CHARACTERIZATION OF ALUMINUM DOPED ZINC OXIDE THIN FILM FOR TRANSPARENT ELECTRODE

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Introduction

The transparent conductive oxide, such as indium-tin-oxide, Al-doped zinc oxide and Zn-doped indium oxide have attracted much interest in the application of optoelectronic devices such as solar cells and liquid crystal displays due to their high conductivity and high transparence in visible region[1]. Among them, aluminum doped zinc oxide films are abundant, nontoxic and inexpensive compared with indium tin oxide [2,3]. So they are attractive materials as transparent conductive electrode. A target consisting of Al_2O_3 2 wt % doped zinc oxide using target thin films were deposited on glass (corning Eagle 2000) substrates by radio frequency magnetron sputtering system. Films were deposited at a substrate various condition. The sheet resistance is measured with four point prove. We investigated the surface of AZO films by using field emission scanning electron microscope (FE-SEM, JSM-6700F). The optical transmittance of the film in the visible range was measured using an Ultra Violet Visible Absorption spectroscopy (HP-8453). Film crystallinity was investigated using X-ray diffraction (XRD, DIMAX2200HR),

Experimental

We produced AZO films on corning eagle glass by RF-magnetron sputtering method using Al_2O_3 2 wt% doped Zinc Oxide target. For remove impurities, the glass substrates were cleaned in an ultrasonic cleaner for 5 min with TCE, acetone, alcohol and then D.I water. The sputtering deposition was performed under thickness 50, 100, 200, 300, 500nm substrate temperature R.T, 250^{o}C, 300^{o}C , 350^{o}C and working pressure 2, 5, 10mtorr respectively. The substrate temperatures arranged at a corner of the sample. Additional process conditions are shown in Table 1.

parameter	Value
RF power	120W
Base pressure	4×10^{-7}torr
Ar flow ratio	40sccm
Target-Substrate Distance	10cm
Film Thickness	50, 100, 200, 300, 500nm
Working pressure	2. 5, 10mtorr
Substrate Temperature	R.T, 250, 300, 350^{o}C

Table 1. Process conditions of AZO deposition on glass substrates.

Result and Discussion

Fig.1 shows the SEM plane and cross section observation of 500nm thickness AZO thin film. This infers that good crystalline quality can be obtained in AZO thin film.

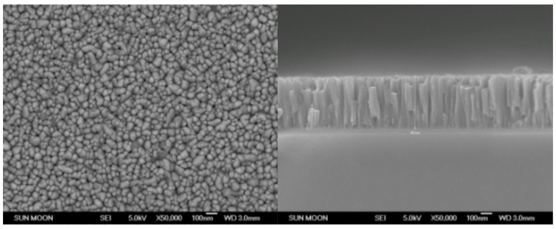

Fig. 1 SEM plane and cross section image of 500nm AZO thin film.

Fig. 2 shows X-ray diffraction patterns of AZO thin films. We can observe growth of main (002)peak According to increase film thickness. Fig. 3 shows thermal dependence of AZO thin film. The substrate temperature increase from R.T to 350^{o}C the X-ray diffraction peaks for the AZO film become stronger, sharper and narrower. This indicates that the crystalline quality of the film is improved with increasing the substrate temperature. Fig. 4 shows the X-ray diffraction patterns of AZO thin film deposited at different working pressure. It shows a higher intensity and sharper distribution in (002) diffraction according to decrease working pressure. This infers that the film crystalline quality could be improved by decreasing working pressure.

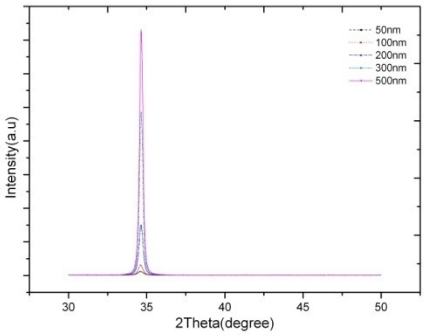

Fig. 2 X-ray diffraction pattern of AZO thin film with film thickness.

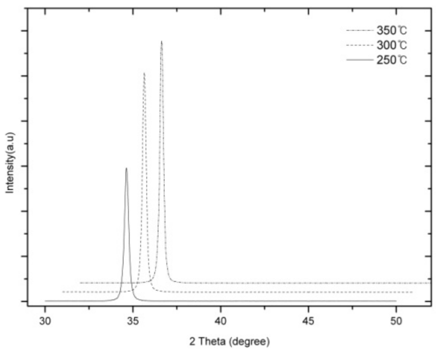

Fig. 3 X-ray diffraction pattern of AZO thin film with substrate temperature.

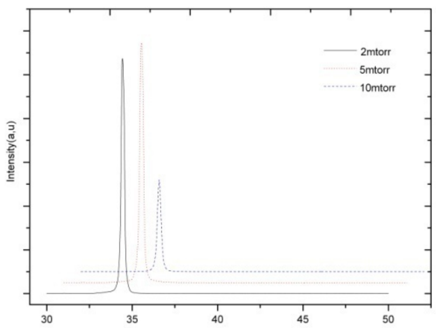

Fig. 4 X-ray diffraction pattern of AZO thin film with working pressure

Fig. 5 shows the resistivity of AZO thin films at various film thicknesses. The film resistivity is strongly dependent on the film thicknesses. The resistivity of AZO thin film is reduced with increasing film thicknesses. It due to that enhanced crystalline quality by increasing film thicknesses. We got the resistivity of $6.5X10^{-4}\Omega cm$ at 500nm film thickness.

Fig. 6 shows the influence of substrate temperature at deposition. It can be seen in the figure that at R.T sample has $2.3x10^{-2}\Omega cm$. And $300^{o}C$ sample is measured $8.4x10^{-3}\Omega cm$ at same film thickness 300nm. The resistivity of the AZO films was decreased as the substrate temperature was increased, since the internal defect is reduced and crystal quality is increased. From these result it can be seen that the film resistivity is dependent on the substrate temperature at deposition

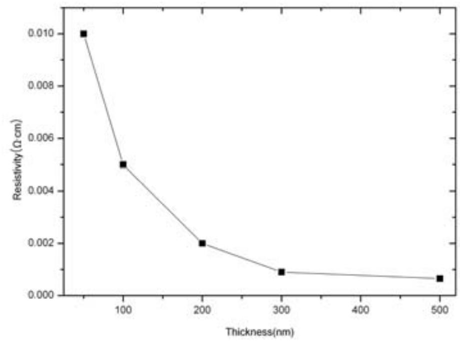

Fig. 5 Resistivity of AZO thin film with film thickness.

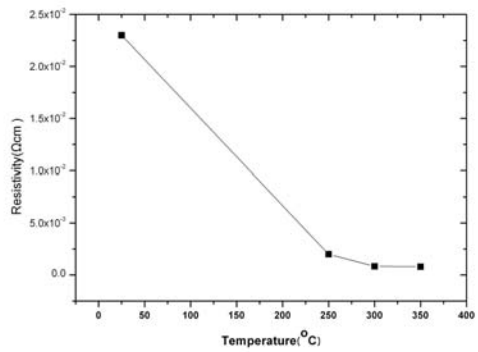

Fig. 6 Resistivity of AZO thin film with substrate temperature.

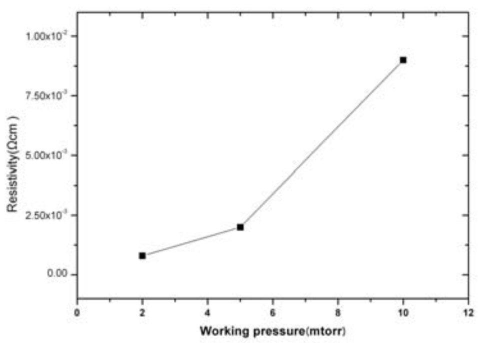

Fig. 7 Resistivity of AZO thin film with working pressure.

Fig. 7 shows the resistivity of AZO thin film with working pressure. AZO film resistivity reduces with decreasing working pressure from 10mtorr to 2mtorr. It shows that the film conductivity is influenced by the working pressure. Fig. 8 shows the optical transmittance of the AZO thin film at thickness 300nm. Transmittance of prepared AZO thin film is over by 85% at visible range (350~900nm). It indicates that AZO thin film is suitable material that applied as a device electrode.

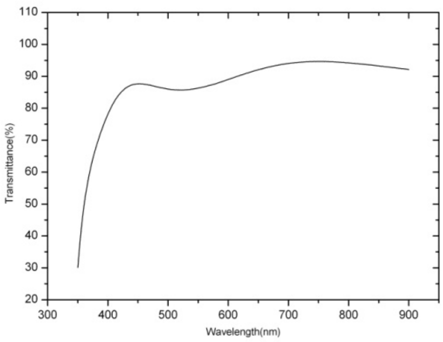

Fig. 8 Optical transmittance spectra for the AZO thin film (350nm~900nm)

Conclusion

We prepared the AZO thin film on corning eagle2000 glass at various process conditions (film thickness, substrate temperature, working pressure). The crystalline and resistivity are improved with increasing film thickness. Add the thermal energy at the substrate makes good film properties. Low resistivity and good crystalline are measured high substrate temperature sample. The film resistivity and crystalline is dependent on the substrate temperature at deposition. According to the working pressure increase, conductivity and transmittance are promoted. And 300nm film has good optical transmittance (85%↑). From these result it can be seen that the AZO film can be good transparent conducting electrode alternate ITO.

Acknowledgement

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References

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