Calcinations Effect on Growth of Zinc Oxide Films Prepared via Dip-Coating Technique

A.R. Ainuddin¹,², R. Hussin¹, S.Y.M. Noorsyakir¹ and R.A. Rosley¹
¹Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia, Parit Raja, 86400 Batu Pahat, Johor, Malaysia

Abstract
Thin films and micro- and nanostructures Zinc Oxide (ZnO) are promising candidates for novel application in solar cells, sensors, emerging transistors and optoelectronic devices. Scanning electron microscope (SEM), atomic force microscope (AFM) and ultraviolet visible spectroscopic (UV-vis) analysis has been conducted on ZnO thin films in order to observe the calcination effect. The thin films prepared via dip-coating were treated at annealing temperatures from 350 °C to 650 °C. The results showed that, the crystal structure quality of the film improved with increasing the annealing temperature.

Keywords: Zinc Oxide Nanostructure, Thin films, Sol-gel, Calcination

Introduction
Thin film is a term associated with the deposition process which purposely to characterize that film and as a protection. Zinc Oxide (ZnO) thin films have attracted great attention for their applications in semiconductor devices, photoconductors and optical waveguide devices because of their low resistivity, piezoelectric properties, high transparency in the visible range and high light trapping characteristics. Consequently, ZnO thin films are grown by a variety of methods such as vacuum evaporation sputtering and sol-gel [1]. The research on preparation and characterization of ZnO thin film is a continuous progression due to the properties of ZnO thin film that is control by its method of preparation [2].

There are a lot of parameters need to be consider in order to prepare high quality ZnO thin film for devices application and one of them is the calcinations process. In this study, the ZnO thin films have been prepared using sol-gel dip-coating method and the annealing effect on growth of the thin films properties has been investigated.

Experimental Method
ZnO thin films were prepared by the sol-gel dip-coating method. The solution was prepared by using zinc acetate dehydrate (ZnAc) as a starting material, diethanolamine (DEA) as a stabilizer, isopropanol (2-PrOH) and water as solvent. The molar ratio of ZnAc: DEA: H2O: 2-PrOH was 1:1:1:20. The solution was stirred at room temperature for 1 hour so that an aging reaction was provoked before using starting sols in dip-coating process. Dip coating was carried out at room temperature using down-speed of 5 mm/s, holding for 10 s, and then withdrawing with an up-speed of 1.05 mm/s. The samples were calcined at 350 to 650 °C in air for 1 hour to induce densification and phase transformation. The surface morphologies of the ZnO were characterized using Scanning electron microscope (SEM) and atomic force microscope (AFM). Optical transmittance measurements were carried out using an UV-vis spectrometer.
**Result & Discussion**

Morphological of thin films have been performed by using SEM. The shape and morphology of ZnO nanoparticles changed with the calcinations temperature. The nucleation and growth rate were increases together with annealing temperature. This was confirmed by AFM results.

Calcinations temperature has a great influence in determining the roughness of the film surface. Fig 1 shows surface morphology of ZnO thin films at different temperatures. Scans of the few areas on the films surface shows the RMS roughness are 13.258 nm and 17.482 nm for 400°C and 600°C respectively. Its show that particle formation is increased which results in denser particle structure. Higher calcination temperature results in higher surface roughness.

Fig. 1: Surface Morphologies of ZnO thin films with annealing temperature: (a) 400°C and (b) 600°C.

The calcined thin films exhibit good transparency in visible region because the percentage of transmitted is above 80%. This is a good characteristic for application as solar cells. Transmittance not occurs at the visible wavelengths between 300 and 380 nm. It's begun to change in the UV region of 380 to 1000 nm wavelength. These changes occur due to the effect of the increase in the calcinations temperature. The band gap energies obtained were decreased with calcined temperature.

**Conclusion**

ZnO thin films were successfully prepared using sol-gel dip-coating method on the glass substrates. As the calcination temperature increased, the grain size was found to be increased as well and improved the surface roughness of the thin films.

**References**
