Annealing of ZnO and SnO_2 transparent conductive oxides

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Abstract

Transparent Conductive Oxide (TCO) are used in different field [1], especially as antireflective layers on the surface of solar cells [2,3].But in the solar cells process, annealing steps are often used , i.e ; the front metallic contacts of solar cells are obtained by serigraphy at high temperature (800 – 830°C). In this case what happen in TCOs used as antireflective layers ?. In this work we present the comparison of changes in physical properties of two TCOs: tin oxide SnO2 and zinc oxide ZnO when they are annealed at low and high temperatures. These films are deposited by the Atmospheric Pressure Chemical Vapour Deposition APCVD technique. Tin oxide is deposited from tin dichloride (SnCl2, $2H_2O$) precursor and zinc oxide is obtained by the use of zinc acetylacetonate $Zn(C_5H_7O_2)2$. The electrical and optical properties of tin oxide and zinc oxide are determined by the four points probes method and spectrophotometry measurement. The values of the resistivity of tin oxide and zinc oxide are 10^{-4} Ω.cm and 10^{-3} Ω.cm respectively. These films present an optical transmission higher than 80%. The scanning electronic microscopy images show that the films have a polycrystalline aspect. A post annealing of these TCOs at 450°C improves their electrical properties, while an annealing at higher temperature damage them.

Key words: Thin films, tin oxide, zinc oxide, APCVD, Annealing

Introduction:

Tin oxide and zinc oxide are transparent conductive oxide. These materials present an optical transmission of about 80%.Their band gaps are large, comprised between 3,2 and 4.6 eV [4]. They are used in microelectronics as thin films in gas sensor and mainly at the surface of solar cells as antireflective layers [4]. In this paper we present the physical properties of tin oxide and zinc oxide obtained by the same technique: atmospheric pressure chemical vapour deposition APCVD. The influence of annealing at high and at low temperature will also be studied.

Experiment

APCVD (figure 1) is a chemical process which consists on heating a precursor under oxygen flow. The vapours of the precursor react with oxygen and are carried on the surface substrate. The precursor used to deposit tin oxide thin films is the hydrated tin dichloride ($SnCl_2$, $2H_2O$) those vapour react with oxygen gas at the surface of the substrate. The deposition temperature is fixed at 490°C.