ISSN (Online): 2320-9682
ISSN (Print): 2320-9674

Spectroscopic study of FTO/CdSe (MPA)/ZnO artificial atoms emitting white color

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Abstract

Objective: To design Light Emitting Diode (LED) based on artificial atoms using spin coating method and to study its optical spectroscopy to determine emission wavelength and emitted color of this LED.
Methods: By using UV-spectrometer, absorption spectra were measured. Photo luminescence spectra were carried out using spectrophotometer (Hitachi-FL250) at room temperature. To determine electronic transition responsible of PL peaks, we analyzed PL spectra using Gaussian profile broading line method using Mathcad program**.**
Finding: The range of absorption wavelength was found (350-550 nm). PL spectra contain four peaks (350-400-500-550 nm) that mean this LED emits white color depending on theory of maxing color. Intensity of blue and yellow peak colors was higher than red and green peak colors. Gaussian analysis reveals that all theoretical electronic transitions and this structure of quantum confinement semiconductor emit white color. By varying the thickness of layers, the order of wavelengths can be changed to emit a single color of visible spectrum. This project can reduce energy consumption in the world by the produce of LED based on Quantum dots.
Improvement: We can enhance performance of this LED by adding active layer of artificial atoms that emit green and red color to make intensity of white color**.**
Keywords**:** CdSe, artificial atoms, LED, PL Spectra, white color.

1. Introduction

Increasing the world's interest on energy source especially to economize the energy consumption for lighting, one of the most important technique designed was the white color Light emitting diode based in Quantum dots artificial atoms [1]. Due to unique properties of quantum dots semiconductors to tunable energy band gap, they absorb, and emit wide range of color [2],[3]. Multi layers LEDs based on quantum confinement effect were prepared in multi technology like, chemical method deposition, sol-gel method, and spin coating method [4]. Multi method used to examine characteristic of prepared LED, thermal stability, brightness, lifetime and color emission [5],[6]. Spectroscopic study of LEDs is the most important method to analysis absorption and photoluminescence spectra and control of quantum size effect of crystal of semiconductor, which was used to produce multi-color LEDs[7].Prepared from the same semiconductor but in different quantum confinement effect (core –shell method, multi layers design offers different types of quantum confinement effect[8].

In this paper, Multi semiconductor's layers are used to design the first type of quantum confinement effect between layers of LED and analyzed through, absorption and PL spectra using Gaussian analysis.

2. Materials

Microscopic Slides, $K_2Cr_2O_7$ for cleaning glass slides, HF (fluoric acid), $SnCl_2.2H_2O$, Ethylenglycol, metapraponic acid (MPA), $CuCl_2$, KI, Se powder, Cd $(CH_3COO)_2 .4H_2O$,Hydrazine, deionized water.

2.1. Synthesis of FTO/ZnO/CdSe (artificial atoms) /FTO

Fluoride Tin Oxide (FTO) Transparent conductive cathode was prepared as [9].ZnO Colloidal solution was prepared by dissolving 0.1 molof $(CH_3COO)_2Zn.2H_2O$ in 100ml of ethanol and heated to $50C^\circ$ [10].WhereasCdSe artificial atoms were prepared by chemical method as mention [11]. Used spin coating method for prepared FTO/ZnO/CdSe (artificial atoms) /FTO as shown in Figure 1.

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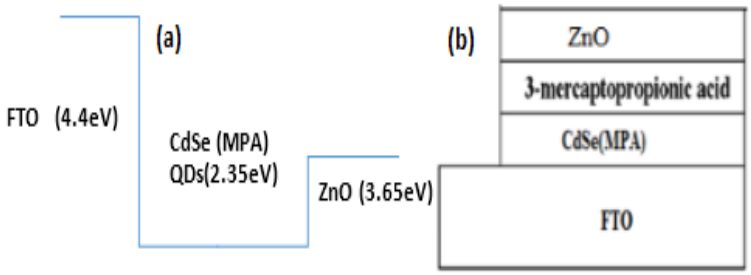
Figure 1a.Energy diagram of quantum well confinement of structure (b) box layer diagram of FTO/CdSe (MPA)/MPA/ZnO.



Energy diagram

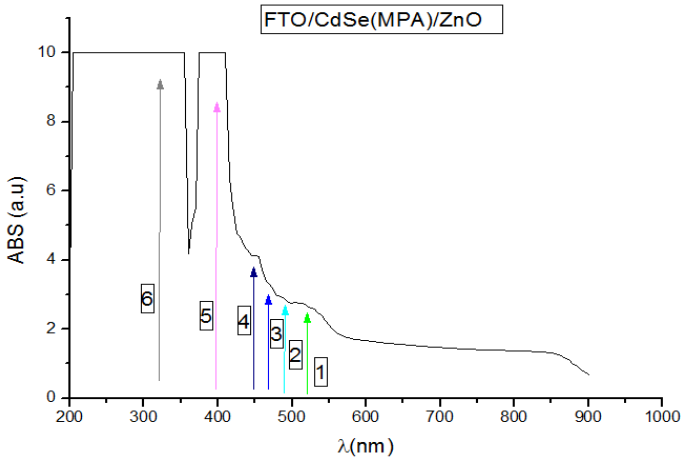
Using UV spectrometer (win.v5), absorption spectra were measured at a wavelength range (200-800nm); PL spectra was measured using Hatiche-FL250.Gaussian analysis was done using Mathcad program.

3. Results and discussion

Absorption spectra of FTO/CdSe (MPA)/ZnO Artificial Atoms

Absorption spectra of FTO/CdSe (MPA)/ZnO Artificial Atoms were measured at room temperature using spectrophotometer (UV Win5 V5.2.0). Six peak of clear absorption spectrum are shown in Figure 2; peak numbers from (1-4) belong to CdSe (MPA) core shell artificial atoms [12]. The five peaks at wavelength 400nm are related to ZnO layer, whereas the six peaks belong to FTO layer as shown in Table 1.

Figure 2. Absorption spectra of FTO/CdSe(MPA)/ZnO.



Absorption spectra

Table 1. Absorption peaks wavelength and their energies in eV for system FTO/CdSe (MPA)/ZnO.

Peak	Wavelength(nm)	Energy (ev)
1	527	2.35
2	490	2.53
3	465	2.66
4	450	2.75
5	400	3.1
6	320	3.87

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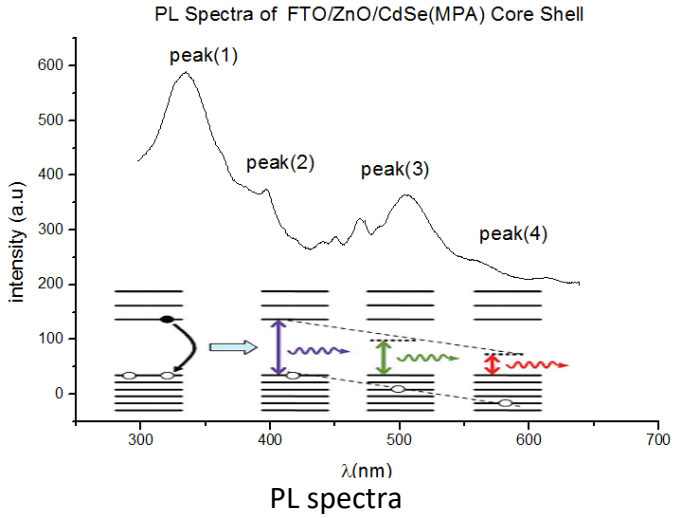
PL Spectra of FTO/ZnO/CdSe(MPA) Core Shell Artificial Atoms

PL spectra were carried out using spectrophotometer (Hatchie-L 250) using wavelength of excitation at 280 nm. Figure 3 shows PL spectra of FTO/ZnO/CdSe(MPA) core shell, whereas there are four clear peaks concentrated at wavelengths (350-400-500-550 nm)corresponding color ultra violet, blue, yellow and red. Which means that FTO/ZnO/CdSe(MPA) emission white color is depending on theory of mixing colors.

Figure 3. PL spectra of FTO/ZnO/CdSe (MPA) core shell.



Fitting between theoretical and experimental PL spectra of FTO/ZnO/CdSe (MPA) core shell

To insure electronic transitions in FTO/ZnO/CdSe (MPA) artificial atoms, which found in structure system, theoretical energy of electronic transitions are shown in Figure 4. By using Gaussian, profile for all theoretical energies transitions of FTO/ZnO/CdSe (MPA) artificial atoms are shown in Table 2.

Figure 4. Fitting PL spectra of FTO/ZnO/CdSe (MPA) core shell

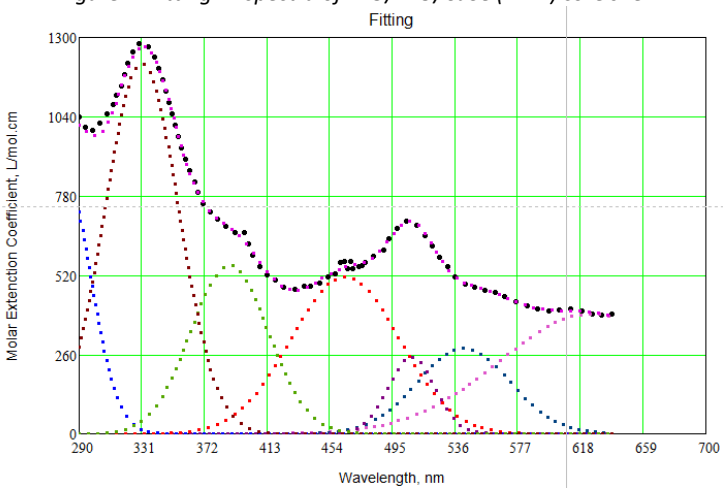


Table 2. PL spectra peaks position of FTO/ZnO/CdSe (MPA) core shell, FWHM and its intensity

Peak	Position peak(nm)	FWHM(nm)	Intensity
1	279.71	26.05	862.63
2	331.08	34.08	1215
3	388.49	35.88	552.82
4	464.06	49.93	514.34
5	507.06	21.73	250.06
6	541.77	42.9	280.47
7	624.8	84.28	392.93

4. Conclusion

Light emitting diode, emits white color which consists of multi semiconductor's layers, CdSe (MPA)core shell which was an active layer sandwich between two layers FTO and ZnO.PL spectra shows multi peaks in wide range of wavelength through visible spectrum due to size Quantum confinement inside the structure of designed LED, which make this LED emit white color when applied voltage bias. By controlling the intensity of colors, this LED can be used to emit one or more colors depending of maxing color theory that can do due to quantum size effect and quantum effect in structure of LED. Wide PL peak was in corresponding with different size of artificial atoms. Energy of Electronic transitions in the Photoluminescence and Absorption spectra were in corresponding to the theoretical transition.

5. Acknowledgements

The authors are grateful to team members of research laboratory 7 at Physics department for their effort(Drs. Ahmed Alomar, Wafaa Hag Esmaeil, Amir Haj Saker, FawazKayali, GhassanNashed and Fatima srouji).

6. References

[1] P.Phukan, D. Saikia.Optical and structural investigation of cdse quantum dots dispersed in pva matrix and photovoltaic applications. *International Journal of Photoenergy.*2013, 2013, 6.
[2] N. Chouhan,W. S. Chang,C. L. Yeh, S. F. Hu, K. H. Chen,J. H. Huang,C. W. Tsai, R. S. Liu. Array of cdseqd-sensitized znonanorods serves as photoanode for water splitting. *Journal of the Electrochemical Society.* 2010; 157(10), 1430-1433.
[3] C. Smith, D. Binks.Multiple exciton generation in colloidal nanocrystals. *Nano materials*. 2014; 4(1), 19-45.
[4] Y. H. Kim, Y.M. Kim, H.S. Yoon. Development of LED Module based on Adjustable AC Line Direct SMPS. *Indian Journal of Science and Technology*. 2015; 8(15), 1-4.
[5] Chia-Lung Tsai, Wei-Che Wu. Effects of asymmetric quantum wells on the structural andoptical properties of ingan-based light-emitting diodes. *Materials.* 2014; 7(5), 3758-3771.
[6] Hui-ChulJu, Yeon-SerkYu. A study on blue light cut-off filter for white light led. *Indian Journal of Science and Technology*. 2016; 9(24), 1-6.
[7] GowrishankarKasilingam, MrithaRamalingam, Chandra Sekar. A survey of Light Emitting Diode (LED) display board. *Indian Journal of Science and Technology*. 2014; 7(2), 185-88.
[8] Yeon-Bo Kim, Jae-Jung Yun. A simple short detection and current regulation circuit for led driving circuit. *Indian Journal of Science and Technology*. 2016; 9(17), 1-4.
[9] M.AnwarBatal, K. Al-yamani. Optical properties of colloidal cdse/cds/zns/pvpqds core/shells embedded in fatty acid medium. *Nano Science and Nano Technology Indian Journal.* 2015; 9(1), 1-7.
[10] Z. Lin Wang. Zinc oxide nanostructures growth properties and applications. *Journal of PhysicsCondense Matter*. 2004; 16(25), 829–858.
[11] P. Gupta and M. Ramrakhiani. Influence of the particle size on the optical properties of cdse nanoparticles. *The Open Nanoscience Journal.* 2009, 3, 15-19.
[12] U. Woggon.Optical properties of semiconductor quantum dots. *Springer*.Berlin.1997, 136.

The Publication fee is defrayed by Indian Society for Education and Environment (iSee). www.iseeadyar.org

Citation:

Mohamed Anwar Batal, Kaesar SalahAL Yamani. Spectroscopic study of FTO/CdSe (MPA)/ ZnO artificial atoms emitting white color.*Indian Journal of Nanoscience.* 2017; 5(1), January.