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A chemical method for the preparation of thin films of CdO and ZnO

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Abstract

Thin films of ZnO and CdO are prepared by the simple, economical and versatile method of chemical spray pyrolysis. This method is based on the preparation of solutions of some salt of the material whose thin films is to be prepared. The thin films obtained by this method are suitable for many scientific studies and technological applications. For the ZnO and CdO thin films, the optical properties are investigated, the energy gaps are estimated, the absorption coefficient, index refraction, extinction coefficient and real and imaginary dielectric constants as well as the lattice parameters were studied and calculated.

Keywords: Thin films growth; Optical properties; Zinc oxide; Cadmium oxide

1. Introduction

Thin films are of increasing interest owing to their numerous applications in all kinds of scientific, industrial and technological applications. For this reason, there are always growing and urgent needs to find new, economical and simple techniques to prepare thin films. Also, a specific need appears for methods of preparation of thin films with large areas used in photovoltaic applications. To respond to this need, several research groups have worked in recent years on the preparation and characterization of the thin oxides films [1,2]

The monoxides are very difficult to evaporate, because of their high melting temperature. To overcome this problem, several techniques were developed for films of such compounds, e.g. ZnO: (i) reactive evaporation [3], (ii) chemical deposition [4] and (iii) reactive sputtering [5] etc. Among these techniques, the spray pyrolysis technique seems to be more suited for the commercial fabrication of materials of this kind [6].

This is the first time we used the chemical spray pyrolysis method to prepare thin films of the two important semiconductors ZnO and CdO. This method is simple, economical and versatile for the preparation of polycrystalline and amorphous thin films. It is used for the preparation of a large number of semiconducting and insulating thin films [7]. The method is based on the preparation of clear solutions of certain salts of the material whose thin films are to be prepared. In the fabrication of the thin oxide films both chemical and thermal reactions are used. In this method, it is easy to prepare thin films of mixtures and thin films with doping materials.

0254-0584/97/\$17.00 © 1997 Elsevier Science S.A. All rights reserved *PII* S0254-0584(96)01863-9 It is suitable for the preparation of thin films of large area. Both thin films studied in this work have a high absorption coefficient which makes them good candidates for use in solar energy systems and allows them to increase efficiency in solar cells.

2. Chemistry

The chemistry involved in the preparation of the ZnO and CdO thin films is summarised as follows.

2.1. ZnO thin films

In the process of preparation of the ZnO thin films, the salt $Zn(NO_3)_2$ is dissolved in doubly distilled water, from which a 0.1 M solution is prepared, the solution is immediately sprayed to avoid any possible changes in the solution with time. The thermal-chemical reaction resulting in the formation of the ZnO thin films is:

$$2Zn(NO_3)_2 \rightarrow 2ZnO + 4NO_2 \uparrow + O_2 \uparrow$$

The thin films are collected on glass substrates preheated to a temperature of 525°C.

2.2. CdO thin films

These films are prepared in a similar way. An amount of the salt $Cd(NO_3)_2 \cdot 4H_2O$ is dissolved in doubly distilled