Indian Journal of Science and Technology, *Vol 8(35), DOI: 10.17485/ijst/2015/v8i35/85918, December 2015*
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Effects of Temperature on Structural Properties of Indium Oxide Thin Layers Produced by CBD Method

Kiarash Pooryusef* and Haleh Kangarlou

Department of Physics, Urmia Branch, Islamic Azad University, Urmia, Iran

Abstract

Indium Oxide thin layers were deposited on microscope glass substrates by chemical bath deposition technique from aqueous solutions containing indium chloride and NH_3 at 70 and 90ºC as deposition temperature. Aqueous solution heated for about 45 minutes and kept at 2.5pH. The effects of temperature toward the properties of the thin layers were investigated. The deposited thin layers were characterized with X-ray Diffraction and Scanning Electron Microscopy analysis.

Keywords: Chemical Bath Deposition, Indium Oxide, SEM, Structural Properties, XRD

1. Introduction

Transparent Oxide Semiconductors (TOSs) are currently being explored as Thin Film Transistor (TFT) materials, an enabling technology for then extenuation of computing, communication and identification devices[1,2]. Indium Oxide (In_2O_3) has been investigated extensively for its semiconducting properties. Indium oxide thin films show unique shape and size dependent properties. Various techniques have been used to prepare In_2O_3 thin layers. These include flash evaporation[3], metal organic chemical vapor deposition[4], sputtering[5], chemical vapor transport[6], electro deposition[7] and molecular beam deposition[8,9]. Among various other methods, the chemical bath deposition method is found to be a cheap and simple way to deposit large area polycrystalline metal chalcogenide thin layers.

The aim of this work is to produce Indium Oxide thin layer at different deposition temperature and investigated about their structure and crystalline properties by XRD and SEM analysis.

2. Experimental Details

Indium Oxide layers were formed in many successively deposition steps that always were performed in renewed Chemical Bath (CBD) prepared from Indium chloride, NH_3 and distilled water. The deposition bath was continuously stirred, heated for about 40 minutes. The substrates were immersed into the deposition bath, by vertically suspending them around the stirrer. The solution heated at 70 and 90ºC as deposition temperatures. Deposition parameters were: [Indium chloride] = $3x10^{-3}$M; [NH_3] = $3x10^{-1}$ M; pH = 2.5. All samples were annealed in air, at 250ºC. Crystal and phase structure of the deposited layers were identified using an X-ray X' pert MPD diffractometer (CuKα radiation , λ = 0.15406nm) with step size of 0.03 and count time of 1s per steps. Nano structures were investigated by SEM (No: S-3400, Hitachi, Japan).

3. Results and Discussion

Figure 1 shows XRD pattern of Indium Oxide layers produced by CBD method at 70 and 90ºC as deposition temperatures.The broad background is due to the amorphous glass substrate and also possibly due to the amorphous phase in thin layer. All resultant product displayed the characteristic XRD peaks corresponding to semi amorphous nature of films.

Figure 2 shows Scanning Electron Microscopy of Indium Oxide layers produced at 70 and 90ºC as

**Author for correspondence*

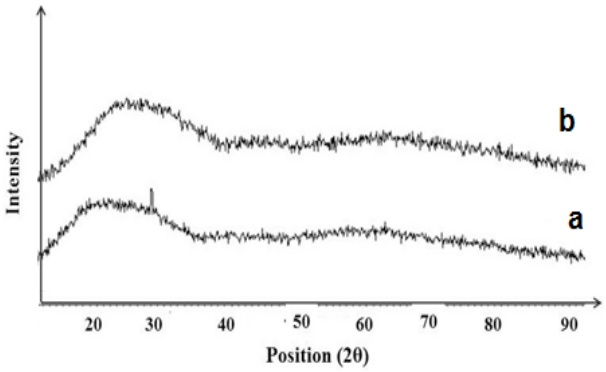

Figure 1. XRD patterns of Indium Oxide layers deposited at different temperatures, a) 70 and b) 90ºC as CBD method.

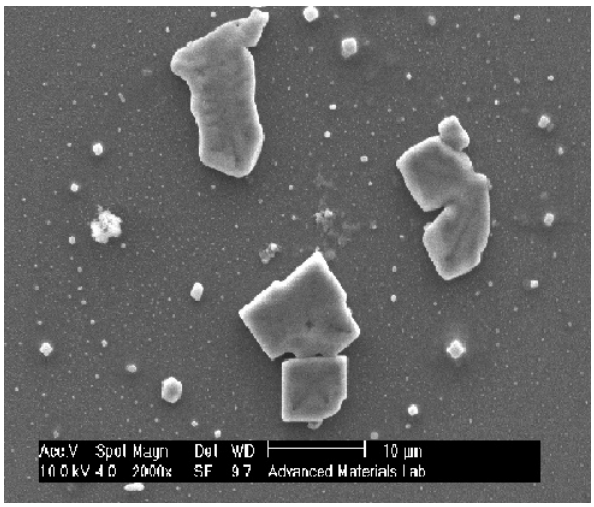

Figure 2(a)

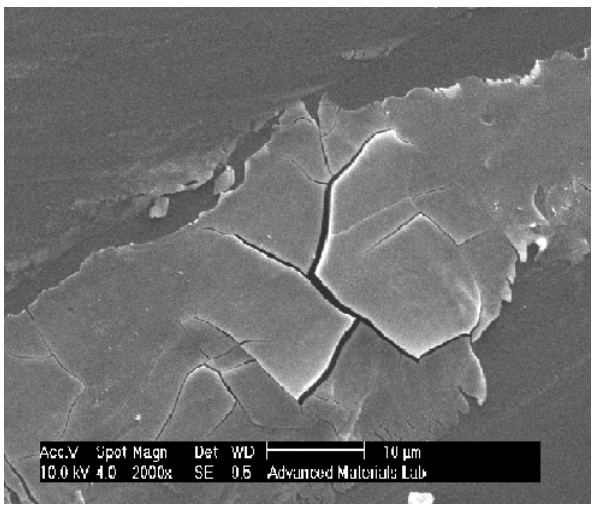

Figure 2(b)

Figure 2. The SEM images of Indium Oxide layers deposited at different temperatures, a) 70 and b) 90ºC by CBD method.

deposition temperatures by CBD method. As it can be seen from Figure 2(a), Indium Oxide grains are produced on glass substrate and nucleation and growth processes happens, also coalescence of grains and clusters along with holes between them configure on substrate. By increasing temperature of deposition to 90ºC, activation energy increases, there for coalescence happens and substrate covers by Indium sulfide grains and because of thermal and mechanical stresses crakes appear on layer (Figure 2(b)).

4. Conclusions

Indium Oxide thin layers were deposited on to amorphous glass substrates by Chemical Bath Deposition technique at 70 and 90ºC as deposition temperatures and other same conditions. XRD results confirm semi amorphous nature of produced layers. By increasing temperature, growth processes happens, also coalescence of grains and clusters along with crakes configure on substrate.

5. References

1. Auer E, Lugstein A, Loffler S, Hyun YJ, Brezna W, Bertagnolli E, Pongratz P. Ultrafast VLS growth of epitaxial β-Ga_2O_3 nanowires. Nanotechnology. 2009; 20(43):434017.
2. Chen PC, Shen GZ, Zhou CW. Chemical sensors and electronic noses based on 1-D metal oxide nanostructures. IEEE T. Nanotechnology. 2008 Nov; 7(6):668–82.
3. Curreli M, Zhang R, Ishikawa FN, Chang HK, Cote RJ, Zhou C, Thompson ME. Real-time, label-free detection of biological entities using nanowire-based FETs. IEEE. Nanotechnology. 2008 Nov; 7(6):651–67.
4. Huang MH, Mao S, Feick H, Yan HQ, Wu YY, Kind H, Weber E, Russo R, Yang PD. Room-temperature ultraviolet nanowire nanolasers. Science. 2001 Jun; 292(5523):1897–9.
5. Ruda HE, Polanyi JC, Yang JSY, Wu Z, Philipose U, Xu T, Yang S, Kavanagh KL, Liu JQ, Yang L, Wang Y, Robbie K, Yang J, Kaminska K, Cooke DG, Hegmann FA, Budz AJ, Haugen HK. Developing 1D nanostructure arrays for future nanophotonics. Nanoscale Research Letters. 2006; 1(2):99–119.
6. Huang CT, Hsin CL, Huang KW, Lee CY, Yeh PH, Chen US, Chen LJ. Er-doped silicon nanowires with 1.54 um light-emitting and enhanced electrical and field emission properties. Applied Physics Letters. 2007; 91(9):093133.
7. Wagner RS, Ellis WC. Vapor-liquid-solid mechanism of single crystal growth. Applied Physics Letters. 1964; 4(5):89–90.

8. Barzegar A, Mortazavi B, Asilian H, Kazemian H. Catalytic degradation of toluene by manganese oxide catalyst loaded on a natural zeolite support. Scientific Journal of Review. 2014; 3(5):345–52. Doi:10.14196/sjr.v3i5.1445

9. Jahanshir A. Philosophy of particles in super quantum structure. Scientific Journal of Pure and Applied Sciences. 2012; 1(1):40–5. Doi:10.14196/sjpas.v1i1.236.