RESEARCH PAPER | Physics | Volume : 5 | Issue : 10 | October 2015 | ISSN - 2249-555X

Ethanol Gas Sensing Properties of Nanostructured Zinc Oxide (Zno)

KEYWORDS: Nanostructure, XRD, TEM, ZnO

Dr. Mahendra Kumar

Assistant Professor, Department Of Physics, University Of Lucknow, Lucknow, India – 226007

ABSTRACT *Metal oxide semiconductors are extensively used as potential materials for the development of sensing devices for toxic and inflammable gases and vapours. The change in resistivity of active material is exploited as a sensing parameter. The invention of nanostructure materials has given a new dimension to the sensor research. Characterization and sensing response of zinc oxide nanostructure powder towards ethanol has been reported in this paper. Zinc oxide powder has been synthesized as nanoparticles by following a chemical route, starting with a solution of 0.1 M zinc nitrate in distilled water, adding ammonium hydroxide drop wise at room temperature with continuous stirring to yield precipitates of zinc hydroxide. These precipitates were dried into powder at 120º and powder thus obtained was claimed in air at 500º for three hours. Synthesized zinc oxide powder was deposited as a thick film to act as a gas sensors and response to ethanol was investigated at different temperatures.*

INTRODUCTION:

Nanostructured semiconductor metal oxide gas sensors have attracted the attention of many researchers due to their exceptional properties [1]. The preference of zinc oxide has gained importance because it synthesized into nanostructures easily and cheap. Among these zinc oxide is an excellent material for fabrication of electronic and optoelectronics devices due to its high chemical stability, low threshold intensity, wide band gap and large exciton binding energy. The scientific fraternity is exclusively exploiting a novel material ZnO for various sophisticated applications such as transparent electrodes in the solar cells, piezoelectric devices, gas sensors etc. In the present paper, nanoparticles have been prepared by chemical route [2].

The thin and thick film of active gas sensing material is deposited using a number of sophisticated techniques such as chemical vapours deposition (CVD), sputtering, molecular beam epitaxy (MBE), screen printing, etc. thick film sensors based upon semiconductor oxides have certain advantages over other types of gas sensors, such as low cost, simple construction, small size and good sensing properties [3]. In the present study we have used the paste of zinc oxide powder to deposit a thick film. Finally the ethanol sensing response of fabricated sensor of zinc oxide at different temperatures has been studied.

EXPERIMENT:

Zinc oxide powder was prepared by following a chemical route, starting with solution of 0.1 M zinc nitrate in distilled water, adding ammonium hydroxide drop wise at room temperature (25°C) with continuous stirring to yield precipitates of zinc hydroxide. These precipitates were dried into powder at 130°C and powder thus obtained was calcined in air at 500°C for three hours. The synthesized powder was characterized for morphology and structure by using XRD ad TEM techniques [4].

To fabricate thin film sensors, a paste as prepared by mixing a proper amount of powder with distilled water. The thick film of paste was then painted onto an alumina glass substrate [5]. The measurements of sensing response of the gas sensor were made with the use of simple electrical measuring system, where the potential drop across the resistor connected in series with sample was observed. Sensors fabricated from synthesized material then exposed to ethanol vapours at different temperatures ranging from 250°C to 450°C for evaluation of their sensing response. The sensor sensitivity was evaluated using relation, G/, (where G is conductance in presence of air & gas and is conductance in air alone).

RESULT AND DISCUSSION:

From X-ray diffraction data of zinc oxide sample calcined at 500°C is shown in figure (a). This plot is in agreement with the standard X-Ray diffraction data studies confirmed that the synthesized material is ZnO of hexagonal Wurtzite phase. The image represented in figure (b) is TEM micrograph of ZnO prepared by above mentioned technique, which clearly reveal that synthesized is in nano range.

Now, Sensor fabricated out of material was exposed to 250 ppm of ethanol vapours at different temperatures and we found that their optimum response is at 400°C is shown in figure (c). A high surface-to-volume ratio of nanostructures is believed to be one of the important parameters responsible for enhanced sensing response. Nanoparticles have larger effective surface area which leads to enhancement in their surface activity. Moreover a large number of nanoparticles can be accommodated on a unit surface area. These contribute to a large number of particle-particle contacts or active sites onto which gaseous species adsorb to initiate sensing.

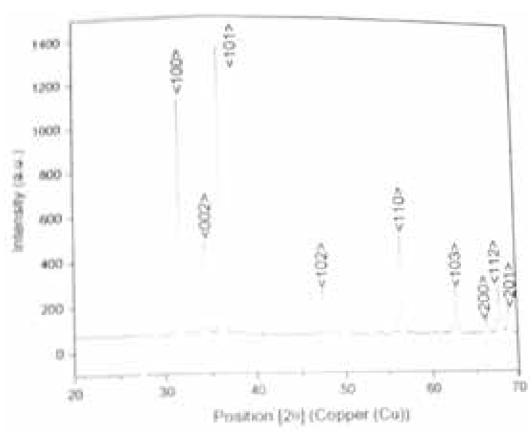

Fig. (a) XRD of ZnO (500°C)

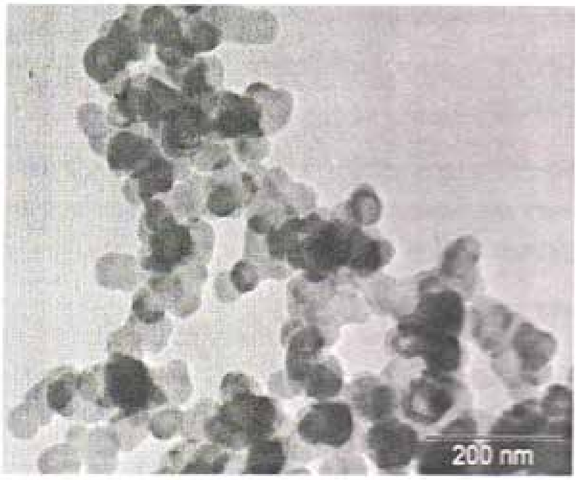

Fig. (b) TEM of ZnO (500°C)

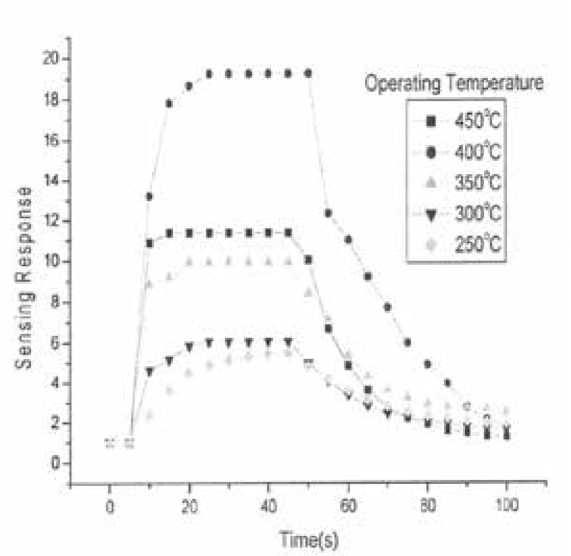

Fig. (c) Sensing response of ZnO at different temperatures

CONCLUSION:

Nanostructure of zinc oxide can be easily synthesized by chemical method. The nanoparticles of ZnO are very sensitive to ethanol vapours. The sensor made from zinc oxide gives maximum response at operating temperature of 400°C.

REFERENCE 1. X.B. Zhao, G.M. Ashley, G.G. Luis, H. Jin, J.K. Luo, J.R. Lu, Protein functionalizedZnO thin film bulk acoustic resonator as an odorant biosensor, Sensors andActuators B 163 (2012) 242–246. | 2. X. Deng, F. Wang and Z. Chen, "A Novel Electrochemical Sensor Based on Nano-Structured Film Electrode for Monitoring Nitric Oxide in Living Tissues," Talanta, Vol. 82, No. 4, 2010, pp. 1218-1224. | 3. R. B. Waghulade, P. P. Patil and R. Pasricha, "Synthesis and LPG Sensing Properties of Nano-Sized Cadmium Oxide," Talanta, Vol. 72, No. 2, 2007, pp. 594-599. | 4. Y. S. Kim, S.-C. Ha, K. Kim, et al., "Room-Temperature Semiconductor Gas Sensor Based on Nonstoichiometry Tungsten Oxide Nanorod Film," Applied Physics Letters, Vol. 86, No. 21, 2005, Article ID: 213105. | 5. D. Gruber, F. Kraus and J. Müller, "A Novel Gas Sensor Design Based on CH4/H2/H2O Plasma Etched ZnO Thin Films," Sensors and Actuators B: Chemical, Vol. 92, No. 1-2, 2003, pp. 81-89. |