Elaboration of Transparent and Conductive Oxide by Sol-Gel method

Abstract

The main objective of the study undertaken in this thesis is to elaborate undoped tin dioxide (SnO_2) thin films and doped by Fluorine and Gadolinum from two methods synthetic sol-gel and pyrolysis spray, and to optimize their optoelectronic properties. The improvement of these properties can lead to FTO thin films alternative to (TCOs) which contain Indium element (for example ITO) which confer it the possibility to be used as optical windows in solar cells.

In the first time, Un-doped and Fluorine doped SnO_2 thin films were prepared by Sol-Gel method and deposited by dip-coating process on glass substrates. After deposition, thin films were analyzed by X-ray diffraction (XRD), Raman and FTIR spectroscopy, UV-Visible and Hall effect. The measure results show that the films have polycrystalline tetragonal crystalline structure with mainly (110) preferential growth plane which modified with the variation of the film thickness, doping levels and annealing temperature. The grain size of the films obtained is nanometric. Un-doped and Fluorine doped SnO_2 thin films have a low transmittance in the visible (range between 60 and 65%). The annealing effect was clear for decreasing porosity in the structure. The optical gap of films is in the range of 3.3 to 3.8 eV. Fluorine incorporation reduced the resistivity which is in order of (10^{-1}-10^{-2} Ω.cm) as well as the annealing at 550 °C.

In the second time, (SnO_2: F) and (SnO_2: Gd) were deposited by spray pyrolysis technique on heated glass substrates at 450 °C and 470°C. Doping generates good transmission and a decreasing in resistivity ρ which is in the order of 10^{-4}Ω.cm and 10^{-3}Ω.cm for (SnO2: 12% F) and (SnO2: 3% Gd) films respectively. The figure of merit value obtained is competitive which is in the order of $10^{-3}Ω^{-1}$.

(SnO_2: Gd) thin films were exploited to realize (SnO_2: Gd) / p-Si heterojunction. The photoelectric effect was observed in all structures (SnO2:Gd). The maximum performances, with an efficiency of the order of 7.8x10 $^{-3}$ were obtained for a doping levels which is equal to 1%. This efficiency value (η) obtained is mediocre but many authors noted this low conversion efficiency in tin dioxide-based cells.

Key Words: Thin films; SnO_2: (F ou Gd); Spray pyrolysis; Sol-Gel; XRD and heterojunction.