ESRF	**Experiment title: Imaging of the transport properties of semiconductor devices by x-ray microbeam induced current (XBIC) measurements**	**Experiment number**: MI 614
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Report:

XBIC (x-ray beam induced current) technique consists in measuring the photocurrent as a function of the position of a focussed x-ray beam scanning onto the electrode surface. Such a tecbnique has been successfully used at the ID21 x-ray microscopy beamline by Tromson et al. [1] and by our group (experiment HE-951, run 04/2000, user report http://ftp.esrf.fr/pub/UserReports/18541_A.pdf and ref. [2,3]) to map the efficiency of CVD diamond detectors.

In the present experiment we have applied such a technique to characterise both CVD diamond detectors and 4H-SiC Schottky diodes.

CVD diamond characterisation [2,4,6]:

We carried out XBIC to map the photoconduttive response of CVD diamond detectors produced by De Beers and processed within the CERN-RD42 collaboration in order to get information on the effects of the polycristalline nature of CVD diamond on its performance as a ionising radiation detectors to operate as a vertex detector in high luminosity colliders.

Details on the experimental set-up and the description of the sample, can be found in [2,4,6].

To interprete the XBIC results, we have implemented a new algorithm to map the mobility x lifetime product (and not the charge collection efficiency) in different bias conditions (Figure 1). These results, obtained by irradiating the sample with 5.5 keV photons, highlight the different behaviour of electrons and holes (the mean drift lengths @ 1 V/μm are 45 and 107 μm, respectively) as well as the inhomogeneity of the photoconductive response due to the polycristalline nature of the material.

4H-SiC Schottky diodes [3,5]:

As for CVD diamond, 4H-SiC is a material suitable for make ionising detectors operating in hostile environments and at high temperature. It was shown that SiC is an interesting material for the realization of neutron or charge particle detectors and dosimeters showing good performances and the potential of operating in high radiation damage environments. However, the technology to synthesize detector grade materials, as well as the process to

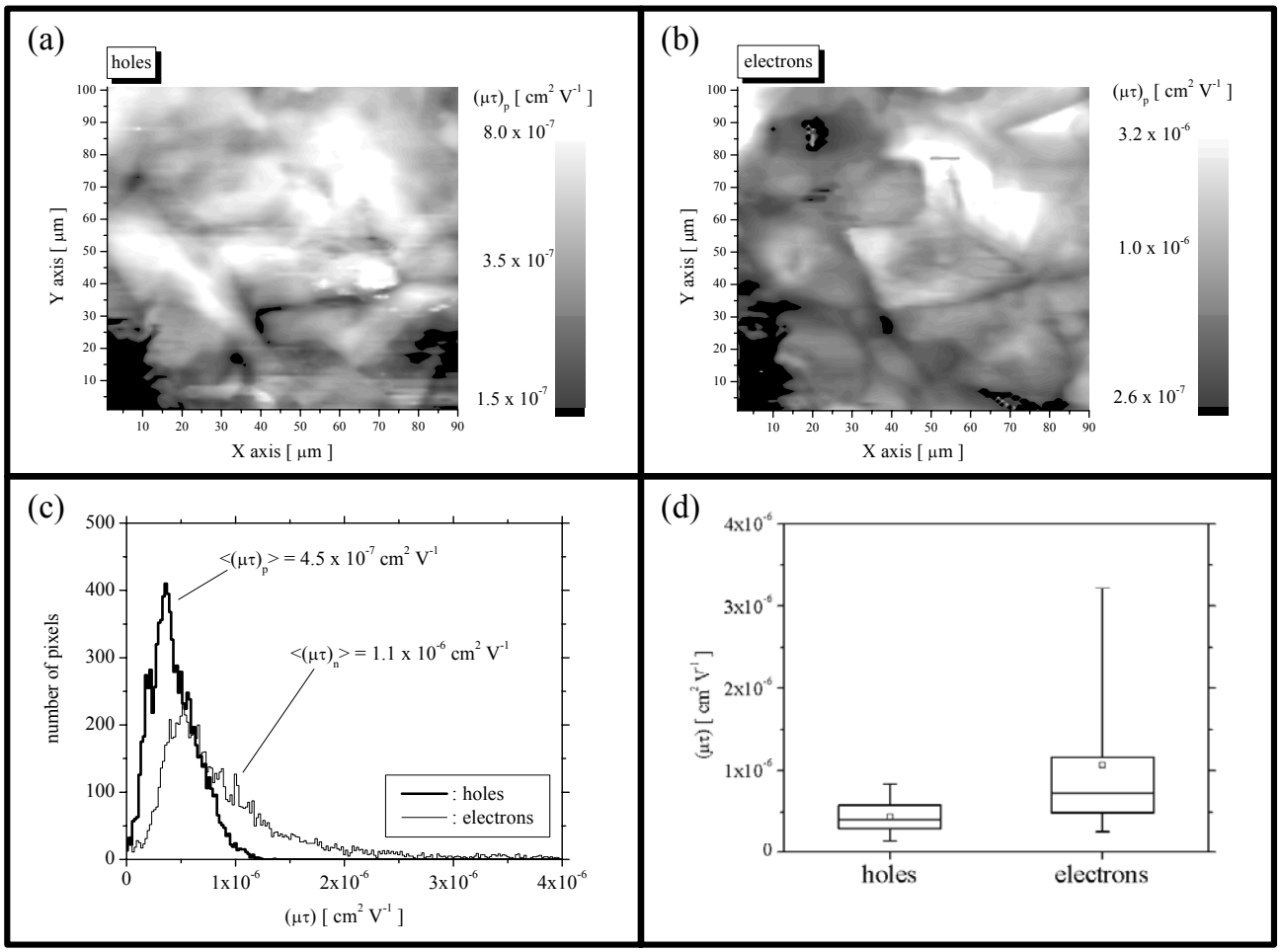

Figure 1: (90 x 100) mm^2 maps of the mobility x lifetime ($\mu\cdot\tau$ in cm$^2\cdot$V^{-1}) product for holes (a) and electrons (b), together with relevant spectral distributions (c) and box-plots (d).

make Schottky contacts is still not mature; for this reason XBIC measurements were carried out to evaluate the main transport properties of the device (minority carrier diffusion length) and to map the homogeneity of the photoconductive response.

Figure 2 shows the XBIC map of a circular Schottky diode. The Schottky contact was deposited onto a 4H-SiC n-type layer epitaxially grown by IkZ-Berlin on a highly doped substrate supplied by CREE [3,5]. The gray scale, shown at the right hand side, indicates the photocurrent induced by 3 keV x-rays focused onto 1 micrometer spot. Dark structures (aligned black points) are attributed to defects underneath the Schottky electrode which appears to an optical inspection perfectly smooth.

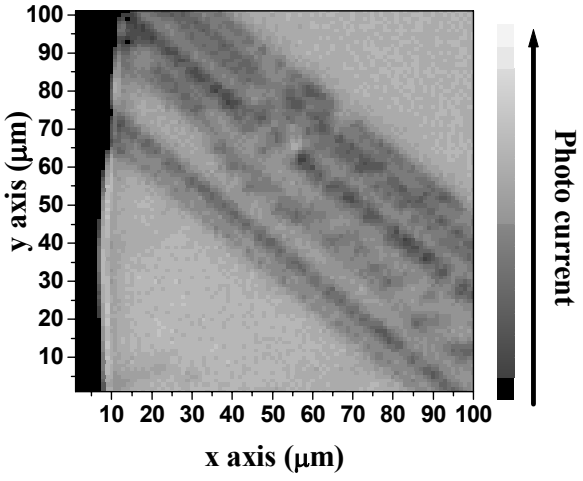

Figure 2: XBIC maps of a circular Schottky diode from IkZ Berlin

Another example of the non-homogeneous response of such detectors not directly due to structural defects is given in Figure 3 where an XBIC map of two pixel detectors is shown. Although the map shows the absence of defects as in figure 2, a remarkable

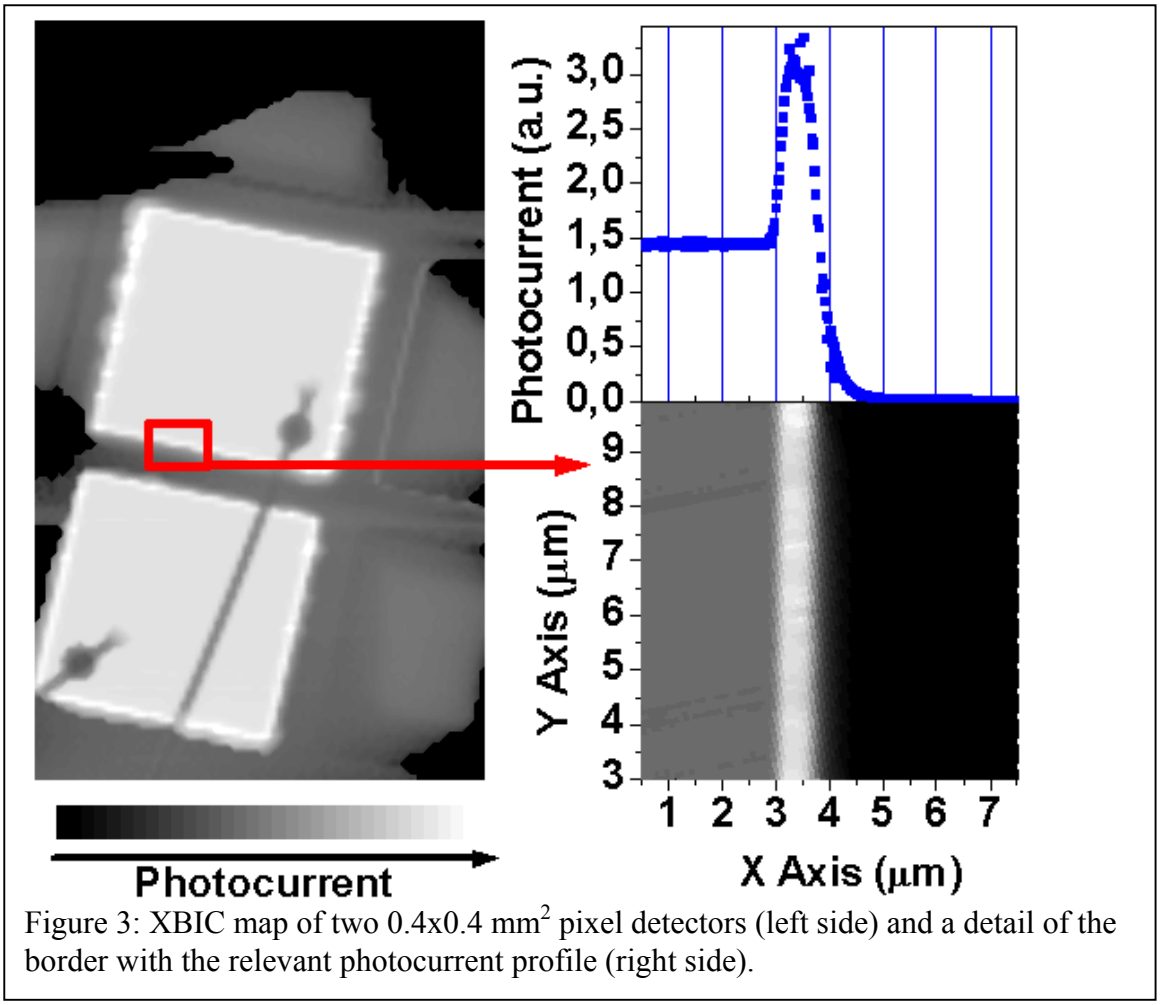

Figure 3: XBIC map of two 0.4x0.4 mm^2 pixel detectors (left side) and a detail of the border with the relevant photocurrent profile (right side).

increase of the photocurrent efficiency has been measured by zooming the x-ray scanning in a small region close to the border of the electrode as highlighted in the photocurrent profile shown in the right hand side of figure 3. This experimental result has allowed the anomalous worsening of the spectral resolution observed in alpha particle spectra to be interpreted.

References

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