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**Abstract:** Because of its physical properties (strong radiation hardness, wide energy gap with a consequent extremely low dark current, very large electron and hole mobility) diamond is a very good candidate for nuclear particle detection, particularly in harsh environments or in conditions of strong radiation damage. Being commonly polycrystalline, diamond samples obtained by chemical vapour deposition (CVD) are not homogeneous, not only from the morphological point of view, but also from the electronic one. As a consequence, as it was indicated quite early starting from 1995, charge collection properties such as charge collection efficiency (cce) are not uniform, but they are depending on the site hit by incoming particle. Moreover, these properties are influenced by previous irradiations which are used in order to improve them and, finally, they are also dependent on the thickness of the sample, since the electronic non uniformity extends also in depth by affecting the profile of the electrical field from top to bottom electrode of the nuclear detector in the standard "sandwich" arrangement. By the use of focussed ion beams, it is possible to investigate these non uniformities by the aid of techniques like IBIC (Ion Beam Induced Charge) and IBIL (Ion Beam Induced Luminescence) with a space resolution of the order of 1 [mu m. This relatively new kind of microscopy, which is called "ion microscopy", is capable not only to give 2D maps of cce, which can be quite precisely compared with morphological images obtained by Scanning Electron Microscopy (generally the grains display a much better cce than intergrain regions), but also to give the electric field profile from one electrode to the other one in a "lateral" arrangement of the ion beam. IBIL, by supplying 2D maps of luminescence intensity at different wavelength, can give information about the presence of specific radiative recombination centers and their distribution in the material. Finally, a new technique called XBIC (X-ray Beam Induced Charge), which makes use of very collimated (to 0.1 mu m) x-ray beams from high energy electron synchrotrons, opens new ways to map cce with a less damaging radiation and with a better energy resolution. In this paper we resume recent and less recent work carried out by our group by using these techniques, a work that has been undertaken afterwards also by other research groups in the world. In particular, topics such as the better homogeneity obtained by "priming" and the effects of "light priming", together with a certain "complementarity" between IBIC and IBIL maps, giving evidence that radiative recombination centers along the grain boundaries or in damaged regions are important in affecting cce, will be presented and discussed in some details. The conclusion is that ion microscopy is a powerful and essentially unique method for the investigation of diamond and other semiconductor materials proposed for nuclear detection.

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