Diamond Synthetic Single Crystals: Characterization of Crystalline Quality and Coherence Preservation

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In view of the growing importance of synthetic single crystal diamonds for X-ray optics applications, the ESRF, the University of the Witwatersrand and the De Beers Industrial Diamonds (PTY) Ltd. Ltd. through their Diamond Research Laboratories have pursued for several years a development programme to improve the quality HPHT synthetic diamond crystals. Over the past few years a systematic characterisation of the crystalline quality of (111)- and (100)- oriented specimens of type Ib and IIa grown by De Beers was conducted.

The crystalline quality of the investigated diamond samples was assessed by means of double crystal x-ray diffractometry with microscopic spatial resolution and x-ray topography [1-7]. The measured rocking curve parameters of interest, such as the width, the peak reflectivity and the angular peak position are calculated for each pixel and represented as contour maps. It has been shown that IIa-type crystals had a much less pronounced overall defect structure and smaller lattice strains than Ib-type crystals, and that this difference was more important for the (100)-oriented specimens than for the (111)-oriented ones. Although there has been a remarkable progress in the HPHT synthesis of diamond and surface preparation techniques, even the best available specimens have a ‘mosaicity’ of typically 1 arcsec.

The use of diamonds for experiments that require full coherence preservation, such as x-ray imaging, has been prohibited. In that perspective, the study of the spatial coherence preservation after x-ray Bragg diffraction by single crystal diamond was undertaken [8]. A (111)-oriented Ib class sample and (100)- oriented specimens of type Ib and IIa were investigated. The spatial coherence preservation was assessed by means of the Talbot effect for x-rays. Correlation between the coherence degradation and the crystalline quality as well as the surface quality was examined.

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