Ion beam analysis of single crystal CVD diamond

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IBIC (Ion Beam Induced Charge) represents a powerful method to investigate the homogeneity of the response of semiconductor nuclear detectors from the point of view of charge collection efficiency (cce) with a spatial resolution of few microns. Polycrystalline materials like CVD diamond displayed in the past non-uniform cce maps, in which it was easy to notice the appearance of single grains. Moreover, the presence of traps in the defective regions around the grain boundaries caused strong polarization effects which in practice impeded in many cases to get reasonable cce maps. With the availability of new homoepitaxially grown CVD diamond samples the situation is now very much improved : maps are very uniform and the non-homogeneous broadening of peaks with the consequent worsening of energy resolution is extremely reduced. In this paper, both proton and alpha microbeams of energies 3 and 4.5 MeV were used for the investigation of single crystal CVD homoepitaxial diamond, with a beam diameter spot of about 1.2 mm over scanned areas of more than 1 mm2, sampled in regions of interest from 450x450 um down to 150x150 um and below. The good spatial homogeneity together with a cce value of about 50 % made it possible to reach energy resolutions of 1.3 % FWHM, including a not negligible electrical noise. These values compare quite well with Si performances, which in the same conditions reached 0.85% FWHM. The stability and reproducibility of the detector was very good without any preliminary priming and polarization effects were reduced to a minimum. The detector was pushed in some cases up to 700 cps with apparently no cce losses and with only a slight worsening of energy resolution.

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