Applications of X-ray refractive optics for fourth generation synchrotrons.

Anatoly Snigirev

Immanuel Kant Baltic Federal University, Kaliningrad, Russia

anatoly.snigirev@gmail.com

New ultimate parameters of the beam provided by the diffraction-limited sources will open up unique opportunities to build up a new concept for the beam- transport and conditioning systems based on in-line refractive optics [1]. Taking an advantage of the reduced horizontal source size and divergence, the refractive optics integrated into the front-end can transfer the photon beam almost without losses from the source directly to the end-stations. In this regard, development of diamond refractive optics is crucial [2, 3]. In addition to traditional focusing applications, 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 [4], and beam-shaping elements [5].

The implementation of the lens-based beam transport concept can significantly simplify the layout of majority of new beamlines, opening novel opportunities for the protein crystallography [6] and for the material science research under extreme conditions [7-8]. The versatile beam conditioning properties of refractive optics enable to develop and implement new X-ray coherence-related techniques including interferometry [9-11], phase contrast imaging [12-14] and dark field microscopy [15] using light polymer micro-objectives made by additive technology [16].

References

[1] A. Snigirev, V. Kohn, I. Snigireva, B. Lengeler, *Nature,* **384** (1996) 49.

[2] S. Terentyev, V. Blank, S. Polyakov et al, *Appl. Phys. Let.,* **107** (2015) 111108.

[3] S. Terentyev, M. Polikarpov, I. Snigireva et al*, J. Synchrotron Rad*., **24** (2017) 103.

[4] M. Polikarpov, I. Snigireva, A. Snigirev, *J. Synchrotron Rad., **21*** (2014) 484.

[5] D. Zverev, A. Barannikov, I. Snigireva, A. Snigirev, *Opt. Express*, 25 (2017) 28469.

[6] M. W. Bowler, D. Nurizzo, R. Barrett et al, *J. Synchrotron Rad.,* **22** (2015) 1540.

[7] N. Dubrovinskaia , L. Dubrovinsky, N. Solopova, et al, *Sci. Adv*., **2** (2016) e1600341.

[8] F. Wilhelm, G. Garbarino, J. Jacobs, et al, *High Pressure Research*, **36** (2016) 445.

[9] A. Snigirev, I. Snigireva, M. Lyubomirskiy, et al, *Opt. express*, **22** (2014) 25842.

[10] M. Lyubomirskiy, I. Snigireva, A. Snigirev, *Optics express, **24*** (2016) 13679.

[11] M. Lyubomirskiy, I. Snigireva, V. Kohn, et al, *J. Synchrotron Rad*., **23** (2016) 1104.

[12] K. V. Falch, C. Detlefs, M. Di Michiel et al, Appl. Phys. Lett., **109** (2016) 054103.

[13] K.V.Falch, D.Casari, M.DiMichiel et al*, J. .Mater. Sci*., **52** (2017) 3437.

[14] K. V. Falch, M. Lyubomirskiy, D. Casari, et al, *Ultramicroscopy*, **184** (2018) 267.

[15] H. Simons, A. King, W. Ludwig et al, *Nature Communications*, **6** (2015) 6098.

[16] A. K. Petrov, V. O. Bessonov, K. A. Abrashitova et al, *Opt. Express*, 25 (2017) 14173.