Optical properties of two-lens system on the base of hard X-ray zone plates

Kuyumchyan A.[a], Kouznetsov S. [a], Isoyan A.[a] , Aristov V.[a] , Shulakov E.[a]
[a]Institute of Microelectronics Technology and High Purity Materials of Russian Academy of Science, 142432, Chernogolovka;
Snigirev A. [b], Snigireva I. [b]
[b]European Synchrotron Radiation Facility, B.P. 202, F - 38043 Grenoble, France;
Kohn V. [c]
[C] RRC Kurchatov Institute, 1, Kurchatov Sq., Moscow, 123182, Russia
Hagelstein M.
Institute for Synchrotron Radiation, D – 76021 Karlsruhe, Germany

We present results of study of focusing and imaging properties of double-lens system for hard x rays, consisting of such elements as Fresnel zone plates (FZP) made from silicon. As it was shown practically, such FZP has advantages like small absorption, high efficiency and high spatial resolution.

This work demonstrates for the first time a phenomenon of focusing x-ray beam by two FZPs mounted with sufficiently large distance between them. The geometrical point of focus is the same as for the system of two thin refractive lenses. The peculiarities of redistribution of intensity within the focal plane when the second FZP is moved across the optical axis are investigated both experimentally and theoretically (computer simulation). It is shown, the shift of the second FZP leads to a moire pattern, which allows one to adjust FZPs with accuracy up to 50 nm. The intensity distribution along the optical axis is also investigated.

We realise for the first time an image transfer by means of double-lens systembased on FZP. The experiments are performed in ESRF, BM-5 beamline with the x-ray energy 9.4 keV.

We elaborate a computer program for theoretical study of double-lens system based on FZP. The program allows simulation all properties of such system with limited number of zones. The calculation is based on the use of Kirchhoff propagator in a paraxial approximation and fast Fourier procedure. The intensity map inside the plane across the optical axis is calculated for any parameters, including the shift of the second FZP across the optical axis.