Optical and structural characterization of nanoscale CdO:Mn thin films grown by chemical spray pyrolysis

Z. A. Hallaj, S. M. Rozati*
Spray Pyrolysis Lab., Department of physics, University of Guilan, Rasht, Iran

Introduction

Transparent conducting oxide (TCO) thin films have great importance in the field of optoelectronic devices and extensively used for a variety of applications such as flat panel displays, organic light emitting diodes and photovoltaic solar cells [1–3]. Among TCO materials, cadmium oxide (CdO) continues to attract attention due to its interesting characteristics such as high electrical conductivity and optical transmittance in visible spectral region. In this work, our aim is to produce a CdO based material with better characteristics (optical, structural) and stability than CdO by Mn incorporation for photovoltaic applications.

Experimental details

The apparatus used for the spray pyrolysis has been described previously [7].The spray solution consists of cadmium acetate dissolved in demonized water and methanol in the ratio 1:1.The carrier gas was purified air that was maintained at a flow rate of 20 ml/min. The nozzle–substrate distance was 25 cm and the substrate temperature 350 ˚C and cadmium ion concentration was 0.015M. X- Ray diffractometry(PW1840-Diffractometer,Phylips) was used to identify the phases present and the structure of each phase, and reflectance vs. wavelength measurements(Cary 100) to determine the variation of the optical absorption coefficient with wavelength.

Results and discussion

Figure 1 shows that optical transmittance for CdO:Mn films with different percentage of dopant. It's clear that there is a shift in cutoff wavelength to higher wavelength, also we expect that with increase of percent doping transmittance value increase because of width band gap of Mn rather than cadmium oxide,

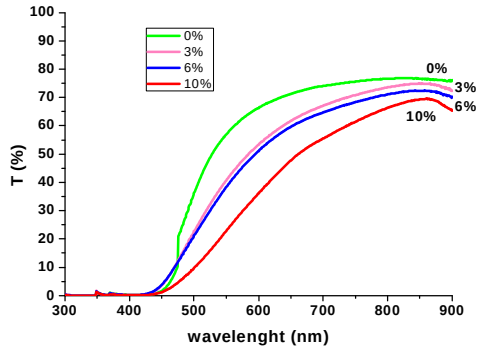


fig1: Transmittance spectra of CdO:Mn films with different percent dopping

but Fig.1 shows a decrease in transmittance that is may be due to damaging lattice structure in substrate temperature of 350 ºC, so after this we obtain optimum substrate temperature for CdO:Mn film at 4% impurity.

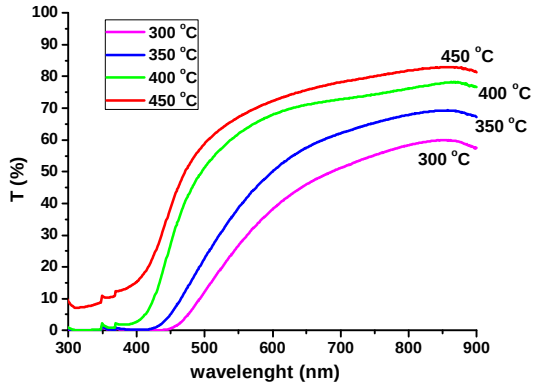
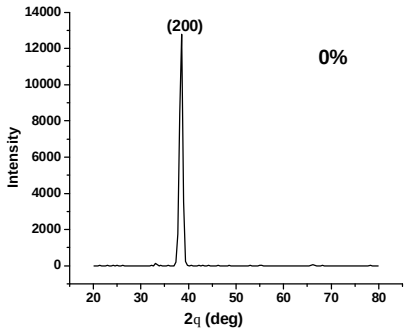
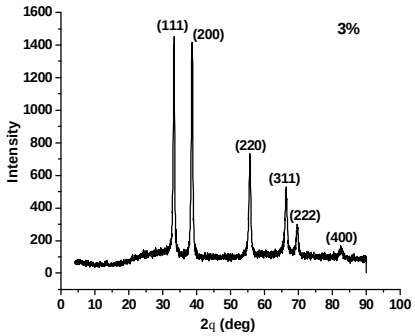


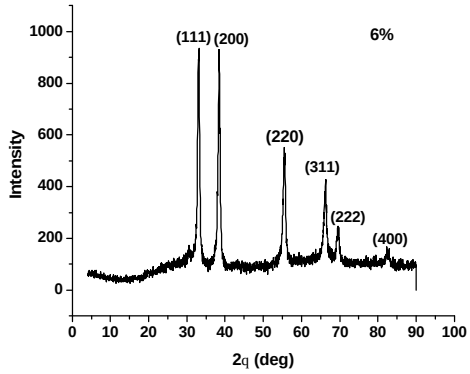
fig2: Transmittance spectra of CdO:Mn films 4% with different substrate temperature

Structural properties:

Figure 3 shows the XRD patterns of CdO:Mn films. There are peaks with different intensity and width showing the polycrystalline nature of the films. The three most intensive peaks belong to the reflections from (220) CdO, (111) CdO and (200) CdO planes. Fig. 1 shows that with adding Mn to CdO films, the (200) peak sharply decrease and the other orientation start to grow.







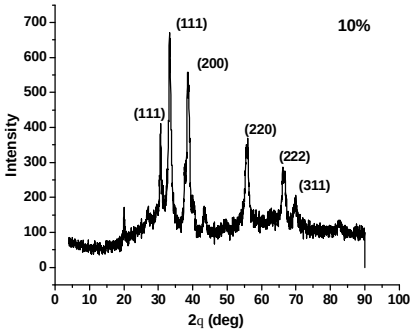


Fig3. XRD patterns of CdO:Mn films

Conclusion:

In this work, we have tried to improve some physical properties of CdO films by Mn doping. Spray pyrolysis technique has been used to obtain the films. Transmission spectra have been taken by UV spectrophotometer, X-ray diffraction patterns have been used to study the structural properties. Grain size and lattice constants have also been determined. Finally, it has been concluded that Mn doped CdO films have improved properties and are good candidates for photovoltaic application.

References

1. B.G. Lewis, D.C. Paine, Mater. Res. Soc. Bull. 25, 22 (2000)
2. H. Kim, C.M. Gilmore, A. Pique, J.S. Horwitz, H. Mattoussi, H. Murata, Z.H. Kafafi, D.B. Chrisey, J. Appl. Phys. 11, 6451 (1999)
3. J.A.A. Selvan, A.E. Delahoy, S. Guo, Y.-M. Li, Sol. Energy Mater. Sol. Cells 90, 3371 (2006)
4. S.M. Rozati, S.J. Mirshoja, M. Habibi, World Renewable Energy Congress *VI*, Brighton, UK, 1-7 ,275-278. (2000)