EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** **Investigation of surface defects in polycrystalline diamond for synchrotron beam monitoring applications**	**Experiment number**:
Beamline:	**Date of experiment**: from: 04/10/00 to: 08/10/00	**Date of report**:
Shifts:	**Local contact(s)**: Ray Barrett	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

P. Bergonzo*, D.Tromson, , A. Brambilla, LETI (CEA - Technologies Avancées)/DEIN/SPE, CEA/Saclay, F-91191 Gif-sur-Yvette

V.N. Amosov*, TRINITI, Division of Physics of Thermonuclear Reactors, Troitsk Moscow reg. 142092 Russia

O. Hainaut*, Institut d'Astrophysique Spatiale, Université Paris Sud, F91405 Orsay, France

Report:

Diamond based radiation detectors have recently demonstrated considerable attraction. Due to the low atomic number of carbon that results in a high transparency, they present many advantages for the monitoring of soft X-ray beams: the large band gap of diamond (5.5 eV) results in low leakage currents (typ. 1pA) and excellent thermal stability. They also can be used in a high temperature environment (up to 250°C), and exhibit high resistance to radiation damage. Diamond has enabled the fabrication of semitransparent X-ray detectors of interests in the low energy domain: the transmission of a 5 µm thick CVD diamond detector at low energies (2 to 5 keV) lies in the 60 to 95 % range. New techniques have emerged in the last years as a way to produce thin layers of diamond with varying thicknesses and material qualities. Namely, the chemical vapour deposition (CVD) technique now enables the production of high quality materials from which radiation detection devices have been fabricated. In close collaboration with ESRF beamline, namely ID26, ID12A, and BM5, devices have been fabricated and characterised that enable the in-line monitoring of synchrotron beams (intensity, position, profile, and temporal response) [see 1].

One inherent problem however associated with CVD diamond synthesis is the formation of a polycrystalline material, with grain sizes in the micrometer range that can be detrimental to the behaviour of detection devices when they are destined for use with small beam sizes. Preliminary experiments were performed on ID 21 as part of experiment MI-347 where a micrometer size beam was used to induce photocurrents in CVD diamond devices. Significant non-uniformities of detector response were observed that could be correlated with the grain structure [see 2]. Such observations are complicated to interpret since the surface roughness of the as-grown film contributes significant film thickness variations which lead to local electric field inhomogeneities whose effects are convoluted with those due to crystalline defects and grain boundaries. In order to assess further these observations, other investigations were performed within MI-452 on polished surfaces, as well as at lower energies (3 keV), allowing probing of the surface of the polycrystalline diamond (< 10-20µm, resp.) on a depth scale comparable with the film grain size.

Maps of the sensitivity were probed on several samples, using varying electric fields, and varying beam energies. Among the results obtained, these experiments demonstrated that the material sensitivity is greatly affected by the grain structure, and that only part of the material actively contributes to the detector signal. This is shown in figure 1 where is displayed a map of sensitivity of a high quality CVD diamond commercially available. Also, the variation of the sensitivity map with respect to electric field variations from 3 kV/cm to 30 kV/cm are shown on figure 2. It appears that the sensitivity only increases in localised regions in the sample, or in other words that the velocity of saturation has been reached in other areas.

This work confirms that strong non uniformities are to be expected when diamond is used for beam monitoring. As long as the measurement relies on the variation of the measured signal between separated pixels, the material can fit applications such as beam position or beam profile monitoring. However, when a high resolution is required with respect to the measurement of the X-ray beam intensity, it seems that the diamond response may be affected by the small beam position instabilities. Since monocristalline diamond is not so far an easy alternative, one solution can however be to couple a diamond intensity monitor to a beam position monitor and to compensate the beam displacements.

references :

1- Diamond-based semi-transparent beam-position monitor for synchrotron radiation applications, P. Bergonzo, A. Brambilla, D. Tromson, R .D. Marshall, C. Jany, F. Foulon, C. Gauthier, V.A. Solé, A. Rogalev, J. Goulon, J. Synchrotron Rad. 6,1 (1999)

2- Geometrical nonuniformities in the sensitivity of polycrystalline diamond radiation detectors, Tromson-D; Brambilla-A; Foulon-F; Mer-C; Guizard-B; Barrett-R; Bergonzo-P, Diamond-and-Related-Materials. vol.9, no.11; Nov. 2000; p.1850-5

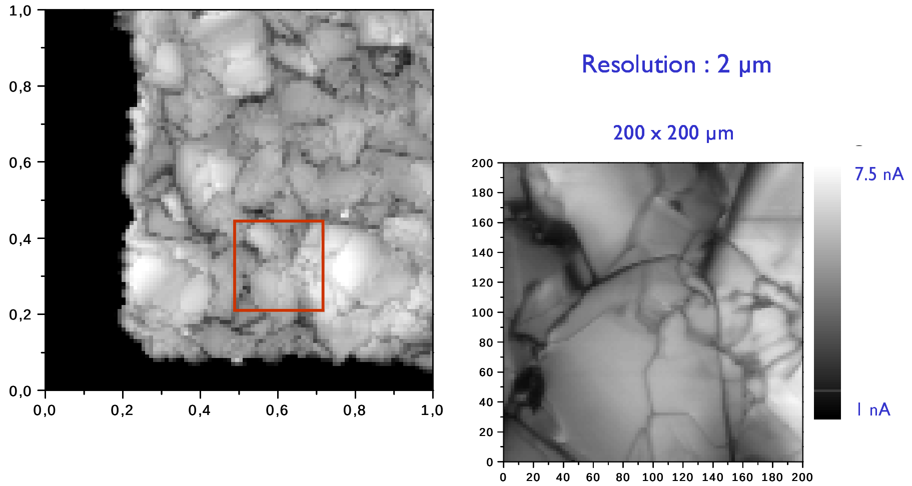

Figure 1

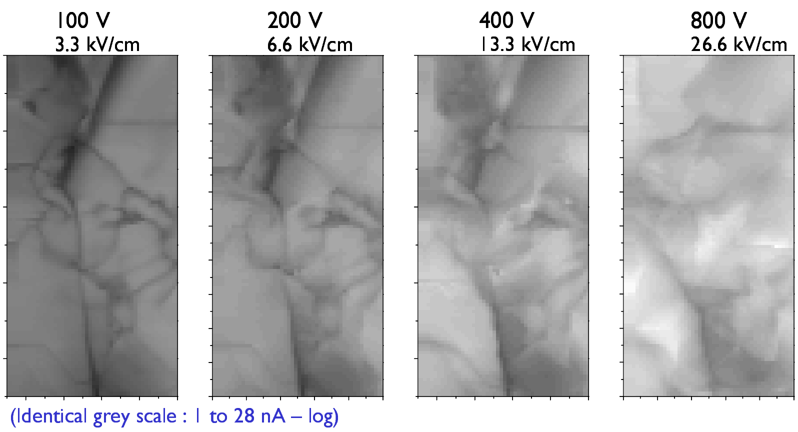

Figure 2