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(CuO-Cu_2O)/ZnO:Al heterojunctions for volatile organic compound detection

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Abstract

Detection and differentiation of volatile organic compounds (VOC) is highly important since these gaseous pollutants degrade the air quality and represent, even in small amounts, a threat to human health. In this work, a simple and cost-effective method to synthesize a multilayered (CuO-Cu_2O)/ZnO:Al nanostructured film forming non-planar heterojunctions for efficient detection of volatile organic compound vapors is presented. While the ZnO:Al layer with different contents of Al (~0.1 and 0.2 at%) was deposited on a glass substrate via a synthesis from chemical solutions (SCS, at a temperature <95 °C), the CuO-Cu_2O composite layer was formed by sputtering a metallic thin layer of Cu on top of the ZnO:Al nanocrystalline film and subsequent thermal annealing at 425 °C. The highest gas response of ~200% to 100 ppm to*n*-butanol at 350 °C operating temperature was observed in the case of a layer thickness of CuO-Cu_2O ~20 nm on top of the ZnO:Al SCS samples. In this case, the enhanced response was attributed to the involvement of (CuO-Cu_2O)/ZnO:Al interface junctions in the gas sensing mechanism. This top layer allows for the formation of an additional enclosed depletion layer, which leads to a higher modulation of the CuO-Cu_2O

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resistance and thus to a higher gas response. The (CuO-Cu_2O)/ZnO:Al heterojunction also showed a reduced dependence of the sensing properties with respect to relative humidity, which is very important for ambient gas sensing applications and VOC vapor detection in human breath analysis, chemical industry, in outdoor and indoor air quality monitoring.