ESRF	**Experiment title:** **Coherence properties and surface quality of Bragg-diffracting diamond plates**	**Experiment number**: MA-1195
Beamline: ID01	**Date of experiment**: from: 24th June 2011 to: 28th Feb 2011 from: 30th Nov 2011 to: 01st Dec 2011	**Date of report**: 10th August 2013
Shifts: 2x12	**Local contact(s)**: Gerardina CARBONE (ID01) Tobias SCHÜLLI (ID01)	*Received at ESRF:*

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Report:

High quality synthetic diamonds are under development as X-ray optical elements for 3rd generation synchrotron radiation and XFEL sources, due primarily to their superior heat-handling properties compared to silicon. For such applications, highly perfect crystals, both in terms of bulk quality and surface quality, are required and much progress has been made in achieving this in recent years.

The intention of this study was to use suitable non-destructive X-ray characterisation methods (and to combine them with optical and other methods like AFM) to characterise the depth-dependent crystalline quality near the surface of synthetic diamond plates. An integral and "indirect" measurement of the detrimental influence of the (limited) crystal quality on the coherence preservation may be done with coherence measurements themselves (e.g. exploiting the Talbot effect [1-3], reports MA-562, MA-742). But this shows the result and not the origin of the problem. However, those measurements are essential as they are close to the experimental conditions of the final application, and they take all detrimental contributions into consideration. We investigated the cleaved surfaces and the hot-metal polished surfaces of 111-oriented samples. To measure the crystalline quality of thin diamond crystal surface layers directly in a depth-dependent way, we combined surface sensitive X-ray Bragg diffraction methods such as GID (grazing incidence diffraction) with GISAXS and X-ray reflectometry. First experiments at ID01 have been carried out (MA-805) and were continued in the experiment MA-1195. Results were reported by posters on conferences like the X-TOP 2010 conference (20th-23rd September, Warwick University, UK), the DeBeers Diamond Conference 2011(7th-12rd July, Warwick University, UK), as well as in the publication [4].

References

[1] R C Burns, A Chumakov, G Carbone, S H Connell, D Dube, H P Godfried, J O Hansen, J Härtwig, F Masiello, M Rebak, A Rommeveaux, R Setshedi, P. Van Vaerenbergh, A Gibaud, *Diamonds for X-ray optical applications at 3rd and 4th generation X-ray sources*, Proc. of SPIE Vol. 6705, 67050K1-6 (2007)

[2] R. Burns, AI Chumakov, SH Connell, D Dube, HP Godfried, JO Hansen, J Härtwig, J Hoszowska, F Masiello, L Mkhonza, M Rebak, A Rommevaux, R Setshedi, P Van Vaerenbergh, *HPHT – growth and X-ray*

characterisation of high-quality type IIa diamond, Journal of Physics: Condensed Matter 21, 364224 (14ppt) (2009)

[3] R Klünder, F Masiello, P Van Vaerenbergh, J Härtwig, *Measurement of the spatial coherence of synchrotron beams using the Talbot effect*, Phys. Status Solidi A **206**, 1842–1845 (2009)

[4] G Bussone, T A Lafford, F. Masiello, A.Gibaud, G. Carbone, T. U. Schülli, S. H. Connell, A Vivo Rommeveaux, M. Wormington, J. Härtwig, *Investigation of surface and sub-surface damage in high quality synthetic diamonds by X-ray reflectivity and grazing incidence diffraction*, Phys. Stat. Sol. A **208**, 2612-2618 (2011)