2nd INTERNATIONAL CONFERENCE ON
RESEARCH IN SCIENCE AND TECHNOLOGY
Istanbul-Turkey 14 March 2016
RSTCONF
دومین کنفرانس بین المللی
پژوهش در علوم و تکنولوژی
ترکیه - استانبول ۲۴ اسفند ۱۳۹۴

Study Synthesis and characterization of nanoparticles CdTe quantum

Mahdi naserimoghadam
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

Mojtaba Hossini Khan bebin
Department of Chemical Engineering
Shahrood branch, Islamic Azad University Shahrood,Iran
Seyedmojtabahosseini@yahoo.com

Meysam Rafiyan
Department of Chemical Engineering
Shahrood branch, Islamic Azad University Shahrood,Iran
Meysam_rafiyan@yahoo.com

Abstract
The effect of additives and the fluorescence spectra and X-Ray Diffraction(XRD) and Transmission Ellectron Microscope (TEM) and Energy Dispersive X ray(EDX) of semiconductor nanoparticle was studied using CdTe 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: Synthesis, Quantum Dot, CdTe nanoparticles

Introduction

The use of quantum dots (QDs) for the development of sensors is one of the most developingfields of nanotechnology so far Their fluorescence efficiency is sensitive to different compounds on their surface. (Gema et al, 2015).Luminescent semiconductor nanoparticles, commonly referredto as‘quantum dots’ (QD), have had a profound impact on research in biological sensing, medical diagnostics and therapeutics The focus has evolved from QDs as passive sensing or imagingagents to exploration of their use as therapeutic agents in the treatment of disease, or as multifunctional platforms capable of simultaneous diagnostic and therapeutic modalities (theranostics)(Aravind et al, 2013, Joseph et al, 2005). Quantum confinement effects are responsible for such remarkable properties, which depend on their size and composition Such effects offer the analyst high fluorescent quantum yields, narrow and symmetric size tuneable emission spectra, high resistance to photobleaching and long fluorescence lifetimes; features which can be highly useful for analytical purposes(Gema et al, 2013, Jie et al, 2014).

CdTe nanoparticles have been the subject of numerous investigations. Because of high quantum efficiency and multicolor availability, CdTe nanoparticles can find applications in solid-state lighting, displays, optical communications, sensors, as well as in biological imaging and detection. Currently, two synthesis strategies, nonaqueous synthesis and aqueous synthesis, are used to prepare CdTe nanoparticles. As compared to the nonaqueous synthesis, aqueous synthesis is more reproducible, cheaper, less toxic, and the “as-prepared” samples are more water-soluble and bio-compatible.(Yuanfang et al,2006, Kiran et al, 2009)

Synthesis of CdTe

The CdTe NPs were synthesized using a two-step procedure:(i) the $CdCl_2$precursor solution was prepared by mixing a solution of $CdCl_2$with the surfactant as stabilizer, upon which the pH of the solution was adjusted by the addition of 1 N NaOH solution under vigorous stirring. (ii) The Te powder was mixed with the $NaBH_4$in a smallflask in the presence of 0.5 mL deionized water. The mixture was maintained at 55°C for 0.5 h to obtain the precursor Te solution as a dark violet solution of NaHTe, which was carefully removed from theflask by using a syringe. Under vigorous stirring, the prepared Te solution was quickly injected into the Cd^{2+} precursor solution in the presence of the surfactant. The molar ratio of Cd^{2+}:Te^{2-}:capping ligand was 2:0.25:1.5. The resulting solution was heated under reflux at 100°C and immediately cooled to room temperature once the reaction was complete. The CdTe NPs were precipitated from the solution using an isopropanol:water mixture (1:1 v/v), followed by centrifugation at 4000 rpm and several washes with deionized water. The purification procedure was repeated several times by repeating the precipitation/centrifugation cycle.(Dongri et al, 2016)

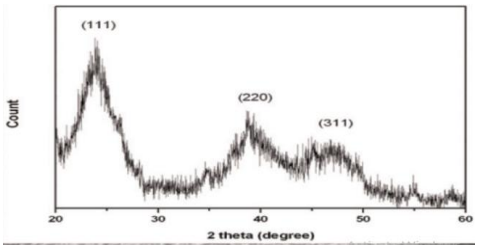

Fig. 1. The XRD pattern of CdTe nanoparticles

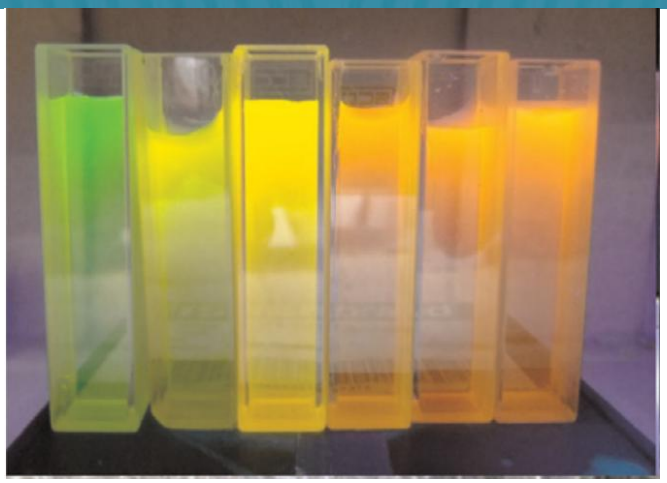

Fig. 2. increasing the reaction time from 30 min to 180 min of CdTe nanoparticles

Synthesis of CdTe/gelatin nanoparticles

Briefly, 10 ml of 5% gelatin solution was prepared at 50 °C under stirring. After the solution cooled down to room temperature, gelatin was desolvated by slowly adding an equal volume of acetone and kept for sedimentation. The supernatant was discarded and the sediment was dissolved in 10 ml as-prepared CdTe QDs colloid with pH near 11. Then 7 ml acetone was added to the gelatin–CdTe QDs mixture dropwise until the solution became turbid. CdTe/gelatin nanoparticles were cross-linked with 0.5 ml formaldehyde solution over night at room temperature. Purification was done by afive-fold centrifugation at 14,000 rpm for 5 min to remove desolvating agent and the excess free gelatin and QDs.(Yunqing et al, 2008)

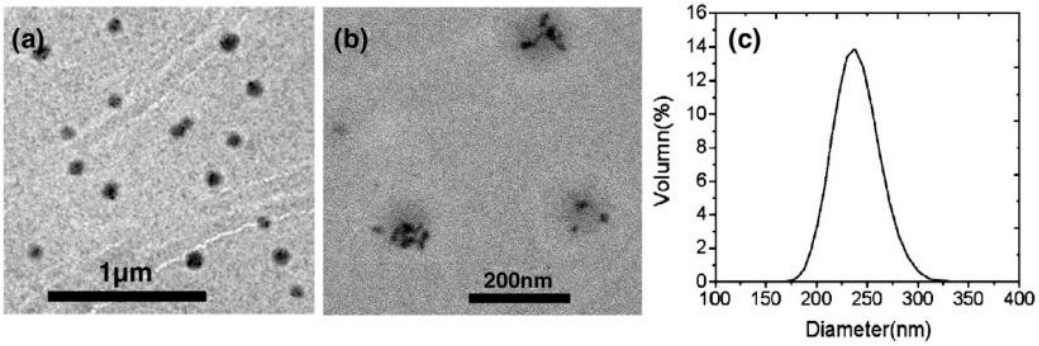

Fig. 3.TEM images ((a), (b)) and size distribution (c) of CdTe/gelatin nanoparticles

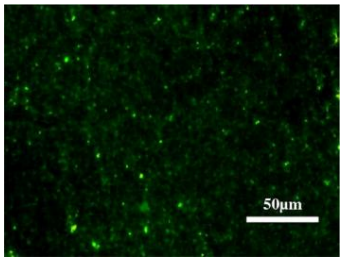

Fig. 3. Fluorescence microscope image of CdTe/gelatin nanoparticles. Objective magnification: 20×

Synthesis of CdTe nanoparticles

Cadmium chloride (1 mM) was dissolved in 100 ml water andthioglycolic acid(5mM) was added indropwiseandthe resultant mixture was stirred. The resultant turbidity appear ance of the mixture indicates the formation of the cadmium- TGA complex which turned into clear

transparent one, when pH was maintained as 10.5 using 1 M NaOH solution. Then tri sodium citrate dihydrate was added with this mixture toavoid the formation of cadmium tellurite ($CdTeO_3$)in the solution. The entire solution was purged with nitrogen in a three necked flask. Then the tellurium nanorods were added simultaneously as tellurium source in the presence of excessive sodium borohydride. The molar ratio of Cd^{2+}:Te^{2-} TGA for this entire synthesis processis1:0.5:5.Now, the mixture was strongly heated to 100°C. The colour of the initial solution was observed as yellow and then converted to orange after prolonged refluxing. Aliquot samples were taken at different time. intervals and the size dependency was checked through absorption and emission spectra. The synthesized particles were precipitated by adding the nonsolvent iso-propanol and centrifuged. The resultant precipitate was washed twice using ethanol to remove the excess of surface ligand and by-products and then dried in vacuum for further analysis. .(S. Ananthakumar Et al ,2014)

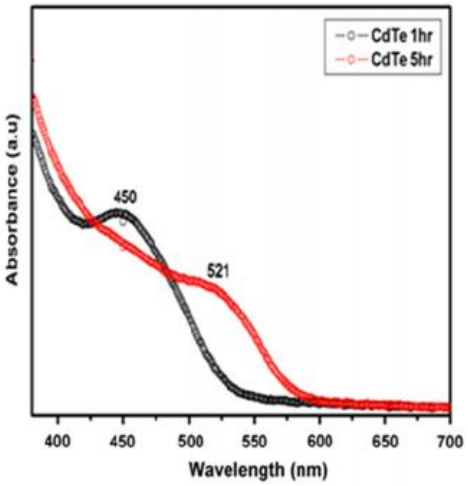

Fig 4.UV/vis and fluorescence spectra of CdTe particles

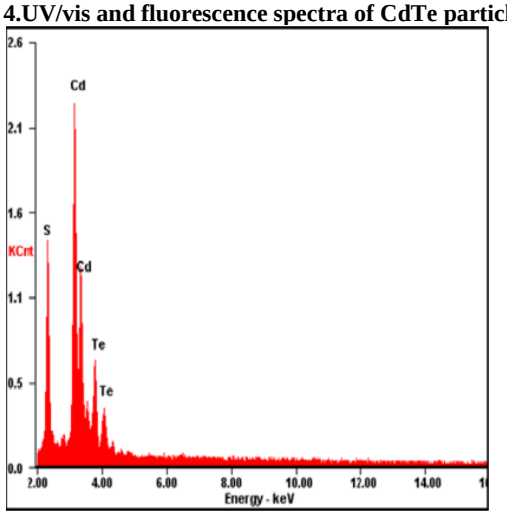

Fig. 4.EDX spectra of the CdTe nanoparticles

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 CdTe QDs.

References

Aravind Baride, Daniel Engebretson, Mary T. Berry and P. Stanley May.(2013). Quenching of coumarin emission by CdSe and CdSe/ZnS quantum dots: Implications for fluorescence reporting. Journal of Luminescence. Vol. 141. No. 1. 99-105

Dongri Jin, Min-Ho Seo, Bui The Huy, Quoc-Thai Pham, Maxwell L. Conte, Daniel Thangadurai andYong-Ill Lee.(2016). Quantitative determination of uric acid using CdTe nanoparticles as fluorescence probes. Journal of Biosensors and Bioelectronics. Vol. 77 No. 2. 359-365

Gema M. Durán, Ana M. Contento and Ángel Ríos.(2015). β-Cyclodextrin coated CdSe/ZnS quantum dots for vanillin sensoring in food samples. Journal of Talanta. Vol. 131. No. 3. 286-291

Gema M. Durán, Ana M. Contento and Ángel Ríos.(2013). Use of Cdse/ZnS quantum dots for sensitive detection and quantification of paraquat in water samples. Journal of Analytica Chimica Acta. Vol. 801. No. 4. 84-90

Jie Mei, Li-Yun Yang, LuLai, Zi-Qiang Xu, Can Wang, Jie Zhao, Jian-Cheng Jin, Feng-Lei Jiang and Yi Liu.(2014). The interactions between CdSe quantum dots and yeastSaccharomyces cerevisiae: Adhesion of quantum dots to the cell surface and the protection effect of ZnS shell. Journal of Chemosphere. Vol. 112. No.5 92-99

Joseph A. Gaunt, Alex E. Knight, Stuart A. Windsor and Victor Chechik.(2005). Stability and quantum yield effects of small molecule additives on solutions of semiconductor nanoparticles. Journal of Colloid and Interface Science. Vol. 290. No. 6. 437-443

Kiran Jain, Vibha Srivastava and Abhilasha Chouksey.(2009).Synthesis and optical prpperties of CdTe nanocrystal whit improved optical properties. Journal of Engineering & Materilas Sciences.Vol. 16 No.7. 188-192

S. Ananthakumar, J. Ramkumar, J. Ramkumar and S. Moorthy Babu.(2014). Facile synthesis and transformation of Te nanorods to CdTe nanoparticles. Journal of Materials Science in Semiconductor Processing. Vol.27. No.8. 12-18

Yuanfang Liu, Wei Chen, Alan G. Joly, Yuqing Wang, Carey Pope, Yongbin Zhang, Jan-Olov Bovin and Peter Sherwood.(2006). Comparison of Water-Soluble CdTe Nanoparticles Synthesized in Air and in Nitrogen. Journal of Phys. Chem. B. No.9.

Yunqing Wang, Haiyan Chen, Chao Ye and Yuzhu Hu.(2008). Synthesis and characterization of CdTe quantum dots embedded gelatin nanoparticles via a two-step desolvation method. Journal of Materials Letters. Vo. 62. No.10. 3382-3384