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Synthesis and Characterization of Functional Nanostructured Zinc Oxide Thin Films

S. Shishiyanu[a], L. Chow[b], O. Lupan[a], and T. Shishiyanu[a]

[a] Department of Microelectronics and Semiconductor Devices, Technical University of Moldova, bd. Stefan cel Mare 168, MD2004 Chisinau, Republic of Moldova
[b] Department of Physics, University of Central Florida, Orlando, FL 32816-2385, U.S.A.

A novel aqueous relatively low-temperature thin film growth technique has been developed to fabricate a new generation of smart and functional nanostructured metal oxide thin film materials. This chemical synthetic route uses stable and inexpensive metal inorganic salts and environment-friendly solvents. The nanomaterials are obtained to analyze the physical and structural requirements of their applications in gas sensors and solar cells. The rapid photothermal processing at the 650 ^{o}C of nanostructured zinc oxide leads to the suppression of deep-defect-level emission and improvement of near-band edge emission. The responses of the sensing elements when exposed to 100 ppm ammonia at temperatures between 20 °C and 300 °C have been assessed.

Introduction

The synthesis and characterization of various wide band gap metal oxides nanostructures such as nanowires, nanorods, nanobelts, nanobridges and nanowalls has attracted great interest due to their size, morphology-related properties, and their emerging applications in novel functional nanodevices (1,2). Recently, research and development of alternative energy technologies, such as low cost flat-panel solar cells thin film devices, and many other innovative concepts have increased. ZnO is an important multifunctional material which has received great attention during the last few years due to their unique applications in microelectronic and optoelectronic devices, and for self-assembled growth of three-dimensional nanoscale systems (3,4). Zinc oxide having a direct band gap of 3.37 eV and an exciton binding energy (60 eV) higher than those of ZnS (20eV) and GaN (21eV), is of interest for various high tech applications, such as optical devices (1), solar cells (5), piezoelectric devices (6), varistors (7), surface acoustic wave (SAW) devices (8), and gas sensors (9,10).

Zinc oxide nanostructures have the potential to significantly improve the performance and durability of certain devices used in areas of importance: energy production and homeland security. A key challenge in this research is to deposit nanostructured metal oxide thin films with consistent morphology and reproducible properties with a long-term stability. ZnO nanostructures have been prepared by different methods like chemical vapor deposition, vapor-liquid-solid method, thermal oxidation, reactive sputtering, sol-gel, and chemical deposition (1-5). Among them, chemical deposition has attracted our interest for the preparation of nanostructured thin films due to the following advantages: (a) its simplicity and low cost, (b) its capability to achieve large area coatings, (c) its low deposition temperature. These advantages result in a low cost processes that has a