Chemical Sensing with ZnO nanowires
Z. Fan and J.G. Lu
Department of Chemical Engineering and
Materials Science and
Department of Electrical Engineering and
Computer Science,
University of California, Irvine, CA 92697, USA

Zinc oxide (ZnO) is a wide band gap (3.37 eV) semiconducting material with broad applications such as optical waveguide, transparent conducting layer, surface acoustic wave device. ZnO nanowires (NWs) has been regarded as a promising material for nanoscale ultra-violet (UV) lasing, light emitting and photodetection. In our research, single crystal ZnO NWs are synthesized using a vapor trapping chemical vapor deposition method. SEM shows NWs are typically 30–150 nm in diameter and ~40 μm in length. TEM shows single crystal structure and NWs are grown along (001) direction. Individual ZnO NWs are configured as field effect transistors (FET) (Fig. 1a). Electrical transport studies show that ZnO NWs behave as typical n-type semiconducting material.

It has been observed that oxygen (O₂) ambient has considerable effect on the performance of ZnO NW FETs. Because surface absorbed O₂ molecules capture free electrons in NW channel by the process \( O_2 + e^- \rightarrow O_2^- \), charge carriers in the NW channel are depleted (Fig. 1b inset), thus conductance is suppressed. Fig. 1b shows that thinner ZnO NWs exhibit higher sensitivity to O₂ ambient due to their larger surface to volume ratio. Here, \( \Delta G/G_0 \) is the relative conductance change from atmosphere to \( 10^2 \) torr. Fig. 1c shows the conductance change when varying the O₂ concentration. A concentration as low as 10 ppm can be detected. Fig. 1d illustrates the dependence of relative conductance change on the gate voltage from 0 ppm to 10 ppm O₂. These results demonstrate that ZnO NW has far better O₂ sensing performance than its thin film counterpart and other metal-oxide bulk material O₂ sensors at room temperature.