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Producing and Investigating Structural Properties of the Semiconductor Multi-Layer of Zinc Sulfide on Magnesium Fluoride on Glass

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ABSTRACT

Background: Thin-film technology is rapidly developing today. They are used to improve the surface properties of thin films. Usefulness of the properties of thin layers and interesting study on the behavior of two-dimensional solid led to the special interest both in science and in technology of thin films Atomic Force Microscopy (AFM) and X-Ray diffraction (XRD) are two effective methods, for obtaining nano structures of nano layers and nano particles. Also by AFM method we can calculate roughness, image profile, image voltage profile and phase images. XRD method also can obtain crystallographic of produced layers and nano particles and Miler indices. There for these two analysis along with each other can determine the properties of productions. For example electric conductivity, height of grains, homogeneous and heterogeneous productions. **Objective:** To investigate about structural properties of ZnS/MgF_2/glass multi layers at room temperature, a physical vapor deposition method (heat evaporation) as ETS160 coating planet were used to produce semiconducting multi layers on glass substrates. The thickness of multi layer is about 170 nm. **Results:** Two and three dimensional AFM images of ZnS/ MgF_2/glass under HV conditions at room temperature were obtained. Two and tree phase images of produced multi layer were obtained. Image profiles and image voltage profiles also XRD patterns were obtained. **Conclusion:** AFM images show that Surface is full of seeds with dome-like tips and a combination of two materials of ZnS and MgF_2 Black spaces is well seen. XRD diagram is very noisy that it was due to the used substrate of amorphous (glass) in the experiment.

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INTRODUCTION

Today's thin-film technology is very broadly developed and making the nano thin film has gone toward nano development. Applications are numerous and include the use of thin films for electronic, optical, metallurgical, tri biological, medical and etc (Franco *et al.,* 2008). Initial start-up costs are often high in these systems due to its particular technology, but if we set up a system of mass production we will see high economy(Murugadoss*et al.,* 2010).The use of thin films increases the longevity of materials and improves their performance. Some of the features including a thin layer are its good optical transmission, low absorption, durable refraction, high density, low dispersion, low pressure, a reasonable thickness, surface tension, good chemical stability, environmental resistance (Xiang *et al.,* 1998). Semiconductor 'layers have been used in this article are one of the most widely used layers in the industry. Intrinsic semiconductors are structurally similar to the semiconductor at very low temperatures (Jesse*et al.,* 2010).With the addition of the semiconductor gross, a new state is created within the energy band gap(Akbarzadeh, A., 2010). If the giver atoms are added to a semiconductor, it is n-type semiconductor and if acceptor atoms are added, it is p-type semiconductor. A special characteristic of multi layers is rising semiconductor band gap with decreasing particle size.

Sulfides are the sulfur compounds including di-anion sulfur, which may be a salt, ester, hydrogen sulfide or they exist directly from reacting sulfur and metal (Bilberq*et al.,* 2010).Sulfides are alkaline in nature that converted to HS- which this compound converted to hydrogen sulfide in the acidic PH. Many semiconductor compounds also have diamond network which in that network, the atoms are different that in this case the network is known as zinc sulfide Network (ZnS) (Balaraju J.N.&,Rajam K.S., 2007). Zinc sulfide network is III-V compounds samples.

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Magnesium fluoride is an inorganic compound with the formula MgF_2.The compound is white crystalline salt composition over a wide range of wavelengths, using commercial materials that are also used in space telescopes (Bilberq*et al.,* 2010). It occurs naturally as the rare mineral Celabit. Magnesium fluoride has been prepared from oxidant magnesium with hydrogen fluoride sources such as ammonium bi fluoride (Balaraju J.N.&,Rajam K.S., 2007).

Preparing multi layers in this study is an entirely new subject that similar to it has not been done so far. But in the previous studies, multi layers have been created with the materials similar to this article but with different methods of deposition that medical research, pharmaceutical, mechanical or electronically, and optical properties, and so on has been done over them. However, the arrangement and order of the layers is not like this article.

MATERIALS AND METHODS

To make all layers of the study physical thermal evaporation technique (PVD) and the evaporation resistance were selected. Sub layers were selected from glass substrates (slide test). The reason for this choice is the availability and cost of glass in order it will be easy to replicate the experiment due to the above-mentioned reasons.

Plant needed to replace the springs on zinc sulfide was selected Tungsten plant and for magnesium, Molybdenum plant. Both zinc sulfide and magnesium fluoride springs are the white powder. Vertical deposition angle for all layers was considered in ideal conditions. Deposition temperature of 100 degrees Celsius for the accumulation of zinc sulfide and for magnesium room temperature (28° C) was selected. Initially the layers of ZnS and MgF_2 were individually made on a glass substrate and their thickness were determined by Krystal quartz thickness gauge 90 nm and 80 nm respectively and then the layers of zinc sulfide on magnesium fluoride on a substrate of glass with the same deposition conditions were prepared and the overall thickness of 170 nm was determined. Maximum attempt is done that the test conditions be the same for all samples. Then advanced laboratory tech and nano-level technology used to determine the structural properties of layers. Advanced atomic force microscopy (AFM), X-Ray diffraction (XRD) have been fully examined.

RESULTS AND DISCUSSION

Figure 1(a) shows two-dimensional image of atomic force microscopy for the sample ZnS / glass. Average thickness is 9.66 nm. Dimensions of measurement are 2µm * 2µm. Surface is full of high levels of fine-grain ZnS and black spaces between the grains are clear.

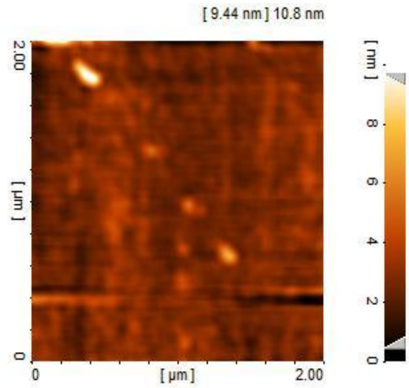

Fig. 1(a): Two-dimensional image of AFM in ZnS / glass.

Figure 2(a) shows three-dimensional image of atomic force microscopy for the sample ZnS/ glass. Dimensions of measurement are 2µm * 2µm from the same area of Figure 1 (a). In this Figure seeds and empty spaces are clearly visible.

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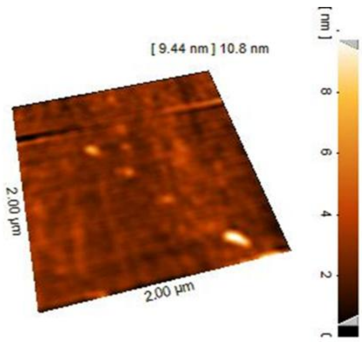

Fig. 2(a): Three-dimensional image of AFM in ZnS / glass.

Figure 3(a) shows two-dimensional phase in layer ZnS / glass with a thickness of 90 nm in size 2µm * 2µm. As you can see the surface is in the three colors that it is due to the impurity of layer.

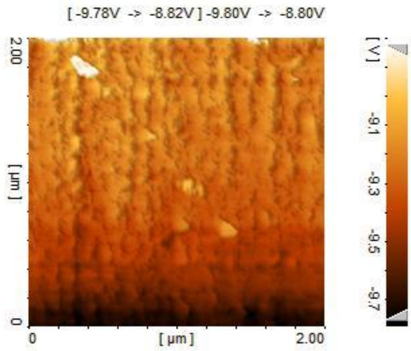

Fig. 3(a): Two-dimensional phase in ZnS / glass.

Figure 4(a) shows three-dimensional phase for layer ZnS / glass with a thickness of 90 nm in size 2µm * 2µm. Rhomboid-shaped spaces between the grains are markedly visible.

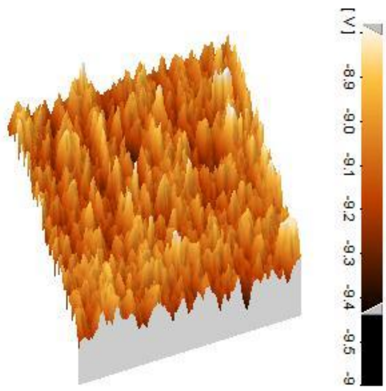

Fig. 4(a): Three-dimensional phase inZnS/glass.

Figure 5(a) shows two-dimensional phase for layer ZnS / glass with a thickness of 90 nm in size 2µm * 2µm. As it is visible, an area with pink arrow is determined that it is for distinguishing the voltage in the determined grains.

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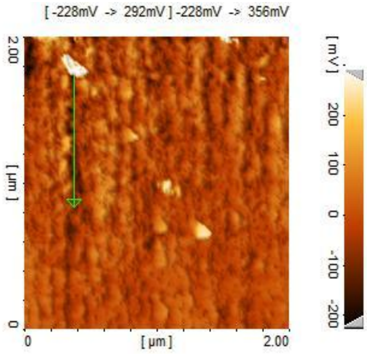
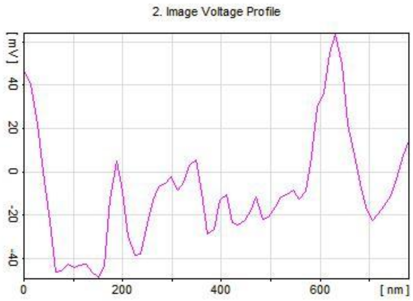


Fig 5a: Two-dimensional phase in ZnS / glass.

Graph 1(a) shows the profiles of marked grains in Figure 5 . Voltage in the determined area is the same. In the clustering areas voltage has a visible increase and this voltage increased even 6.5 microvolt.



Graph 1(a): The profiles of marked grains in Figure 5.

The above steps repeated for MgF_2/glass.

Figure 1 (b) shows two-dimensional image of atomic force microscopy for the sample MgF_2/ glass with the thickness of 80 nm with dimensions of 5µm*5µm. Average thickness is 9.27 nm. As it is clear surface is full of high levels of fine-grain $MgF_2$and black spaces between the grains.

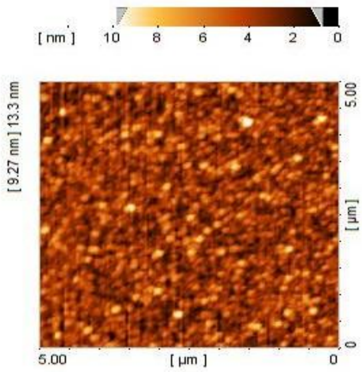


Fig. 1(b): Two-dimensional image of AFM in MgF_2/ glass.

Figure 2 (b) shows three-dimensional image of atomic force microscopy for the sample MgF_2 / glass with the thickness of 80 nm with dimensions of 5µm*5µm. Small grains with dome-like tips and empty spaces among them are visible.

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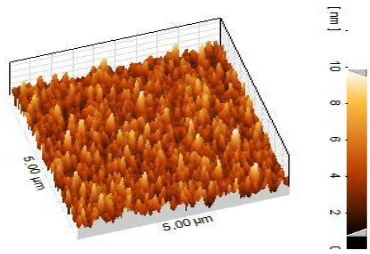


Fig. 2(b): Three-dimensional image of AFM in MgF_2 / glass.

Figure 3 (b) shows two-dimensional phase in layer Mgf_2/ glass with a thickness of 80 nm in size 5µm * 5µm. Differences in colors are due to the impurity of layer.

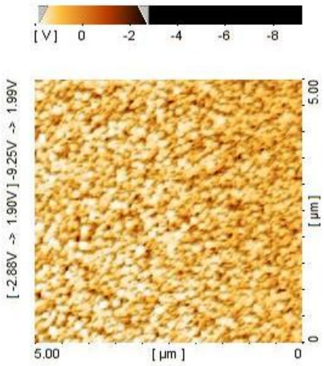


Fig. 3(b): Two-dimensional phase in layer Mgf_2/ glass.

Figure 4 (b) shows three-dimensional phase for layer Mgf_2/ glass with a thickness of 80 nm in size 5µm * 5µm. The grains are markedly visible.

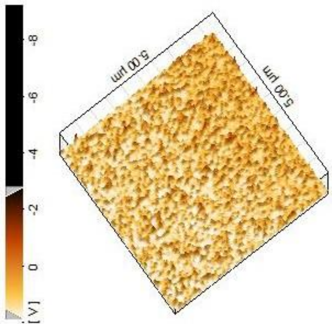


Fig. 4(b): Three-dimensional phase in Mgf_2/ glass.

Figure 5 (b) shows two-dimensional phase for layer Mgf_2/ glass with a thickness of 80 nm in size 5µm * 5µm. As it is visible, an area with pink arrow is determined that it is for distinguishing the voltage in the determined grains.

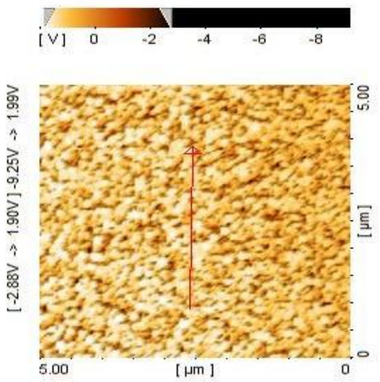
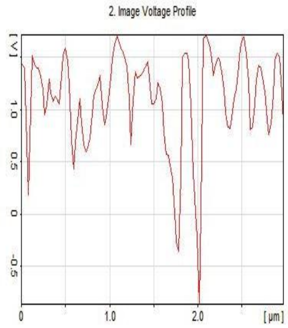


Fig. 5(b): Two-dimensional phase in Mgf_2/ glass.

Graph (1) (b) shows the profiles of marked grains in Figure 5 (b). As it is clear voltage alarming with same frequency. In general this layer showed low conduction that regarding its energy (about 12eV in balk manner) is completely natural.



Graph 1(b): The profiles of marked grains in Figure 5 (b).

Finally the same phases repeated for ZnS / MgF_2/glass. At the final phase X-ray diagrams were drawn for samples ZnS/glass,MgF_2/glass, ZnS/ MgF_2/glass.

Figure 1 (c) shows atomic force microscopy image of the sample ZnS / MgF_2/glass in two dimensions. Average thickness is obtained 5.36 nm.

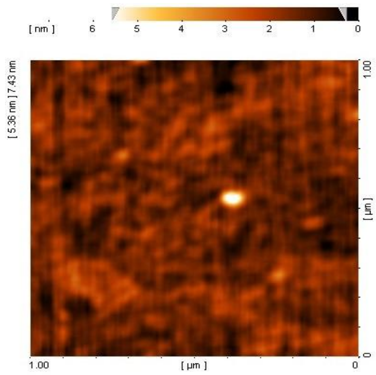


Fig. 1(c): AFM image in ZnS / MgF_2/glass.

Figure 2 (c) shows three-dimensional atomic force microscopy image of the sample ZnS / MgF_2/glass with the thickness of 170 nm. Surface is full of seeds with dome-like tips and a combination of two materials of ZnS and MgF_2 Black spaces is well seen.

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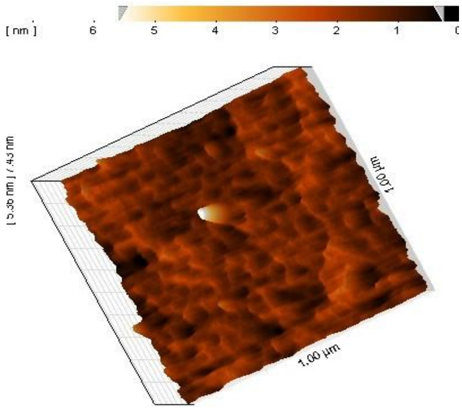


Fig. 2(c): Three-dimensional AFM image inZns / MgF_2/glass.

Figure 3 (c) shows two-dimensional image of atomic force microscopy of sample ZnS/MgF_2/ glass with three marked areas and thickness of 170 nm.

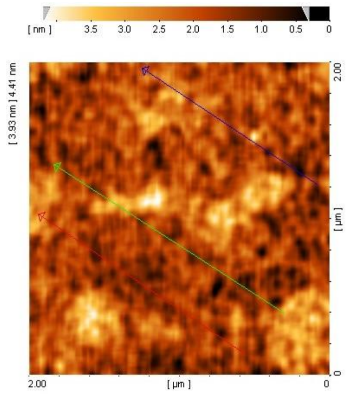
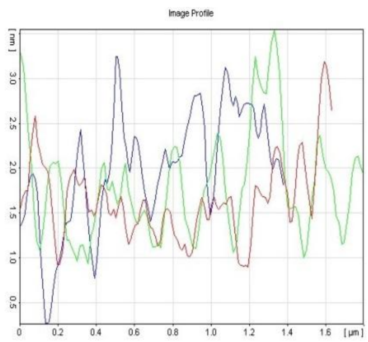


Fig. 3(c): Two-dimensional image of AFM inZnS/MgF_2/ glass.

Graph (1) (c)shows profiles of marked grains in Figure 3 (c) for three determined arrows. The height changes from 49 nm to 67.3 nm.



Graph 1(c): The profiles of marked grains in Figure 3 (c).

Figures a, b, c show X-ray diffraction diagrams for samples of ZnS / glass and MgF_2/glass and ZnS/MgF_2/glass. Considering that the thickness of all layers and accumulation temperature have shown themselves in the form of amorphous, there is no specific structural peaks, broad peaks in the range of 20 to 30 degrees is due to the glass structure and the reason for being noisy is because of amorphous substrate (glass) used in the experiment.

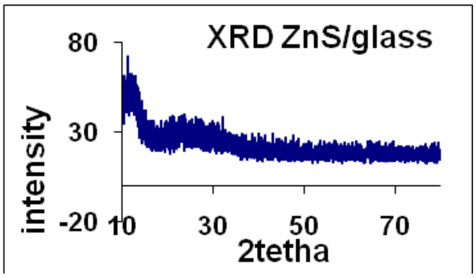


Fig. a: XRD diagram in ZnS / glass.

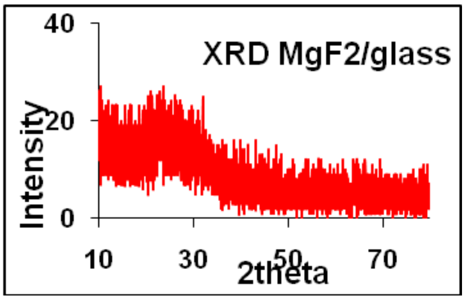


Fig. b: XRD diagram in MgF_2 / glass.

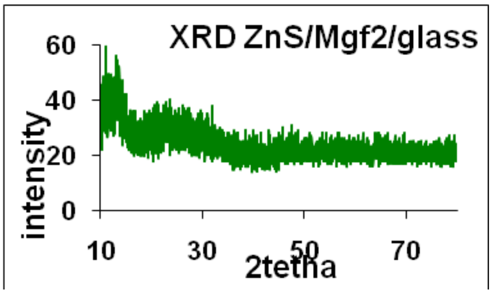


Fig. c: XRD diagram in ZnS/ MgF_2 / glass, multi layer.

Conclusion:

The four layers ZnS / MgF_2/glass were constructed on glass substrates using (ETS160) under high vacuum conditions at room temperature with vertical angle by physical thermal evaporation method. Nano four- layers' thickness was determined by a quartz crystal device. Thickness of 170 nm was obtained for multi-layers. To examine the structure of a multi-layer, analysis of atomic force microscopy (AFM), X-ray diffraction (XRD) have been obtained respectively.

Voltage curve for ZnS / glass is almost equal. Voltage is increasing in spikes areas and this pick of voltage has been increased to 6.5 microvolt.

In general, MgF_2/glass showed very little conduction that due to material's energy (about 12eV in bulk mood) it is quite natural.The surface of multilayer ZnS / MgF_2/glass is full of seeds with the dome tip which is a combination of two materials of ZnS and MgF_2 and empty black spaces is clearly seen.

XRD diagrams are very noisy that it was due to the used substrate of amorphous (glass) in the experiment.

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