Cryogenically-cooled Monochromators

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We had been performed high heat load experiments at BL3 of the ESRF as technical collaboration between ESRF, SPring-8 and APS on November 1994 and May 1995. Here we summarize the results of last two-time experiments very briefly.

Figure 1 shows thermal conductivity and expansion coefficient of silicon and diamond as a function of temperature. It is clear that at cryogenic temperatures those crystal works better than those at room temperature. Superiority of diamond crystal is also obvious because its thermal character at room temperature is already comparable to that of silicon at cryogenic temperature.

The beamline BL3 has 44-pole wiggler source and Pt-coated toroidal mirror that was used to focus the beam in horizontal and vertical directions. Normally we can get the focal spot size of about 0.15 mm^2 in this beamline. First heat load experiment for cryogenically cooled diamond crystal was performed on this beamline[1]. The crystal edge was cooled indirectly and it was supported special mount system with In and Ga. The results show that the performance of the cryogenically cooled diamond was well. But when crystal was cooled from room to cryogenic temperature, its mount system gave strong strain to the crystal. Cryogenically cooled diamond crystal could give a solution for extremely high heat load. But some technological problem remains, especially for remaining strain from the mount system when it is cooled down from room to cryogenic temperature.

APS group made the experiments for directly cooled silicon crystal which has thin diffracting part with internal cryogenicly-cooled thick part[2]. Figure 2 shows summary of the results. The rocking curve width is kept almost constant for various power density. It exhibits less than 1 arcsec of thermal strain up to incident power of 186 W and average power density of 520W/mm^2. The difference of thick and thin parts in Fig. 2 is due to the mechanical strain. Thick part was less affected by the strain when the crystal is cooled down to cryogenic temperature . But we have to note that thicker crystal would absorb more power than thin crystal and larger heat load consumes more liquid nitrogen.

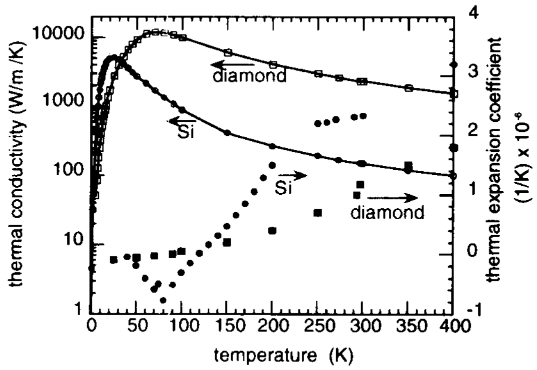

Fig. 1 Thermal conductivity and thermal expansion coefficient of silicon and diamond as a function of temperature.

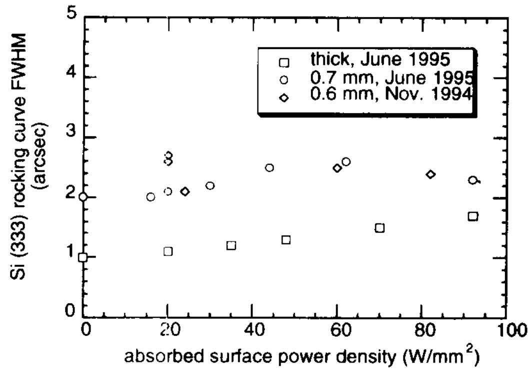

Fig. 2 Si 333 rocking curve width (FWHM) at 30 keV as a function of absorbed power density on the surface of the crystal for the thin (0.7 mm) and thick (more than 25 mm) parts and previously tested thin (0.6 mm) crystal.

References

[1] H. Yamaoka et al., Nucl. Instrum. & Methods **A364**, 581 (1995).

[2] C. S. Rogers et al., Rev. Sci. Instrum. **66**, 3494 (1995).