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Symposium NM03: Progress in Developing and Applications of Functional One-Dimensional Nanostructures

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8:00 PM - NM03.09.14
Individual $(In_{1-x}Ga_x)_2O_3$ Nanowire-Based Gas Sensor

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Hide Abstract

The gas sensing properties of Ga_2O_3 and In_2O_3, either in thin films or nanowire (NW) morphology, have been widely studied, establishing the charge transfer mechanisms that lead to resistance changes correlated with the concentration of the gas species. The synthesis of a mixed (Ga, In)$_2O_3$ material has been attempted and reported, but, to the best of our knowledge, there has been no attempt to use this material as gas sensor. In our study, we present the synthesis of different (Ga, In)$_2O_3$ NWs and the study of the sensing properties of gas sensors based on individual nanowires of this material. Working with sensors based on individual NWs permits a much lower power consumption compared to their bulk counterpart, attainable by an adequate device layout, allows to match the limits required in mobile gas sensing applications and the detailed study of the sensing material.
$(In_{1-x}Ga_x)_2O_3$ metal oxide nanowires have been fabricated according to a vapor-liquid-solid (VLS) mechanism, via carbothermal reduction using a chemical vapor deposition (CVD) furnace. The NWs have been structurally and optically characterized using X-ray diffraction, scanning and transmission electron microscopy and related techniques as well as photoluminescence and Raman spectroscopy. Correlation between shape, crystallinity and optical properties of the formed nanostructures and their chemical composition will be shown and will be discussed and justified based on the known properties of the pure forming materials.
After the structural and optical properties of the $(In_{1-x}Ga_x)_2O_3$ NWs were analyzed, the gas sensing properties of these nanostructured materials have been tested. To achieve this goal, the NWs were removed from the substrates applying sonication, followed by the deposition on top of suspended microhotplates with prepatterned electrodes. Finally, individual nanowires were contacted by a Focused Electron-Beam Induced Deposition (FEBID) technique. The fabricated gas nanosensors have been tested towards relevant gases in air quality monitoring, like CO and NO_2, water vapor as well as towards O_2 and ethanol. The measurements have been carried out at different gas concentrations and operating temperatures. The results will be discussed and correlated with the morphological and chemical properties of the sensing material.