NANOCRYSTALLINE DIAMOND THIN FILMS IN ELECTRONICS, CHEMISTRY AND BIOLOGY

REZEK Bohuslav

Institute of Physics of the ASCR, v.v.i., Prague, Czech Republic, EU

Abstract

In the field of semiconductors, diamond represents a relatively novel material which provides unique combination of excellent electronic, mechanical, chemical and biocompatible properties for diverse applications [1]. Here we present the most recent advances in the growth of nanocrystalline diamond films by chemical vapor deposition (CVD) techniques.

We demonstrate fundamental differences in plasma chemistry that can lead to formation of diamond nanostructures (including highly porous films) or to electronic grade films across large areas (10“) depending on the employed CVD technique and/or process parameters [2]. We present methods of diamond micropatterning by pre- or post-processing using selective diamond nucleation, three-dimensional nucleation scaffolds (based on polymers or carbon foams), and self-assembled nanodot etching masks. Moreover, we show how various properties of otherwise rather stable diamond can be relatively simply yet significantly affected by modification of its surface by foreign atoms (H, O, F, N), organic molecules (dyes, proteins, DNA) and even cells.

Material features and quality of the diamond films and nanostructures are characterized by micro-Raman spectroscopy, scanning electron microscopy (SEM), and atomic force microscopy (AFM) in topography, phase detection and Kelvin probe regimes. We also characterize (opto)electronic, chemical, and biointerface properties of the diamond films by using impedance and field-effect transistor configurations, surface photovoltage measurements, optical microscopy, AFM, SEM, and other methods. We show that grain boundaries in the nanocrystalline diamond are not detrimental to its funtionality (often even vice versa [3]) and the transistors with grains as small as 30 nm and with thickness ~ 100 nm are still fully operational [4]. The electronic functionality remains stable even after gamma irradiation of 5 Gy. We provide examples and discuss use in practical applications such as novel chemical detectors, bioelectronic sensors, optical elements (photonic [5], FTIR [6]), and energy conversion systems.

Keywords: Diamond, chemical vapor deposition, electronic properties, surfaces, biointerfaces, nanostructures

LITERATURE

[1] B. Rezek: Habilitation thesis, Vutium, Brno 2013, ISBN 978-80-214-4763-9. (available online);

[2] Adv. Sci. Eng. Med. 5 (2013) 509;

[3] ACS Appl. Mater. Interfaces 4 (2012) 3860;

[4] Sens. Actuators B 20 (2012) 239;

[5] ACS Nano 5 (2011) 346;

[6] Langmuir 30 (2014) 2054

Author did not supply full text of the paper/poster.