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Synthesize of ZnO Nano structure for toxic gas sensing application

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Abstract

Gas sensors having zinc oxide (ZnO) nanoparticles as a sensing layer are consumes low power, operates at low temperature, have great level of selectivity as well as inexpensive too. Development of nanostructured metal oxide semiconductor (MOS) for quality sensing is important. So the affect of grain size and thickness is on the sensing materials (MOS) are discussed. A simple and feasible way to synthesis zinc oxide nano particles at 90^0C temperature is followed. Basic requirements of chemical of this process is zinc powder, hydrogen per oxide (H_2O_2), and acitic acid (CH_3COOH).The synthesized ZnO is deposited on silicon wafer and the characterization is done through Scanning electron microscopy (SEM) and X ray diffraction (XRD).

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Keywords: Zinc Oxide, nano particle, gas sensor, metal oxide semiconductor

1. Introduction

Nano sized particles of semiconductor materials such as ZnO, SnO_2 or WO_3 have caught the much more interest in recent years because of their excellent sensing properties like resistivity or conductivity change in presence of target gas molecules, response and recovery time. [1-5] Zinc oxide (ZnO) is a semiconductor which belongs to the

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group (I) – (VI) family and has extensive applications due to its direct band gap (3.37 eV) and large excite binding energy of 60meV. [6] ZnO is basically n-type in nature. Chemically, it is non toxic. [7] Some key features based on which gas sensing applications are done are, high sensitivity to various oxidizing and reducing gasses, easy to fabricate, and miniaturized as well. [8] Zno is fabricated as nano structured like nanowire, nanorods, nanobelts and 2D structure like nanoplates. High surface to volume ratio , small size of ZnO are the main reason behind detecting with a wide range of concentration by lowering the limit of detection. [9]

It is reported that, the adsorption of gas molecules, primarily considered with the chemisorptions of the O_2 on the surface causes the change in electrical properties of the metal oxide semiconductor. Here Zno is considered as the metal oxide semiconductor. The toxic gasses like CO,CH4 are made contact with ZnO gas sensor at high temperature, the chemisorbed oxygen stars reaction with the reducing gasses. Electrons are injected into the MOS crystallites of the oxygen as well as the height of the potential barrier at intergranular contacts in figure1.

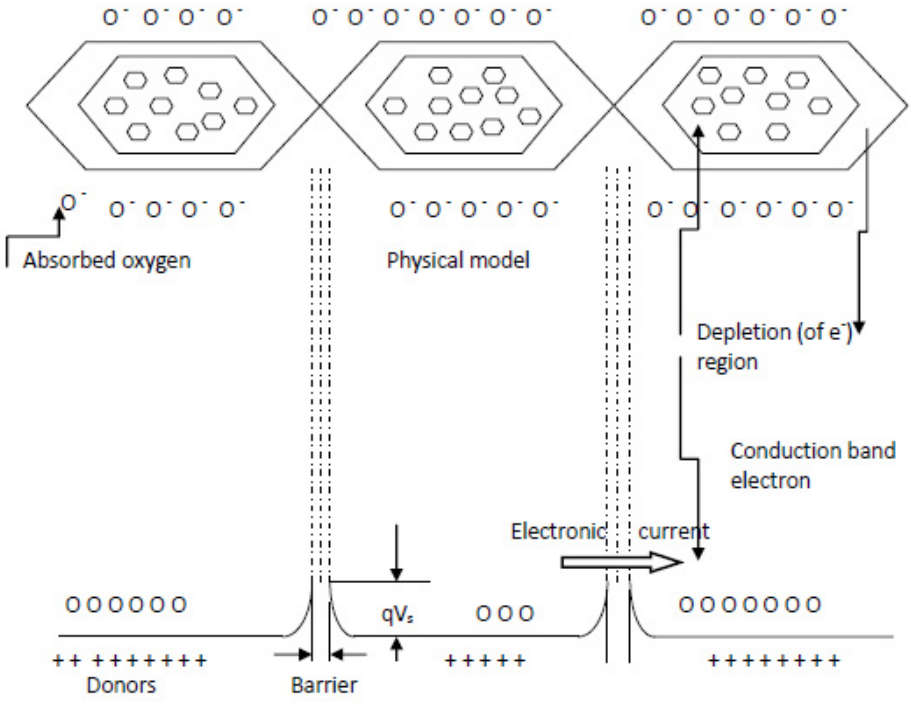

Fig.1 Intergranular contacts of gas sensing layer

Chemical Reactions: Electrons are extracted through the following reactions,

$$ZnO + O + e^- \rightarrow ZnO - O^-$$

$$ZnO + 2O + e^- \rightarrow ZnO - O_2^-$$

As a result resistance is changed increasingly.

Electrons are injected when reducing gas molecules (G) react with the chemisorbed oxygen at grain boundary.

$$G + ZnO - O^- \rightarrow ZnO - GO + e^-$$

As a result, resistance changes decreasingly.

Similarly for detecting a gas which is oxidizing in nature, the reaction may follow-

$$ZnO - O + O + e \rightarrow ZnO - O_2^-$$

Result is that the resistance is increased even further. Thus by observing the change in resistance or conductivity, the toxic gasses present in atmosphere can be detected. [10]