Surface Morphology and Structure of Nanocrystalline CdSe Thin Films Deposited by RF Magnetron Sputtering

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Abstract --- The surface morphology and structure of nanocrystalline CdSe thin films deposited by radio frequency (RF) magnetron sputtering have been studied. The properties of CdSe thin films were affected by film thicknesses. The crystalline structure and surface morphology were investigated using an X-ray diffractometer (XRD) and a field-emission scanning electron microscope (FESEM). The XRD and SEM results indicate that 500-nm-thick film on a glass substrate had the strongest intensities of (002) diffraction peak, but its on ITO glass substrate had the biggest grain size of nanocrystalline CdSe thin films.

Keywords: Cadmium selenide, RF magnetron sputtering, Surface morphology, Thin film

1. INTRODUCTION

The compound cadmium selenide (CdSe) is one of the elements of the groups II-VI having wide range of applications. Usually CdSe is a n-type material (1.7 eV) and they are of interest for their applications as photoconductors, solar cell, thin film transistors, gas sensors, biomedical imaging agents [1], acousto optic devices, vidicons, photographic photoreceptors, etc. CdSe films deposited using vacuum evaporation, molecular beam epitaxy (MBE), metal oxide molecular beam epitaxy (MOMBE), Laser ablation technique and chemical deposition methods have already been studied extensively [2]. Among the various techniques available for the preparation of thin films, recently, radio frequency (RF) magnetron sputtering deposition has become a popular technique, because of its simplicity and its economic viability and it has significantly contributed to the growth of high quality thin films. In this paper, CdSe thin films were deposited at various thicknesses onto unheated glass and indium tin oxide (ITO) glass substrates by RF magnetron sputtering. The crystalline phase and surface morphology of the deposited films were observed using X-ray diffraction (XRD) and field-emission scanning electron microscopy (FESEM), respectively. The effects of film thickness on the characteristics of CdSe thin films are discussed.

2. EXPERIMENTAL PROCEDURE

2.1 Preparation of CdSe thin films

CdSe thin films were prepared using an RF magnetron sputtering method with a CdSe ceramic target (WAM Technologies Taiwan Co., Ltd., Grade: 99.999%, diameter: 10 cm, thickness: 5 mm) as the source material and Ar gas (99.995%) as the sputtering gas. A stainless steel chamber was evacuated using a turbo pump to a base pressure less than 2 × 10⁻⁵ Torr. Before the deposition of the samples, the chamber was kept in the pre-sputtering regime for 7 min (shutter closed) to remove contamination on the target surface in order to stabilize the deposition parameters. Samples denoted A_gl, B_gl, and C_gl were deposited onto a glass substrate, and samples denoted A_ITO, B_ITO, and C_ITO were deposited onto an ITO glass substrate. The area of sample was 20 mm × 20 mm. The sheet resistances of the ITO glass substrate were 7Ω/□. Glass and ITO glass substrates were ultrasonically washed successively in acetone, isopropanol, alcohol, and deionized water each for 15 min. After the substrates were cleaned, they were statically placed on a sample holder facing the target at a fixed distance of 25 mm in a vacuum chamber. The sample holder with the substrates was neither heated nor rotated. The thickness of the thin films was monitored in real-time using a crystal thickness monitor (TM350, Maxtek, U.S.A) during the deposition. Samples with film thicknesses of 100, 300, and 500 nm were prepared. In our experiment, the deposition rate was 6.6 Å/sec and the deposition time was 2 ~12 min. Details of the deposition conditions of the CdSe thin films are summarized in Table 1.