

Study on Fluorescent Detection Glucose Molecule Marked with ZnSe Nano Crystalline in Microchannels

Zhong-chen Bai, Xin Zhang and Shui-jie Qin

Laboratory for Photoelectric Technology and Application,
Guizhou University Guiyang 550025, China
yufengvc@163.com, le.xzhang@gzu.edu.cn, sjqin@mail.gzst.gov.cn

ABSTRACT

Shell-core structure of ZnSe nano crystalline cluster is used for marking glucose molecules in this paper. Fluorescent detection is successfully realized in microchannels. Mercaptoacetic acid is used for packing ZnSe nano crystalline cluster, which is dissolved in the water. Carboxyl of mercaptoacetic acid is used for connecting glucose molecule, and mixture solution of glucose molecule marked with ZnSe nano crystalline cluster is inhaled by capillary force in multi-microchannels with diameter of 30 microns. Exciting light with the wavelength range from 265nm to 420nm is used for stimulating glucose molecules marked with ZnSe nano crystalline cluster in multi-microchannels, and fluorescent detection is carried out for glucose molecules. It is concluded that shell-core structure of ZnSe nano crystalline cluster is feasible for marking glucose molecules. The new method will lead to new application in many fields such as biologic analysis, bio-sensor, biologic detection and spaceflight, and so on.

Keywords: nano crystalline, bio-sensor, microchannels, fluorescent detection, nano cluster

1 INTRODUCTION

Nano crystal[1] and nano crystalline cluster have been interested as their potential application in biology and medical analysis. Nano crystalline cluster [2-5] used for fluorescent marking has many merits in contrast with traditional dye fluorescent such as small size in surface, specific chemistry characterization, and the range wide of frequency spectrum of exciting light, continuous distribution, symmetrical distribution of emissive spectrum, wide-narrow of spectral line, adjustable color, and so on. Based on these photochemical stability and spectral characterization, nano crystalline cluster is rapidly developed in biologic analysis and detection. In general, nano crystalline cluster can be dissolved in the water or buffer solution[6]. In the last few decades, nano crystalline cluster can transmit a lot of photons and fluorescent stability, which has been a hot topic in biologic analysis and detection, particularly, nano crystalline cluster of shell-core structure can be widely applied.

Glucose molecules is cardinal element of blood sugar and urine glucose. Diabetes can be discovered and forestalled early by detecting glucose molecules. Glucose molecules exists widely in biologic organism. Detecting glucose molecules in biologic organism has significant in

studying on energy transition between two biologic body, and unscramble life origin. Detecting glucose molecules in food can protect health of person from aggravating of disease, which has a significance.

Usually, glucose molecules is detected by many methods, such as glucose oxidized enzyme methods(GOD), oxidative electrode rate methods, fluorescent methods, and so on. All these methods consume lots of sample with low detecting sensitivity. Especially, detecting experiment of blood glucose and urine glucose in body need extract blood many times, which can causes pain to patients. In scale of microchannels determine consumption of sample, the size of microchannels can affect sensitivity of glucose molecules. In this paper, microchannels as the detecting container content a few sample and satisfy easily detecting demand, withal high sensitivity. Recently, transparent material multi-microchannels with improving of processing microchannels technology was applied more and more in biologic analysis and detection[7]. Microchannels with diameter of 30 microns was applied for detecting container, fluorescent detection glucose molecule marked with ZnSe nanocrystalline cluster is implemented commendably in multi-microchannels in this paper.

2 EXPERIMENTAL

2.1 Setup for fluorescent detection

Shell-core structure Nano crystalline cluster is indicated in figure 1. Many active molecule groups in surface of shell can connect detecting molecules by adsorption or chemical bonding methods, and that ZnSe nano crystalline cluster photoluminescence characterization is used for exciting light. Moreover bring fluorescent is collected by CCD. Sequentially, fluorescent detection glucose molecule marked with ZnSe nano crystalline cluster is realized successfully in microchannels. Solution of Figure 1 is inhaled in multi-microchannels by capillary force. The range of wavelength from 265nm to 420nm is used for exciting mixture solution of microchannels, and fluorescence is produced at the same time. CCD is used for observing all the course of fluorescent bring.

The setup of fluorescent detection is indicated in Figure 2. Exciting light in the range of wavelength from 265nm to 420nm illuminates glucose molecules which is marked with ZnSe nano crystalline cluster in multi-microchannels in the stage at 45 degree. Fluorescent that is bring by exciting ZnSe nano crystalline cluster overpasses objective lens and

two-way color selective mirror, and is filtered by optical filter. The picture is obtained by CCD and computer system.

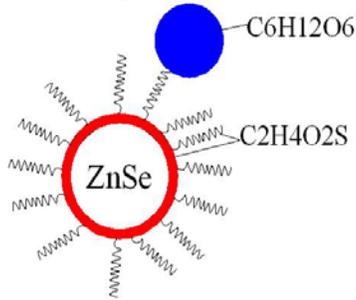


Figure.1 Schematic of detected molecules marked with ZnSe nanocrystalline cluster

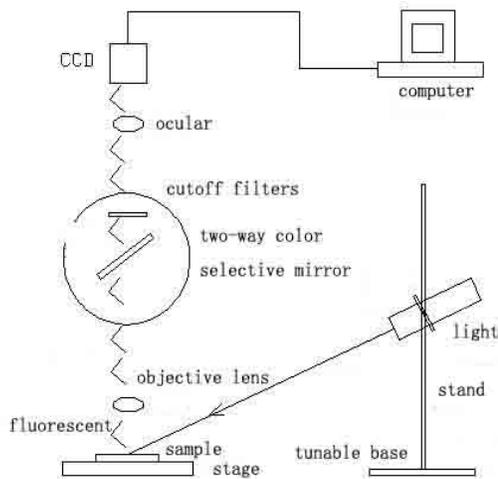


Figure.2 Schematic of the setup for fluorescent

2.2 Preparing experimental sample

2.2.1 Preparation of ZnSe nano crystalline cluster

Se(selenium) and Na_2SO_3 (sodium carbonate) are dissolved in water of 90°C and agitated by magnetic force four hours, which can gain Na_2SeSO_3 solution-1; $\text{Zn}(\text{AC})_2$ (zinc acetate) is dissolved in water and add to $\text{C}_2\text{H}_4\text{O}_2\text{S}$ (mercapto-acid).Next, adding NaOH (sodium hydroxide), and adjusting $\text{PH}=8$. Last, adding to solution-1 by N_2 protected and stirring by magnetic force nine hours at 90°C , which can synthesize ZnSe nano crystalline cluster of shell-core structure.

2.2.2 Preparation of auxiliary sample

Glucose crystal is accurately cranked out 10ml of 0.5mol/L solution-2. Solution-2 of 1ml is diluted 10 times by de-ionized water, which is cranked out 0.05mol/L solution-3. Between solution-3 1ml and 1ml of ZnSe packed $\text{C}_2\text{H}_4\text{O}_2\text{S}$ solution are mixed. Then standing 45 minutes in test tube, which is made solution-4. Transparent material multi-microchannels with inside diameter of 30 microns and tube wall of 5 microns is provided by xi'an institute of optics and precision mechanics of GAS in this experiment.

2.2.3 Inlet sample

One end of transparent material multi-microchannels is submerged solution-4. Solution-4 can be inleted slowly microchannels by capillary force. When microchannles is filled of solution-4, microchannels is taken out and fixed carefully on the stage, observed under microscope. If microchannels without solution-4 is black in microscope. The reason is that light is refracted between air interface and microchannels wall. However, microchannels with solution-4 is bright in microscope. The reason is refractive index of solution-4 is close to microchannels wall comparing with air.

3 RESULTS AND DISCUSSION

3.1 Fluorescent observed results

Glucose molecule marked with ZnSe nano crystalline is observed in multi-microchannels by CCD. Adjusting the stage of Figure 2, solution of glucose molecules marked with ZnSe nano crystalline cluster is illuminated by exciting light at 45 degree of the horizontal direction and ZnSe nano crystalline cluster radiates light. CCD display technology is used for recording experimental results (Figure 3).

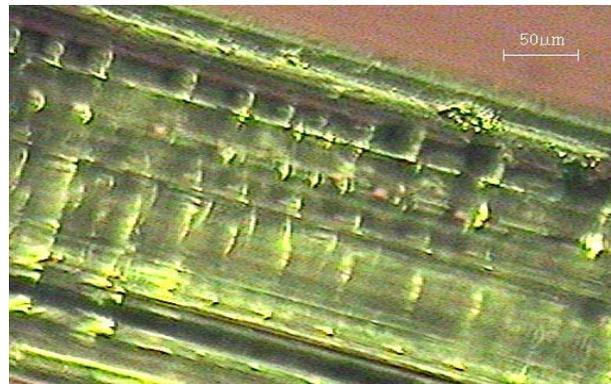


Figure.3(a) Fluorescent molecules excited by the range of 265nm-420nm with 470nm filter brings fluorescence in microchannels

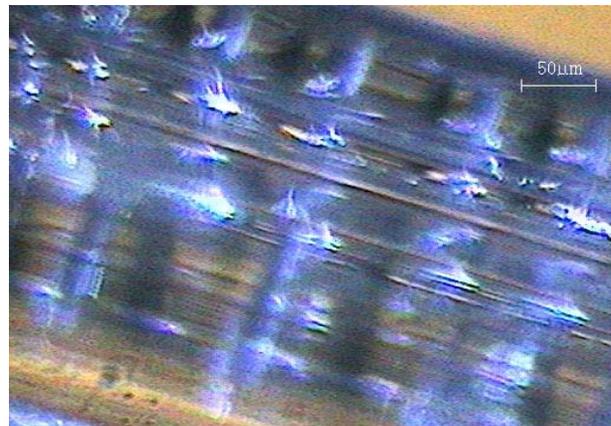


Figure.3(b) Fluorescent molecules excited by the range of 265nm-420nm without filter brings fluorescence in microchannels

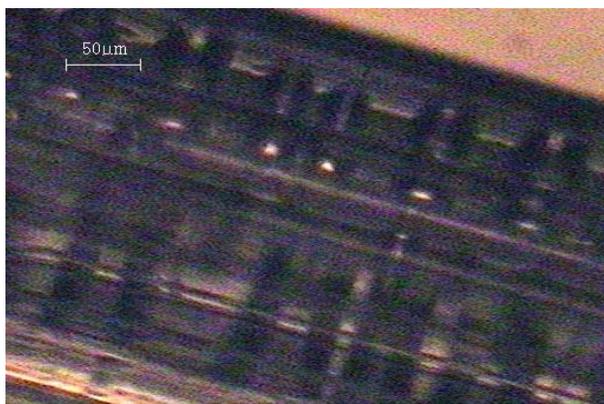


Figure.3(c) Microchannels molecules without exciting light We can observe remarkably glucose molecules marked with ZnSe nano crystalline cluster from (a), (b), (c) in Figure 3, and distinct effect of fluorescent.

3.2 Experimental results effected by wavelength of exciting light

Absorb curves and fluorescent curves of ZnSe nano crystalline cluster are indicated in Figure 4. we can see from Figure 4(a): when exciting light in the range of wavelength is more than 400nm, ZnSe nano crystalline cluster can not absorb any exciting light, but less-than 400nm, ZnSe nano crystalline cluster can absorb exciting light and absorb continuously; we can see from Figure 4(b): line width of fluorescent of ZnSe nano crystalline cluster is narrow and in the range of wavelength from 300nm to 550nm has fluorescent peaks which is very important to marking molecules.

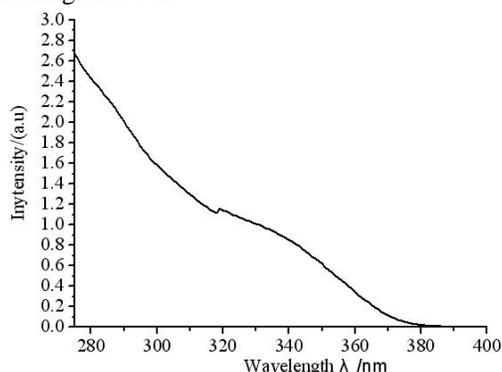


Figure.4(a) PH=8, absorb curves of ZnSe solution

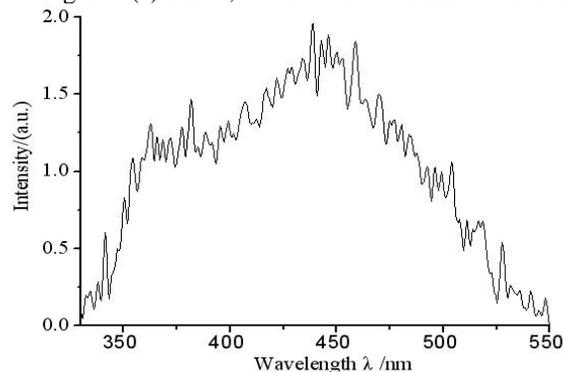


Figure.4(b) PH=8, fluorescent curves of ZnSe solution

Exciting light in the range of wavelength from 265nm to 420nm can be in accord with Figure 4(a). Selecting different filters can come out different results in this experiment. When high pass filter of 470nm is used for filtering background light, we can get green light of Figure 3(b); when without any filter, we can get blue light of Figure 3(c), which is received by CCD. The reason is that main peak of ZnSe nano crystalline cluster lies round 430nm.

3.3 Experimental result affected by exciting light intensity

Experimental results is effected seriously by intensity of exciting light in the experiment. Adjusting distance between exciting light and fluorescent molecules can adjust exciting light intensity. The result shows that when distance between exciting light and fluorescent molecules is less-than 30mm, fluorescence is very strong by CCD receiver, but it has fluorescent quenching; when distance between exciting light and fluorescent molecules is more than 110mm, because of lower power of light, a few molecules can not bring fluorescent at once. Exciting light lasts 20 second, weak fluorescent can be brought. Adjusting distance between exciting light and fluorescent molecules from 30mm to 110mm, fluorescent is brought and fluorescent intensity changes from strong to weak, later on from weak to strong. The picture that glucose molecules marked with ZnSe nano crystalline is clae. In addition; the material of microchannels can scatter light which affects results of experiment.

4 CONCLUSION

In this work, shell-core structure of ZnSe nano crystalline cluster was used for marking glucose molecules. Our results suggested that shell-core structure of ZnSe nano crystalline cluster can mark glucose molecules easily. Furthermore fluorescent intensity is stronger, receiving fluorescent color be adjusted easily. We also found that exciting light power and wavelength have an important effect on experimental results. Changing size of ZnSe nano crystalline cluster changes absorb curves and fluorescent curves of ZnSe solution. The water-dispersible ZnSe nano crystalline cluster has potentials in large-scale application of biologic analysis, bio-sensor, biologic detection, voyage and spaceflight[8-10], and so on.

ACKNOWLEDGEMENTS

This work was supported by Laboratory. for Photoelectric Technology and Application of Guizhou university in China and the National Nature Science Foundation of China Programs (Grant No. 50375031)

REFERENCES

- [1] Wei-Qi Huang, Li Xu, Ke-Yue Wu, et.al, "Enhancement of photoluminescence emission in low-dimensiona structures formed by irradiation of laser". J.Appl.Phys.,**102**,053517(5),2007.

- [2] Xu Rong-hui, WANG Yong-xiang, Xu Wan-bang et. al, "Study on Synthesis and Fluorescent Property of CdS Nanocrystals", *Journal of Synthetic Crystals*, **35**,1007-1011,2006.
- [3] Sung Ju Cho, Dusica Maysinger, Manasi Jain, et al, "Long-Term Exposure to CdTe Quantum Dots Causes Functional Impairments in Live Cells", *American Chemical Society*, **23**,1974-1980, 2007.
- [4] Huang Feng-hua, Peng Yi-ru, "Preparation and Fluorescence Property of ZnS Quantum Dots. Chinese *Journal of Synthetic Chemistry*",**12**,529-531,2004.
- [5] Narayan Pradhan, David M. Battaglia,, Yongcheng Liu.,et al, "Efficient, Stable, Small, and Water-Soluble Doped ZnSe Nanocrystal Emitters as Non-Cadmium", *Biomedical Lbbels.Nano Letters*, **7**,312-317,2007.
- [6] Sha Xiong, Shihua Huang, Aiwei Tang, et al, "Synthesis and luminescence properties of water-dispersible ZnSe nanocrystals", *Materials Letters*, **61**,5091-5094, 2007.
- [7] S.J Qin, Wen J. Li, Michael Y. Wang, "Fabrication of Subbmicro Channels in Quartz Cubes Using LASER-Induced Splitting", *International Journal of Nonliner Sciences and Numerical Simulation* ,**3**,763-768,2002.
- [8] Shengyuan Yang, M. Taher A. Saif, "MEMS based force sensors for the study of indentation response of single living cells",*Sensors and Actuators*,**135**,16-22,2007.
- [9] O. J. Pallotta, G. T. P. Saccone, R. E. Woolford, "Bio-sensor system discriminating between the biliary and pancreatic ductal systems", *Med Biol Eng Comput*, **44**,250-255,2006.
- [10] Montserrat Calleja, Javier Tamayo, "Low-noise polymeric nanomechanical biosensors", *Applied Physics Letters*, **88**,11390(3),2006.