Microelectrode Arrays of Diamond-Insulated Graphitic Channels for Real-Time Detection of Exocytotic Events from Cultured Chromaffin Cells and Slices of Adrenal Glands

Federico Picollo,^1‡,8,† Alfio Battiato,^1‡,8,† Alberto Pasquarelli,∥ Emilio Carbone,∥ Paola Olivero,∥ Andrea Marcantoni,‡ and Valentina Carabelli‡

1Istituto Nazionale di Fisica Nucleare (INFN), 10125 Torino, Italy
2Physics Department, University of Torino, 10125 Torino, Italy
3“Nanostructured Interfaces and Surfaces” Inter-departmental Centre, University of Torino, 10125 Torino, Italy
4Consorzio Nazionale Interuniversitario per le Scienze Fisiche della Materia (CNISM), Torino Unit, 10125 Torino, Italy
5Department of Drug Science and Technology, University of Torino, 10125 Torino, Italy
6Institute of Electron Devices and Circuits, Ulm University, 89081 Ulm, Germany

ABSTRACT: A microstructured graphitic 4 × 4 multi-electrode array was embedded in a single-crystal diamond substrate (4 × 4 μG-SCD MEA) for real-time monitoring of exocytotic events from cultured chromaffin cells and adrenal slices. The current approach relies on the development of a parallel ion beam lithographic technique, which assures the time-effective fabrication of extended arrays with reproducible electrode dimensions. The reported device is suitable for performing amperometric and voltammetric recordings with high sensitivity and temporal resolution, by simultaneously acquiring data from 16 rectangularly shaped microelectrodes (20 × 3.5 μm²) separated by 200 μm gaps. Taking advantage of the array geometry we addressed the following specific issues: (i) detect both the spontaneous and KCl-evoked secretion simultaneously from several chromaffin cells directly cultured on the device surface, (ii) resolve the waveform of different subsets of exocytotic events, and (iii) monitoring quantal secretory events from thin slices of the adrenal gland. The frequency of spontaneous release was low (0.12 and 0.3 Hz, respectively, for adrenal slices and cultured cells) and increased up to 0.9 Hz after stimulation with 30 mM KCl in cultured cells. The spike amplitude as well as rise and decay time were comparable with those measured by carbon fiber microelectrodes and allowed to identify three different subsets of secretory events associated with “full fusion” events, “kiss-and-run” and “kiss-and-stay” exocytosis, confirming that the device has adequate sensitivity and time resolution for real-time recordings. The device offers the significant advantage of shortening the time to collect data by allowing simultaneous recordings from cell populations either in primary cell cultures or in intact tissues.

Supporting Information

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