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AMMONIA GAS DETECTION USING DOPED ZINC OXIDE THIN FILMS

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Ammonia is a toxic gas which is harmful to human health and the environment. It is mainly emitted from agricultural fertilizer and in manufacturing plastics, dyes and fabrics. The exposure limit of ammonia to the human being is 25 mg l^{-1} for 8 h or 35 mg l^{-1} for 10 minutes. Therefore, accurate monitoring of ammonia gas in the environment is critical. The present study investigates doped zinc oxide thin films for constructing low-cost, quick-response and high-sensitivity ammonia gas sensors. Pure zinc oxide (ZnO), Al-doped and Fe-doped ZnO thin films were synthesized on glass or alumina slides via a simple and cost-effective sol-gel method using zinc acetate, 2-methoxyethanol and monoethanolamine. The elemental composition, structure and surface morphology of crystals were characterized by X-ray fluorescence (XRF), X-ray diffraction (XRD) and scanning electron microscopy (SEM), respectively. In addition, the effects of various doping materials on optical properties were investigated by UV-Visible spectroscopy. The bandgap energy (E_g) for pure ZnO thin films was 3.40 eV, and the lowest bandgap energy of 3.38 eV was observed for Al-doped thin films. The sensor responses for Al-doped ZnO thin film are 83% and 49% for 500 mg l^{-1} NH_3 at operating temperatures of 200 ^{0}C and at room temperature, respectively. The response time and recovery time at 200 ^{0}C were 11 and 7 min, respectively. The gas sensing analysis showed that increased NH_3 concentration and doping material improved the gas sensing response.

Keywords: Aluminum doping, Ammonia sensor, Ferric doping, Response time, Zinc oxide films