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TUNABLE LUMINESCENCE OF CdTe QUANTUM DOTS

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ABSTRACT

This paper reports the synthesis and characterization of CdTe system with highly luminescence properties. The QDs was prepared by quick injection of tri-n-octylphosphine telluride into reactor that contains a hot mixed cadmium acetate hydrate, 1-octadecent, n-octadecyl phosphoric acid and oleic acid. We have successfully synthesized the CdTe QDs with highly yellow luminescence by controlling the concentration of cadmium. The CdTe QDs with unique bright emission wavelength from 550 nm to 574 nm. Our observation found that the quantum yields of the CdTe quantum dot are high with value up to ca 80 %. The CdTe QDs may be used in LEDs, biolabellings and solar cells.

INTRODUCTION

Semiconductor nanocrystals, also known as quantum dots (QDs), have attracted considerable attention past decades due to their unique properties, such as high chemical stability, resistance to photo degradation and radial tunable optical properties [1-2]. The properties of nanosized materials have generated a great deal of interest, because of the science involved in these studies and technological dimension of the particle approach to the nanometer scale, quantization and surface effect begin to play an important role, leading to drastic changes in measured properties [3].

To obtain good luminescence properties (i.e. emission color, color purity, quantum yield, and stability), the surface structure of semiconductor must be strictly controlled. The high temperature for growth CdTe quantum dot helpful for uniform growth quantum dot in this protocol [5]. Cadmium telluride (CdTe) nanocrystal is one of the most attractive QDs because of its size-dependent emission in a visible region and high photoluminescence quantum yield [6]. However different size of QDs was obtained by controlling its nucleation QDs.

We have successfully synthesized the CdTe QDs with the variation cadmium of cadmium precursor. Here, n-octcyl phosponic acid critical in term exchangeable the photoluminescence properties, this system we can get control growth time and it saw to emission highly photoluminescence quantum yields. The CdTe QDs maybe used in

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LEDs, biolabelings and solar cells.

EXPERIMENTS

Materials used for synthesis CdTe QDs are: cadmium acetate hydrate (Cd, 99% pure), tellurium powder (Te, 99% pure), tri-n-octylphosphine (TOP, 95% pure), n-octadecyl phosponic acid, 1-octadecene, techn (90%, pure) and oleic acid.

The CdTe QDs were synthesized via wet chemical process by adopting Talapin method with several modifications [7]. At, first two solution were prepared; tellurium precursor or TopTe and cadmium precursor. Tellurium precursor was prepared by dissolving tellurium powder in tri-n-octylphosphine and was heated at 200 ^{o}C for 30 minutes. Meanwhile, the cadmium precursor solution was obtained from cadmium acetate hydrate, 1-octadecent, n-octadecyl phosponic acid and oleic acid and was heated to 350 ^{o}C. The next step is to grow CdTe QDs. The TopTe solution at room temperature was added to the cadmium precursor solution which was heated 350 ^{o}C. In this study we made variation of mixing by Cd : Te 1:1,1:2 and 2:1. After the addition of TopTe and quenched the nanocrystal growth time by injection them into ice cooled of 5 ml hexane solution. The aliquots amount of reaction solution was extracted at several period of time namely 5 s, 10 s, 25 s, 40 s and 70 s. Hence, the QDs with different growth times can be obtained.

The synthesized of CdTe QDs characterisized by measuring photoluminescence (PL) using Perkin-Elmer LS55 Luminescence spectrophotometers. Their size and morphology was studied transmission electron microscopy (TEM) experiment (CM 12 Philips TEM).

RESULTS AND DISCUSSION

The CdTe QDs with variation cadmium were successfully synthesized using wet chemical process. Figure 1A shows the photos of colloidal solution CdTe QDs under UV lamp exposure (365 nm). There are five solution with different growth time was namely was namely 5s, 15 s, 25 s. 40 s and 70 s to concentration ratio was Cd : Te 1:1. Figures 1 (B) shows the corresponding emission spectra of the colloidal measured by photoluminescence spectrofotometer

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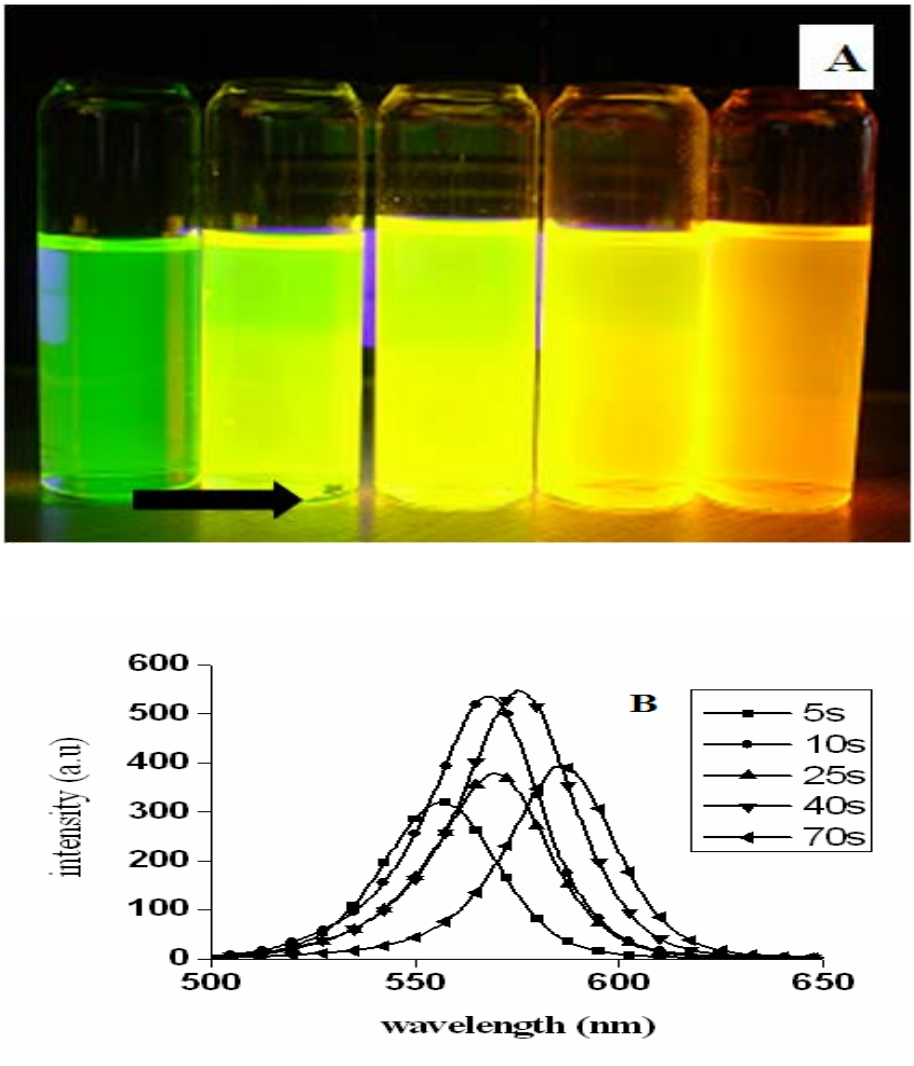

Figure 1. (A) The photos of five colloidal solution of QDs under UV lamp grow with 5s, 15 s, 25 s. 40 s and 70 s concentration Cd : Te 1:1. (B) The emission spectra of with variation growth time.

There variation color of solution, it was indicated to size QDs. Figure 2 shows the TEM images of the CdTe QDs that was taken from the sample grown for 25 s. It showed the lattice of the particles with an average size of 4 nm.

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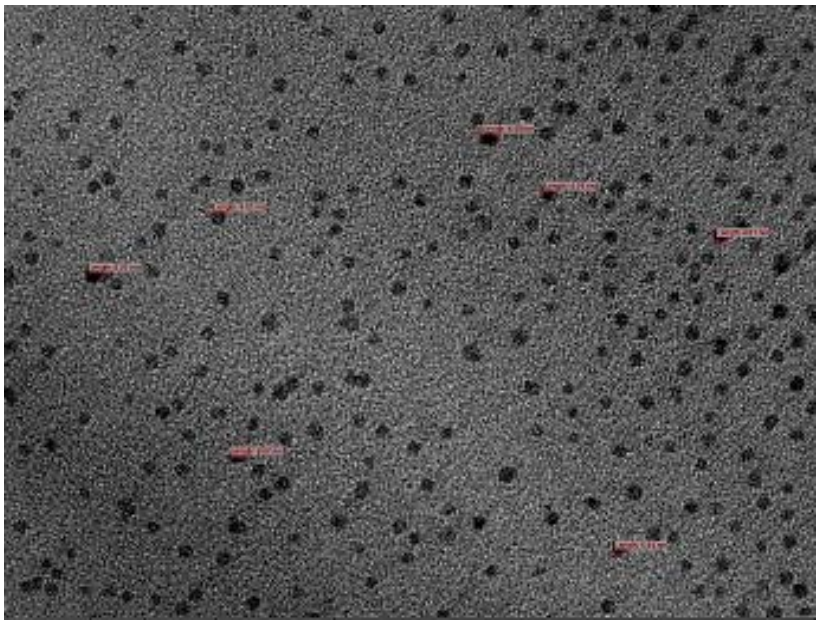

Figure 2: Shows the TEM images of the CdTe QDs that was taken from the sample grown for 25 s.

Table 1 shows the correlation growth time CdTe QDs with wavelength and quantum yield to ratio concentration Cd : Te (1:1)

Growth time (s)	Wavelength (nm)	Quantum Yield (%)
5	550	70
15	560	78
25	563	80
40	567	80
70	574	77

Table 1 summarized the results from Figure 1. The Increasing growth time mean that the size of the QDs increased. Hence the increasing growth our observation the size of QDs increased, it can be seen wavelength from 550 nm to 574 nm. Our surprise growth time 25 s and 40 s QDs the quantum yield was increased to 80 %, resulting very highly yellow emission. At 70 s, this condition the quantum yields decreased to 77 %. This may be due to the effect of intense surface recombination, as the result of increasing the sizes (Table 1).

The following is,our observation to synthesis CdTe QDs to different ratio Cd : Te. The first, ratio concentration Cd : Te (1:2); there is relatively low concentration of cadmium , the wavength changed from 523 nm to 543 nm, so size QDs was decreased. The Quantum yield (QY) further increased when growth time 15 s after that QY

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decreased to 51 % (Table 2). Possibly due to dislocation and new defects that were formed with further gowth CdTe QDs resulting from the intrinsic strain due to the lactice CdTe mismach. Table 2

Table 2: shows the correlation growth time CdTe QDs with wavelength and quantum yield to ratio concentration Cd : Te (1:2)

Growth time (s)	Wavelength (nm)	Quantum Yield (%)
5	550	70
15	560	78
25	563	80
40	567	80
70	574	77

The second, ratio concentration Cd : Te (2:1); the Intensity of the emission decreased with the growth time, reflecting the decreasing of quantum effisiency of QDs (Table 3). At, this condision high concentration of tellurium than cadmium, the size QDs increased, however QY decrease. This may be due to the effect of intense surface recombination, as the result of increasing the size

Table 3: shows the correlation growth time CdTe QDs with wavelength and quantum yield to ratio concentration Cd : Te (2:1)

Growth time (s)	Wavelength (nm)	Quantum Yield (%)
5	601	30
15	610	23
25	623	15
40	634	12
70	640	10

CONCLUSIONS

The CdTe QDs have been successfully synthesized using that chemical method. Variation concentration or cadmium can increased size of QDs, to our surprise, when the ratio between Cd:Te (1 : 1). CdTe quantum yield is highly yellow luminescence with a photoluminescence quantum yield up to 80 %.

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