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PREPARED TiO_2/CdSe, TiO_2/MPA/CdSe ANODE FILMS FOR APPLICATION IN SOLAR CELLS

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Abstract: ***In previous acticles, we have successfully synthesized the fabrication process of CdSe quantum dots (QDs) by colloidal method. The results, we obtained photoluminescence (PL) narrow, high absorption spectrum of the overall spectrum from ultraviolet to visible, the solution reaches a steady state well in three months. In this paper, we put the CdSe QDs on TiO_2 films brought by dipping in a solution of CdSe. Through which we did carry TiO_2 control by two parameters are temperature and time. The results were obtained for analysis of absorption spectra, luminescence spectra, we found that bring crystal optical properties of strongly dependent on temperature calculation, the thickness of films.... In addition, we also used biological agents 3- mercaptopropionic acid (MPA, COOH-R-SH) containing carboxyl groups and groups those with two purposes: The first one to do surface passivation of CdSe QDs, reducing the surface state and increasing the intensity of the luminescence spectra. The second MPA as a bridge between the CdSe QDs with TiO_2 particles, help for the conversion of electrons into TiO_2 is easier, can take advantage of the electron temperature. All the results obtained in order to guide for applications in solar cells to replace a photosensitive dye in the next research.***

Keywords *- Thin film; Defect states; CdSe nanocrystals; Solar cells.*

I. INTRODUCTION

There were many methods which have been employed to synthesize semiconductor quantum dots (QDs) in recent years. These methods include the reverse micelle [4,5], epitaxial, colloidal, hydrothermal [2,3]… to depend on the aims of the different applications. The quantum dots have shown potential applications in thin film light emitting devices (LED) [6,7], nonlinear optical devices [8], fluorescent labels for biological applications [9], solar cells [8], displays, sensors or biosensors, lasers [11]… A large of number of high quality quantum dots as such CdS, CdSe, CdTe were successfully synthesized.

In this paper, CdSe QDs and TiO_2/CdSe thin films have been prepared via a colloidal route using Mercaptoethanol (Thioglycol) as a capping agent. We have successfully fabricated the CdSe QDs and TiO_2/CdSe thin films. We researched optical characteristic of CdSe QDs and TiO_2/CdSe thin films for the application in the solar cell device. Dye sensitized solar cell bases wide band gap semiconductors have the potential advantages of lower cost production and versatility in comparison to the conventional solid state cells.

In addition, we also used biological agents 3-mercaptopropionic acid (MPA, COOH-R-SH) containing carboxyl groups and groups those with two purposes: the first, one to do surface passivation of CdSe QDs, reducing the surface state and increasing the intensity of the luminescence spectra. The second MPA as a bridge between the CdSe QDs with TiO_2 particles, helping for the conversion of electrons into TiO_2 is easier, can take advantage of the electron temperature [12-16]. All the results obtained in order to guide for applications in solar cells to replace a photosensitive dye in the next research.

II. EXPERIMENT

Materials.

$Cd(CH_3COO)_2.2H_2O$ (99%), Dimethyl formamide (DMF) C_3H_7NO (99%), Mercaptoethanol (Thioglycol) $HOCH_2CH_2SH$ (99%), Sodium selenite pentahydrate $Na_2SeO_3.5H_2O$ (98%), acetone, obtained from Merck.

Preparation of TiO_2 films:

TiO_2 thin films were fabricated by printed silk with TiO_2 paste, the films were heated by the process: TiO_2 film was heated at 325°C for 5min, at 375°C for 5min, at 400°C for 15min, at 500°C for 15min and dipped in solution $TiCl_4$ 40mmol for 30min at 70°C, and final were heated at 500°C for 30min.

Preparation of TiO_2/CdSe films:

TiO_2 film is dipped in the solution CdSe with different time periods to change the thickness of the film. Then, it takes three times to wash in solvent acetone. Final, was heated in a vacuum environment with different temperatures to avoid oxidation.

Preparation of TiO_2/MPA/CdSe films:

Mixture TiO_2 was dipped in a solution of (MPA 5ml +50 ml acetone) at 100°C during 4hours. After it was washed three times with acetone, and was brought outside to dry naturally. Continue dipping in the solution CdSe with different time periods to change the thickness of the film. Then, it takes three times to wash in solvent acetone. Final, was heated in a vacuum environment with different temperatures to avoid oxidation.

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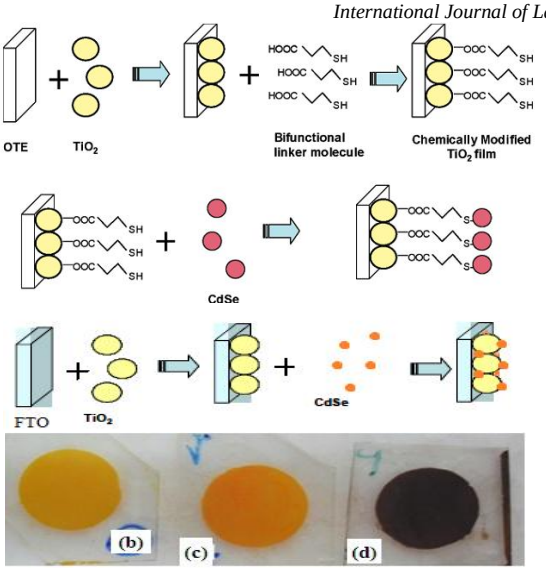


Figure 1. *Diagram and graph of TiO_2/CdSe, TiO_2/MPA/CdSe thin films linked 3-mercaptopropionic acide for process stranfer electrons from CdSe QDs to TiO_2.*

III. RESULTS AND DISCUSSION

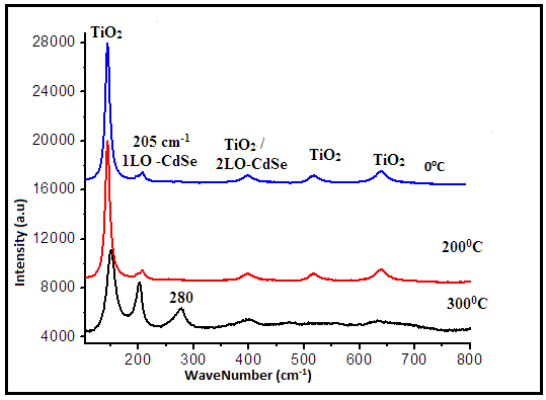
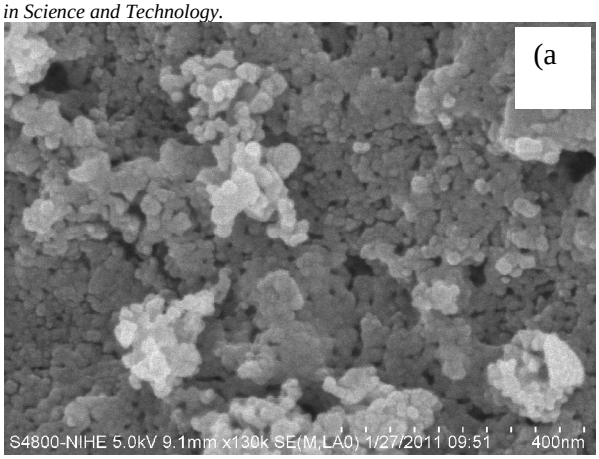


Figure 2. *Raman spectrum of TiO_2/CdSe thin films at different temperatures.*

In the Raman spectrum, there are three peaks at 201cm^{-1}, 402cm^{-1} and 601cm^{-1}. These are the peaks corresponding to the phonon of longitudinal optical vibration in CdSe, the first lies at 201cm^{-1} (longitudinal optical - LO), the second at 402cm^{-1} is the second harmonic of the first peak (2LO), the third at 601cm^{-1} is the third harmonic of the first peak (3LO). Origin of branch LO and the interactions between photons with surfaces of CdSe QDs depend on the size of electron-hole pair interaction. Each peak is asymmetrical tends to stretch toward the low frequency, which is attributed to the surface vibration. Blue-shifted were also seen in the two peaks LO and 2LO at 201cm^{-1} and 402cm^{-1} of CdSe powder in comparing with the peaks 210cm^{-1} và 418cm^{-1} [2] of CdSe bulk. The red-shifted proved that CdSe QDs, with high ratio area/volume, were created in the sample. Raman spectra of TiO_2/CdSe thin films at different temperatures, show both anatase of TiO_2 and a zinc blenbe of CdSe structure.



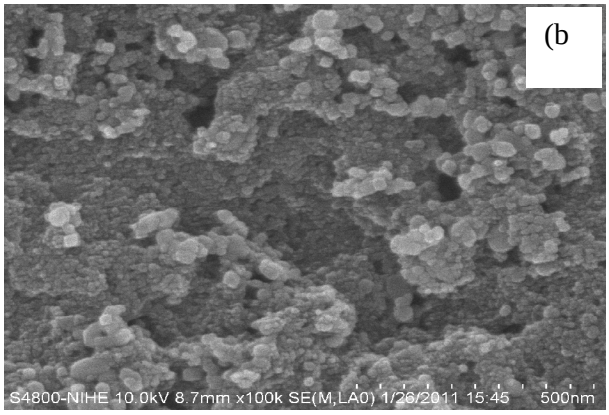
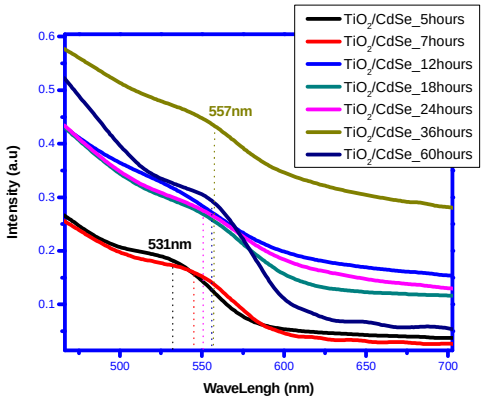


Figure 3. *SEM image of the TiO_2/CdSe thin film (a) and TiO_2 film on glass (b).*

Figure 3 shows the TEM images of carry TiO_2/CdSe (left) and TiO_2 (right) on a glass substrate. Inside TiO_2 nano porous thin films have plenty of space, after dipping films in the solution of CdSe QDs. The particle size of QDs is smaller than TiO_2's size, so particles of CdSe QDs have filled in rank space of TiO_2 films. Moreover, the differences in color of two films suggest that CdSe QDs have filled with nano TiO_2 thin films.



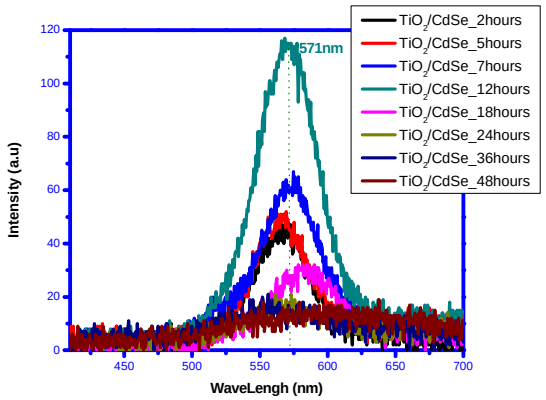


Figure 4. *Absorption spectrum and PL of TiO_2/CdSe with different times.*

Absorption spectrum depends on the dipping times, the particle size's changing related to shift peak of the absorption spectrum from 531nm to 557nm when the dipping time increased. During this process, CdSe QDs in small size have filled in the space of TiO_2 thin films, they were adsorbed on the TiO_2 surface. When the dipping times increases, films have formed more CdSe – CdSe and CdSe -TiO_2. Therefore, the particle size of QDs also increases correspond to the peak of the absorption spectrum shifting towards long waves. However, samples at 36hours and 60hours are the peak of absorption spectrum peak unchanged. Figure 6 (right) shows PL spectra of the TiO_2/CdSe films vary with dipping times, we see the peak of the PL spectra much unchanged around 571nm with him dipping time at 12hours.

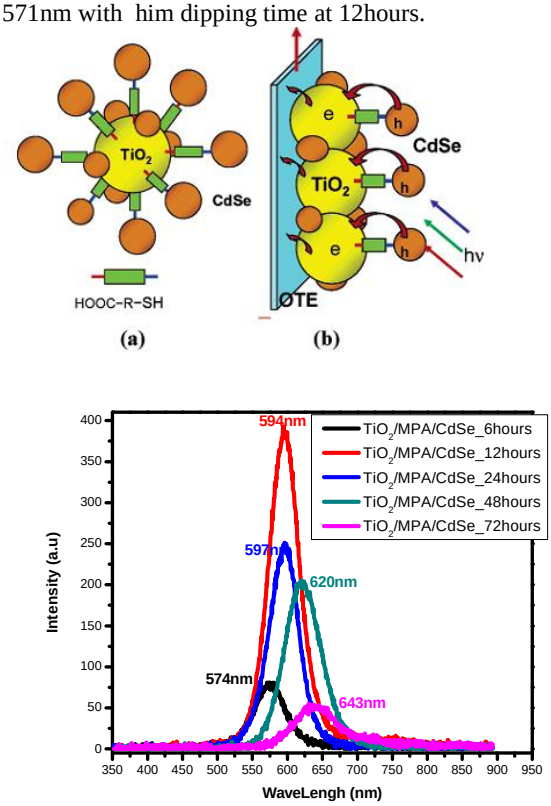


Figure 5. *Shows PL spectra of TiO_2/MPA/CdSe thin films at different times and diagram of TiO_2/MPA/CdSe film.*

Figure 5 shows PL spectra of TiO_2/MPA/CdSe films corresponding different dipping times. MPA is a biological agent to help us control the QDs's surface (surface passivation quantum dots) and become a bridge link TiO_2 particles with CdSe QDs through group COOH- and SH- groups. MPA is chosen because its links is not so stronger nor weaker as mercapto hexadecanoic acid thiolacetic [12-16]. Look at the peak of PL spectra, we see that the shift don't much, if compared with results obtained by carrying PL spectra of TiO_2/CdSe films. The films contain biological molecules MPA will have stronger and narrower PL spectra than PL spectra of TiO_2/CdSe films. This is also understandable because MPA has done a good job of surface passivation of QDs, so it should be obtained better results. In the next study we will perform to make films on FTO substrates to measure Hall effect, to determine the number of electrons in the films. To measure total resistance determining the lifetimes of electrons and the transition electrons from CdSe QDs – MPA to TiO_2 films.

IV. CONCLUSIONS

We have successfully made efforts to control the particle size of CdSe QDs, created TiO_2/CdSe thin films and research dependence on dipping times through absorption spectra, PL spectra. The results obtained the shift peak of both absorption spectra and PL spectra dipping times. To improve the luminescence efficiency, we have put biological agents MPA as bridge to do surface passivation of CdSe QDs, initial success by the increasing in intensity of PL spectra, peak of PL spectrum is more narrow than TiO_2/CdSe films do.

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REFERENCES

[1] Murray. C. B, Kagan. C. R and Bawendi. M. G, Annu. Rev. Mater. Sci. **30**,545 (2000).

[2] Peng. Q, Dong. Y.J, Deng. Z.X, Li. Y.D, Inorg. Chem. **41** (2002) 5249.

[3] Chen. M.H, Gao. L, Am. J. Ceram. Soc. **88** (2005) 1643.

[4] Xi. L.F, Lam. Y. M. Colloid Interface. Sci. **316** (2007) 771.

[5] Maillard. M, Giorgio. S, Pileni. M.P. Adv. Mater. **14** (2002) 1084.

[6] (a) Alivisatos. A. P, Nat. Biotechnol, 2004, **22**, 47. (b) Jaiswal. J. K and Simon. S. M. Trends Cell Biol, **14**, 497.2004

[7] Nanda. J, Narayan. K. S, Kuruvilla. B. A, Murthy. G. L and Sarma. D. D. Appl. Phys. Lett,**72**, 1335. 1998.

[8] (a) Koktysh. D. S, Gaponik. N, Reufer. M, Crewett. J, Scherf. U, Eychmuller. A, Lupton. J. M, Rogach. A. L and Feldmann. J. ChemPhysChem. 2004, **5**, 1435; (b) Gao. M.Y, Lesser. C, Kirstein. S, Mohwald. H, Rogach. A. L and Weller. H. Appl. Phys, 2000, **87,** 2297.

[9] Klimov. V. I, Mikhailovsky. A. A, Xu. S, Malko. A, Hollingsworth. J. A, Leatherdale. C. A, Eisler. H. J and Bawendi. M. G. Science, 2000, **290**, 314.

[10] Efros.A.L, Rosen.M, Kuno.M, Nirmal.M, Norris. D.J and Bawendi. M.Phys. 1996, **54**, 4843.

[11] Kuno.M, Lee.J.K, Dabbousi.B.O, Mikulec.F.V, Bawendi.M.G. J. Chem. Phys. 1997, **106**, 9869.

[12] Klimov. V.I, Mikhailovsky.A.A, Xu.S, Malko.A, Hollingsworth.J.A, Leatherdale C A, Eisler.H –J and Bawendi.M.G.Science **290**, 314 (2000).

[13] Lawless. D, Kapoor. S, Meisel. D. J. Phys. Chem. 1995, **99**, 10329.10335.

[14] Granot. E, Patolsky. F, Willner. I. J. Phys. Chem. B 2004, **108**, 5875. 5881.

[15] Baron. R, Huang. C. H, Bassani. D. M, Onopriyenko.A, Zayats.M, Willner.I. Chem. Int. Ed. 2005, **44**, 4010. 4015.

[16] Kamat. P. V, Barazzouk. S, Hotchandani. S. Chem., Int. Ed. 2002,**41**, 2764 2767.

[17] Zayats. M, Kharitonov. A. B, PogorelovaS. P, Lioubashevski.O, Katz.E, Willner.I.J. Am. Chem. Soc 2003, **125**, 16006 16014.

[18] Efros.A.L, Rosen.M, Kuno.M, Nirmal.M, Norris.D. J and Bawendi.M.Phys.Rev.B.1996,**54**,4843.

[19] 18 Brus. L. E. J. Chem. Phys. 1984, **80**, 4403.

[20] Efros. A. L, Rosen. M, Kuno. M, Nirmal. M, Norris. D. J and Bawendi. M. Phys. 1996. Rev. B, **54**, 4843.

[21] Nirmal. M, Norris. D. J, Kuno. M, Bawendi. M. G, Efros. A. L and Rosen. M. Phys.1995. Rev. Lett . 75, 3728.