Abstract

In this work, Indium tin oxide (In_2O_3:Sn or ITO) films were prepared with a von Ardenne Laboratory System LA 500S by dc and rf magnetron sputtering method under different oxygen partial pressures, substrate temperatures, sputtering powers and pressures.

The optical transmittance and reflectance of ITO films have been simulated based on the dielectric modeling using a commercial computer program SCOUT98. For ITO films, the standard dielectric model is composed of the OJL model, a harmonic oscillator and the classical Drude term. In order to improve the simulation, the Drude model was modified with a frequency-dependent damping term to overcome the too strong absorption in the visible range and the OJL model could be replaced by the other band gap transition models to account for the crystalline films. It has been found that both the optically derived carrier density and mobility are higher than those of the respective electrically derived parameters. This could be attributed to the microstructure of the films, namely, the badly conducting grain boundaries and electrically isolated grains. It has also observed that the band gap increases with increasing carrier density, resulting from the Burstein-Moss shift.

It has been observed that the lattice distortion in the film generally increases with increasing oxygen partial pressure. This can be explained by the model of oxygen incorporation into the bixbyite structure. The carrier density and mobility decrease with increasing interstitial oxygen because interstitial oxygen both captures free electrons and forms the new scattering center. It has been also revealed that the line broadening of XRD reflections resulted from both the finite grain size and microstrain in the films.

The properties differences between the central and peripheral ITO samples (above the erosion track) have been attributed to the effect of sputter geometry and plasma distribution.

It was found that there exists a critical film thickness at about 0.5 µm in terms of the film growth and the structural and physical properties of ITO films. The results can be interpreted by more oxygen incorporation at the initial of film growth.

In this work, the effect of the plasma excitation mode, i.e. dc and rf sputtering, on the properties of ITO films has been also investigated.