Optical and electrical characterization of CuO/ZnO heterojunctions

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The lack of p-type electrical conductivity in ZnO emphasizes the importance of the study of hybrid heterojunctions. Among different p-type materials, copper oxide is a good candidate to create a p-n heterojunction with ZnO with a broad application potential in different optoelectronic devices. The main advantage of copper oxide is nontoxicity, low market price, and high absorption coefficient. The combination of p-type copper oxide and n-type zinc oxide appears promising for the implementation in photovoltaic devices with copper oxide as an absorbing layer and wide band gap zinc oxide as a windows layer. Another application area is gas sensing; however, metal oxide sensors suffer from poor selectivity. The selectivity can be enhanced by the fabrication of p-n junctions between different metal oxides.

In this work we present a cost-effective technology for the preparation of coper oxide/zinc oxide heterojunctions. The p-n heterojunctions were fabricated by sputtering of a metallic Cu thin film on top of solution grown ZnO nanorod arrays followed by thermal annealing at 400°C. Structural, morphological, and optical properties of both copper thin films and zinc oxide nanorod arrays were studied. The electrical properties of the junction were investigated by current-voltage and impedance spectroscopy measurements. Electrical characteristics of these junctions are sensitive to gas mixtures with a low hydrogen concentration and show fast response and recovery time. The copper oxide/zinc oxide heterojunction is shown to be more efficient to hydrogen detection at room temperature in comparison with the resistivity sensor based on zinc or coper oxides.

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Figures

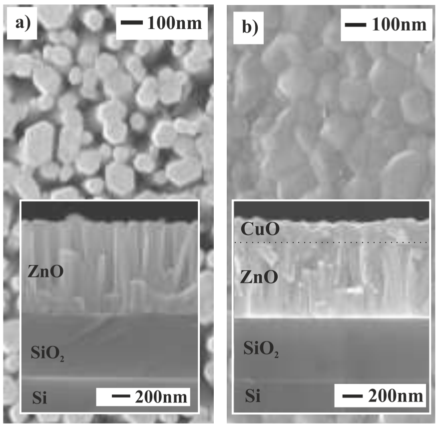

Figure 1. Top-view and cross-sectional SEM images of (a) ZnO nanorods; (b) copper oxide/zinc oxide heterojunction.

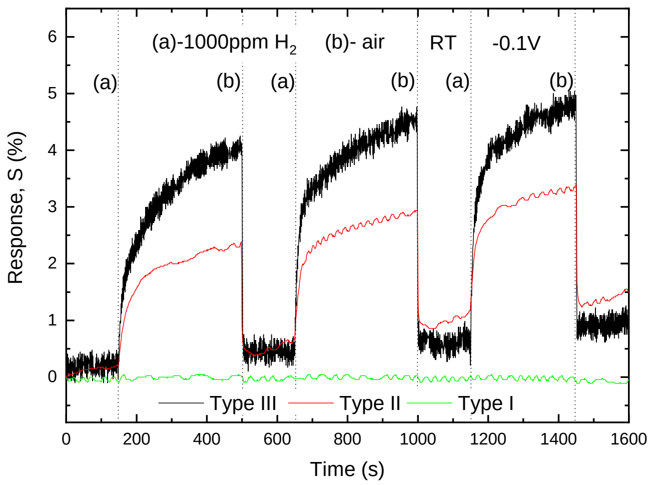

Figure 2. The room temperature transient response measured at -0.1 V. Type I - resistivity sensor based on copper oxide; Type II - resistivity sensor based on zinc oxide nanorods; Type III - copper oxide/zinc oxide p-n heterojunction sensor.