Preparation of ITO Thin Films for Display Application with O_2 Gas Flow Ratio and Input Current by FTS (Facing Targets Sputtering) System

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ABSTRACT

In this work, the ITO thin films were prepared by FTS (Facing Targets Sputtering) system under different sputtering conditions which were varying O_2 gas flow, input current at room temperature. As a function of sputtering conditions, electrical and optical properties of prepared ITO thin films were measured. The electrical, optical characteristics and surface roughness of prepared ITO thin films were measured. In the results, as increasing O_2 gas 0.1[sccm] to 0.7[sccm], resistivity of ITO thin film was increased with a decreasing carrier concentration, O_2 gas over 0.3[sccm] the carrier mobility have a similarly value. Transmittance of prepared ITO thin films were improved at increasing O_2 gas 0.1[sccm] to 0.7[sccm]. And transmittance of all of the prepared ITO thin films was over 80%. We could obtain resistivity 6.19×10^{-4}[O·?], carrier mobility 22.9[? /V·sec], carrier concentration 4.41×10^{20}[? $^{-3}$] and transmittance over 80% of ITO thin film prepared at working pressure 1mTorr, input current 0.4A without any substrate heating.

INTRODUCTION

Many kinds of transparent conducting oxide (TCO) thin films such as indium oxide, tin oxide, and zinc oxide have been widely used as transparent conductors for numerous opto-electrics applications[1,2]. Especially, tin-doped indium oxide (ITO) thin films much have been studied for application to flat panel display devices because the ITO thin film has a low resistivity, high transmittance, and chemical stability. Then, the ITO thin film on flexible substrate or organic layer which used in OLED [3, 4] are strong demanded. In order to prepare the ITO thin films on organic layer with low damage by sputtering method, it's required that the preparation at low substrate temperature and suppression of high energy particles such as secondary electrons or negative oxygen ions. But many conventional sputtering methods [5, 6] were difficult to obtain the ITO thin films on organic layer with low resistivity and low organic layer's damage because the high energy particles, such as energetic atoms and ions are impinging on organic layer and transfer their energy to the organic layer or growing film. These interactions between ions and organic layer may cause substantial damage to substrate and result in degraded device performance [7]. Additionally, conventional sputtering methods were needed substrate heating for low resistivity of ITO thin film.

So we studied that electrical characteristics, surface roughness and transmittance of the ITO thin films were prepared by the FTS (Facing Targets Sputtering) system which can suppress substrate damage [8, 9] under different sputtering conditions without any substrate heating.

RESULTS

Fig.1 showed deposition rate of prepared ITO thin films by FTS system is increased as increasing input current. However, deposition rate independence the O_2 gas flow ratio.

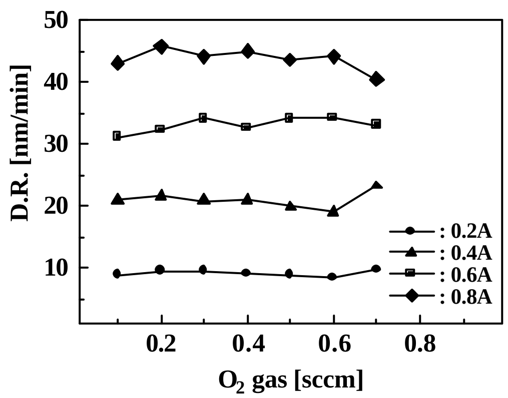

Fig. 1 Deposition rate of ITO thin films

Fig.2 showed electrical properties of prepared ITO thin films as a function of varying input current and O_2 gas flow rario. We could obtain resistivity 6.19×10^{-4}[O·?], carrier mobility 22.9[? /V·sec], carrier concentration 4.41×10^{20}[? $^{-3}$] and transmittance over 80% of ITO thin film prepared at working pressure 1mTorr, input current 0.4A without any substrate heating.

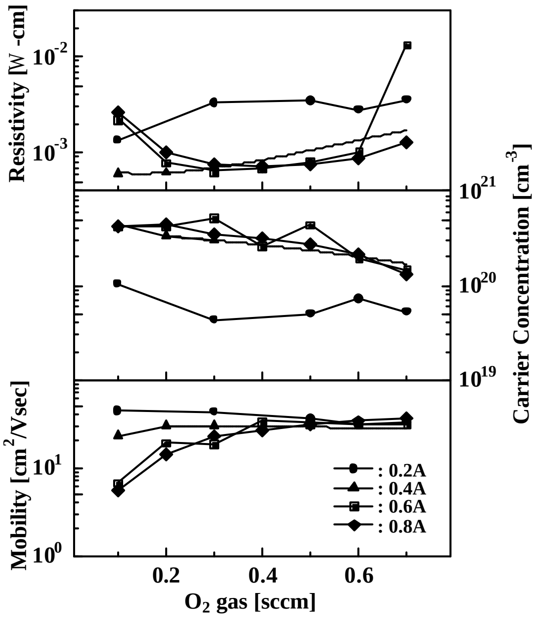

Fig. 2 Electrical properties of prepared ITO thin films with input current at 1mTorr

Fig. 3 showed transmittance of ITO thin films were prepared with varying input current and O_2 gas flow ratio. Transmittances of all prepared thin films were over about 80%.

X-ray diffraction pattern of ITO thin films were measured. But we can't observe any peaks it means prepared ITO thin films are amorphous. We consider that it may be not thick enough to crystallize [10].

Fig. 4 showed SEM image of ITO prepared thin film with varying input current at O_2 gas flow ratio 0.2.

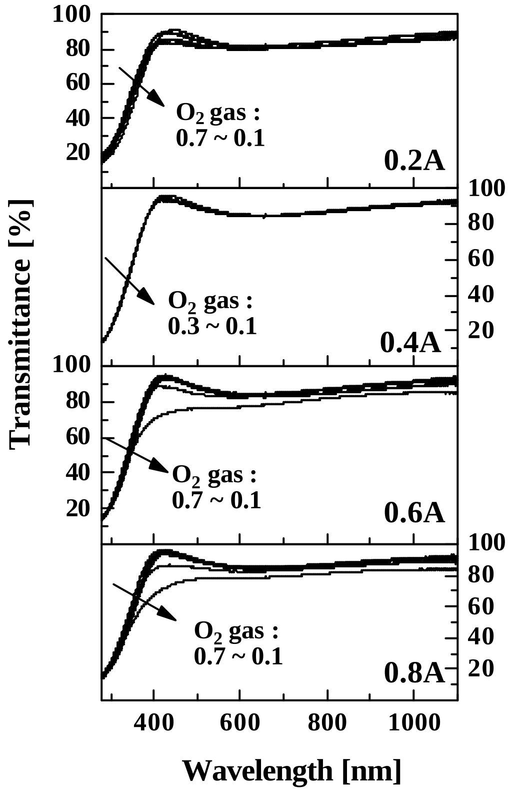

Fig. 3 Transmittance of ITO thin films

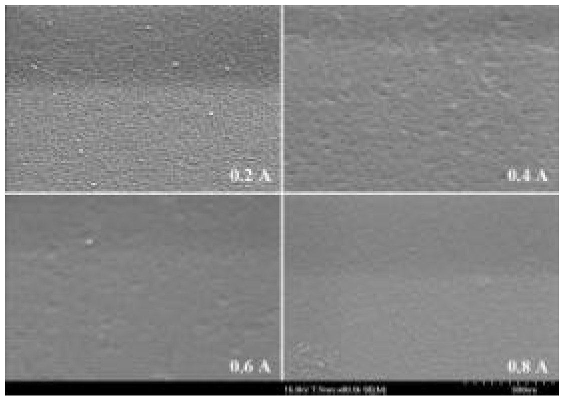

Fig. 4 SEM images with input current

CONCLUSION

ITO thin films applications for display were fabricated by FTS system. We could obtain resistivity 6.19×10^{-4}[O·㎝], carrier mobility 22.9[㎠/V·sec], carrier concentration 4.41×10^{20} [$㎝^{-3}$] and transmittance over 80% of ITO thin film prepared at working pressure 1mTorr, input current 0.4A without any substrate heating. Therefore, we noticed that the FTS system is suitable sputtering method to prepare ITO thin film for OLED device or flexible substrate which is required room temperature process.

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