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The primed state of CVD diamond under blue light illumination

Y. Garino, F. Fizzotti, A. Lo Giudice, E. Vittone, C. Manfredotti *

Experimental Physics Department, University of Torino, and Centre of Excellence NIS, University of Torino, Torino Italy

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Abstract

Broad beam IBIC measurements with 2 MeV protons have been carried out on CVD diamond as a function of temperature in order to investigate the effect of illumination (white and blue light) on charge collection properties of electrons, even in absence of a previous X-ray priming. The results indicate that there is no direct effect of the light, apart from a contribution to noise and that blue light has the effect of improving charge collection in low charge collection efficiency regions. The fact that there is no noticeable change of collection properties as a function of temperature excludes effects such as temperature assisted detrapping of carriers: the conclusion is therefore that optically assisted detrapping of electrons in disordered regions around the grain boundaries seems to be the dominant mechanism during blue illumination of CVD diamond.

Keywords: CVD diamond; Priming; Illumination; IBIC

1. Introduction

In a previous paper [1] we reported on the effects of light illumination on the primed state of CVD diamond as investigated by using alpha particles: in the present work, which is a progress report on the same argument, we will discuss the results obtained in similar way by a beam of 2 MeV protons. According to our experience, as far as electrons collection is concerned, a previous priming with X or beta rays is not that important. As a consequence, large part of this paper will concern only the priming effect only due to illumination.

The use and the effects generated by light (in particular blue light) during the working of CVD diamond as a nuclear detector has generated several controversies [2,3]. Always according to our experience, blue light illumination can help in avoiding polarization and in improving the homogeneity of response [4]. However, our previous data are limited to the use of low energy protons in microbeams by IBIC (Ion Beam Induced Charge) and protons which, with respect to minimum ionising particles (mip), have a very short penetration depth, of the order of no more than some tens of micrometer. On the contrary, mips are crossing the whole thickness of the detector with a ionisation density two or three orders of magnitude lower. Apart from its use as a track detector, CVD diamond can and should be used in low energy physics, both as counter and may be also as a spectrometer. In this respect, and apart from some more general considerations, we guess that phenomena generated in CVD diamond by light illumination deserve other and more systematic investigations. This in fact is the purpose of the present paper, which makes use of detectors of typical thickness (600 μm) for tracking applications. Phenomena related to the direct and only effect of illumination, to noise generation, to other possible effects at lower temperatures and to transients after shutting off of the light have been carefully investigated, in order to isolate the effect of light on the performances of the detector. In this respect, we are mainly interested to the behaviour of electrons, since, as described in details in previous papers [5–8], they were proved to give the most important contribution to the charge collection efficiency (cce) during illumination.

2. Experimental

The investigated detector was a CVD diamond sample of 600 μm thickness which was equipped with standard evaporated Au/Cr contacts on both sides about 0.5 cm in diameter and 200 nm in thickness. The $I-V$ characteristics displayed a good ohmic behaviour up to 500 V with very low dark currents.

* Corresponding author.
E-mail address: manfredotti@to.infn.it (C. Manfredotti).

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