Semiconductor Properties of Nanostructured Al doped ZnO thin film Annealed at Different Temperatures

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ABSTRACT

The semiconductor properties of nanostructured aluminum (Al) doped zinc oxide (ZnO) thin film. This project has been focused on semiconductor properties that consist of electrical, optical and structural properties of Al doped ZnO thin film. The effects of annealing temperatures of Al doped Zno thin film properties have been investigated. This project consist of three processes which are thin film preparation, deposition and characterization. The thin films were characterized using 2 probe Current-Voltage (I-V) measurement and UV-Vis-NIR spectrophotometer for electrical properties and optical properties respectively. The surface morphology has been characterized using field emission scanning electron microscope (FESEM). The I-V measurement result indicated electrical properties of Al doped ZnO thin film improved with increased of annealing temperature. The absorption coefficient spectra obtained from UV-Vis-NIR spectrophotometer measurement show all films have low absorbance in visible and near infrared (IR) region but have high UV absorption properties. The calculated Urbach energy indicated the defects concentrations in the thin films increase with doping concentrations The FESEM investigations shows that the grain size becomes increase when the annealing temperature increase.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT OVERVIEWS

The characterization of various wide band gap metal oxides nanostructures such as nanoparticles, nanorods, nanowires, nanobelts, nanowalls and nanobridges has attracted great interest due to their morphology-related properties, size, and their emerging applications in novel functional nanodevices [1,2]. Nanostructured materials have been widely studied due to their optical, unique electronic and optoelectronic properties and potential applications in nanoscale devices. Among these materials, ZnO has been considered as a promising candidate for nanotechnology applications. ZnO is a wide band gap semiconductor material with numerous applications such as varistors and surface acoustic wave devices. It has possible future applications including UV light-emitting diodes and transparent field-effect transistors [3].

ZnO is naturally n-type semiconductor material with direct band gap energy of 3.37 eV at room temperature and has free-exciton binding energy of 60 meV [4], higher than those of ZnS (20eV) and GaN (21eV) [5]. ZnO material has been the subject for various high technology applications, such as optical devices, solar cell, piezoelectric devices, varistors, surface acoustic wave (SAW) devices and gas sensors [5]. It is expected that this exciton properties of ZnO will improved the efficient of light emiting devices at room temperature compare to device which fabricated using GaN and ZnS [6]. The properties of ZnO including electrical and optical properties heavily depend on crystallinity, crystallographic orientation, crystalllite size and morphology [4].