Advanced Structural and Functional Materials for Protection

Edited by
Ma Jan and Santhiagu Ezhilvalavan

TRANS TECH PUBLICATIONS

Advanced Structural and Functional Materials for Protection

Edited by
Ma Jan
Santhiagu Ezhilvalavan

Advanced Structural and Functional Materials for Protection

Selected, peer reviewed papers from the
Symposium T on
Advanced Structural and Functional Materials for Protection,
International Conference on Materials for Advanced Technologies
(ICMAT2011),
International Convention & Exhibition Centre
June 26 - July 1, 2011, Singapore

Edited by

Ma Jan and Santhiagu Ezhilvalavan

Trans Tech Publications Ltd
Kreuzstrasse 10
CH-8635 Durnten-Zurich
Switzerland
http://www.ttp.net

Volumes 185 of
Solid State Phenomena
ISSN 1662-9787
(Pt. B of Diffusion and Defect Data - Solid State Data (ISSN 0377-6883))

Full text available online at *http://www.scientific.net*

***Distributed** worldwide by*

Trans Tech Publications Ltd
Kreuzstrasse 10
CH-8635 Durnten-Zurich
Switzerland

Fax: +41 (44) 922 10 33
e-mail: sales@ttp.net

and in the Americas by

Trans Tech Publications Inc.
PO Box 699, May Street
Enfield, NH 03748
USA

Phone: +1 (603) 632-7377
Fax: +1 (603) 632-5611
e-mail: sales-usa@ttp.net

Preface

This special volume of Solid State Phenomena contains papers selected from those presented at the International Conference on Materials for Advanced Technologies (ICMAT2011), Symposium T - Advanced Structural and Functional Materials for Protection, held on 26th June – 1st July 2011 at the Singapore International Convention & Exhibition Centre, Singapore. A total of 120 papers were presented at the symposium, including 15 invited papers, 65 oral and 40 poster presentations.

Protection materials represent one of the most challenging materials to synthesize and process due to the extreme application requirements. The understanding of the various mechanisms & sciences behind materials' behavior will contribute invaluably to the development of materials for protection applications. This symposium provided a platform for academics, scientists, technologists and industrial players to present innovations, exchange views, share results and discuss opinions and thoughts in the field of advanced structural and functional materials for protection. Specifically, the symposium focused on materials for protection of civilians and soldiers against collision of vehicles, blast, fragmentation, unconventional attack, and also multi-functional materials for enhancement of civilians and soldier performance in extreme conditions.

The areas covered at the symposium included novel synthesis, processing and applications of advanced materials, micro and nano-structures, design and fabrication of structural materials, self-healing materials, advanced ceramic materials, multi/hybrid layers, films/coatings for protection, thermoelectric materials and thermal protection, materials for radiation protection and extreme conditions, development of materials evaluation techniques, modeling and simulation, smart materials for structural and/or functional management, sensors and devices, failure analysis and characterization of materials, applications of protection materials – civilians, soldiers, aerospace, navy and heavy vehicles and sustainable protection materials.

The success of this truly international symposium has to be attributed to the efforts of the organizing committee. In particular, Dr Tan Eu Jin played an important role of coordinating all the delegates, before and during the symposium. We are grateful to Professor T.Y. Tseng, Professor W.K.Chiu and Dr Richard Kwok, our keynote speakers at the symposium, for kindly helping us in many ways both before and after the conference. We also want to thank all the invited speakers, oral and poster presenters, reviewers of manuscripts, participants of this symposium, Republic Polytechnic, Temasek Laboratories@NTU, Nanyang Technological University and Materials Research Society of Singapore for their valuable contributions. They have contributed to the success of this international symposium and the publication of this special volume of the proceedings. Once again, thank you all!

Professor Ma Jan
School of Materials Science and Engineering
Nanyang Technological University, Singapore

Dr. Santhiagu Ezhilvalavan
New Materials Technology Development Centre
School of Applied Science
Republic Polytechnic, Singapore

Table of Contents

Solid State Phenomena Vol. 185 (2012) pp 1-4

doi:10.4028/www.scientific.net/SSP.185.1

ZnO Nanostructures for Sensor Applications

Tseung-Yuen Tseng

Department of Electronics Engineering,
National Chiao Tung University,
Hsinchu 300, Taiwan
Email: tseng@cc.nctu.edu.tw

Keywords: Nanostructure, ZnO, gas sensor, sensitivity.

Abstract. The wide-gap semiconductor ZnO with nanostructures such as nanoparticles, nanorods, nanowires has high potential for a variety of sensor applications. This paper reviews the recent developments of ZnO one dimentional nanostructures for future gas sensor applications. Presented first is the factors contributing to the high performances of gas sensors using such nanostructures. Then various fabrication methods of the ZnO nanostructures including vapor phase growth, solution growth, and template-assisted growth are introduced. The characterization and properties of the ZnO nanostructures-based gas sensors are described. The basic mechanisms for explaining the behaviors of the gas sensors are also discussed.

Introduction

One dimensional(1D) zinc oxide(ZnO) nanomaterials have recently received much attention for their potential applications in nanophotonics, nanoelectronics, lasers, sensors and actuators, field emission displays, ultraviolet radiation etc..

Among various applications, ZnO materials have been widely employed in the field of gas sensors. The important figures of merit for gas sensors are sensitivity, response time, minimum detectable gas concentration, repeatability, selectivity. The 1D nanostructures are expected to exhibit higher sensitivity and faster response toward the analyte gas because they have much larger surface-to-volume ratios compared with their thin film and bulk material counterparts[1,2]. Therefore, 1D ZnO nanostructures are promising candidates for gas sensors. The objective of this paper is to briefly review synthesis and properties of 1D ZnO nanostructures with specific examples from literature. The gas sensing mechanisms are also described.

Synthesis of 1D ZnO nanostructures and their gas sensing properties.

The 1D nanostructures were synthesized by various methods including vapor phase growth, solution growth, and template-assisted growth as shown in Fig.1. Vapor phase synthesis is extensively studied to preparing 1D nanostructures. Anisotropic growth via metal catalyzed vapor-liquid-solid process was adopted to grow ZnO nanowires[3]. The SEM photographs shown in Figs. 2(a) and (b) indicate the microstructure of the ZnO nanowires using Au and Cu catalysts. The