Topic (Advances in fabrication & instrumentation)

Simultaneous Fluorescent and Amperometric Detection Of Catecholamine Release From Neuroendocrine Cells With Transparent Diamond MEAs

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Motivation

Among all materials suitable for the fabrication of Type-0 electrodes, diamond is the one that shows the best pros/cons ratio. It is in fact very sensitive, chemically inert, biocompatible and transparent. This latter property was used so far only for cell inspection and not for optical measurements. In this work, we demonstrate for the first time the suitability of diamond MEAs for the simultaneous amperometric and fluorescent detection of catecholamine release from *in vitro* cultured chromaffin cells. This was possible thanks to the recently improved technology of the diamond MEAs, which allows now to reach a transmittance of ~ 50% in the whole optical range of interest, while keeping excellent amperometric sensitivity.

Material and Methods

New 16Ch-MEAs were fabricated on a 200 µm thick high-temperature glass carrier, having the same thermal expansion coefficient of silicon. This results in a minimal compressive stress of the diamond film after fabrication and therefore very little risk of delamination, without any adhesion promoter, which can spoil the optical properties. The growth of the nanocrystalline diamond (NCD) film was done in two microwave plasma CVD reactors after a convenient seeding step, needed to provide a starting-layer. The growth itself comprised two main steps, a first one for the deposition of a ~ 1 µm thick intrinsic NCD-film, which was overgrown in a second step with a ~ 200 nm thick boron-doped NCD-layer (BDD). This double-layer technique yields better electrical properties than the single deposition of just a BDD-layer, i.e. conductivity and background noise, of the conducting structures. The 16 channel MEA-pattern was realized by means of standard microfabrication processes, following the same procedure described in [1].

Bovine chromaffin cells were prepared following the standard protocol described in [2], plated onto the diamond MEA, incubated at 37°C in water-saturated atmosphere with 5%CO_2 and used within 2-4 days after plating.

Results

The fabricated chips exhibited in the diamond areas an integral transmittance of ~50% in a wide wavelength range, starting from ~300 nm and extending into the near infrared region.

The electrical recording setup was operating in amperometric mode, with a transimpedance gain factor of 100 MOhm over a bandwidth from DC to 1 kHz. Under these conditions, the background noise was < 1 pA rms.