B06

A cryogenically cooled monochromator for wiggler beams

L. Assoufid and C. S. Rogers
Advanced Photon Source, Argonne National Laboratory, Argonne, Illinois 60439

Cryogenically cooled silicon monochromators are a proven solution capable of handling the power load from insertion devices at third-generation synchrotron radiation facilities, such as the Advanced Photon Source (APS). Using finite element analysis, we model the expected performance of a cryogenic Si monochromator in the Bragg reflection geometry having rectangular cooling channels. This analysis was done for the power load from APS Wiggler A. Both single-phase and boiling heat transfer were studied. The thermal strain varies linearly with the ratio of the expansion coefficient to the thermal conductivity. Near liquid-nitrogen temperature, the thermal conductivity of Si increases by a factor of about 9 compared to room temperature. The thermal expansion coefficient passes through zero at 125 K and becomes slightly negative. For these reasons, the cooling channels can be placed relatively far from the diffraction surface allowing the heat to spread radially, thereby utilizing a very large heat transfer surface area. The resistance to heat transfer in cryogenic crystals is dominated by the fluid boundary layer. Therefore, the monochromator performance is greatly improved when boiling heat transfer occurs. The mechanical strain due to fluid pressure, mounting, bonding, etc., can be a significant portion of the overall strain. The proposed design seeks to minimize these effects.

This work is supported by the U.S. Department of Energy, BES-Materials Sciences, under contract No. W-31-109-ENG-38.