Parallel Alignment of Nanowires for Fast Fabrication of Nanowire Based Gas Sensors

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Nanowires have emerged as potential blocks for future electronic devices [1]. However, significant requirements arise from the use of elements with dimensions in the nanoscale: large scale synthesis of structures with homogeneous properties and reliable, affordable and fast contact fabrication, among others. In this work, a methodology for the fabrication of gas sensors based on individual metal oxide nanowires (NWs) is presented. Dielectrophoretic (DEP) alignment is used in combination with Focused Ion Beam (FIB) lithography for the deposition of contacts to obtain reliable and reproducible gas sensors, reducing the time necessary for their fabrication.

First of all, monocrystalline SnO_2 nanowires were dispersed on ethanol, making solutions with different concentrations. Afterwards, their manipulation was carried out by spreading a droplet of the solution (~10 µl) onto a SiO2 / Si wafer with pre-patterned microelectrodes, while an AC voltage of controlled frequency between these microelectrodes was applied. These experimental conditions were kept constant until the complete evaporation of the suspension was reached. Efficiency of DEP alignment process with different nanowire concentrations and frequency of the AC voltage applied was analyzed by means of SEM inspection. This step allowed determining the optimal experimental conditions to perform the DEP alignment process with SnO2 nanowires. To guarantee the formation of good electrical contacts between pre-patterned microelectrodes and nanowires, Electron Beam Assisted Deposition and Ion Beam Assisted Deposition processes were performed. These nanowires were electrically contacted using a FEI Strata 235 dual beam instrument equipped with an injector to deposit Pt. The details of this fabrication method were explained in detail elsewhere [2]. Finally, two- and four-probe dc electrical measurements were done using a Keithley 2602 Source Measure Unit, enabling the estimation of the key-parameters of these nanowires. On the other hand, some of these nanowires were also tested as gas sensors, using well-controlled environmental conditions. For this objective, some nanowires were placed onto suspended microhotplates which contained integrated microheaters. This kind of measuring platform enables an optimal control of the working temperature allowing fast and reproducible modulation of the temperature up to 600 K. The obtained results demonstrated the huge potential of nanowires as building-blocks of a new generation of devices with improved performances. It is noteworthy that DEP-aligned nanowires did not exhibit any significant difference in their electrical response than those reported with non-aligned nanowires [3]. For this reason DEP-based technologies are a promising approach for the fabrication of nanosensors in a scalable process which fulfill the requirements to become industrialized.

References:

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