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Highly Porous Tungsten Oxide Nanowires As Resistive Sensor for Reducing Gases

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Gas sensor properties of WO_3 nanowire structures have been studied. The sensing layer was prepared by deposition of tungsten metal on porous single wall carbon nanotubes followed by thermal oxidation. The morphology and crystalline quality of WO_3 material was investigated by SEM, TEM, XRD and Raman analysis. A highly porous WO_3 nanowire structure with a mean diameter of 82 nm was obtained. Response to CO, NH_3 and H_2 gases diluted in air were investigated in the temperature range of 100～340°C The sensor exhibited low response to CO gas and quite high response to NH_3 and H_2 gases. The highest sensitivity was observed at 250°C for NH_3 and 300°C for H_2. The effect of the diameters of WO_3 nanowires on the sensor performance was also studied. The WO_3 nanowires sensor with diameter of 40 nm showed quite high sensitivity, fast response and recovery times to H_2 diluted in dry air. The sensitivity as a function of detecting gas concentrations and gas sensing mechanism was discussed. The effect of dilution carrier gases, dry air and nitrogen, was examined.

Keywords: Tungsten oxide, Nanowires, Single wall carbon nanotube, Gas sensor, Porosity

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Synthesis of High-quality Graphene by Inductively-coupled Plasma-enhanced Chemical Vapor Deposition

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Graphene has attracted significant attention due to its unique characteristics and promising nanoelectronic device applications. For practical device applications, it is essential to synthesize high-quality and large-area graphene films. Graphene has been synthesized by eloborated mechanical exfoliation of highly oriented pyrolytic graphite, chemical reduction of exfoliated grahene oxide, thermal decomposition of silicon carbide, and chemical vapor deposition (CVD) on metal substrates such as Ni, Cu, Ru etc. The CVD has advantages over some of other methods in terms of mass production on large-areas substrates and it can be easily separated from the metal substrate and transferred to other desired substrates. Especially, plasma-enhanced CVD (PECVD) can be very efficient to synthesize high-quality graphene. Little information is available on the synthesis of graphene by PECVD even though PECVD has been demonstrated to be successful in synthesizing various carbon nanostructures such as carbon nanotubes and nanosheets. In this study, we synthesized graphene on $Ni/SiO_2/Si$ and Cu plate substrates with CH4 diluted in Ar/H_2 (10%) by using an inductively-coupled PECVD (ICPCVD). High-quality graphene was synthesized at as low as 700°C with 600 W of plasma power while graphene layer was not formed without plasma. The growth rate of graphene was so fast that graphene films fully covered on substrate surface just for few seconds CH_4 gas supply. The transferred graphene films on glass substrates has a transmittance at 550 nm is higher 94%, indicating 1～3 monolayers of graphene were formed. FETs based on the grapheme films transferred to Si/SiO_2 substrates revealed a p-type. We will further discuss the synthesis of graphene and doped graphene by ICPVCD and their characteristics.

Keywords: Graphene, ICP-CVD