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# Investigation of chemical vapour deposition diamond detectors by X-ray micro-beam induced current and X-ray micro-beam induced luminescence techniques☆

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**Abstract**

Tracking detectors have become an important ingredient in high-energy physics experiments. In order to survive the harsh detection environment of the large hadron collider (LHC), trackers need to have special properties. They must be radiation hard, provide fast collection of charge, be as thin as possible and remove heat from readout electronics. The unique properties of diamond allow it to fulfill these requirements. In this work we present an investigation of the charge transport and luminescence properties of "detector grade" artificial chemical vapour deposition (CVD) diamond devices developed within the CERN RD42 collaboration, performed by means of X-ray micro-beam induced current collection (XBICC) and X-ray micro-beam induced luminescence (XBIL) techniques. XBICC technique allows quantitative estimates of the transport parameters of the material to be evaluated and mapped with micrometric spatial resolution. In particular, the high resolution and sensitivity of the technique has allowed a quantitative study of the inhomogeneity of the charge transport parameter defined as the product of mobility and lifetime for both electron and holes. XBIL represents a technique complementary to ion beam induced luminescence (IBIL), which has already been used by our group, since X-ray energy loss profile in the material is different from that of MeV ions. X-ray induced luminescence maps have been performed simultaneously with induced photocurrent maps, to correlate charge transport and induced luminescence properties of diamond. Simultaneous XBICC and XBIL maps exhibit features of partial complementarity that have been interpreted on the basis of considerations on radiative and non-radiative recombination processes which compete with charge transport efficiency.


*Keywords:* CVD diamond detector; X-ray induced photocurrent; X-ray-induced luminescence; Electronic properties; Charge transport

## 1. Introduction

The interest in the use of diamond as ionizing radiation detector arises from its unique combination of electronic, mechanical and thermal properties. The high band gap, small dielectric constant, chemical inertness and radiation hardness make diamond an ideal candidate to operate as a vertex detector in high luminosity hadron colliders with long times and without significant degradation in performance [1]. For the past several years, the CERN-based RD42 collaboration has worked on improving diamond detector performances and on prototyping diamond-based microstrip and pixel detectors. Radiation sensors are fabricated from diamond synthesized by means of chemical vapour deposition (CVD) technique. The fact that the samples are polycrystalline influences

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