Chemically Deposited Polycrystalline CdO Thin Films

P. N. Chug, P. R. Padalkar, V. S. Jamadade and C. D. Lokhande*

Solid State Physics & Thin Film Physics Laboratory,

Department of Physics. Shivaji University Kolhapur 416004

Corresponding author Email: l_chandrakant@yahoo.com (Prof C.D. Lokhande)

Abstract. In the present work, CdO thin films have been successfully prepared by chemical deposition and successive ionic layer adsorption & reaction (SILAR) methods on to glass substrates. The structural, optical, electrical and surface wettabilty properties of films were examined. Polycrystalline nature of CdO films has been confirmed by XRD analysis. Optical band gap of 2.1 eV was obtained for CBD and SILAR deposited CdO films. SEM images show porous morphologies for CBD & SILAR deposited films. Wetability studies revealed the hydrophobic surface of CdO thin films with contact angles 130^o and 114^0 for CBD and SILAR methtod, respectively.

Keyword: Thin film, CBD and SILAR, CdO, XRD, Optical, Electrical, Surface wettability.

INTRODUCTION

Thin solid films of CdO have been a subject of interest for many years, mainly because of their gas sensor properties. However, many of their physical properties were found to be depending on the methods and conditions of preparation. A variety of techniques such as electrodeposition, thermal evaporation, spray pyrolysis, chemical vapour deposition (CVD), chemical bath deposition (CBD) and successive ionic layer adsorption and reaction (SILAR) have been used for deposition of CdO thin films.

CBD and SILAR methods have the advantage of being simple, low temperature, inexpensive and invariant for large-area deposition. These methods are extensively used in growing group II–VI semiconductors [1-5]. However, only a few attempts are made to grow CdO thin films using CBD and SILAR methods. In both cases, ammonia has been used as the complexing agent. The XRD, band gap, electrical resistivity and contact angle are studied for as-deposited as well as annealed films.

2. EXPERIMENTAL

2.1 Synthesis of CdO Thin Films

A) CBD method:

Preparation of CdO by chemical bath is based on the alkaline bath of cadmium salt containing the substrates immersed in it. The source of cadmium used was 0.1 M $CdCl_2$, and to make it alkaline, aqueous ammonia was added. Initially, precipitate of $Cd(OH)_2$ occurred which was dissolved after further addition of aqueous ammonia. The pH of the resultant solution was ≈12. The glass microslides were used as substrates. Cleaned substrates were immersed in the above bath and this bath was kept at room temperature for 48 hrs. The depositions are taken for different deposition time.

B) SILAR method:

The SILAR method is used for synthesis of CdO thin films. This method consists of two beaker system. In SILAR method the cationic precursor is maintained at 300K while anionic was maintained at 348K. The aqueous precursor solutions used were 0.1M cadmium acetate $Cd(CH_3COO)_2$ and 1% H_2O_2 with complexing agent ammonia for adjusting the pH as 12 and 5, respectively. The SILAR deposition was carried out with adsorption and reaction time as 20 and 15s, respectively. The numbers of cycles are varied for getting desired film thickness.

3. RESULT AND DISCUSSION

3.1 X-Ray Diffraction Studies

Fig. 1 show the X-ray diffraction patterns of chemically deposited CdO thin films on glass substrates by CBD and SILAR methods. The diffraction peaks are indexed to the cubic phase of CdO.

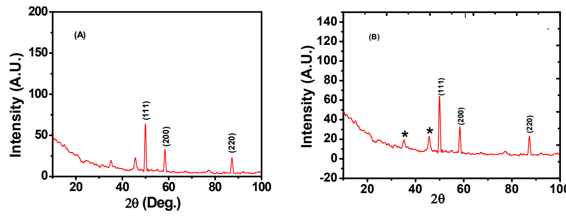

Figure.1 a) CBD method b) SILAR method

CdO films exhibits the orientations along (1 1 1), (2 0 0) and (2 2 0) planes. The XRD peak intensity of (1 1 1) plane was relatively higher than those of other reflections. The absence of impurity peaks suggests the high purity of the CdO. The crystallite size (G) is calculated using equation, [7]

$$G=0.9\lambda/\beta\cos\theta$$

Where, β is the half width of diffraction peak measured in radians. The average crystallite size of 45 for CBD and 44 nm for SILAR are obtained, which clearly supports nanocrystalline nature of the CdO.

3.2 Optical Studies

The variation of optical absorbance (αt) with wavelength λ (nm) of the CdO film is shown in Fig. 2(A, B). These spectrums reveal that CdO film has low absorbance in the visible region. Fig. 2 (A, B) shows the band gaps of 2.1eV and 2.12eV by CBD and SILAR respectively.

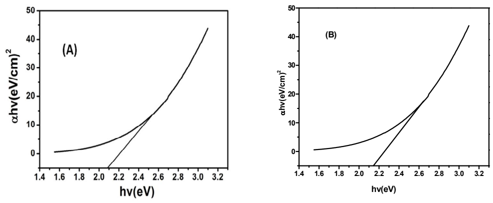

Figure.2 a) CBD method b) SILAR method

3.3 Surface Morphological Studies

Fig. (A, B) shows surface morphologies of CdO thin films deposited using CBD and SILAR method respectively. From the micrograph, it is observed that grain sizes are not of much uniformity. The average grain sizes of the films are found to vary from 48 to 93 nm and are porous in nature.

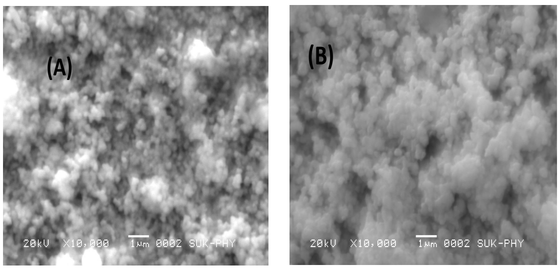

Figure.3 a) CBD method b) SILAR method

3.4 Surface Wettability

Surface water contact angles of CdO thin films are measured which are hydrophobic in nature. Figure.4 (A, B) shows the contact angles of 130^0 for CBD and 114^0 for SILAR method, respectively.

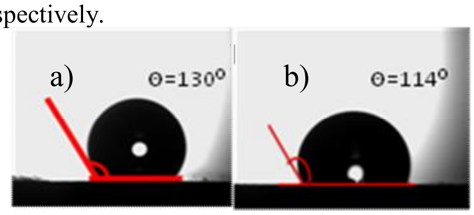

Figure.4. a) CBD method b) SILAR method

CONCLUSIONS

The polycrystalline nature with cubic structure of CBD & SILAR deposited CdO thin films are confirmed by XRD analysis. SEM images show porous morphologies grown on to surface of substrates. From optical studies, direct band gap is found to be 2.1eV for CBD and SILAR deposited films. Surface wettability showed hydrophobic nature of CdO thin films.

REFERENCES

[1] S. H. Park, H. J. Kim, J. Am. Chem. Soc. 126 (2004) 14368.
[2] P. Jeevanandam, Y. Koltypin, A. Gedanken, Nano Lett. 5 (2001) 263.
[3] Y. Ding, G. Zhang, H. Wu, B. Hai, L. Wang, Y. Qian, Chem. Mater. 13 (2001) 435.
[4] T. P. Gujar, V. R. Shinde, W. Y. Kim, K. D. Jung, C. D. Lokhande, O. S. Joo, Appl. Surf. Sci. 254 (2008) 3813.
[5] R. S. Mane, S. H. Han, Electrochem. Commun. 7 (2005) 205.
[7] Benramdane, W. Murad, R. H. Misho, M. Ziane, Z. Kebbab, Mater. Chem. Phys. 48 (1997) 119.