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Research Paper

Interaction of Epirubicin (Ep) and Novel CMC-CdTe / ZnS QDs nanosensor

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Abstract

Cancer named as a group of disease that causes abnormal cell growth with the ability to spread to other parts of body. Epirubicin (Ep) is one of medicine that commonly used for cancer treatment. Evaluation of low concentrations of this drug in body samples requires sensitive, rapid, and accurate analysis methods. Here we report the interaction of novel CMC-CdTe/ZnS QDs nanosensor with Ep. In the presence of 36.45×10^{-6} mol/L Ep 9.5% of fluorescence intensity of CMC-CdTe/ZnS QDs was quenched at 575 nm. This obviously illustrated that CMC -CdTe/ZnS QDs could good interact with Ep and decrease fluorescence intensity of these nanosensor.

Keywords: Nanosensores, Quantum Dots, Carboxymethyl cellulose, Drug determination.

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1. Introduction

Cancer is a general term used to express the disease that can affect different parts of the body. Uncontrolled cellular changes and cell division are common symptoms of the disease. Some types of cancer cause the cell to grow rapidly, while others cause the cells to grow and divide at a slower rate. However, when these changes reach the metastatic stage, we will see death from cancer. Currently, according to WHO statistics, the most common cancers by priority are lung (2.09 million), breast (2.09 million), colorectal (1.80 million), prostate (1.28 million), skin cancer (Non-melanoma) (1.04 million), stomach (1.03 million) [1, 2]. All in all a wide range of medicine applied for different kind of cancer up to now. For example, epirubicin (Ep) is approved to treatments of breast cancer [3]. However, measuring low concentrations of this drug in environmental and body samples requires sensitive, rapid, and accurate analysis methods. Today, the use of chemical sensors, nanosensors and biosensors in measuring low concentrations of drug compounds seems too attractive[4]. The sensor is actually a chemical device or species that is able to reversibly interact with the analyte. This interaction observed by color, and fluorescence changes [5]. Among the different types of sensors, quantum dots nanosensors have received the most attention due to nanometer dimensions that provided a very high accuracy and reactivity. However, as QDs could be toxic, that needs organic polymer protection [6]. Sodium alginate (SA) is one of biopolymers that applied for polymeric protection of GSH-stabilized CdTe/ZnS QDs. Furthermore, the determination of amantadine has done by these nanosensore [7] Another report back to modification of CdTe quantum dots by molecularly imprinted polymer. Whereas, this naosensor reduced emission wavelengths in the presence of norfloxacin [8] By the way, water-solubility and environmentally friendly are two most important parameter for polymeric protection of QDs. As a result, carboxymethyl cellulose (CMC) as the first water-soluble ionic that has produced commercially in the 1920's could be

a good selection for this work. Whereas, depending on the type of CMC, it has applied in food, textile, pharmacy, and coating industry [9]. Consequently, CMC-CdTe/ZnS QDs nanosensor designed, characterized, and investigated in this work. Moreover, the interaction between QDs with Epirubicin (Ep) by using fluorescence spectroscopy has studied.

2. Materials and methods

2.1 Material

Tellurium powder (Te), sodium hydroxide (NaOH), sodium borohydride (NaBH4), cadmium chloride, carboxymethylcellulose (CMC), thioglycolic acid and zinc chloride, were purchased from Sigma Aldrich or Merck chemical componies. All reagents used without further purification.

2.2 Apparatus

Thermogravimetry analysis (TGA) was achieved by Pyris Diamand TG / DTA method under nitrogen gas flow, at a temperature of 25 to 750 ˚C, with a rate of 20 ˚C / min. The fluorescence spectra of sample were measured on SCINCO's Fluorescence Spectrometer FluoroMate FS-2.

2.3 A procedure for synthesis of CdTe / ZnS QDs

The basic synthetic procedure was taken from Bardajee et.al. [10]. Firstly, 0.025 g of Te powder was added to 2.5 mL of double distilled water that degased for 15 minutes previously. After 10 minutes, 0.025 g $NaBH_4$ was added to the reaction system and it continued for 120 min under pure nitrogen. Secondly, 0.11 g of $CdCl_2$ was dissolved in another flask containing 80 mL double distilled water. Then 1.4 mmol of thioglycolic acid was added to the precursor of Cd and the pH of the solution adjusted to 7–8 by adding the 1 Molar NaOH. Finally, to prepare the desired QDs, 1.5 mL of sodium hydrogen telluride solution was injected into 80 mL of cadmium thioglycolate solution very quickly and under nitrogen gas flow to achieve brown solution. Then 0.24 g of zinc sulfide dissolved in 2 mL of double distilled water and add to the solution inside the balloon. For the growth of the obtained quantum dots, the reaction vessel refluxed in an oil bath at 100 ˚C during one hour. The vessel transferred to a cold water bath to obtain QDs with the highest fluorescence emission.

2.4 Synthesis of CMC-CdTe / ZnS QDs nanosensor

Firstly, 3 g of CMC added to 40 mL of boiling water, it placed in a hot water bath at 90 °C, and it mixed with a mechanical stirrer for 25 minutes. After cooling step, 5 mL of CMC solution mixed with 5 mL of CdTe / ZnS QDs.

2.5 Analytical Procedure

Ep drug was prepared with a concentration of 4×10-4 mol / L. Next, 20 µl of it was added to 2 mL of the prepared fluorescence nanosensor at 25 ˚C. After one hour, fluorescence spectra were taken from this solution.

3. Results and Discussions

3.1 Structure and Composition Characterization

Thermal gravity analysis (TGA) was carried out on the commercial CMC, and the result is presented in Figure 1. Two distinct weight losses are observed. The first weight loss is about 17 % in the temperature range of 0 and 250 ˚C. The initial weight loss refer to the presence of moisture in the sample. The second weight loss is 32% in the temperature range of 250 to 580 ˚C due to the loss of CO_2 from the polysaccharide. The final loss of 12% is observed in the temperature range of 580 to 700 ˚C, representing the degradation of the remaining material into carbon residues [11]. The TGA curve CMC-CdTe / ZnS QDs illustrated 17% weight lost up to 150 ˚C. After that it showed a significant weight lost around 44% in the range of 150-560 ˚C. The final loss of 17% is observed in the temperature range of 560 to 700 ˚C, representing the degradation of the remaining material into carbon residues. This result reveals that the CMC-CdTe / ZnS QDs can be used at ambient temperature and moderate temperatures (250 ˚C), which are suitable for biomedical device such as nanosensores.

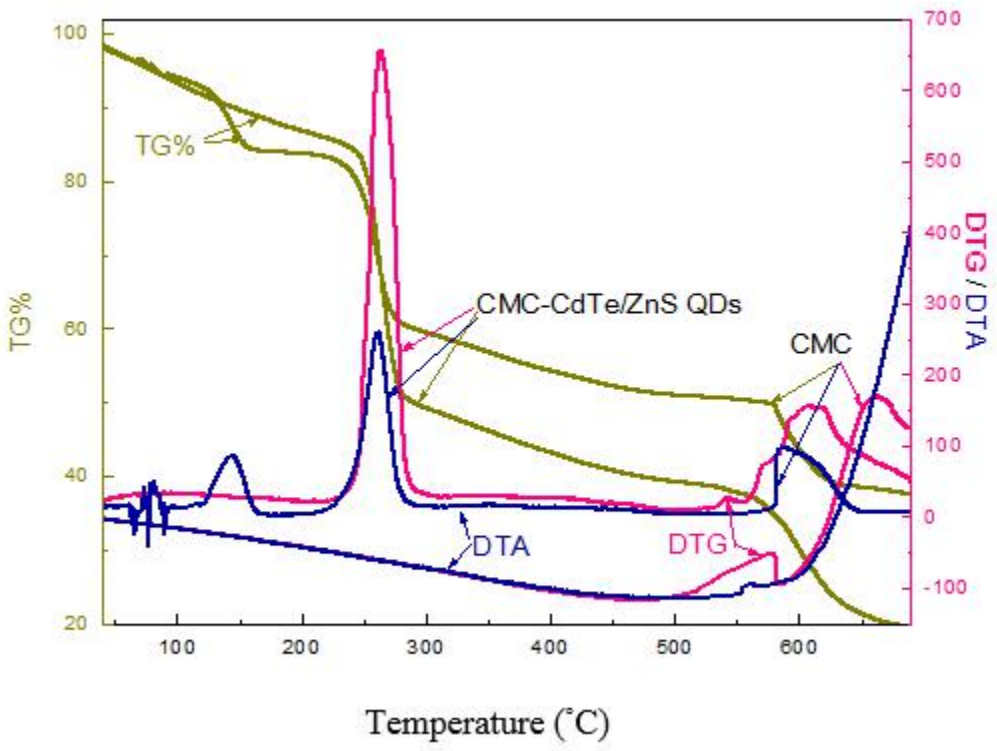

Fig 1: Thermal stability of CMC, and CMC-CdTe/ZnS QDs

3.2 Fluorescence Response of CMC -CdTe/ZnS QDs Towards Ep

The interaction of Ep with CMC-CdTe/ZnS QDs as a nanosensor was studied. As shown in Fig. 2, the fluorescence of CMC-CdTe/ZnS QDs was quenching after adding various concentrations of Ep. In the presence of 36.45 × 10^{-6} mol/L Ep, 9.5% of fluorescence intensity of CMC -CdTe/ZnS QDs was quenched at 575 nm. This obviously illustrated that CMC -CdTe/ZnS QDs could good interact with Ep and decrease fluorescence intensity of the nanosensor.

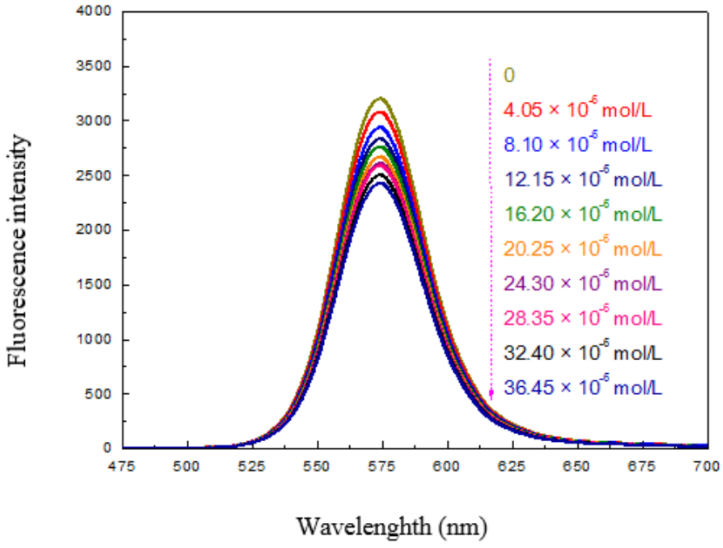

Fig 2: Fluorescence spectra of CMC-CdTe/ZnS QDs

4. Conclusion

In conclusion CMC-CdTe/ZnS QDs was successfully prepared by aqueous method. TGA characterizations indicated the formation of robust bonding between CdTe QDs and the biopolymeric ligands. Fluorescence response of CMC -CdTe/ZnS QDs towards Ep showed that this nanosensor can

be regarded as a good candidate for further biological applications.

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