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FABRICATION OF ZnSe BASED DYE SENSITISED SOLAR CELL AND ITS CHARACTERIZATION

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ABSTRACT

To a make a low cost dye sensitized solar cell zinc selenide nanoparticles were prepared by a cost effective chemical method. The structure of synthesized nanoparticles was characterized by Transmission Electron Microscope and X-ray diffraction. Optical absorption and photoluminescence properties of as grown nanoparticles had been studied. Dye sensitized solar cell based on ZnSe had been fabricated. Anthocyanin a kind of vegetable dye was used as sensitizer in prepared dye sensitized solar cell. The optical properties of anthocyanin were also studied. The current-voltage characteristics of the dye sensitized solar cell had been studied in dark and light condition. The measurement of efficiency and fill factor of the dye sensitized solar device were also performed.

KEYWORDS: Znse Nan oparticles, Structural Properties, Optical Properties, Dye Sensitized Solar Cell

INTRODUCTION

The energy crisis in present time has led great interest in the research of renewable energy sources. Global energy crisis can be confronted by using non conventional sources like solar energy. The current strategy is to fabricate low cost photovoltaic devices and increase its efficiency [1-9]. The semiconducting nanoparticles are promising material for application in solar cell .Nanoparticles exhibit exciting structural, optical, electronical etc. properties different from their bulk [10-12]

Zinc selenide a grII - grVI semiconductor is an important material in photovoltaic devices, LED, Laser etc. [13-15].

Dye sensitized solar cells are emerging as a low cost photovoltaic device. Different bio inspired strategies have been taken to enhance the efficiency of the device. Dye Sensitized Solar cell (DSSC) contains four components as follows: (1) solar energy absorber containing the electrode dye sensitized layer (2) the transparent conductive oxide layer that facilitates charge transfer from the electrode layer (3) graphite paint on ITO glass act as counter electrode . (4) the redox electrolyte layer for reducing the level of energy supplied from the dye molecules [5,6,15-25]. Dye-Sensitized Solar Cell, composed of the ZnSe layer acting as the electron carrier and the organic dye layer acting as the electron generator, which will recover to its original state by electron donated by the electrolyte solution.

In this work a chemical reduction method is used to grow ZnSe nanoparticles [18]. The used method is simple and highly cost effective and free from environmental hazards. A dye sensitized solar cell has been fabricated based on as prepared ZnSe nanomaterials. Anthocyanin acts as dye in the fabricated device which is extracted from red leaf plant. The value of efficiency and fill factor of the ZnSe based dye sensitized solar cell device are determined.

EXPERIMENTAL SECTION

The ZnSe nanoparticles have been synthesized using a chemical reduction method. Zinc chloride, selenium powder and sodium borohydride are used to grow ZnSe in the dispersive medium of Ethylenediamine (EDA). The method of sample preparation is reported elsewhere [18]. The structural and optical characterizations have been performed.

The morphological and structural characterization of the as prepared samples is performed using transmission electron microscope and x-ray diffraction. The optical and photoluminescence properties of the as prepared samples have been performed. ZnSe based dye sensitized solar cell has been fabricated. Anthocyanin acts as dye which is extracted from leaf of plants.

Device Fabrication

ZnSe nano particles (0.5 gm) are added with 1 ml acetic acid (pH 3-4) and grinding in mortar for lump free pestle. A uniform layer of ZnSe is deposited on the conducing surface of ITO glass. ZnSe layer on conductive glass is heated in a furnace at 150˚ C for one hour. This glass plate has placed in anthocyanin solution for 10 minutes. Anthocyanin is extracted from the leaf of plants. Apply light graphite paint on second ITO coated glass plate on conductive side. Align two conductive glass plates, placing one upside down while the one to be coated is right side up. Two binder clips are placed on longer edges to hold plates together. Place 2-3 drops of iodide/ KI electrolyte solution at one edge of plate. Two binder clips act as two electrodes.

The schematic of the ZnSe based dye sensitized solar cell mechanism is displayed in figure 1

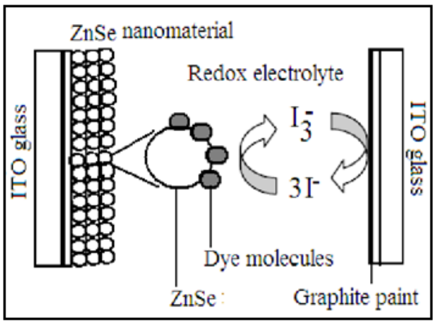


Figure 1: Schematic Overview of a Dye Sensitized Solar Cell

Open circuit voltage and short circuit currents are measured with the multi meter. One multi meter has connected across the solar cell, and one lead of another meter to the negative side and the other lead to the load acting as voltmeter and ammeter respectively.

RESULTS AND DISCUSSIONS

The TEM image of as synthesized ZnSe nanoparticles is shown in figure 2.

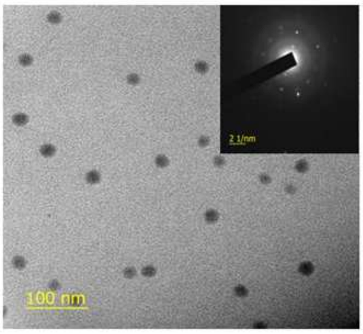


Figure 2: The TEM Image and Sad Pattern of as Prepared Nanoparticles

The grown nanoparticles are not agglomerated and the average size of the nanoparticles is found to be 20 nm. The XRD pattern of ZnSe nano materials is shown in figure 2.

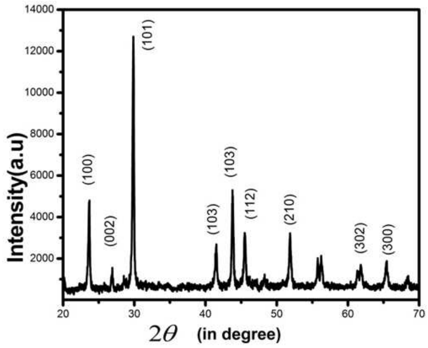


Figure.3: XRD Pattern of as Synthesized Znse Nanoparticles

The XRD pattern of the as prepared samples shows that the as grown ZnSe nanoparticles are in hexagonal phase.

The optical absorption spectrum of as prepared ZnSe samples is given in figure 4.

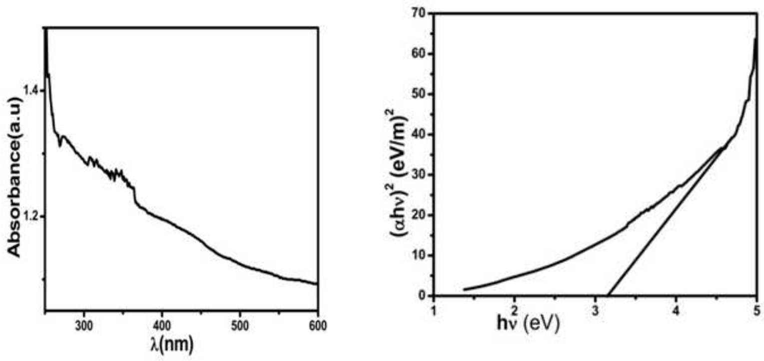


Figure 4 (a) **Figure 4 (b)**

Figure 4: Optical Absorption Spectrum of Znse Nanoparticles and Band Gap Determining Plot

The band gap of the grown sample is determined from the $(\alpha h\nu)^2$ vs hν plot, where α is absorption coefficient, h is Plank constant and ν is the frequency of light. The band gap of as synthesized ZnSe nanoparticles is found to be 3.2 eV.

The photoluminescence spectrum of as synthesized sample is shown in figure 5.

The peak of the spectrum is attributed to surface states [20-22].

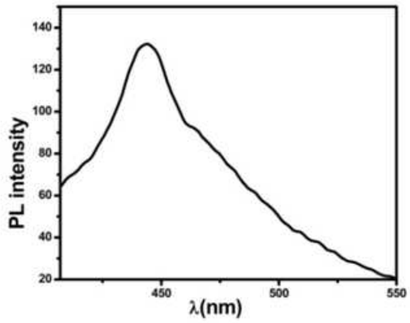


Figure 5: Photoluminescence Spectrum of Znse Nanoparticles

The optical absorbance spectra and PL spectrum of the prepared dye (anthocynin) was shown in figure 5(a) and (b). From absorbance spectra it is clear that anthocynin has absorption in visible region. i.e. it would be excite in visible spectrum.

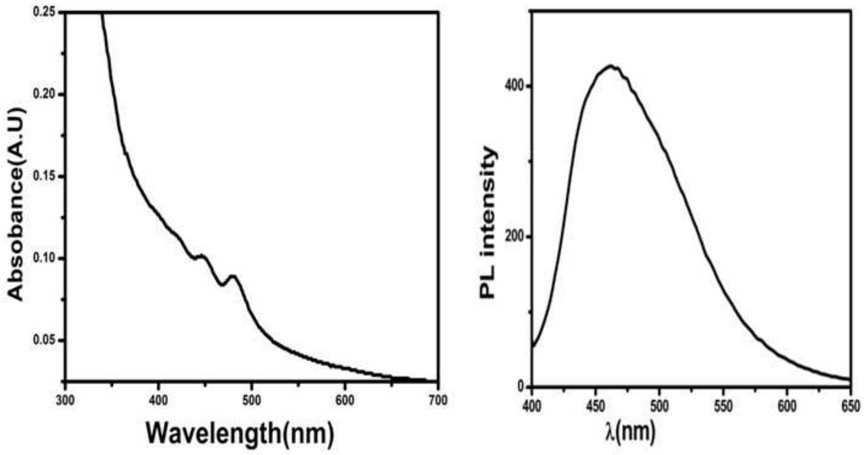
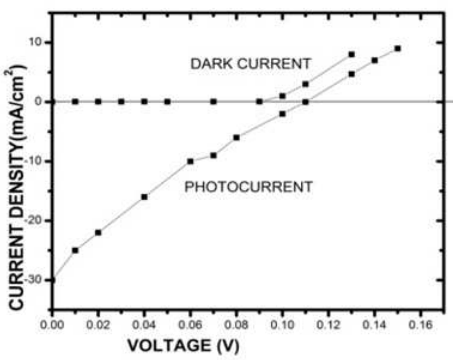


Figure 5 (a) **Figure 5 (b)**

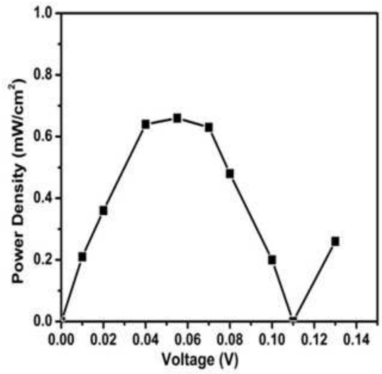
Figure 5: Optical Absorbance and Photoluminescence Spectrum of Anthocyanin

Device Characteristics

When light enters from the ZnSe side, we measure open circuit voltage and short circuit current. Fill Factor and efficiency of the photovoltaic devices are determined from J-V characteristics.



(a)



(b)

Figure 7: (a) Current Density (J) Vs Applied Bias (V) Characteristics and (b) Power Density (P) Vs. Voltag (V) Plot Fill Factor and Efficiency Can Calculated from the Relation Given Below

$$FF = \frac{V_{mp}J_{mp}}{V_{oc}J_{sc}}$$

$$\eta = \frac{J_{sc}V_{oc}FF}{P_{in}}$$

Where V_{mp}, J_{mp} are Voltage and current density at maximum power.

V_{oc}, J_{sc} are open circuit voltage and short circuit current respectively, P_{in} is the incident power and η is the efficiency.

Fill factor is determined from the J-V characteristics.

The calculated FF and efficiency are 20% and 0.65% respectively.

Table 1: Different Parameters Dye Sentisized Solar Cell Obtained From J-V Characteristics

Vmax	Jmax (Ma/Cm^{-2})	Voc (V)	Jsc (Ma/Cm^{-2})	Fill Factor	Efficiency
0.055(V)	12	0.11	30	20%	0.65%

CONCLUSIONS

We have synthesized ZnSe nanoparticles for dye sensitized solar cell by a simple chemical method. The structural, optical properties of ZnSe nanoparticles have been studied. The optical properties of vegetable dye anthocyanin are also studied. We have fabricated a dye sensitized solar cell based on ZnSe. The anthocyanin is used as sensitizer. The current density-voltage characteristics of the fabricated device have been studied. The fill factor and efficiency of as prepared solar cell have been measured. The efficiency of the device is low due to presence of surface traps in nano ZnSe.

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