X-Ray Optics Research

Beamlines: X13B, X25

Techniques: Dynamical X-Ray Diffraction

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Motivation: Research is carried out addressing x-ray optics that are grounded in dynamical x-ray diffraction principles. Mostly these have addressed monochromator optics for high heat load beamlines such as the insertion device beamlines X25, X13B, and most recently X21 (and in the future X9), with emphases on adaptive crystal optics, cryogenic crystal cooling, and diamond crystal monochromators. Also, tailored-bandwidth optics such as multilayers, and polarizing optics such as crystal phase plates, have been investigated for particular experimental applications, as have figured mirrors.

Results: A recent example was the examination of a diamond crystal wafer, of (001) orientation, for use as an x-ray phase retarder, when set to diffract the (111) Bragg reflection in asymmetric Laue geometry. This is a simple device that produces circularly-polarized x-rays from linearly-polarized x-rays. Its performance was evaluated using a multiple-beam-diffraction based crystal analyzer to determine the Stokes-Poincaré polarization parameters of the beam transmitted by the diamond phase retarder (see Figure). The results show near-perfect production of left- or right-handed circularly polarized x-rays at certain settings of the phase retarder.

Shown are measured values of the Stokes-Poincaré polarization parameter P_3 for the beam transmitted by the diamond crystal phase retarder at various angle settings of the diamond (111) Bragg reflection rocking curve. P_3 represents the degree of left- or right-handed circular polarization of the beam, with values of –1 or +1 representing perfect circular polarization respectively, and 0 representing no circular polarization. The measured data points are compared with a calculation that assumes no divergence of the x-ray beam. At rocking curve angles close to –0.015° or +0.015°, the transmitted beam is almost completely circularly polarized.