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Synthesis and characterization of Cu-doped ZnO one-dimensional structures for miniaturized sensor applications with faster response

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ABSTRACT

Detection of chemicals and biological species is an important issue to human health and safety. In this paper, we report the hydrothermal synthesis at 95 °C of Cu-doped ZnO low-dimensional rods for room-temperature (RT) sensing applications and enhanced sensor performances. X-ray diffraction, scanning electron microscopy, X-ray photoelectron spectroscopy, Raman and photoluminescence are used to characterize the material properties. To demonstrate the suitability of the Cu-doped ZnO rods for gas sensor applications and for comparison with pure ZnO, we fabricated a double rod device using Focused Ion Beam. The responses of pure-ZnO and Cu-doped ZnO rods studied in exactly the same condition are reported. We found that Cu-ZnO sensors have enhanced RT sensitivity, faster response time, and good selectivity. Miniaturized Cu-ZnO rod-based sensors can serve as a good candidate for effective H_2 detectors with low power consumption.

1. Introduction

Recently, increasing attention has been paid to the utilization of hydrogen as a renewable and clean energy source because it provides a timely solution to the future energy supply [1,2] in addition to other renewable energies. Thus, hydrogen gas detection measurements became an essential step for safety in industrial and household places to alert the formation of potentially explosive mixtures with air [3]. Another significant demand on rapid and accurate sensors able to monitor and control hydrogen concentration is in industrial processes where hydrogen is used in synthesis or chemical reactions, as well as for nuclear reactor safety [3]. A main issue in hydrogen sensor technology is the development of higher sensitivity, higher selectivity, and faster detection mechanisms. Although current hydrogen sensor technologies [4,5] are suitable for many industrial applications, some of them are not appropriate for fuel cells, household, biomedical, and transportation applications because of their size, high temperature operation, slow response, high cost, and energy input [6]. Individual one-dimensional metal oxide structures have become promising candidates for hydrogen sensing applications in recent years due to their special geometry and chemical–physical properties [7–11]. In such gas sensors the change in the electrical resistance

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