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Single and networked CuO nanowires for highly sensitive p-type semiconductor gas sensor applications

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Abstract

Development of high-performance p-type semiconductor based gas sensors exhibiting fast-response/recovery times with ultra-high response are of major importance for gas sensing applications. Recent reports demonstrated the excellent properties of p-type semiconducting oxide for various practical applications, especially for selective oxidation of volatile organic compounds (VOCs). In this work, sensors based on CuO nanowire (NW) networks have been successfully fabricated via a simple thermal oxidation process on pre-patterned Au/Cr pads. Our investigation demonstrates high impact of the process temperature on aspect ratio and density of copper oxide NWs. An optimal temperature for growth of thin and densely packed NWs was found to be at 425 °C. The fabricated sensors demonstrated ultra-high gas response by a factor of 313 to ethanol vapour (100 ppm) at an operating temperature of 250 °C. High stability and repeatability of these sensors indicate the efficiency of p-type oxide based gas sensors for selective detection of VOCs. A high-performance nanodevice was fabricated in a FIB-SEM system using a single CuO NW, demonstrating an ethanol response of 202 and rapid response and recovery of ~198 ms at room temperature. The involved gas sensing mechanism of CuO NW networks has been described. We consider that the presented results will be of a great interest for the development of higher-performance p-type semiconductor based sensors and bottom-up nanotechnologies.