

Article

Development and Characterization of a Diamond-Insulated Graphitic Multi Electrode Array Realized with Ion Beam Lithography

Federico Piccolo ^{1,2,*}, Alfio Battiato ^{1,2}, Emilio Carbone ³, Luca Croin ^{4,5}, Emanuele Enrico ⁵, Jacopo Forneris ^{1,2}, Sara Gosso ³, Paolo Olivero ^{1,2}, Alberto Pasquarelli ⁶ and Valentina Carabelli ³

¹ Istituto Nazionale di Fisica Nucleare, Sezione di Torino, via P. Giuria 1, Torino 10125, Italy; E-Mails: battiato@to.infn.it (A.B.); forneris@to.infn.it (J.F.); olivero@to.infn.it (P.O.)

² Physics Department and NIS Center, University of Torino, via P. Giuria 1, Torino 10125, Italy

³ Department of Drug Science and Technology and NIS Center, University of Torino, Corso Raffaello 30, Torino 10125, Italy; E-Mails: emilio.carbone@unito.it (E.C.); sara.gosso@unito.it (S.G.); valentina.carabelli@unito.it (V.C.)

⁴ Department of Applied Science and Technology—DISAT, Politecnico di Torino, Corso Duca degli Abruzzi 24, Torino 10129, Italy; E-Mail: luca.croin@polito.it

⁵ Nanofacility Piemonte, National Institute of Metrologic Research (INRiM), Strada delle Cacce 91, Torino 10135, Italy; E-Mail: e.enrico@inrim.it

⁶ Institute of Electron Devices and Circuits, Ulm University, Ulm 89069, Germany; E-Mail: alberto.pasquarelli@uni-ulm.de

* Author to whom correspondence should be addressed; E-Mail: picollo@to.infn.it; Tel.: +39-011-670-7879; Fax: +39-011-670-7020.

Academic Editor: Stefano Mariani

Received: 5 November 2014 / Accepted: 24 December 2014 / Published: 30 December 2014

Abstract: The detection of quantal exocytic events from neurons and neuroendocrine cells is a challenging task in neuroscience. One of the most promising platforms for the development of a new generation of biosensors is diamond, due to its biocompatibility, transparency and chemical inertness. Moreover, the electrical properties of diamond can be turned from a perfect insulator into a conductive material (resistivity $\sim \text{m}\Omega \cdot \text{cm}$) by exploiting the metastable nature of this allotropic form of carbon. A 16-channels MEA (Multi Electrode Array) suitable for cell culture growing has been fabricated by means of ion implantation. A focused 1.2 MeV He^+ beam was scanned on a IIa single-crystal diamond sample ($4.5 \times 4.5 \times 0.5 \text{ mm}^3$) to cause highly damaged sub-superficial structures that were defined with