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Diamond double-crystal transmission monochromators

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Diamond transmission monochromators have become an attractive option for third generation undulator beamlines. The favorable thermal and crystallographic properties of perfect diamond are well matched to both the low emittance and high heat load characteristics of the new undulator sources. A series of such x-ray transparent diamond monochromators can use the same white beam and supply several experimental stations simultaneously with monochromatic x-rays of slightly different energies thus multiplying the use of the undulator source. Perfect (100) oriented diamond crystals allowing reflection from (111) lattice planes in asymmetric Laue geometry are successfully used in single bounce transmission monochromators. The Laue geometry is however not ideally suited for double crystal devices due to the non matched acceptances and emittances in the asymmetric case and because of the intrinsic reflectivity limitation (50% reflectivity for a thick crystal in symmetric Laue geometry). We have tested a diamond double crystal transmission monochromator with two (111) oriented diamond single crystals in horizontal Bragg geometry for the TROIKA II station at ESRF. This involved heat load tests of the first 120 µm thick, water-cooled crystal in a white undulator beam with help of an asymmetrically cut Si(220) analyser crystal. The convoluted width (FWHM) for this arrangement of two perfect crystals is 16.98 µrad (16.4 µrad for the diamond and 4.4 µrad for illuminating small parts of the crystal (300 µm x 300 µm) and an increase of up to 34 µrad when illuminating the whole crystal and thus sampling over imperfections in the crystal. There was no indication of the heat load induced broadening upon opening of the beam defining slits. Replacing the Si(220) analyser by a second 500 µm thick diamond, a convoluted width of 33.2 µrad with a peak reflectivity of 67% was observed. These results demonstrate the feasibility of diamond double crystal monochromators for multiple station undulator beamlines.