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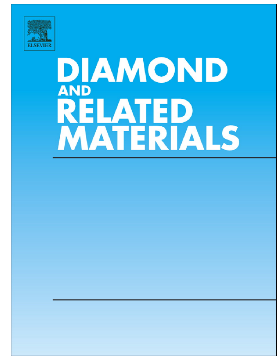

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Diamond Graphitization by Laser-Writing for all-Carbon Detector Applications

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Keywords

Diamond film. Graphitization. Surface characterization. Ohmic contacts. All-carbon detectors.

Abstract

The surface of a detector grade CVD polycrystalline diamond sample ($5 \times 5 \times 0.05$ mm^3) was irradiated by an ArF excimer laser (λ = 193 nm, τ = 20 ns) to produce graphitic conductive layers.
In particular, two sets of four parallel graphitic strip-like contacts, with 1 mm pitch, were created along the whole sample on the top and on the rear surfaces of the sample respectively. The two series of stripes lie normally to each other. Such a grid allows to obtain a segmented all-carbon device capable of giving bi-dimensional information on particle detection processes in nuclear applications.
Afterwards, an extensive characterization of the samples was performed: SEM and micro-Raman investigations to study the morphological and structural evolution of the irradiated areas, EDS measurements to individuate any absorption phenomena from environment associated to laser treatment, and nanoindentation mapping to understand how the hard-soft transformation occurred depending on the locally transferred energy. Finally, current-voltage analyses were carried out checking the ohmic behaviour of the diamond-graphite contact. By comparing the results of the different characterization analyses, a strong periodicity of the modified surface properties was found, confirming the reliability and reproducibility of the laser-induced graphitization process.
The results demonstrate that the laser-writing technique is a good and fast solution to produce graphitic contacts on diamond surface and therefore represents a promising way to fabricate segmented all-carbon devices.

1. Introduction

The physical properties of diamond, such as the radiation hardness, high thermal conductivity, large bandgap, high carrier mobility, chemical stability, bio-inertness and biological tissue equivalence, have proved to be attractive for different applications. In particular, diamond devices are considered performing sensors for detection, beam monitoring and time of flight measurements in nuclear physics [1-3], and besides dosimetry in medical applications [4,5]. In order to exploit the great potentialities of diamond sensors, a significant effort for electrical contacting is required. In particular, good adhesion, stability, radiation hardness and ohmic behavior are required properties for electrodes on diamond surfaces.

Traditionally, electric contacts on diamond are produced by metal layer deposition. This technique involves many complex process steps, such as surface cleaning, carbide formation with Cr or Ti, thermal annealing, metal contact layer deposition with Au or W, and lithography process for strip or