# Co-Synthesis of $SnO_2$-Core/ZnO-Shell and $Zn_2SnO_4$ Nanowires by Carbo-Thermal Reduction and Their Gas Sensing Properties

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## Abstract

One-dimensional nanostructures made up of multiple metal oxides witnessed huge progress over the past years due to their applications in energy conversion and storage and environmental sensing. We report here a facile single step synthesis of $SnO_2$-core/ZnO-shell and $Zn_2SnO_4$ nanowires via a carbo-thermal reduction process and their gas sensing properties. Ball milled powders of ZnO and $SnO_2$ was used as precursors with activated carbon as the reducing agent. Growth was performed in a quartz tube placed inside a tube furnace at 900 °C. At the end of growth, we observed both $SnO_2$-core/ZnO-shell nanowires in the powder container and $Zn_2SnO_4$ nanowires on gold thin film coated alumina substrate. The growth mechanism for the $SnO_2$-core/ZnO-shell nanowires was found as vapor-solid (VS) and for $Zn_2SnO_4$ nanowires was vapor-liquid-solid (VLS). The fabricated nanostructures were examined using field emission scanning electron microscopy (FESEM), transmission electron microscopy (TEM) and X-ray diffraction (XRD) to determine the structural properties. Gas sensors were also fabricated using the nanostructures and their sensing properties were studied against ethanol, methane, hydrogen and carbon monoxide. Sensors fabricated by $SnO_2$-core/ZnO-shell nanowires exhibited higher sensitivity for all the gases tested. In addition to that, $SnO_2$-core/ZnO-shell nanowires sensor exposed good selectivity to ethanol compared with $Zn_2SnO_4$ nanowire sensor.