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Synthesis and gas sensor applications of nanostructured ZnO grown at low temperatures

Oleg LUPAN[1,2,3,*], **Thierry PAUPORTÉ**[2], **Lee CHOW**[3]
[1]Department of Microelectronics and Biomedical Engineering, Technical University of Moldova, Chisinau, Moldova
[2]Institut de Recherche de Chimie-Paris, CNRS-Chimie Paris UMR8247, 11 rue Pierre et Marie Curie, 75005 Paris, France
[3]Department of Physics, University of Central Florida, Orlando, FL, USA

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Abstract: ZnO nanoarchitecture-based nano- and microdevices came into the focus due to their multifunctional operation. In this work, we summarize cost-effective procedures to grow ZnO nano- and microstructures, namely hydrothermal growth and electrochemical deposition. These techniques allow the controllable growth of ZnO nano- and microarchitectures at relatively low temperatures, below 100 °C, and do not require sophisticated equipment. We report on technological details for synthesis of ZnO and its characterization and applications in different novel devices such as gas sensors. Nanosensors and microsensors were fabricated using a focused ion beam and by metal welding an individual nano- and microstructure to form rigid contacts. Devices made from pure and doped ZnO nanostructures are presented and discussed. Developed nano- and microdevice structures show promising performances and are quite attractive for further investigations in sensor applications. Several factors determine the gas sensing mechanism of pure and doped ZnO micro- and nanowire/nanorods and discussions on this are summarized.

Key words: ZnO, nanosensor, microdevices, electrochemical, hydrothermal

1. Introduction

At present, there exists emerging interest in the synthesis and applications of ZnO nanomaterials at relatively lower temperatures, especially below 100 °C. ZnO is a key multifunctional material exhibiting semiconducting, magnetic, and piezoelectric properties [1,2]. It has a wide direct band gap of 3.37 eV at 300 K, large exciton binding energy of 60 meV, and excellent chemical, mechanical, and thermal stability and biocompatibility [1–4]. New devices based on nanoarchitectures such as nanowires, nanotubes, and nanorods have attracted vast and persistent attention for a variety of applications, including detecting ultraviolet (UV) radiation, gas sensing, and detecting chemical and biological molecules [1–8]. It is of major interest to fabricate new multifunctional devices. That is why it is important to develop a well-controlled technology to grow ZnO that exhibits the most abundant configurations of nanostructures. In this work, we will review some cost-effective procedures to grow ZnO nano- and microstructures at relatively lower temperatures below 100 °C and their characterization, sensing mechanisms, and applications in different device structures.

*Correspondence: oleg.lupan@chimie-paristech.fr