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Ionoluminescence in CVD diamond and in cubic boron nitride

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Abstract

Using the new ion beam-induced luminescence (IBIL) apparatus in National Legnaro Laboratories, Italy, a series of measurements concerning both wide-area luminescence spectra and monochromatic luminescence maps with a space resolution of a few μm has been carried out on several CVD diamond and c-BN samples. Protons of 2 MeV with a penetration depth of approximately 25 μm have been used in order to investigate the materials in the bulk. These measurements have been correlated with particle-induced X-ray emission (PIXE) and EPR data. The measurements have been performed at increasing proton doses in order to also investigate the radiation hardness of luminescence peaks. The results indicate that ionoluminescence of CVD diamond is dominated by three bands at approximately 2, 2.4 and 2.9 eV, with the intermediate band being very radiation-hard, and the other two radiation-weak. The band at 2 eV is correlated with N content, and is particularly high in samples with poor electronic properties. IBIL in c-BN is also dominated by three bands, one at approximately 2 eV, and the other two at higher energies with respect to CVD diamond. All these three bands seem to be relatively radiation-hard with respect to CVD diamond, and to be related to defects induced by doping.

Keywords: Chemical vapor deposited (CVD) diamond; c-BN; Ionoluminescence; Radiation damage

1. Introduction

Ion beam-induced luminescence (IBIL) is a very powerful technique [1–5] for material investigation by looking at radiative recombination centers. With respect to photoluminescence, it has the big advantage of full excitation of all the existing radiative centers and of a complete control of the emission region, which is given by the range of ions and by the scanned surface area, while, with respect to cathodoluminescence, it is a real bulk technique. It has a much larger signal-to-noise ratio, can operate in a time-resolved regime and measure the local radiative lifetime of carriers, and can also be coupled with a much more sensitive technique for detection and mapping of trace elements, such as particle-induced X-ray emission (PIXE), on the same apparatus.

Moreover, IBIL has been used in the recent past [6–8] together with ion beam-induced current or charge (IBIC) in order to investigate the radiative or non-radiative nature of centers which lower the performance of detectors (nuclear, light) built with new materials, such as CVD diamond.

Until now, the IBIL apparatus at Legnaro Laboratories (Italy) has been used in a panchromatic mode in a

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