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RESEARCH

ZnO/Al_2O_3 layered structures deposited by RF magnetron sputtering on glass: growth characteristics, optical properties, and microstructural analysis

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Abstract

In this study, Al_2O_3 thin films of different thicknesses (50 nm, 100 nm, 150 nm, 200 nm, and 250 nm) were, first, grown using RF magnetron sputtering technique on glass substrate at 30 °C temperature, with 120 W power value. Then 250 nm ZnO was grown on these thin films. Microstructural analyses of the thin films were made by scanning electron microscope (SEM). It was observed that the particle size changed with increasing thickness of Al_2O_3 thin films. ZnO layer was grown onto alumina grown tubes with an approximate thickness of 250 nm. The grain morphology of ZnO was similar to alumina, about 25–30 nm grain size. Energy-dispersive X-ray analysis (EDX) detector was used to determine the chemical composition of the samples. These results have indicated that ZnO thin films are successfully formed on alumina tubes. Crystal structure analyses of all samples were examined using the X-ray diffraction (XRD) technique. In addition, the optical properties of the samples were examined with ultraviolet-visible-near infrared spectrometer (UV-VIS-NIR). This work provides valuable references for the application of Al_2O_3 as insulating buffer layers.

Keywords Al_2O_3 · ZnO · Magnetron sputtering · SEM · XRD · Optical properties

Introduction

In the last few decades, transparent conductive oxides, such as ZnO, ITO, and CdO, have attracted great attention among researchers due to their unique properties which are reflecting the light in the visible region and transparent and conductive nature. Because of these, they are preferred in many scientific researches and industrial applications. In addition, these oxide materials are the most preferred materials among metal oxide semiconductors especially since they have reflection property in the visible region.

ZnO is a semiconductor with a hexagonal wurtzite crystal structure, and it is an n-type semiconductor material with high conductivity, high transmittance, wide band gap of 3.3 eV, and 60 meV exciton binding energy at room temperature [1]. Due to these properties, it is one of the most popular materials among transparent conductive oxide materials. ZnO semiconductor compound has a high breakdown voltage and high melting temperature (1975 °C). For these reasons, nano-sized ZnO materials can be used in temperature control circuits operating at high power and frequency, and in the composition of sunscreen creams in the cosmetics industry due to their transparency. So, it has also become a candidate material, which will be used in solar cells, gas sensors, different types of transducers, luminescent materials, transparent conductors, heat mirrors, and semiconductor heterogeneous intersections [2, 3].

Alumina started to be used commercially for the first time in 1907 with a patent taken on a high alumina ceramic production. It is widespread commercial production, and use took

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