03,13

Surface Modification of ZnO Nanowires with CuO: a Tool to Realize Highly-Sensitive H_2S Sensor

© C.P. Goyal[1,2,3], D. Goyal[1], N.S. Ramgir[4], M. Navaneethan[1], Y. Hayakawa[3], C. Muthamizhchelvan[1], H. Ikeda[2,3], S. Ponnusamy[1,¶]

[1] Functional Materials and Energy Devices Laboratory, Department of Physics and Nanotechnology, SRM IST, Kattankulathur, Tamil Nadu 603 203, India
[2] Graduate School of Science and Technology, Shizuoka University, Hamamatsu 432 8011, Japan
[3] Research Institute of Electronics, Shizuoka University, Hamamatsu 432 8011, Japan
[4] Technical Physics Division, Bhabha Atomic Research Center, Mumbai 400 085, India

¶ E-mail: suruponnus@gmail.com

Received: October 29, 2020
Revised: October 29, 2020
Accepted: November 3, 2020

Hydrothermally grown ZnO nanowires (NWs) have been successfully synthesized and surface modified by an ultrathin layer of CuO using dip coating technique to achieve a highly sensitive H_2S sensor. XRD analysis confirmed the hexagonal structure of ZnO without any Cu sub-oxide peaks. After CuO modification, the peak shift was observed in the electronic states of O and assigned to the defects and increase in adsorbed oxygen species. Similarly, a red shift was also observed in the band edge absorption after CuO modification arising due to defects. The sensor film showed an overall *n*-type character as confirmed using $I(V)$ characteristics. Interestingly, sensor response kinetics towards H_2S were enhanced after CuO modification. The highest sensor response value of 298 was measured towards 10 ppm H_2S at 150°C for CuO : ZnO NWs sample having 1.26 at.% of Cu. This improved sensor response has been attributed mainly to the formation of randomly distributed $p-n$ nano-hetero-junctions between *p*-type CuO and *n*-type ZnO over the sensor surface. In particular, the $p-n$ nano-hetero-junctions collapsed due to conversion of semiconducting CuO into metallic CuS after the unique interaction with H_2S.

Keywords: ZnO nanowires, gas sensing, H_2S, surface modifications, $p-n$ hetero-junctions.