enable to develop and implement novel X-ray coherence-related techniques including Fourier optics [11-13] and interferometry [14-18]. Further development of phase contrast bright [19-24] and dark field microscopy [25] will benefit by recently proposed light and ultracompact objectives based on polymer and diamond microlenses made by 3D printing [26-27] and FIB technology [28].

All mentioned achievements and applications based on refractive optics are becoming especially relevant for the new SKIF synchrotron in Novosibirsk.

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