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Nano structural and optical properties of four-phase multi layer ZnS/TiO_2/glass

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Abstract: Zns/ Tio_2 /glass multilayer in high vacuum condition and vertical accumulation angle has been determined prepared by resistance evaporated method with 50.3 nm thickness for Tio_2 layer and 71.2 nm thickness for ZnS layer. Accumulated temperature of $Tio_2\ layer\ was\ 28°c\ but\ for$ Zns layer Accumulated temperature was100°c. The Atomic Force Microscopy (AFM), optical Spectroscopy and XRD analyses are perfectly accomplished for this multilayer. It has tried that the results of this research have a positive effect on nuclear energy.

Key words: AFM; XRD; spectrophotometer; nanostructure

INTRODUCTION

Titanium - dioxide injection has been developed as new environmental mitigation technology for BWRS. It utilizes a photoelectrical effect of irradiated Tio_2 to reduce ECP in the reactor water. Micro particles of Tio_2 are injected in to the reactor water to form a deposit on the surface of reactor internals ad recirculation piping. Cherenkov radiation in the reactor core region is the light source for photo –excitation of Tio_2. Thus, Tio_2 injection is thought to be an effective mitigation technique for reactor internals and vessel penetrations without any hydrogen addition. (Bloss, W.H., *et al.*, 1988; GOLD, R.E.,)

The addition of soluble zinc additives to PWR primary coolant leads to incorporation of zinc in the nickel substituted ferrite films and inner chromite layers that form on nickel based alloys exposed to primary water. The main goals of using zinc injection are: 1) reduction in plant radiation fields 2) mitigation of PWSCC. Initial studies indicated that zinc injection into primary water was successful in delaying PWSCC initiation and that the effect is related to the zinc injection concentration. Subsequent analysis has indicated that the effectiveness of zinc injection as a PWSCC inhibition agent is related to the integrated quantity of zinc that ends up in the corrosion films of PWSCC susceptible nickel based alloys and welds. The amount of zinc in the films is related to the average zinc concentration present in the coolant and the time present. As such, the integrated zinc concentration, as defined by the “PPB-mo” integrated exposure, is thought to be a good indication of the effectiveness of zinc for infiltrating the corrosion product film. (OKAMURA M., *et al.*,)

ZnS is an important II-VI group semiconductor material with a direct band gap between 3.4 to 3.70 ev depending up on composition. It is potentially important material to be used as an antireflection coating for hetero junction solar cells. (Chemistry of Nuclear Reactor Systems 2006)

It is an important device material for the detection , emission and modulation of visible and near ultra violet light. (Joji, I., *et al.*, 2008; Marquerdt, E., *et al.*, 1994)

In particular, zinc sulfide (zns) is believed to be one of the most promising materials for blue light emitting laser diodes, and thin film electroluminescent displays. (Hirabayashi, K., H. Koza, 1986)

Nano structural materials have attracted a great deal of attention in the last few years for their unique characteristics that cannot be obtained from conventional macroscopic materials .Owing to quantum size effects and surface effects , nano particles can display novel optical , electronic, chemical, magnetic and structural properties that might find many important technological applications.(Juotip, *et al.*, 2008).

Extensive investigation of Tio_2 thin films are caused by actual perspectives of their applications in photo catalytical and biomedical materials due to a complex of their important properties such as high dielectric constant , photo catalytical activity , bioactivity (Nicolau, Y.F., *et al.*, 1990; Heinrichs, J., *et al.*, 2008)

Titanium dioxide (Tio_2) is a well known material and it’s used in pigments, solar cells and sunscreens.

Oil and gas. Which are at present the main sources of energy, will eventually exhaust after sometime, necessitating the search for newer energy resources .Nowadays we can use of Nuclear energy.

Experimental:

First we wash glass substratum whose quality is laboratory lamina by distilled water and washer material then clean it in a supersonic bath by acetone for 15 minutes and then by pure alcohol for 15 minutes . For the purpose of forming Tio_2 layer, we pure the white powder of Tio_2 in a boat whose quality is tungsten and then install it in a required place. We locate substratum vertically on the top of the boat and in a space of 45 cm of boat on the top of the holder, then block the container and reach vacuum (emptiness) ($10^{-3}tor$) by rotary pump, and then we reach a higher vacuum about ($10^{-6}tor$) by turbo molecular pump. Now Tio_2 powder starts

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evaporating and complete memento layer near 50.3 nm, for the purpose of making Zns/ Tio_2 / glass multilayer, we put the white powder of zinc sulfide in a boat whose quality is molybdenum and install it in a required place and we use Tio_2 /glass substratum and once more install it by holder in a space of 45 cm of boat in a required place. Now we close the container and do the vacuum process to reach a higher vacuum and increase container temperature to 100 °c by heater. Now the evaporation of ZnS starts in which the thickness of stored Zinc Sulfide is 71.2 nm and the final thickness of built multilayer in the procedure is about 121.5 nm which is determined by crystal quartz device. AFM and XRD analysis were used for determination of nano structure and crystallographic direction of multi layer. Spectrophotometer device were used in visible light wave length range to obtain optical reflectivity.

The aim of this work is to produced 4 phase multilayer's, and investigate about optical and structural properties of these layers and their communication.

RESULT AND DISCUSSION

The Atomic Force Microscopy (AFM), spectrophotometer and XRD analyses are perfectly accomplished for this multilayer and the results are mentioned in detail.

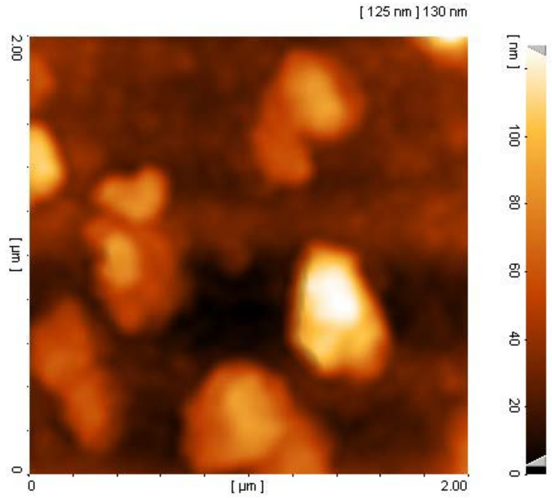

Fig. 1: in this article, the microscopic image shows atomic power of built Zns/glass multilayer. This multilayer high vacuum condition and vertical accumulation angle has been determined by crystal quartz device in 50.3 nm thickness for Tio_2 layer and in 71.2 nm thickness for Zns layer.

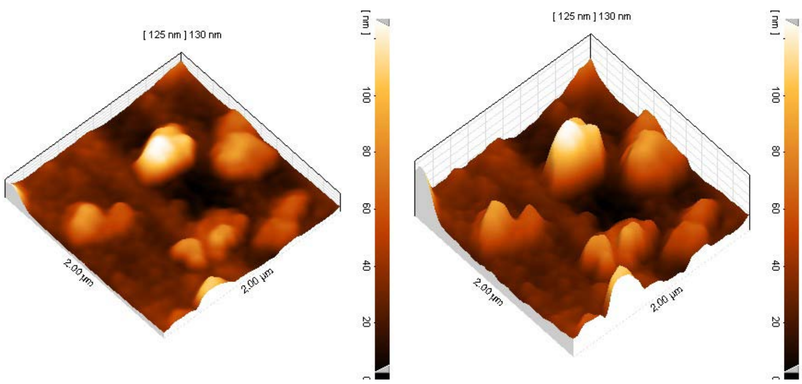

Fig 2.a Fig 2.b

Fig. 2.a: shows AFM tow dimensional image of Zns/ Tio_2 /glass multilayer in two different areas of the built model (prototype) in 2µm×2µm dimensions as it is shown, the surface is full of conjoint clusters and empty space is completely visible.

Fig. 2.b: shows AFM three dimensional image of Zns/ Tio_2 /glass multilayer in two different areas of the built model (prototype) in 2µm×2µm dimensions. This image shows the movement of domed peak units as a result of the presence of temperature and linking, and combining of pieces and forming tooth ilk clusters. The black holes are visible on the image.

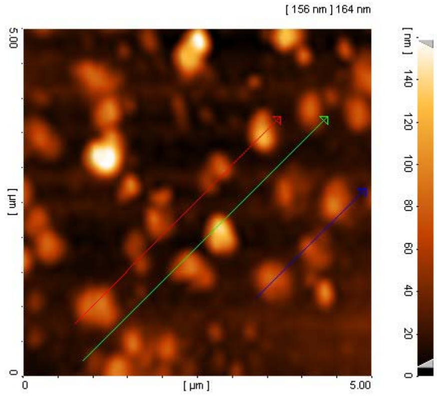

Fig. 3: shows image profile of ZnS/ Tio_2 /glass built multilayer in these article 1n three areas of ZnS/ Tio_2 /glass built models adjacent masses are determined by blue, red and green pointers.

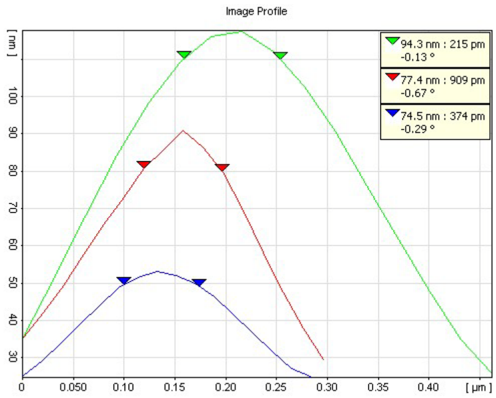

Fig. 4: shows distribution function of adjacent masses in three blue, red and green areas. The masses determined by green pointer, in a space of 94.3 nm, their maximum height is about 2.5 pm and the masses determined by green or red pointer in a space of 77.4 nm, their maximum height is about 909 pm and the masses determined by blue pointer in a space of 74.5 nm their maximum height is about 374 pm.

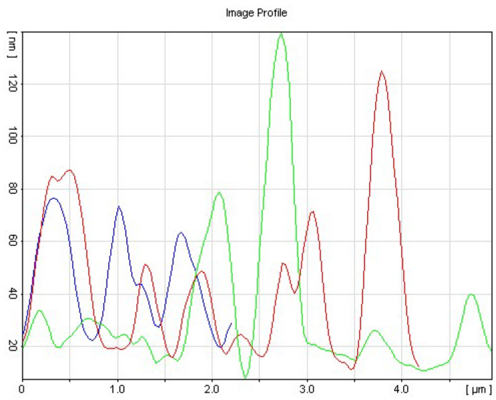

Fig. 5: shows voltage change of three determined masses in ZnS/ Tio_2 /glass model. As it is shown, because of the difference in masses accumulation in three groups in the model, the voltage change is visible.

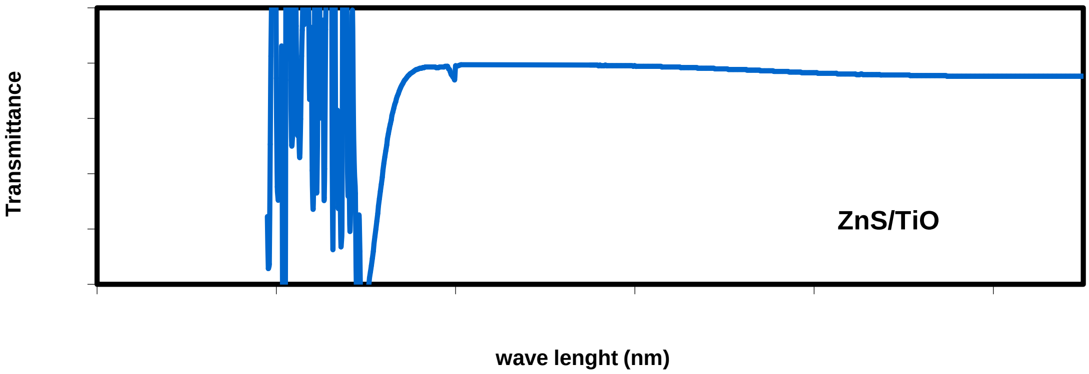

Fig. 6: shows transmission diagram of ZnS/ Tio_2 /glass multilayer in the model according to productive radiance wave length. As it is determined, we have about 80% transition and transmission. Diagram is visibly different from accumulation of ZnS units that near 400nm a hollow is visible which is related to inherent features of zinc sulfide.

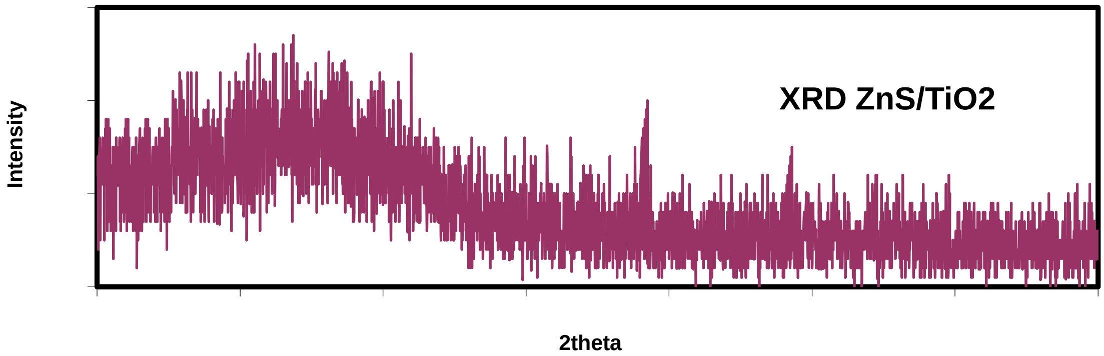

Fig. 7: shows diagram of X-ray diffraction of ZnS/ Tio_2 /glass multilayer .At first Tio_2 is shapeless and layer thickness especially with the presence of temperature. Crystal ZnS peaks show themselves in the direction of 200and 311 crystal manufacturing. Extended peak related to shapeless substratum of glass is visible in 20 to 30 and in addition, in general condition XRD is noisy. Accumulated ZnS layer shows itself properly.

Summery:

Four phase multilayer of ZnS/ TiO2/glass were prepared by resistance evaporated method under UHV conditions, morphology of multilayer showed big domed grains with high roughness and

Inhomogeneous surface, this layer was beginning to crystalline as we can see from XRD pattern. This multi layer has a good transmittance and there was a good agreement between nano structure and optical property of produced multi layer.

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