Fabrication of Multi-walled Carbon Nanotubes based Nanoelectrode Arrays for Bio Probe

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Carbon nanotubes have began to attract enormous interest in electrochemistry because of their small size ad good electrochemical properties. Gaining greater control over the distribution and amount of nanotubes to give a nanotube electrode has been attempted. The growth of aligned multi-wall carbon nanotubes (MWCNTs) directly onto an electrode surface has been performed. Among various synthesis methods for carbon nanotube growth, chemical vapor deposition (CVD) method has been widely used for various advantages such as high quality, vertical alignment, controlled diameter and length of nanotubes and so on. Especially, vertically aligned MWCNT arrays could be grown using plasma-enhanced chemical vapor deposition (PECVD)[1]. In this paper, the fabrication of nano-electrodes by the synthesis of multi-wall carbon nanotubes (MWCNTs) has been investigated for biological applications. To form Fe catalyst dots with diameter of 100 nm and thickness of 10 nm, nano holes patterned imprint resin with PMMA was used for lift-off process. Imprint lithography is easy and inexpensive to fabricate large areas of nano-patterns [2]. MWCNTs were grown on TiN electrode layer with Fe catalyst patterned by UV nano-imprint lithography (NIL) on quartz wafer. The proposed study is realization of a simple, inexpensive and reproducible method to produce nanoscale electrode arrays in large areas. The patterns were defined by an array of circle with 100 nm in diameter, and 200 nm in pitch. The nano-patterned master and Fe catalyst are observed with good pattern fidelity over a large area by atomic force microscope (AFM) and scanning electron microscopy (SEM).

Among various synthesis methods for carbon nanotube growth, plasma-enhanced chemical vapor deposition (PECVD) was used for the growth of vertically aligned multi-wall carbon nanotube arrays. Ammonia (NH_3) and acetylene (C_2H_2) were used as the etchant gases and carbon source. Nanoelectrodes of MWCNTs have diameters ranging from 20 nm to 40 nm and lengths of about 300 nm. The results showed that vertically aligned MWCNT electrodes into individually addressable probing elements could be applied for bio-compatible platforms for dynamic electrophysiological measurements in and around excitable cells.

References:

[1] Meyyappan M, Delzeit L, Cassell A and David H, Plasma sources Sci. Technol. 12, 205 (2003).

[2] W.M. Choi, O.O. Park, Microelectron. Eng. 70, 131 (2003).