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VARIATION IN OPTICAL PROPERTIES OF ZnO/ $(CdS)_{1-x}$ $(ZnS)_x$ CORE SHELL BUFFER LAYER NANOSTRUCTURES WITH MICROWAVE POWER

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ABSTRACT

We prepared the ZnO/$(CdS)_{1-x}(ZnS)_x$ core shell buffer layer nanostructuresbyusing zinc oxide (ZnO) nanowires (NWs) as the core and shell as Zinc sulphide(ZnS) /buffer layer of cadmium sulphide(CdS). The ZnO NWs were synthesized on FTO(Fluorine doped tin oxide) by using Microwave(MW) irradiation.Three samples of ZnO/ $(CdS)_{1-x}$ $(ZnS)_x$ core shell buffer layer nanostructureswere prepared at different power of MW.It was observed that the XRD peak intensity of ZnO/ $(CdS)_{1-x}$ $(ZnS)_x$ core shell buffer layer nanostructures prepared at low power is high along witha variation in morphology with the power of MW.A uniform ZnS shell with a grain size of approximatelyseveral tens of nanometers was formed on the surface of ZnO nanowire cores after annealing at 350°C for 30 min.The absorption spectra and forsamples prepared at different MWpower was also studied to observe variations in NWs optical properties of ZnO/$(CdS)_{1-x}$ $(ZnS)_x$ core shell buffer layer structures.

Keywords: ZnO Nanowire, Core-Shell, Buffer Layer, Heterostructures

I. INTRODUCTION

Nano sized heterostructures can be constructed by surface modification or surface coating[1].Semiconductor heterostructures, such as super lattices [2], core/shell [3], and biaxial nanostructures [4, 5]are very important in the assembly of nano scale photonic and electronic devices. ZnO and ZnS are important II-VI semiconductors with wide band-gaps of 3.37 and 3.67 eV,respectively have been studied for applications in a wide range of instruments e.g. UV sensors, lasers, nanogenerators, solar cells, photo catalysis, and so on[6].The role ofbuffer layer of CdS in a heterojunction is to form a junction with the absorber layer while admitting a maximum amount of light to the junction region and absorber layer .This layer should have minimal absorption losses and it may be capable of driving out the photo generated carries with minimum recombination losses and transporting the photo generated carriers to the outer circuit with minimal electrical resistance [7].The benefit of the buffer layers arises because they remove the contact which has high minority carrier recombination losses from the absorber or base layer. Secondly when these layers are used near the top of a cell [8], because of reduced absorption and reflection losses, optical enhancement is achieved [9].In this study, ZnO/ZnS heterostructures in the form of CdS covered (ZnO/ZnS) NWs constructed of ZnOcores and ZnS shells with CdS buffer layer was synthesized. XRD, SEM and optical properties of theZnO/ $(CdS)_{(1-x)}$ $(ZnS)_x$ core/shell NWs were studied. Optical propertiesofZnO/ $(CdS)_{1-x}$ $(ZnS)_x$ core/shell NWs shows the variation in the opticalabsorption with MW power during synthesized.

II. MATERIALS AND METHODS

2.1 Synthesis of ZnO/ (CdS) 1−x (ZnS) x Nanostructures Arrays

To prepare ZnO/ $(CdS)_{1-x}(ZnS)_x$ core/ shell buffer layer nanostructures arrays at different power variation. We use ZnOnanowire arrays that will be directly grown on fluorine-doped tin oxide (FTO) substrate by a seed assisted hydrothermal method.FTO were initially dipped with (1:3 ratio of HCl and H_2O_2) solution for 24 hours and ultra sonicated in ethanol and deionized water for30minrespectively, then dried it in air. Then cleaned FTO substrates were deposited with the solution containing ethanol, zinc acetate, MEA in appropriate proportions for the seed layer preparation. The coated substrates were annealed in a muffle furnace under air condition at 350°C for .5h hour to form a seed layer of ZnO nanoparticles.Afterward,the seeded substrate were immersed into the solution containing zinc nitrate and HMTA in appropriate proportions for nanowire preparationkept in microwave at power 400watt at time 30m in pulse of 1min. on 30 sec. off. As prepared nanowires were washed with deionized water for several times and annealed at 400°C for 30min in muffle furnace.After that, the furnace was naturally cooled down to room temperature and ZnO nanowires arrays were synthesized on the FTO.Then to fabricate ZnO/ZnS coaxial nanowire arrays based on as-synthesized ZnO nanowire arrays. For this ZnO nanowire arrayson substratesFTO were immersed into 50Mm thiourea (≥ 99%) aqueous solution and kept in a microwave with power 500watt for 5min in pulse form as before. The final substrates were washed with deionized water for several times to eliminate the impurities & dried at 300°C. The grown ZnO NWs were served as the cores over which ZnS coatings deposited as shell, this is the sulfidation.Finally the preparation of ZnO/(CdS)1-x (ZnS)x coaxial nanowire arrays cation exchange reaction was adopted, based on as- synthesised ZnO/ZnS coaxial nanowire arrays. Thesubstrate with ZnO/ZnS coaxial nanowire arrays were immersed into 50 Mm Cadmium chloride (≥ 99%) aqueous solutions and kept in a microwave at different power at 300watt, 500watt, 700watt as before 15min. in pulse form. The final substrate was washed with deionized water repeatedly to remove the possible impurities and dried at 350°C before being studied. The exchange of a thin layer from ZnO nanowires to ZnS and CdS buffering is done in three steps.Thereby, there are forming that will cover ZnO nanowires in which the final structure is called ZnO/$(CdS)_{1-x}(ZnS)_x$ core/ shell buffer layer nanostructures arrays.

III. RESULTS AND DISCUSSION

3.1 Morphology and Structure

The microstructure of the films was analysed using a “Hitachi SU 6600” scanning electron microscope. Figure 1 shows the SEM images of the hydrothermally grown ZnO/ $(CdS)_{1-x}$ $(ZnS)_x$core shell buffer layer nanostructures at different powers in the microwave assisted method. The surface morphology of the films varied with microwave power. A variation in the grain density and roughness of the sample is observed atvarious MWpower. This indicates that the films were grown in three-dimensionally (3D) and the rate of growth increased further until the maximum power of 700watt.

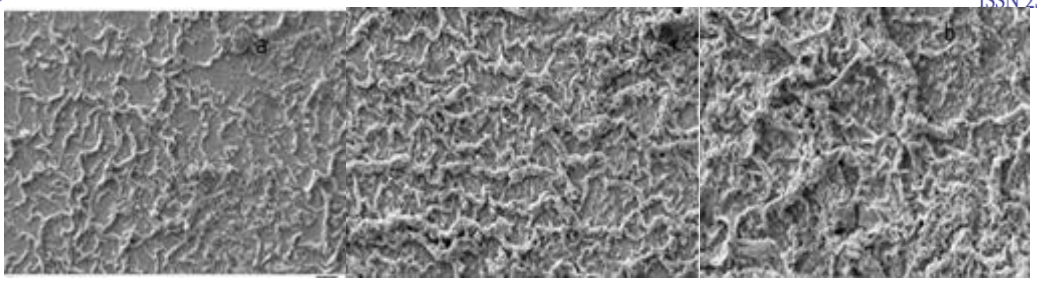

Figure 1. SEM images of ZnO/$(CdS)_{1-x}(ZnS)_x$ core shell buffer layer prepared by microwave assisted method at different power variation at (a) 300watt (b)500watt (c)700watt respectively

3.2 Structural Properties Using XRD of ZnO/ $(CdS)_{1-x}$ $(ZnS)_x$ Core Shell Buffer Layer

The $ZnO/(CdS)_{1-x}(ZnS)_x$ thin film were characterized by X-ray diffraction (XRD) measurements were performed using Philips PW 1710 diffractometer.XRD characterization can establish the crystal structure of the obtained film. The XRD patterns shows variationin intensity for (101) peak for different power of synthesis.Maximum intensity was observed for the film prepared at 700watt and minimum intensity for 300wattpower. The grain sizes (*GS*) of the ZnO films can be calculated using Scherer's formula. $D = 0.9\lambda / \beta \cos\theta$ (1) [9] θ and βare the X-ray wavelength (0.154 nm), the Bragg diffraction angle and the line-width at half-maximumrespectively. The XRD pattern of samples is shown above. The cubic phase of ZnO was observed with the help of JCPDC card no. [79-0207]. It shows well defined crystalline structure with 7 major peaks. Some crystal structure parameters of the above graph have been calculated.The calculated grain sizes of the samples were 10.9(at 300watt power), 11.5(at 500watt power) and 13.7nm (at 700watt power) for the samples oxidized at 400°C. Obviously, the grain size of the samples increased with increasing power.

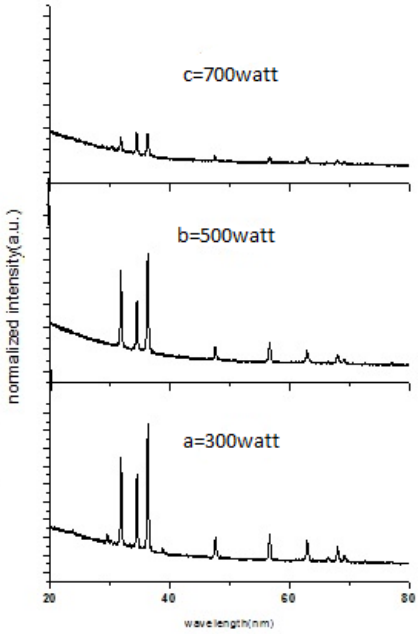

Figure 2. XRD patternsof ZnO/ $(CdS)_{1-x}(ZnS)_x$core shell buffer layerat (a) 300watt (b) 500watt (c) 700watt respectively.

3.2 Optical Absorption

ZnO/ $(CdS)_{1-x}(ZnS)_x$core shell buffer layerhave a much broader absorption increases with increasing power because of the improved structure. The increased optical absorption and the extended photo-response region are expected to improve the utilization efficiency of solar energy and most favourable for photovoltaic reactions processes.

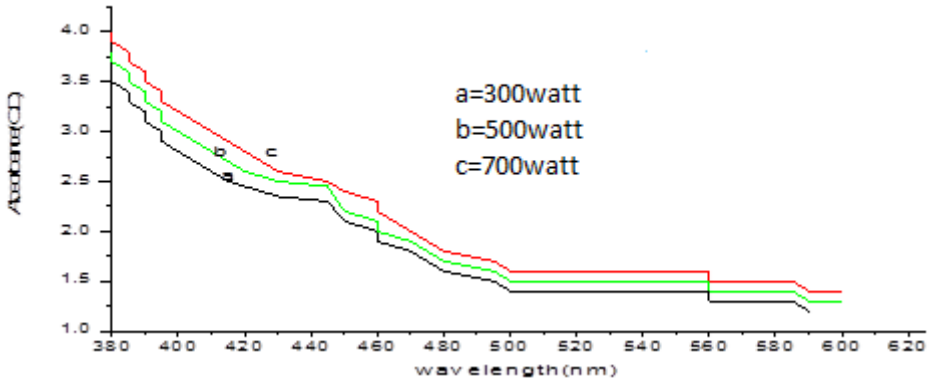

Figure3.Optical absorption curve of$ZnO/ (CdS)_{1-x}(ZnS)_x$core shell buffer layer(a) 300watt (b) 500watt(c) 700watt respectively

IV. CONCLUSIONS

Morphology and structure controlled synthesis of heteroepitaxial $ZnO/ (CdS)_{1-x} (ZnS)_x$core shell buffer layer have been achieved via a simple MW assisted method at different power during the synthesis. The buffer layer ofCdSand ZnSshell is single crystalline and preserves the crystal structure and orientation of the ZnO core. The as-synthesized heterostructures may provide ideal systems for fundamental research and highly promising building blocks for nano scale device applications due to its simplicity and efficiency.

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