Properties of planar X-ray waveguide-resonator and its application for nanoanalysis and nanotechnology

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In the last few years new X-ray optics devices characterized by super narrow beams were appeared. These devices are planar X-ray waveguide-resonators (PXWR) [1]. PXWRs are built on effect of X-ray standing wave interference field appearing in all space of a narrow extended slit formed by the planar polished dielectric reflectors. Experiments showed that the effect of the slit space filling by the uniform interference field takes place for a small size interval of a slit width. For example, this interval is 30-200 nm for CuK_α radiation when quartz reflectors are used. X-ray waveguide-resonator produces the thread radiation beam with width near 100 nm. The density radiation in the beam is higher in comparison with the conventional forming system built on base of slit-cut devices on 3-4 orders. It is connected with the capture of an initial radiation flux by PXWR slit in the angle $\delta\theta = 2\theta_c$, where θ_c is the critical angle of the radiation total reflection for the reflector material. The divergence of X-ray beam after a simple PXWR is not usually higher as 0.2 grad. At using of PXWR with the special design one can receive the beam divergence near 0.005 grad [2]. The supernarrow beam after PXWR is characterized by absence of diffraction satellites. We have some experience of PXWR application in total reflection X-ray fluorescense (TXRF) analysis and X-ray diffractometry of nanoobjects. These beams can be used with success for nanosize lithography.

[1] Egorov V.K., Egorov E.V. Waveguide-resonance mechanism for X-ray beam propagation: physics and experimental background // Advances in X-ray Analysis. v46. 2003. pp. 307-313.
[2] Egorov V.K., Egorov E.V. Composite X-ray waveguide-resonator as a background for a new generation of the material testing equipment for films on Si substrates // Proceeding of MRS. v716. 2002. pp. 189-195.

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