High performance lanthanide doped semiconductor gas sensor for alcohol detection

Manreet Kaur Sohal [1], Aman Mahajan [1, #], R. C. Singh [1]

Department of Physics, Guru Nanak Dev University, Amritsar-143 005, India.
[#]Email: aman.phy@gndu.ac.in

Abstract: In this work, thin films based chemiresistive gas sensors have been studied for industrial and environmental monitoring. Metal oxides are well known for their excellent gas sensing performance and stability; however, they suffer from poor selectivity issues [1]. Doping of semiconductor oxides is a reliable way to enhance their selectivity [2]. With this aim, the low-cost co-precipitation method has been employed to synthesize gadolinium-doped tin dioxide (Gd-SnO_2) nanoparticles of different doping concentrations viz. 0 %, 1 %, 3 % and 5 %. Nanocomposite thin films of Gd-SnO_2 have been obtained via electron-beam evaporation technique. Structural study such as X-ray diffraction confirmed the formation of rutile structure and dopant dependent average particle size. Further, from FESEM the average crystallite size has been found to be decreasing with increasing doping concentration. UV-visible spectroscopy has been used to calculate the band gap of doped thin films which is found to be less than that of pure SnO_2. Raman spectroscopy suggested the formation of local disorder due to lanthanide doping. The optimum operating temperature of fabricated sensor has been found to be at 300°C.In addition to this, to check the selectivity, the sensor has been exposed to various test gases and found selective towards isopropanol. The 3 % doped sensor showed excellent sensing response (1617 %) when exposed to 300 ppm of isopropanol. The mechanism behind the enhanced sensor response has also been elucidated (Figure 1).The doped sensors also exhibited shorter response and recovery times in comparison to pure SnO_2 sensors. The observed enhancement in sensor response to isopropanol is due to creation of gas adsorption sites and reduced surface acidity of metal oxide surfaceby doping.

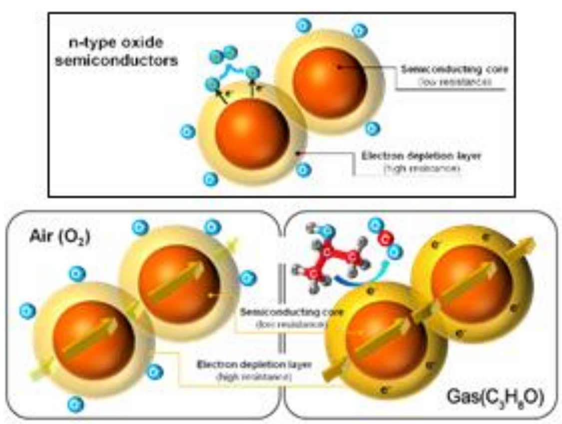

Figure 1: Schematic showing isopropanol sensing mechanism by metal oxide [3].

References:

[1] Govardhan K., Grace, A. N. Sensors Letters 2016, 14 (8), 741–750.
[2] Nagirnyak, S., Dontsova, T. Nano Res. Appl. 2017, 3(2), 8.
[3] Kim, H.-J., Lee, J.-H., Sens. Actuators, B2014**,** 192, 607-627.

5th International Conference on Nanotechnology for Better Living (NBL-2019), Jointly organized by National Institute of Technology (NIT) Srinagar and Indian Institute of Technology (IIT) Kharagpur; April 7 – 11, 2019 at SKUAST, Shalimar Srinagar, Jammu and Kashmir, India; Editor: Dr. M. A. Shah and Prof. P. Banerji, ISBN:978-81-939516-0-6; Published by Applied Science Innovations Pvt. Ltd., Pune, Maharashtra, India.