CARBON NANOTUBE INTEGRATION FOR BIO-SENSING APPLICATIONS

I. Martin-Fernandez, G. Gabriel, G. Rius, R. Villa, E. Lora-Tamayo, F. Perez-Murano, P. Godignon
Insto. de Microelectrónica de Barcelona, Campus UAB, Cerdanyola del Vallès, Spain
inigo.martin@cnm.es

In this contribution we present a technology for batch fabrication of high density of chemical vapour deposition (CVD) grown carbon nanotube (CNT) modified bio-compatible Pt electrodes by using Pt as the CNT catalyst material.

Bio-compatible impedance needles and multi electrode arrays (MEAs) were simultaneously fabricated by using standard microtechnologic technologies at wafer scale as described in ref. [1]. Selective growth of the CNTs was performed in two steps. A 15 nm SiO_2 layer and a 4 nm Pt layer were respectively deposited at wafer scale and selectively on the electrodes as CNT catalyst bi-layer. CNTs growth took place at a rapid thermal CVD system at 800 ºC in a H_2 and CH_4 ambience. Device final fabrication step consisted in removing the 15 nm SiO_2 layer on the connection pads with a HF based solution.

Photographs in Fig. 1 showing homogeneous selective growth of CNTs at a 4-inch wafer scale and SEM imaging (Fig. 2) confirm high density growth and vertical alignment of the CNTs. TEM characterization of the CNTs demonstrated they were multi-walled and that there were covered by an amorphous carbon layer.

Two different electrical measurements on the electrodes were performed. Two probe measurements between the different layers forming the electrode (Fig. 3) demonstrate the CNT layer constitutes the main part of the series resistance since directly contacting the electrode in areas where the CNTs had been removed provides lower series resistance. Impedance measurements comparison for bare Pt electrodes and a CNT modified electrodes (Fig. 4) do not show an impedance improvement with respect to bare electrodes.

Based on the electrode improvement when directly depositing single-walled CNTs on the electrode [2] and because of the amorphous carbon surrounding the CNTs inhibits electron transfer from the electrolyte to the CNT layer, we believe that by optimizing CNT synthesis conditions we will achieve an improvement of the characteristic of the electrode.

Despite the fact that the impedance of the modified electrodes has not been improved, the technological process for CNT integration into devices for bio-sensing is demonstrated.

[1] Gabriel, G., I. Erill, J. Caro, R. Gómez, D. Riera, R. Villa, and P. Godignon, **Microelectronics Journal** 38 (2007),406-415.
[2] Gabriel, G., R. Gomez, M. Bongard, N. Benito, E. Fernandez, and R. Villa, **Biosensors and Bioelectronics** (2008), doi:10.1016/j.bios.2008.09.036.

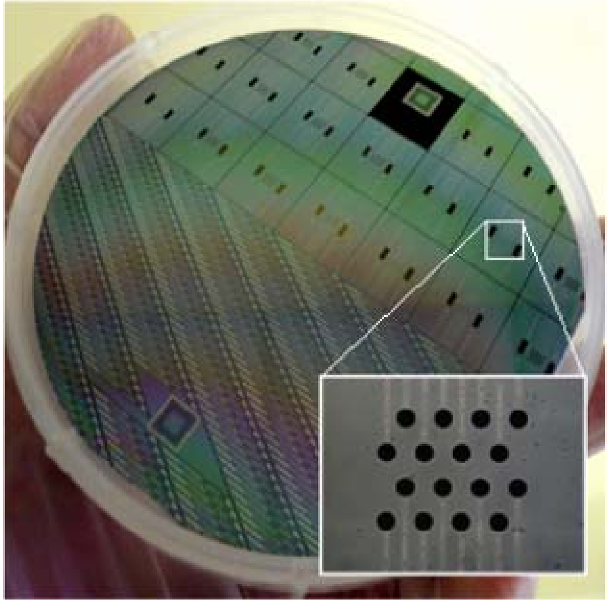

Fig. 1: Impedance needles and MEA 4 inch wafer after CNT integration. Dark areas are the places where CNT have been selectively grown.

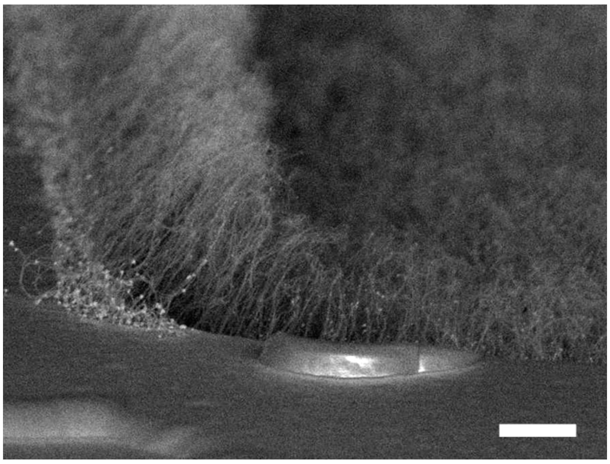

Fig. 2: Tilted SEM image of an electrode. Vertically aligned CNTs grow from inside the electrode

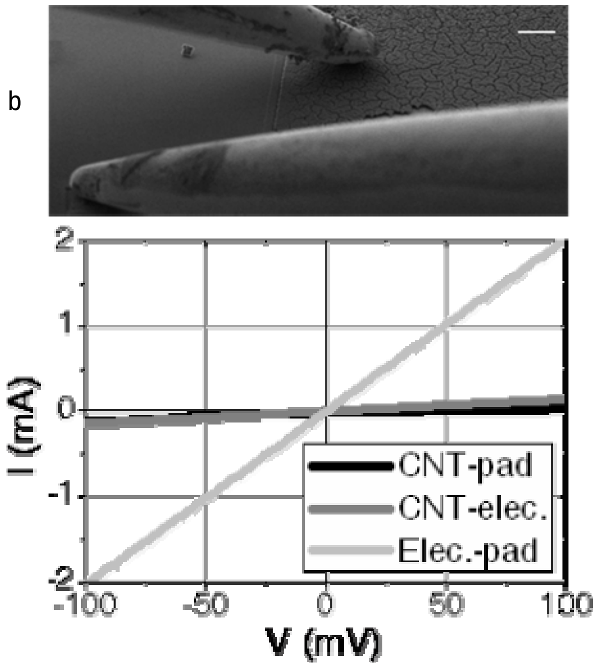

Fig. 3: Two probe electrical measurements between the different layers forming the electrode - CNT layer-SiO2 layer (CNT-pad); CNT layer-electrode (CNT-elect.); electrode-SiO2 layer (Elec.-pad) - were performed inside an SEM chamber in order to control the positioning of the probes not to damage the layers.

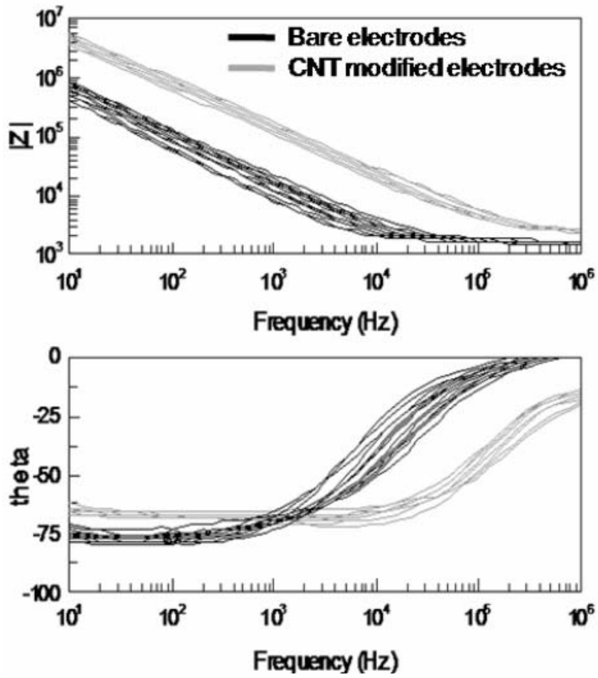

Fig. 4: Impedance measurements on the CNT modified electrodes show an impedance increase with respect to bare electrodes.