4th INTERNATIONAL CONFERENCE ON
RESEARCH IN ENGINEERING, SCIENCE AND TECHNOLOGY
6th. September 2016 Athens GREECE
چهارمین کنفرانس بین المللی پژوهش در مهندسی، علوم و تکنولوژی
آتن یونان ۱۶ شهریورماه ۱۳۹۵

Check the synthesis and properties of quantum particles ZnSe

Mehdi Naseri Moghadam
Department of Chemical Engineering
Shahrood branch, Islamic Azad University Shahrood,Iran
mnaserimoghadam@gmail.com
Meysam Namvar
Department of Chemical Engineering
Shahrood branch, Islamic Azad University Shahrood,Iran
maisamnamvar@yahoo.com
Seyed Mojtaba Hosseini khan bebin
Department of Chemical Engineering
Shahrood branch, Islamic Azad University Shahrood,Iran
seyedmojtabahosseini@yahoo.com
Shoorangiz Alaie Oregani
Department of Chemical Engineering
Shahrood branch, Islamic Azad University Shahrood,Iran
Alaie.shoorangiz@gmail.com
Seyed Mohsen Ziaei Sistani
Department of Chemical Engineering
Shahrood branch, Islamic Azad University Shahrood,Iran
Mohsenziaei69@gmail.com

Abstract
The effect of additives on the fluorescence spectra of semiconductor nanoparticles was studied using ZnSe particles of various sizes and composition. Based on the fluorescence quenching of quantum dots caused by material a simple, sensitive and rapid method was developed. In the end satisfactory results were obtained. The different synthesis methods was also discussed

Keywords: nanoparticles, ZnSe, synthesis

Introduction

Quantum dots (QDs), also called semiconductor nanocrystals, are inorganic particles with nanoscaled dimensions and unique size-tuneable luminescent properties. QDs have demonstrated several remarkable and attractive optoelectronic characteristics, such as a broad excitation spectrum, narrow emission spectrum, high photobleaching threshold, excellent photostability andflexibility of functionalization with conjugating ligands for the selective nanosensing of analytes, which are especially suited for analytical and bioanalytical applications(Gema et al,2014). The sizes of QDs could be controlled by the synthesis methods(Weimin et al,2016).

Zinc Selenide (ZnSe) is an important II\\VI semiconductor with a direct band-gap of Eg = 2.7 eV at room temperature. With a wide band-gap, high luminescence efficiency, and low absorption coefficient, ZnSe has potential for a variety of applications such as shortwavelength lasers, light-emitting diodes, thin film solar cells and other photoelectronic devices(Guanghua et al,2016).

The synthesis of QDs can be divided into two categories: organic phase high temperature decomposition and aqueous phase synthesis. The organic phase high temperature synthesis can get nanoparticles with wide wavelengths, evenly dispersed, narrow particl size and high fluorescent intensity but poor water-soluble and serious flicker . The aqueous phase synthesis has been a hotspot for the obtained water-soluble QDs can be directly applied in thebiological field. Compared with the organic phase high temperature synthesis the fluorescence intensity of aqueous phase synthesis QDs is lower, but they have the obvious advantages of simple operation, controllable surface charge, stronger anti photobleaching ability, better optical properties and others. And along with the synthesis methods improved, the fluorescence intensity of aqueous phase synthesis QDs is enhanced greatly(Jianqiu et al, 2015, Jing, 2015).

Recently, fluorescence resonance energy transfer (FRET) has been widely implemented in biosensors(Hong and Jong2015).Fluorescence spectroscopy is a type of electromagnetic spectroscopy which analyzes fluorescence from a sample. It involves using a beam of light, usually ultraviolet light thatmexcites the electrons in molecules of certain compounds and causes them to emit light; typically, but not necessarily,visible light . A complementary technique is absorption spectroscopy.

Synthesis of ZnSe

Synthesis of ZnSe was performed using a green photochemical method in a queous medium at room temperature.Thioglycolic acid (TGA)was used as a capping agent.At first, the solution of NaHSe as selenium precursors was prepared by adding 0.024 g Se powder to 0.04 $NaBH_4$ in 2 ml deionized (DI) water in athree necked flask by stirring under argon gas flow.After 5 min,the mixture solution was transferred to asyringe througha filter.

Second, 0.1314 g zinc acetate was dissolved in 75 ml DI water and then 0.1 ml (2.4mmol)TGA was added as a capping agent.The molar ratioof $[Zn^{2+}]$:[TGA]:$[Se^{2-}$_] was 2:8:1.The pH of the solution was adjusted to 11 by adding a proper amount of NaOH and then the resulting solution was placed under argon flow for 15 min.In the next step NaHS eprepared solution was injected into the zinc solution.Finally,the prepared solution was exposed to UV illumination using an 80 W high pressure mercury lamp,placed 20 cm above the solution at room temperature.(M. Molaei et al,2015).

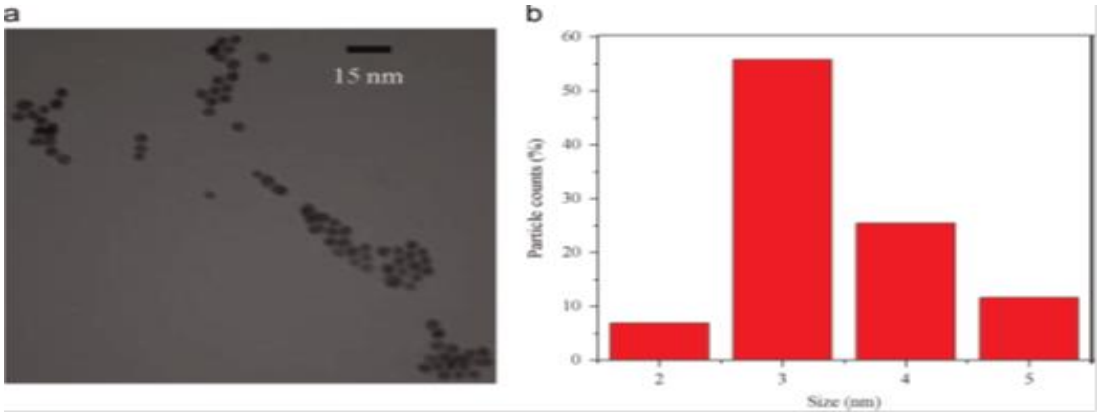

Fig. 1. TEM image (a) and size distribution histogram (b) of ZnSe NCs

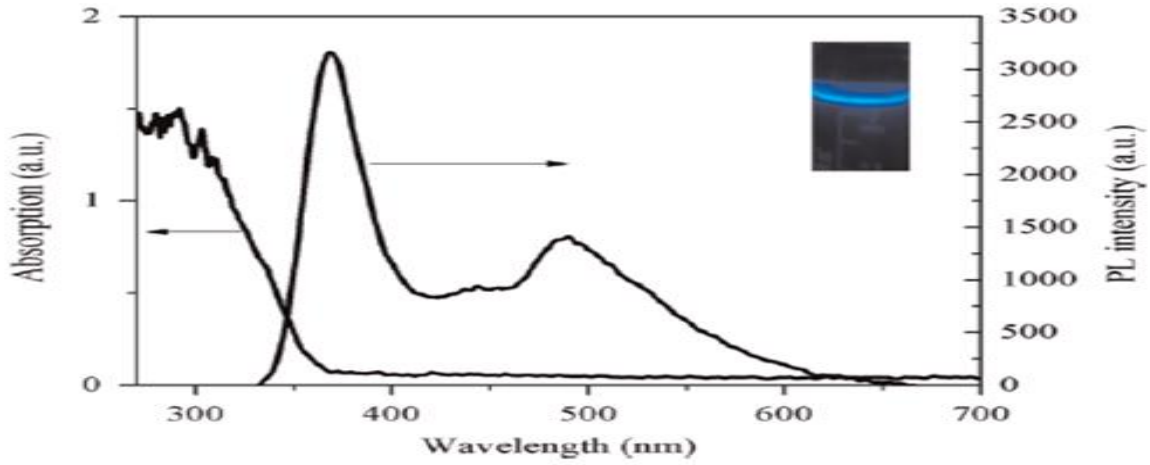

Fig. .۲. Absorption and PL spectra of ZnSe NCs (inset: emission image of ZnSe NCs).

Synthesis of ZnSe

In a typical synthesis process of the spherical-like ZnSe, 2 mmol $Zn(NO_3)_2.6H_2O$ and 2 mmol Na_2SeO_3 were dissolved into 30 ml deionized water to form turbid solutions with stirring in a 60 mL Teflon-lined autoclave, and then 15 ml $N_2H_4.H_2O$ (80 wt% in water) was added into the solutions. After the mixture was stirred for another two min, the autoclave was sealed and then heated at 180°C for 24 h. The autoclave was then cooled down to room temperature naturally. The final precipitates were collected by centrifugation, washed several times with absolute ethanol and deionized water, and then dried in a vacuum oven at 60°C for 10 h.(YunFu et al,2015).

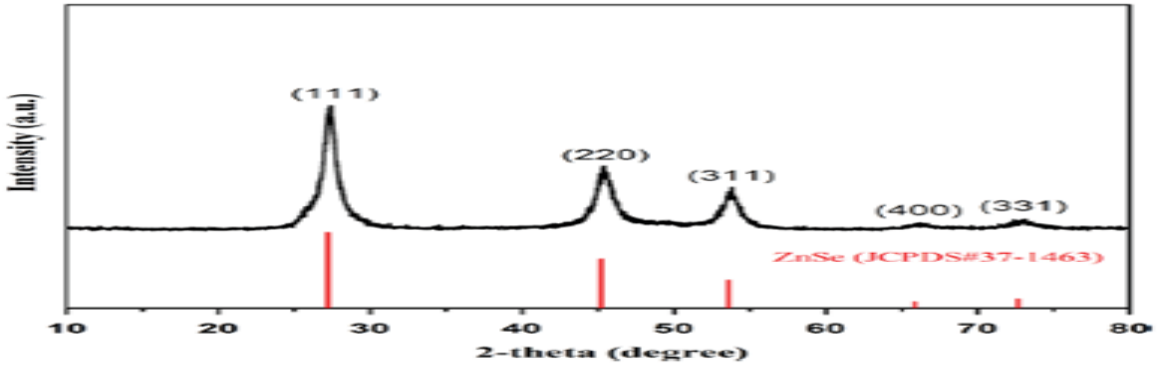

Fig.3. XRD pattern of the ZnSe particles

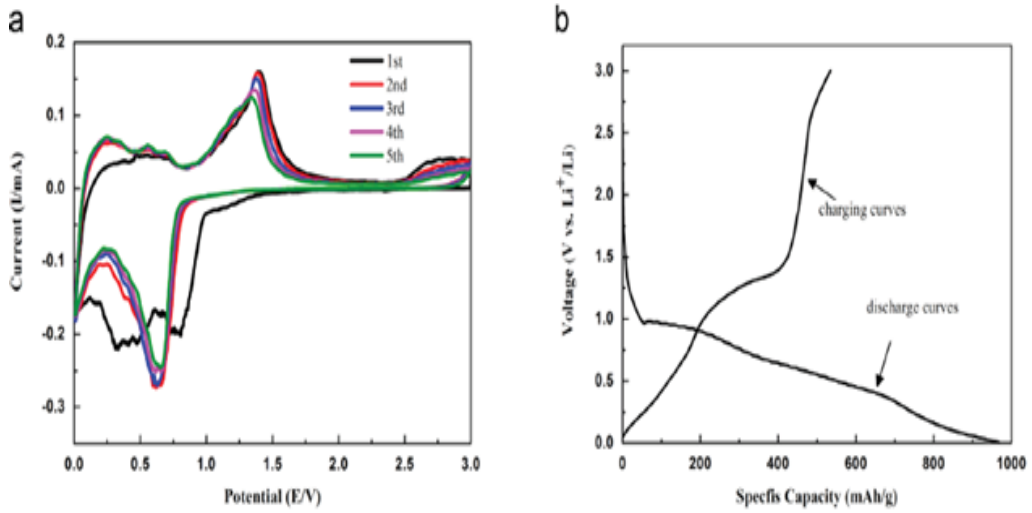

Fig.4. (a) cyclicvoltammogramsofthe first five cycles of ZnSe particles ;(b)dischargeandchargecurvesofthe first cycle of ZnSe particles

Synthesis of ZnSe

For sample preparation, 1 mmol of $ZnCl_2$ (Baker, 98.2%) was dissolved in deionized water at room temperature with constant stirring. After that, Extran was added. Additionally, 1 mmol of selenium powder (Aldrich, 99.5%) and 2 mmol of sodium borohydride ($NaBH_4$, Sigma 95%) were dissolved in deionized water under constant stirring and maintained for 13 min at 75 °C. Following, the two solutions were mixed during 30 min at room temperature. A cleaning process was performed to eliminate the generated by-product. adding 1 ml of HCl (37%) in the solution and stirred during 15 min, after, the stirring was stopped and then precipitation of the NPs was produced. Finally, NPs were dried at 45 °C for 2.5 h. The pH of the solutions was varied from 8 to 11 and the Zn:Se molar concentrations were varied as: 3:1, 2:1, 1:1, 1:2, 1:3.(R. Hernández et al,2015).

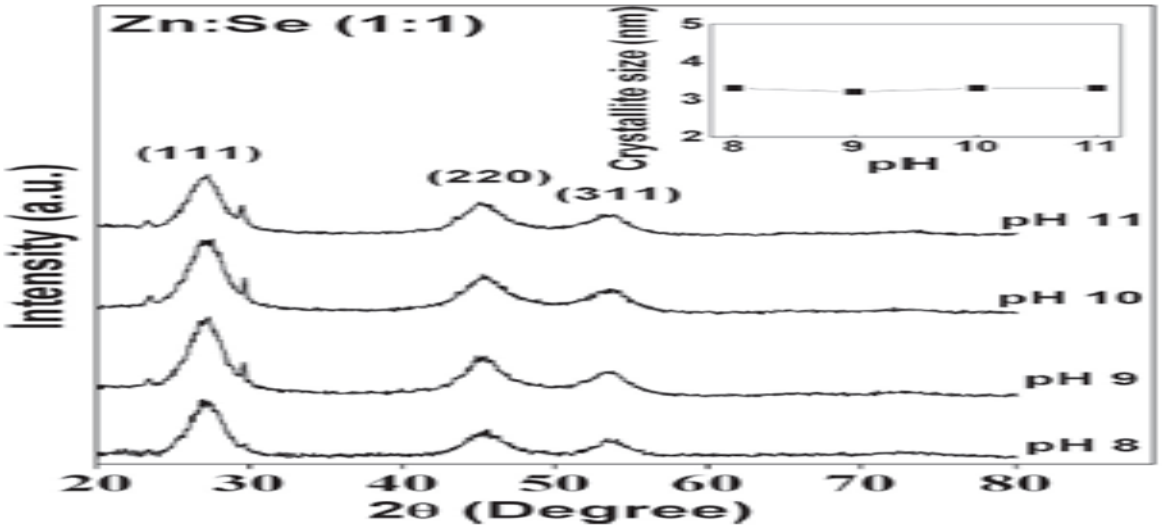

Fig.5. XRD patterns of NPs-ZnSe samples with Zn:Se molar concentration(1:1). Inset shows the crystallite size vs molar pH plot

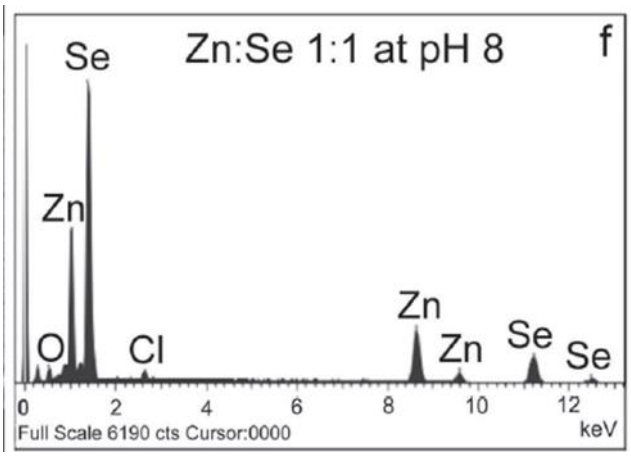

Fig.6. EDS spectrum of the NPs-ZnSe.

Synthesis of ZnSe

The 0.25 M sodium selenosulphate solution was prepared by mixing 2.36 gm selenium powder (99% purity) with 9.48 gm anhydrous sodium sulfite in 120 ml of distilled water with constant stirring for 8 h. It was sealed and kept overnight, since on cooling, a little selenium separated out from the solution. It was then filtered to obtain a clear solution. A 25 ml of (0.5 M) zinc acetate solution was taken in a beaker of 200 ml capacity. To, it 1ml of hydrazine hydrate (80 %) was added under a constant stirring. To this, under constant stirring, a sufficient amount of ammonium solution (25 %) was added to dissolve the turbidity of resultant solution. The desired pH of the resultant solution was adjusted by adding sodium hydroxide (1 M) solution. Then the reactant vessel was kept at 343 K in a constant temperature water bath. When appropriate temperature of 333 K was reached,sodium selenosulphate (0.25 M, 25 ml) solution was added to the bath. Then heated continuously at constant 343 K temperature for 3 - 4 hour and cooled to the room temperature. White colored precipitates obtained at

the bottom of the beaker were filtered, washed a number of times in distilled water and dried in a vacuum.(M.P. Deshpande et al,2011)

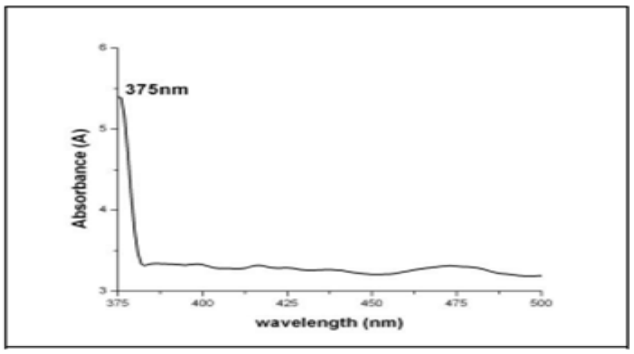

Fig.7. Absorption spectra for ZnSe nanoparticles

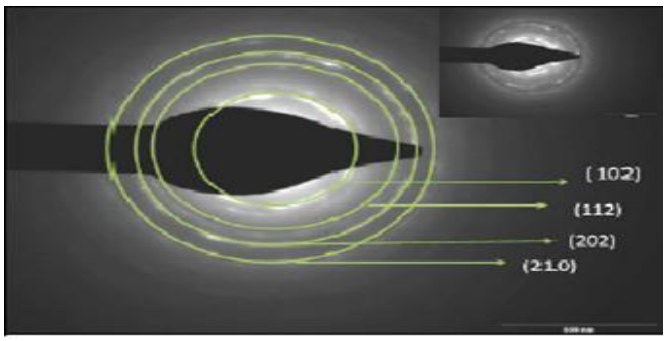

Fig.8.Selected area diffraction pattern for ZnSe nanocystallites

Conclusion

In conclusion, we have synthesized a series of paramagnetic and luminescent nanoparticles with high quantum yield and relaxivity and simple, rapid and sensitive method for material analysis has been established based on the fluorescence intensity quenching of, ZnSe QDs.

References

Guanghua Liu, Xuanyi Yuan, Jiangtao Li, Kexin Chen, Yuyang Li, Laifeng Li.(2016). Combustion synthesis of ZnSe with strong red emission. Journal of Materials and Design. Vol. 97. No.1 . 33-44

Gema M. Durلn, Marيa R. Plata, Mohammed Zougagh, Ana M. Contento, Ángel Ríos. (2014). Microwave-assisted synthesis of water soluble thiol capped CdSe/ZnS quantum dots and its interaction with sulfonylurea herbicides. Journal of Colloid and Interface Science. Vol. 428. No. 2. 235-241

Hong Dinh Duong and Jong Il Rhee.(2015). Electronic energy transfer from sol–gel matrix and CdSe/ZnS quantum dots to protoporphyrin IX (PpIX) and its application for PpIX detection. Journal of Industrial and Engineering Chemistry. Vol. 21. No. 3. 166-171

Jianqiu Chen, An Xiao, Zhengwei Zhang, Yan Yu and Zhengyu Yan.(2015). The synthesis and modification of CdTe/CdS core shell quantum dots. Journal of Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy. Vol. 151. No. 4. 506-509

Jing Dai, Xiaoyun Yang, Morgan Hamon and Lingzhao Kong.(2015). Particle size controlled synthesis of CdS nanoparticles on a microfluidic chip. Journal of Chemical Engineering. Vol. 280. No. 5. 385-390

M. Molaei, A.R.Bahador, M.Karimipour. (2015). Green synthesis of ZnSe and core–shell ZnSe@Zn Snanocrystals (NCs) using a new ,rapid and room temperature photochemical approach. Journal of Luminescence. Vol. 166. No. 6 . 101-105

M.P. Deshpande, S.H. Chaki, N.H. Patel, S.V. Bhatt, B.H. Soni.(2011). STUDY ON NANOPARTICLES OF ZnSe SYNTHESIZED BY CHEMICAL METHOD AND THEIR CHARACTERIZATION. Journal of Nano- Electron. Phys. No. 7. 193-202

R. Hernández, E.Rosendo, R.Romano-Trujillo, A.I.Oliva, G.García, G.Nieto, T.Díaz, C.Morales, H.Juárez, M.Pacio, R.Galeazzi. (2015). Colloidal synthesis of ZnSe nanoparticles at room temperature. Journal of Materials Letters. Vol. 159. No. 8. 229-232

Weimin Yang, Huafang Yang, Wenhao Ding, Bing Zhang, Le Zhang, Lixi Wang, Mingxun Yu, Qitu Zhang.(2016). High quantum yield ZnO quantum dots synthesizing via an ultrasonication microreactor method. Journal of Ultrasonics Sonochemistry. Vol. 33. No.9. 106-117

Yun Fu, Zhian Zhang, Ke Du, Yaohui Qu, Qiang Li, Xing Yang.(2015). Spherical-like ZnSe with facile synthesis as a potential electrode material for lithium ion batteries. Journal of Materials Letters. Vol.146 No. 10. 96-98