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Beam suppression and focusing in multi-plate crystal cavity with compound refractive lenses

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Fabry-Perot type multi-plate crystal cavities consisting of compound refractive lenses were prepared on silicon wafers by micro-electronic lithographic techniques. The crystal orientation of this X-ray optical device is the same as that of the two-plate x-ray resonators reported (Phys. Rev. Lett. 94, 174801, 2005). Experimentally, X-ray (12 4 0) back diffraction from these monolithic silicon crystal devices for various photon energies showed interference fringes as a function of photon energy due to cavity resonance, but with less pronounced amplitudes. The expected focusing effect from the CRL is observed and energy-dependent focal length is detected. Detailed analysis on cavity interference and beam focusing will be discussed.

Keywords: focus, compound refractive lens, cavity

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Beam conditioning by diffractive-refractive crystal monochromators in Bragg and Laue geometries

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Beam shape conditioning and high-resolution monochromatization for laboratory and synchrotron sources is achieved by crystal monochromators with flat surfaces. In coplanar geometries, Bragg reflection geometry is used for single flat diffractors, double diffractor arrangements and Bartels monochromators working in parallel beam set-up. On the other hand, diffractive-refractive optical devices involve non-coplanar geometry arrangement. Devices with V-shape arrangement of flat diffractors or with cylindrical or parabolic grooves set in Bragg non-coplanar geometry focus the incident beam into a distant focal spot. Their focusing properties and their aberrations were studied in the past. Recently, we have extended studies of the diffractive-refractive devices into the Laue geometry. Then both the transmitted and the diffracted beams pass through the device. Therefore, these devices can be prepared as a flat thin plate or as a shaped plate-parabolic, double-parabolic or double-tunnel crystals. Theoretical predictions and the first experiments by synchrotron radiation show focusing properties as well. We will present results of the beam propagation and focusing properties resulting from aligning a sequence of these devices with crystal diffractors with high asymmetry.

Keywords: X-ray optics, monochromators, synchrotron radiation

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Study of complete transfer phenomenon for media with various thermal conductivity

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In this work the effect of complete transfer (from diffracted-transmitted direction to the diffracted-reflected direction) of x-rays for the media with different thermal conductivity is considered in presence of temperature gradient (TG). The media with different conductivities were experimentally realized by simply changing the pressure of the same medium. It has been found experimentally in a quartz monocrystal that the relative intensity of the beam depending from the TG is increasing and at the certain values is saturating. It is seen that with decreasing the pressure from 760 Torr until 10 Torr, decreasing also the corresponding to the complete transfer the magnitude of the TG. The consequent decreasing of the pressure results to increasing the magnitude of the corresponding TG. No saturation is taking place at the smallest pressure (0.03 Torr). We have to mention that for the transmitted beam taking place the contrary scenario. With the increasing the TG the intensity of the beam is decreasing practically until the zero. In order to explain the obtained results it has been solved the thermal conductivity equation with the boundary conditions corresponding to the experiment. We have obtained the expression for the displacement function $U_x(x,z)$. It is shown that $U_x(x,z)$ is solution of Takagi equations only in case of condition of the complete transfer and that solution is unique. In that case the behavior of the relative intensity of the diffracted beam is well matching with the results of the experiment. In fact we have found the relation in between wave and corpuscular processes in case of condition of the complete transfer. Method for measuring the thermal conductivity coefficient is proposed based on obtained results.

Keywords: dynamical X-ray diffraction theory, heat transfer, crystal lattice distortion

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Observation of rocking curves in Bragg-Laue case

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High resolution rocking curves of X-rays in Bragg-Laue case diffracting have been measured by using synchrotron radiation at KEK-PF in Japan. The measured rocking curves are shown in Fig. 1. The used X-ray energy was 11100 ± 0.5 eV and its angular resolution was about 0.3 arcsec. The distance (L) from incident point of X-ray to the side edge of the sample was 143 μm. P_h is the intensity of diffracted beam from the incident surface, P_h' and P_t' are those of the diffracted and transmitted beams from the side surface, respectively. The peak heights of the three rocking curves are normalized so as to show the same height. The abscissa is the angle deviation from the exact Bragg condition. It is noted that the intensities of P_h' and P_t' are approximately ten times smaller than that of P_h, and the FWHM