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PROPERTIES OF NANO-STRUCTURED ZINC OXIDE THIN FILMS FOR ULTRAVIOLET PHOTOCONDUCTIVE SENSOR APPLICATIONS

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Candidate`s Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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Abstract

Nanostructured zinc oxide (ZnO) materials in thin film structure have been synthesized using the sol-gel method. The thin film depositions have been carried out by spin-coating technique and hydrothermal aqueous chemical growth method on silicon and glass substrates. The thin films were annealed for 1 hour before characterization process. The surface morphologies of prepared ZnO thin films were observed using Field Emission Scanning Electron Microscopy (FESEM) and Scanning Electron Microscopy (SEM) to investigate the evolution of ZnO particle and surface morphology. The structural properties of ZnO thin films were characterized using X-Ray Diffraction (XRD) for purity and crystallinity of ZnO thin films and particle size estimation. The optical properties of ZnO thin films were examined using UV-Vis-NIR spectrophotometer for transmittance, absorption coefficient, band gap energy, carrier concentration, porosity and Urbach energy study. The optical properties of ZnO thin films also were studied using Photoluminescence (PL) spectrophotometer to investigate the luminescence properties, crystallinity and defects state of ZnO materials. The electrical properties were investigated using current-voltage (I-V) measurement to study the conductance behavior of the thin films. ZnO thin film-based ultraviolet (UV) sensors have been prepared by sol-gel spin-coating method. The sensors have been characterized using I-V measurement system under UV lamp irradiation to investigate the response of ZnO thin films to the UV light.

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CHAPTER 1

INTRODUCTION

1.1 Nanotechnology

Research in nanotechnology has increased remarkably due to unique characteristic of nanomaterials. Nanotechnology refers to the control and manipulation of matter at nanometer dimensions [1]. However, the term nanometer dimension is limited up to 100 nm [2]. Nanomaterial is defined as material which has dimension or size up to 100 nm. The control and manipulation of matter within nanometer range has created novel and improved materials which could be used to fabricate nanoscale devices. Nanotechnology is considered to be among the most important future technologies of several disciplines such as solid state, materials engineering, medicine and biotechnology. Nanotechnology provides many advantages such as high surface area per volume of the material, highly efficient materials for applications and cost effective device fabrication [2, 3]. The large surface areas enable reaction and diffusion process to become more effective. Moreover, properties such as crystallinity, integration density and power consumption of devices fabricated by nanomaterials show improvement compared to bulk materials [4]. One of the momentous characteristic of nanomaterials is the dependence of certain properties with the size in nanoscale region as shown by quantum size effect. The quantum size effect which is caused by spatial confinement of delocalized valence electron give properties such as tunable band gap, higher optical gain and faster operation speed [4]. Nanotechnology also change structural properties of the materials which open the doors to modify materials by given properties in order to synthesis and fabricate functional materials with improved properties. Some of the