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The Effect of the Annealing on the Properties of ZnO/Cu/ZnO Multilayer Structures

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Abstract

Study of ZnO / Cu / ZnO multilayer film stack using Cu film as a sandwich layer, in order to improve the overall performance of the transparent conductive film, structural, electrical and optical properties. ZnO / Cu / ZnO multilayer films prepared at room temperature by a DC and RF magnetron sputtering technique. The results showed that ZnO / Cu / ZnO multilayer film has good crystalline properties. With an increasing Cu layer thickness, a visible light transmittance of the multilayer film is reduced, while the electrical performance improved significantly. In the Cu layer thickness of 20 nm, ZnO / Cu / ZnO multilayer film optoelectronic integrated for optimal performance

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Keywords: RF sputtering; multilayer; Optical and Electrical properties.

1. Introduction

Ultrathin films of metals (Au, Ag, Cu) with at nanosized thickness are widely used. The transparent conductive film is a transparent and electrically conductive combination of two properties in one thin film and this kind of materials specially used in photoelectric device[1], flat panel displays, solar cell, and infrared reflective film. In Research for a long time, the transparent conductive films focused on ITO (In_2O_3:Sn) film. ITO having excellent photoelectric Performance, but also have weaknesses, such as: the price is high, toxic, and not stable enough. By Compared ITO with ZnO thin film the ZnO-based transparent conductive electric film has rich raw materials, cheap, non-toxic, etc[2]. In recent years, more possible alternatives to ITO, it's become a hot research. Currently, Al doped

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ZnO (AZO) films more widely used, but also it has a weakness because Al is a highly reactive element, thin film when the film growth Al-doped prone Al_2O_3 phase[3-5]. In order to further improve the conductivity, the ZnO-based single metal thin film is introduced with excellent conductivity. Many Conducted ZnO thin films as a multilayer structure research have been done using different metal such as Ag[6-8], Cu[9,10], Al[11,12], Fe[13,14] and so on. Metal Cu has excellent conductivity, and the price is relatively low compared with Ag and it become have more advantage.

In this study, Cu metal layer is used between two ZnO thin film layers by sputtering method at room temperature to prepare a ZnO / Cu / ZnO transparent conductive multilayer film. By design the Cu thickness to obtain high performance photovoltaic element as transparent conductive film.

2. Experimental work

Thin film growth

Figure 1 shows prepared ZnO / Cu / ZnO multilayer film structure diagram using DC and RF magnetron sputtering system at room temperature. ZnO layer and Cu layers in the order are alternately deposited on a glass substrate. On the bottom preparation ZnO film is 99.999% purity ZnO target. Sputtering power fixed at 140W. There are two layers in a multilayer film ZnO layer, each ZnO film layer sputtering time are 2min, each having a thickness of approximately 60nm.

Preparation of Cu layer with a metal purity target of 99.99% the sputtering carried out at atmosphere with the high-purity Ar gas, the gas pressure was 1.0 Pa, sputtering power is fixed at 100W. For fix Cu layer thickness we have controlled the sputtering time, which was, 5nm, 10nm, 15nm and 20nm.

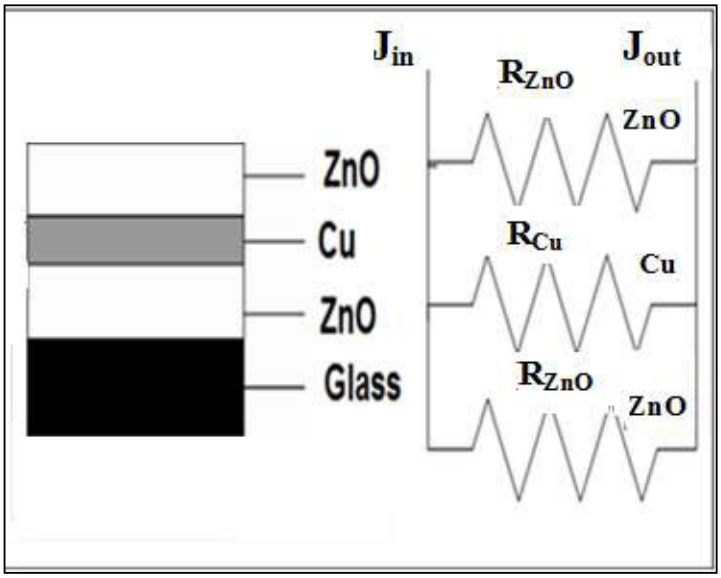

Fig.1. Schematic diagram of transparent conductive ZnO/Cu/ZnO multilayer films

3. Results and discussion

3.1. Characterization

In this study we have used XRD (PANalytical) to get the crystallization performance testing Crystal structure of the multilayer film,. Use Hall tester (Accent optical technologies Inc HL 5500pc-hall effect four-point probe method) sample Conduct resistivity, and mobility tests. Use UV- visible infrared spectrophotometer. (Agilent Technologies cary series UV-VIS-NIR sepectrophotome) for thin film sample transmission spectra test.