The gas sensing characteristics of Tungsten Trioxide Nanowires and Nanoparticles

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Abstract

Metal oxides have been extensively used to detect toxic, pollution and combustion gases. Among these, tungsten trioxide is known to be a promising material for low level detection of N₂O. The nanoscale materials could potentially provide benefits with performance compared to their counterparts. In the case of gas sensing, it is not entirely clear whether nanowires would be advantageous over nanoparticles. Therefore, in this report, we compared the gas sensing characteristics of nanowire samples with the nanoparticles of tungsten trioxide using N₂O. The results from this study could be extended to gain a global understanding of the fundamental differences associated with the performance of nanowires and nanoparticles.

Gas sensing behavior of both nanowire mats (Fig.1a) and nanoparticle thin films (Fig.1b) were studied exposing them to various concentrations of nitrous oxide at different temperatures. The results showed that the nanowire based sensors are highly sensitive and their resistance variation is extremely consistent even with small changes in concentration of N₂O (Fig.2). The highest sensitivity is achieved at 725 K for both wire and particle sensors, however the sensitivity of the wires is as much as 4 times higher than that of the particles (Figure 3). At lower temperatures, both the sensors showed overshooting problems in resistance during N₂O desorption and additional heating was needed to attain the base resistance. At higher temperatures, the nanowire samples showed excellent reversibility with faster rate of resistance increase than the nanoparticle samples. Also, the nanowires exhibited faster recovery times compared to nanoparticles.

Fig.1. SEM images of Tungsten Trioxide samples: (a) nanowires; and (b) nanoparticles.

Fig.2. The resistance of nanowire sample measured as a function of N₂O concentrations at 725 K. The inset shows the sensitivity as a function of N₂O concentration.

Fig.3. The comparison of sensitivities obtained with nanowires and nanoparticles over a temperature range of 300 – 725K using 100ppm N₂O concentration.