Mixed Oxides as VOCs Detectors in Biomedical Applications

Dinu Litra(✉), Cristian Lupan, Nicolae Magariu, Adrian Bîrnaz, and Oleg Lupan

Center for Nanotechnology and Nanosensors, Department of Microelectronics and Biomedical Engineering Technical, University of Moldova, 168 Stefan cel Mare Av., MD-2004 Chisinau, Republic of Moldova

dinu.litra@mib.utm.md

Abstract. Mixed nanostructures based on zinc oxide (ZnO), copper oxide (CuO) and iron oxide (Fe_2O_3) were synthesized through thermal oxidation in air, and their gas sensing properties were investigated. The motivation for combining these oxides lies in their complementary semiconductor behaviour: ZnO and Fe_2O_3 are n-type materials, while CuO is a p-type material. Forming p–n junctions enhances charge transfer and increases surface reactivity, thereby improving sensitivity and selectivity. Structural characterization using scanning electron microscopy (SEM) revealed interconnected nanostructures with sponge-like morphologies. Gas sensing experiments were conducted using a Keithley 2400 source meter to evaluate the sensor response towards n-butanol, 2-propanol and acetone at concentration of 100 ppm within a temperature range of 22–275 °C. The highest response was observed for 2-propanol, followed by acetone and n-butanol, with optimal performance at 250–275 °C. Response and recovery times were found to be in the range of a few to tens of seconds, indicating good reversibility and repeatability. The sensing mechanism is governed by the interaction of adsorbed oxygen species (O_2^-, O^-, O^{2-}) with target gases, leading to electron release and changes in conductivity. The promising performance in detecting acetone highlights the biomedical potential of these mixed nanostructures, particularly for non-invasive breath analysis related to diabetes monitoring.

Keywords: ZnO · CuO · Fe_2O_3 · sensors · nanostructures

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