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Synthesis and Structural Characterisation of Zinc Oxide thin Layers Deposited by Chemical Bath Deposition

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ABSTRACT

Zinc Oxide thin films were produced by chemical bath deposition method. Aqueous solution temperature for synthesis was about 85ºC and kept at pH=9 and substrates were glasses. Crystalline structure were investigated by XRD and SEM analysis. By increasing times of deposition ZnO grains and clusters produced and layers got more crystalline.

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INTRODUCTION

Thin films are very important materials in microelectronics, optoelectronics and several other technologically important fields. ZnO, one of the most important metal oxides, has a wide band gap of 3.37 eV and a high exaction binding energy of 60 meV at room temperature[3]. Zinc oxide is widely used in solar cells, sensors, field effect transistors, light emitting diodes and others. Development in the zinc oxide area recently moving towards nanostructures. The most promising of them are one dimensional (1-D) nanostructures such as nanotubes, Nano ribons [2], nanowires [4], Nano belts , Nano cables and Nano rods [6]. Zinc oxide can be made using the Chemical Bath Deposition (CBD) [5] CBD is a simpler method and less expensive than its predecessor with some methods such as Chemical Vapor Deposition (CVD)[1], one-step soft solution, spray pyrolysis[7], and anodization. CBD method is done by simply immersing the substrate into a solution of "aqueous metal salt" which are controlled by temperature condition, pH and duration of immersion. In this paper we have deposited good quality ZnO thin films by the CBD method. The aim of this work is to produced ZnO thin layer in one, two and three times deposition and investigated about their structure and crystalline properties by SEM and XRD analysis.

Experimental part:

The details of the procedure are: appropriate amounts of zinc chloride ZnCl2 solution and ammonia solution (NH4OH) were separately prepared. Formed mixture is thoroughly stirring for several minutes in order to dissolve the formed precipitate and solution to become homogeneous. Then in obtaining solution was added distilled water. These solutions were mixed in a beaker and stirred well for a few minutes. The deposition bath was continuously stirred and heated at 85ºC for 50 minutes. The substrates were immersed into the deposition bath, by vertically suspending them around the stirrer. The substrates were taken out after 1, 2 and 3 time run deposition. Deposition parameters were: [zinc chloride] = $3x10^{-3}$M; [NH_3] = $3x10^{-1}$ M; pH = 9; All samples were annealed in air, at 400ºC. Zinc Oxide thin films were characterised by SEM, crystalline structure and XRD analysis.

RESULTS AND DISCUSSION

ZnO thin layer produced by CBD method, in one, two and three times deposition:

Figure 1-3 shows production of ZnO/glass thin film at 85 ºC by CBD method for one, two and three times depositions, respectively. As it can be seen from figure1, nucleation proses happens and hexagonal ZnO grains grow on substrate. By increasing deposition run to two times in figure2, more hexagonal ZnO grains along ZnO

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clusters and voids between them on surface, actually growth appear on layer. In figure 3, after 3 times deposition of ZnO grains, surface is full of ZnO hexagonal clusters and of course we are encountered with on layer, and as it can be seen fraction of voids decreases.

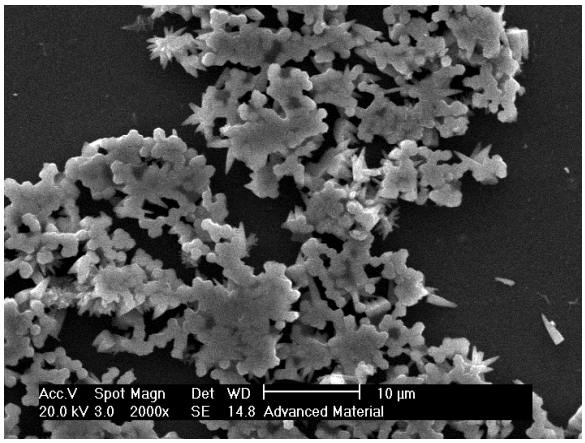

Fig. 1: Scanning electron microscopy of one time deposition ZnO/glass thin film by CBD method.

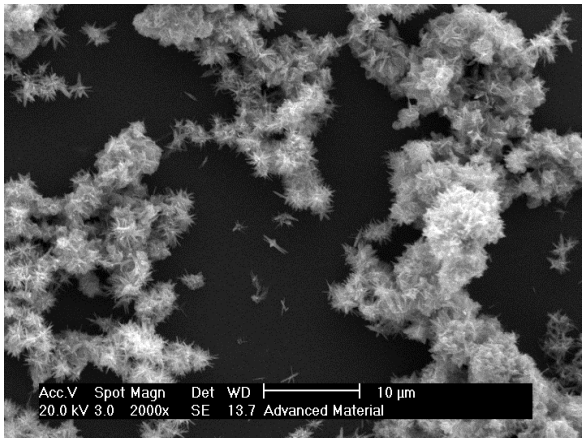

Fig. 2: Scanning electron microscopy of two times deposition ZnO/glass thin film by CBD method.

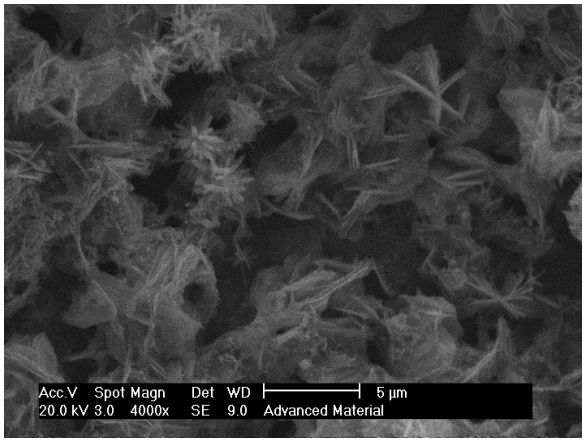

Fig. 3: Scanning electron microscopy of three time deposition ZnO/glass thin film by CBD method.

Figure 4 shows the XRD pattern of ZnO thin layers produced by CBD method a) one time deposited, b)two times deposited and c) three times deposited films. From the presence of diffraction peaks produced by the films, we can be seen that in one time deposition layer, the preferred orientation of the film is the (002) (fig3a). In figure 4b, which is corresponding by two times deposition, intensity of (002) peak decreases and other peaks

appeared. When films produced by three times deposition, the preferred orientation of the films are (101) , as can be seen in fig3c. Actually by increasing deposition rounds ZnO layers get more crystalline.

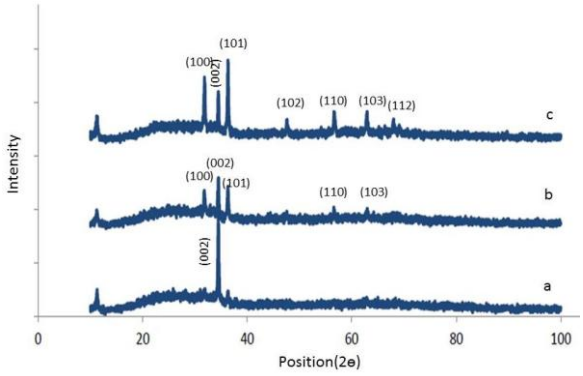

Fig. 4: XRD pattern of ZnO thin layers produced by CBD method one time deposited, b)two times deposited and c) three times deposited films.

Conclusions:

ZnO thin layer produced by CBD method, in one, two and three times deposition.

Crystalline structure were investigated by XRD and SEM analysis.By increasing the times of deposition, layers get completed and more clusters of ZnO appear that tends to more crystallization of layers with several preferred orientation peaks.

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