Carbon Nanotubes-based Sensing Platforms

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ABSTRACT

Patterning and alignment of carbon nanotubes (CNTs) between microelectrodes are prerequisite for realization of different device configurations such as chemiresistors and field-effect transistors (FETs) as components for the fabrication of highly sensitive and specific biochemical sensors [1]. The reported techniques namely photolithography, laser-based photo-ablation, inkjet printing, chemical vapor deposition (CVD), and dip-pen nanolithography (DPN) either involve complicated fabrication processes, use of various chemicals, or preconditioning the substrate/AFM tips etc. We have developed chemical-free technology for patterning the CNTs between source and drain using silicon shadow mask and spray coating process (Fig 1(a)) to realize liquid gate CNTFET devices [2]. In addition, the reusable silicon shadow mask with ~ minimum 1 μm gap between electrodes has been used to make end-to-end metal contacts over CNTs (Fig 1(b)) [3]. Silicon shadow masks were fabricated via bulk micro-machining and other common semiconductor technological processes. The technology for alignment and on-chip sorting of semiconducting CNTs between electrodes have been successfully developed to fabricated aligned CNTs based platform, which is useful for different highly sensitive biochemical sensing applications. Taking NO_2 gas sensing as a test case, sensitivity enhancement (up to ~ 200%) has been observed in case of aligned CNTs devices w.r.t. random network devices. Flexible CNTs based sensing platform was developed over PTFE substrates and was employed to fabricate a flexible CNTs-based NO_2 gas sensor operated at room temperature for different gas concentrations (0.75 to 5 ppm) [4]. The reliability of the fabricated flexible chemiresistors was tested with physical bending around different curvatures. The developed CNTs based various sensing platforms would be useful for the variety of biochemical sensing applications.

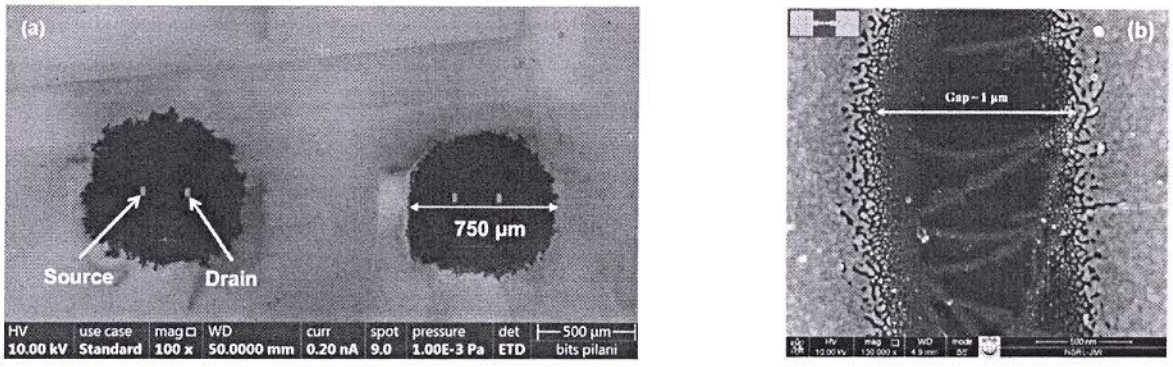

Fig. 1. FESEM image (a) showing the patterned CNTs network over prefabricated source-drain pairs at two locations, and (b) of the electrodes, which indicate the ~1 μm gap and end-to-end metal contacts with CNTs between electrodes.

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