

Properties of ZnO:Al thin film on variation of substrate temperature for display applications

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ABSTRACT

ZnO:Al(AZO) has been investigated for the photovoltaic cell or TCO(Transparent Conductive Oxide) of the display, because it has good electrical and optical properties. In this study, the ZnO:Al(AZO) thin film prepared on variation of substrate temperature by FTS(Facing Targets Sputtering) system. In case of TCO, because resistivity and roughness values affect the lighting of the OLED, their factors are very important. Therefore, in this paper, the electrical and optical properties of the AZO thin film were investigated with the deposition conditions and its roughness was investigated on variation of the substrate temperature.

In results, AZO thin film deposited with the transmittance over 80% and the resistivity was reduced from 1.36×10^{-3} [O-cm] to 4×10^{-4} [O-cm] with increasing the substrate temperature from R.T to 200[]. Especially, we could obtain the resistivity 4×10^{-4} [O-cm] of AZO thin film prepared at working pressure 1[mTorr], input current 0.4[A] and substrate temperature 200[]

INTRODUCTION

Transparent conductive oxide (TCO) films, mainly indium tin oxide (ITO) films, have been widely applied to manufacture transparent electrodes for flat panel displays, solar cells and organic light-emitting diodes due to the high luminous transmittance, good electrical conductivity, good adhesion to substrate and chemical inertness [1-5]. However, the need of another substrate is enhanced because of high cost of ITO. So ZnO film doped with Al, AZO which has the properties of low resistivity, high transparency and low cost has been investigated [6-8].

AZO thin films can be produced by various deposition techniques including plasma enhanced chemical vapor deposition (PECVD) [9], pulsed laser deposition (PLD)[3,5], RF magnetron sputtering[2,4,6] and facing targets sputtering (FTS) [10,11]. Among these, sputtering method is widely used for its tendency to grow highly oriented AZO thin films and its high productivity [12]. AZO thin film could be deposited with the high transmittance over 80% and the low resistivity about 10^{-4} [O-cm] as a function of sputtering conditions. Especially, because low temperature deposition was possible, sputtering method is suitable

for OLED applications that require deposition at room temperature.

In this study, the electrical and the optical properties of AZO thin film that were prepared by FTS system [10, 11], with substrate temperature have been investigated.

RESULTS

Fig. 1 shows the XRD patterns of AZO thin film at input current 0.4A and working gas pressure 1mTorr with the various substrate temperatures. The strongest peak is observed at 200 . The Peak at 100 exhibited similar value at R.T.

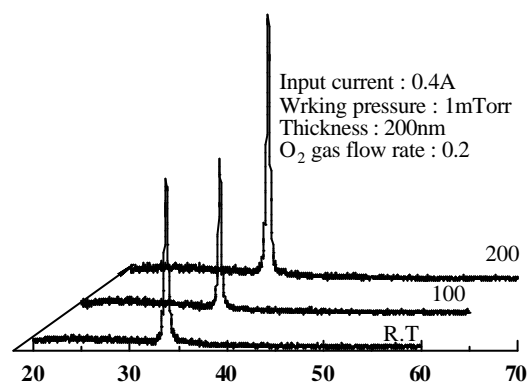


Fig.1 XRD patterns of AZO thin films prepared with substrate temperature

Fig. 2 shows the resistivity and grain size of AZO thin films at R.T, 100 , 200 . The resistivity decreased to 4×10^{-4} [O-cm] at substrate temperature 200 . However, the grain size increased to 26.4[nm] at substrate temperature 200 .

The reduction of the resistivity is presumed the increment of grain size i.e. the increment of grain boundary with a rise in substrate temperature.

Fig. 3 shows the surface-images of AZO thin films at R.T, 200 . It is observed that the grain size was increased at 200 like a Fig. 2. And this is presumed by XRD patterns too.

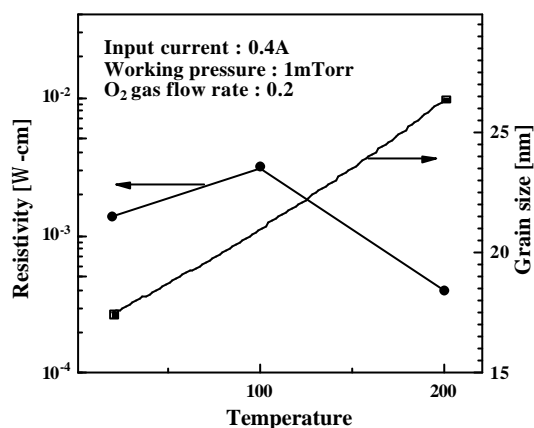


Fig.2 The resistivity and grain size of AZO thin films prepared with substrate temperature

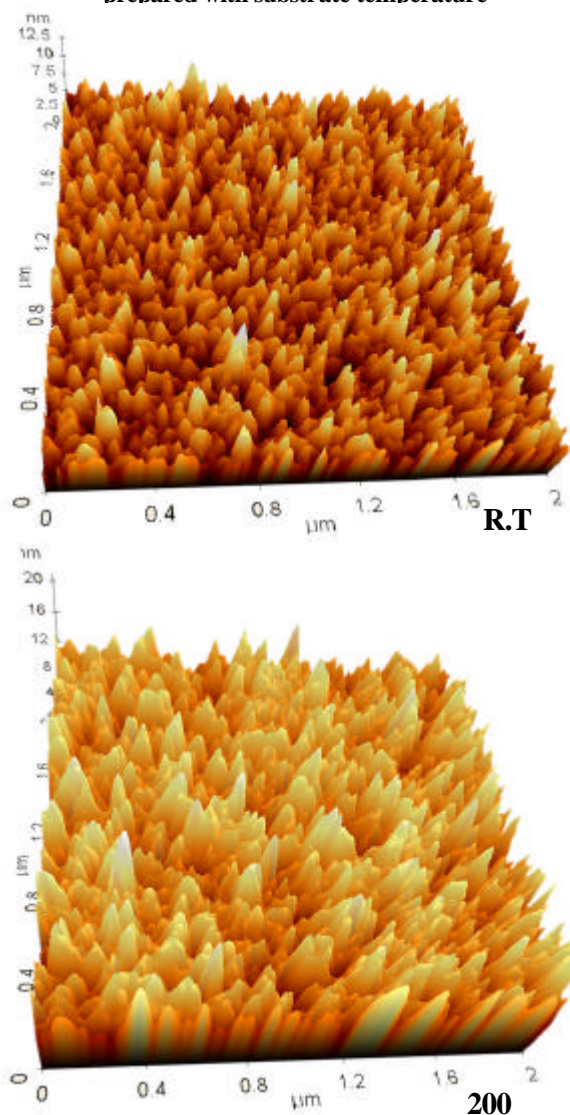


Fig.3 AFM images of the AZO thin films prepared with substrate temperature

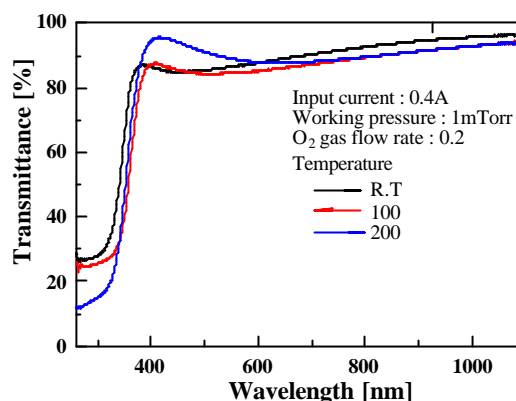


Fig.4 Transmittance of prepared AZO thin films prepared with substrate temperature

Fig. 4 shows the transmittance of AZO thin film at input current 0.4A, working gas pressure 1mTorr. The optical transmittances of AZO thin films were measured by UV/VIS spectrometer in the wavelength range between 300 and 800nm. Transmittance of prepared TCO thin films by FTS is over 80%.

CONCLUION

We prepared the AZO thin film on slide glass at R.T, 100 and 200 using FTS apparatus. As a result, AZO thin film prepared at 200 has good properties such as a low resistivity, a large grain-size.

However, transmittance of AZO thin films has similar values regardless the substrate temperatures.

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