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Effect of Annealing on Structural Properties of In_2S_3 thin Film Prepared by PVD Method

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ABSTRACT

Indium Sulfide thin layers were produced by physical vapor deposition method on glass substrates at70ºC and high vacuum condition and almost vertical deposition angle. Then produced layers were annealed at 400 ºC in presence of hydrogen gas. Crystalline structure were investigated by XRD and SEM analysis. By annealing process clusters produced and Columnar crystals configure on surface. Also crystal structure changes from tetragonal to cubic in presents of annealing process.

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INTRODUCTION

In_2S_3 is an *n*-type semiconductor that belongs to the III–VI group of compounds. Depending upon synthesis temperature and pressure, it exists in three crystallographic phases such as α, β, and [2]. Among these phases, β-In_2S_3 is the most stable phase at room temperature. Amorphous In_2S_3 films on glass substrates have also been obtained by had been used to prepare this compound in thin film form such as organometallic chemical vapor deposition [6], physical vapor deposition (PVD) [1], thermal evaporation [5] and rf sputtering [4]. The aim of this work is to produced In thin layer in different deposition temperature and investigated about their structure and crystalline properties by SEM and XRD analysis. The aim of this work is to produced In_2S_3 thin layer by PVD method and anneal produced layer at 400 ºC in presence of hydrogen gas and investigated about their structure and crystalline properties by SEM and XRD analysis.

Experimental part:

Indium sulphide layers were deposited on glass substrates (18*18*1 mm, cut from microscope slide) by using resistive evaporation method, from tungsten boats, at 70ºC temperature. The evaporation material was In_2S_3 powder with 90% purity. An ETS 160 (vacuum evaporation system) coating plant with a base pressure of 10^{-5} mbar was used. Prior to deposition, glass substrates were ultrasonically cleaned in heated acetone first and then in ethanol. The substrate holder was a disk of 36.5 cm in diameter with adjustable height up to 45cm and also adjustable holders for placing and kind of substrates, deposition angle was almost vertical. The structure of this films were studied by using a Philips XRD analysis and morphology was studied by SEM analysis.

RESULTS AND DISCUSSIONS

In_2S_3thin layers were produced by physical vapor deposition method on glass substrates at 70 ºC.

Figure 1 shows the scanning electron microscopy of In_2S_3/glass thin layer produced by PVD method at 70ºC and high vacuum condition and almost vertical deposition angle. As it can be seen surface is full of tiny In_2S_3 grains with voids between them that is in agreement with zone I of structural zone model[6]. Figure 2

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shows shows the scanning electron microscopy of In_2S_3/glass thin layer thin layer annealed at 400ºC in presence of hydrogen gas. As it can be seen grains coalescences and clusters of indium sulphide produced. Columnar crystals configure on surface that is in agreement with zone II of SZM, also $\frac{T_s}{T_m} > 0.3$ that is a reason for zone II, that is in agreement with our results in figure 2.

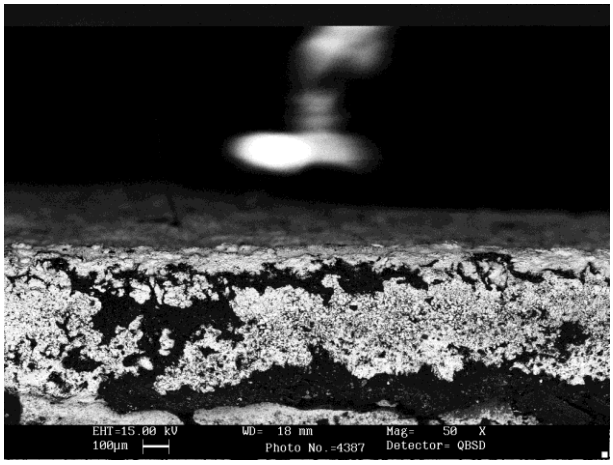

Fig. 1: Scanning electron microscopy of In_2S_3/glass thin layer produced by PVD method.

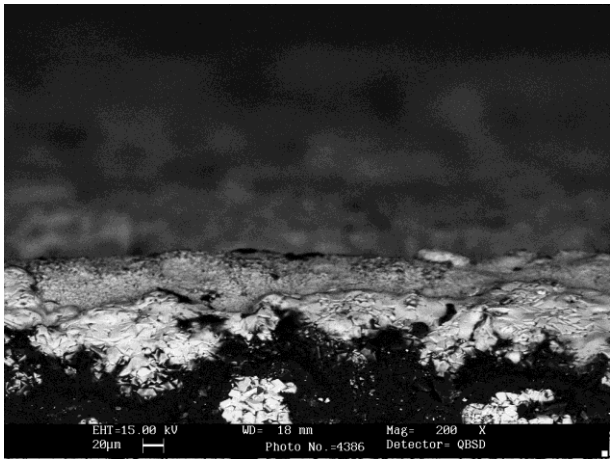

Fig. 2: Scanning electron microscopy of In_2S_3/glass thin layer thin layer annealed at 400ºC in presence of hydrogen gas.

Figure 3 shows the XRD pattern of In_2S_3/glass thin layer thin layer produced by PVD method at 70ºC and high vacuum condition and almost vertical deposition angle. As it can be seen there is only a small peak corresponding to (103) reflection observed in films, which is correspondence to tetragonal structure. The (311) reflection as preferred orientation which depends to cubic crystallite can be seen in In_2S_3/glass thin after annealing at 400ºC in presence of hydrogen gas (fig3b).

Conclusions:

In_2S_3 thin films were produced by physical vapor deposition method on glass substrates at 70ºC and high vacuum condition and almost vertical deposition angle. Then deposited layer were annealed at 400 ºC in presence of hydrogen gas. Crystalline structure was investigated by XRD and SEM analysis. By annealing layers at 400 ºC In_2S_3 grains coalescences and clusters of indium sulphide produced. Columnar crystals configure on surface. Annealed layer exists in two crystallographic phases of ' α and β corresponding to cubic and tetragonal structure.

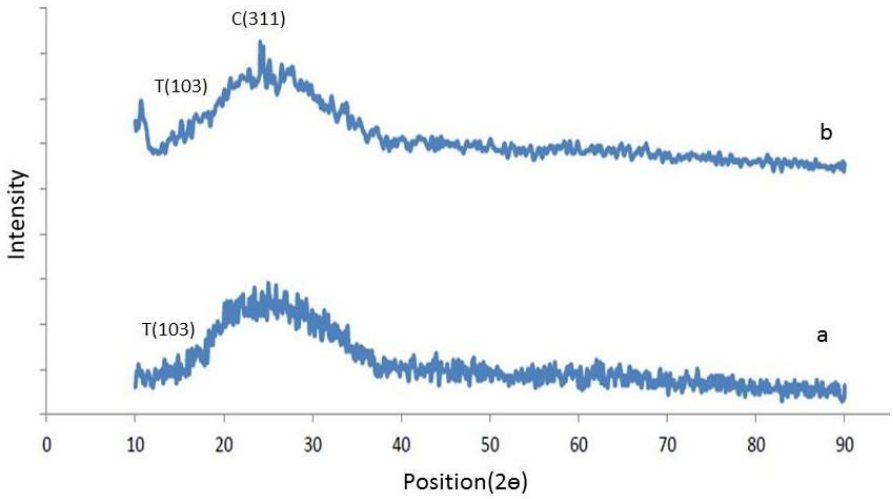

Fig. 3: XRD pattern of In_2S_3 films produced by PVD method a) as-deposited, b) annealed at 400 ºC.

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