Diamonds for 3rd and 4th Generation X-ray Sources

P. Van Vaerenbergh, J. Härtwig, M. Mattenet, J. Hoszowska, T. Mairs, J. Morse
European Synchrotron Radiation Facility, B.P. 220, 38043 Grenoble, France

S.H. Connell, M. Rebak, D. Dube, L. Mkhonza, R. Setshedi
University of the Witwatersrand, P.O WITS 2050, Johannesburg, South Africa

R.C. Burns, J.O. Hansen
Element Six Technologies, Booysens Reserve rd, Theta Johannesburg, South Africa

The 3rd and 4th generation sources are characterised by their high brilliance. This induces a high heat load and a high local power density on the beamline optical elements like monochromators, filters, phase plates, beam splitters, lenses, but also on detectors, beam position monitors and vacuum windows. Such components are often made of silicon (available in large dimensions, grown with high crystal perfection and very good surface quality). Instead of silicon we can use diamond, a material that has excellent thermal characteristics and thus considerable advantages compared to silicon. Nevertheless, up to now, the diamond material available had small dimensions and many defects in the bulk and on the surface. Nowadays, the diamond industry is on the way to produce highly pure type IIa Single Crystal diamonds made by High Pressure High Temperature grown process. This results in a considerable reduction of the number of crystallographic defects within the material. The key parameters of a diamond crystal for X-ray applications are the perfection of his bulk and also of its surface, which may conserve the coherence of the X-ray beam. Industry efforts have to be focused on these directions as well as on the increase of the crystal dimensions. In a successful collaboration project between the authors, many diamond samples have been studied over the last two years. At ESRF, X-ray topography is the most important and effective experimental method used to characterise the defect structure of diamond crystals. Some of the topographs will be presented.

It appears that for most of the future diamond applications the cooling efficiency has to be improved; this will reduce the thermo-mechanical deformation of the crystal. We are working at ESRF on two complementary approaches. The first approach is to increase the surface of thermal exchange with the cooled support. The size of available single crystal diamond plates is about 7x7 mm^2 (perfect central region of about 4x4 mm^2, 100-orientation). Therefore single crystal diamonds will be brazed on larger CVD diamond plates. Presently brazing tests have been initiated in order to qualify the different brazing techniques and to measure the stress induced within the single crystal material. The second approach is to increase the efficiency of the cooling support. Design and manufacture of dedicated support are in progress.