TRANSPARENT CONDUCTING OXIDE FILMS FOR SIS SOLAR CELLS

by

E. SHANTHI
DEPARTMENT OF PHYSICS

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THESIS SUPERVISOR :

PROFESSOR K.L. CHOPRA
Thin Film Solid State Technology Cell
Indian Institute of Technology, Delhi
New Delhi-110016

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E. Shanthi

(E. SHANTHI)

ABSTRACT

In the present work we have carried out a systematic and detailed study of transparent conducting oxide films, namely, tin oxide and zinc oxide, prepared by spray pyrolysis.

Tin oxide films have been doped with number of dopants, such as, Sb, F and (Sb + F) and their effects on the different properties of the films have been investigated. Auger analysis and depth profile have been carried out to determine the concentration of the dopant and the concentration gradient throughout the thickness of the films.

Structural studies have been carried out using transmission electron microscope. Reflection diffraction study of doped films reveals that these films exhibit preferred orientation. The surface topography of these films has been examined using scanning electron microscope. The effects of substrate temperature and doping, on grain size and surface morphology of the films, have been studied.

Sheet resistance as low as 9.2 ohm/□ with high optical transmission (> 80%) and high infrared reflection (~ 90%) have been obtained in F-doped tin oxide films. The temperature dependence of electron mobility has been analysed to establish the electron conduction mechanism. The electrical properties of the films are profoundly modified by the nature and concentration of the dopants used. The electrical properties

of Sb-, F- and (Sb+F) - doped tin oxide films have been studied, in detail, to determine the role of impurities. The annealing characteristics of undoped and antimony - doped tin oxide films, upto temperatures of 400 $^{\circ}C$, in various ambients have been carried out with a view to ascertain the role of oxygen on the electrical properties.

Variation in optical properties with dopant concentration has been studied in the entire ultraviolet to infrared region. Fundamental absorption edge occurs in uv range. Large Moss-Burstein shift has been observed in these films. Optical properties near the plasma edge occuring near the infrared range have been analysed using Drude theory. The dependence of effective mass has been explained on the basis of nonparabolicity of the conduction band. The shift in the Fermi energy, calculated on the basis of energy dependent effective mass, is consistent with the measured shift in the absorption edge.

The effect of the dopants on the different properties of the ZnO films has also been the subject of detailed investigation. Resistivity as low as 3 x 10^{-3} ohm cm. with optical transmission of 80-90 % has been obtained in vacuum/hydrogen-annealed Al-doped ZnO films. The cause for the variation in electrical properties of the films on annealing in different ambients has also been examined.

Fluorine-doped tin oxide films, prepared by spray pyrolysis technique, has been used to fabricate F-doped tin oxide/n-Si solar cells. These cells are characterised by I-V, C-V and spectral response measurements.

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