Asian Journal of Chemistry; Vol. 28, No. 4 (2016), 779-781

ASIAN JOURNAL OF CHEMISTRY

http://dx.doi.org/10.14233/ajchem.2016.19476

Synthesis and Characterization of Polyethylene Glycol Capped *Bis*(8-hydroxyquinoline)zinc Nanoparticles

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Received: 15 July 2015; *Accepted*: 15 September 2015; *Published online*: 30 December 2015; AJC-17690

Bis(8-hydroxyquinoline)zinc nanoparticles were synthesized by simple precipitation method using polyethylene glycol as a capping agent. The crystalline natures of the particles were characterized by powder X-ray diffraction analysis. The morphology and the presence of elements in the nanoparticles were confirmed by scanning electron microscopy and energy dispersive X-ray analysis. The presence of functional groups of the particles was confirmed by Fourier transform infrared spectroscopy analysis. The wavelength and band gap of the particles are determined from the UV-visible spectrum. Band emission peak was observed from the photoluminescence spectrum to confirm the possible applications in organic light emitting devices.

Keywords: *Bis*(8-hydroxyquinoline)zinc nanoparticles, Polyethylene glycol.

INTRODUCTION

Organic electronics has attracted much attention due to the distinctive advantages of organic materials, such as low cost processing, low weight and mechanical flexibility [1]. As a promising technology for flat panel display organic electroluminescence have attracted more and more attention since 1987. Many organic materials including low-weight molecule and polymer have been utilized to fabricate organic light emitting diodes (OLEDs) [2-4]. Among them, 8-hydroxyquinoline chelates *e.g.*, *bis*(8-hydroxyquinoline)zinc have been extensively investigated for their high stability, good emission and electron-transporting properties [5].

In this paper we report the preparation of polyethylene glycol 6000 (PEG) capped *bis*(8-hydroxyquinoline)zinc nanoparticles by simple precipitation method. The polyethylene glycol 6000 (PEG) has acted as a surfactant, which modify the surface of nanoparticles and prevents the growth of particle to a larger size.

EXPERIMENTAL

Zinc acetate, 8-hydroxyquinoline and ammonia all of Merck brand, were used as starting materials. All these chemicals were of high purity and no further purification was done. Polyethylene glycol (PEG) was used as the surfactant.

Synthesis of *bis*(8-hydroxyquinoline)zinc nanoparticles: Initially, 4.3175 g of zinc acetate was dissolved in 100 mL of water and stirred using magnetic stirrer for 1 h at room temperature. In this solution, 0.0345 g of polyethylene glycol dissolved in 20 mL of water was added. The 8-hydroxyquinoline solution was separately prepared by dissolving 5.442 g of 8-hydroxyquinoline in a mixed solvent of ammonia (0.04 mL) and water (100 mL) and then it was added drop by drop to the above solution under continuous stirring. Yellow precipitate was formed immediately. The precipitate was filtered and dried in vacuum oven for 6 h.

Characterization studies: Powder X-ray diffraction (PXRD) analysis was carried out using a Rich Seifert X-ray diffractometer with CuK_α ($\lambda = 1.5418$ Å) radiation to observe the crystallinity of the sample. Scanning electron microscope (SEM) was employed to study the morphological behaviour of the sample using a CARI ZEISS MA15/EVO18 operated at 30 kV with energy dispersive X-ray analyzer (EDAX). The FTIR spectrum of *bis*(8-hydroxyquinoline)zinc nanoparticles was recorded in the range of 4000-400 cm^{-1} using a BRUKER 66 V FTIR spectrophotometer by KBr pellet method in order to study the metal complex coordination. The optical absorption spectrum of the sample was recorded in the range between 200-800 nm using Labindia 3032 UV-visible-NIR spectrophotometer. The photoluminescence study was done using a JOBIN YVON FLUROLOG-3-11 spectroflurometer with an excitation

wavelength (λ_{ex}) of 380 nm to confirm the organic light emitting diode property of the polyethylene glycol capped *bis*(8-hydroxyquinoline)zinc particles.

RESULTS AND DISCUSSION

Powder X-ray diffraction analysis: Fig. 1 shows the powder X-ray diffraction (PXRD) pattern of polyethylene glycol capped *bis*(8-hydroxyquinoline)zinc nanoparticles prepared using simple precipitation method. The PXRD peaks were indexd as (0 2 3), (0 4 1), (0 3 4), (0 5 0), (0 5 2), (0 5 3), (0 6 2), (0 7 0), (1 0 6) and (1 6 3) planes corresponding to orthorhombic system [6,7].

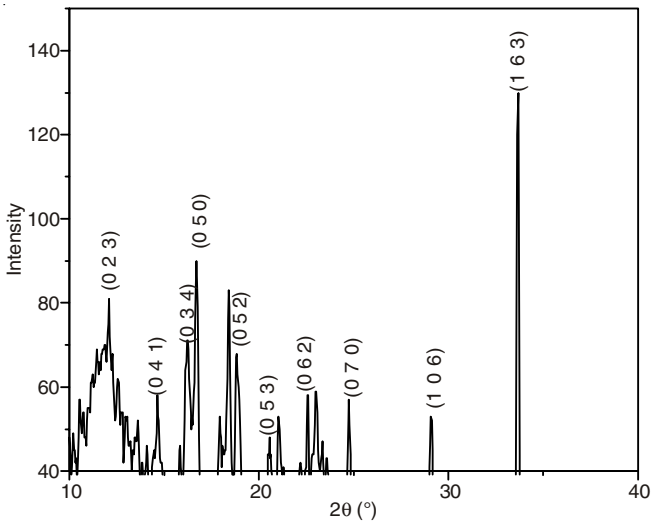

Fig. 1. PXRD pattern of *bis*(8-hydroxyquinoline)zinc:polyethylene glycol

SEM and EDAX analysis: The morphology of the polyethylene glycol capped *bis*(8-hydroxyquinoline)zinc nanoparticles is shown in Fig. 2(a), it reveals that the sample appears as clustered particles. The thickness of the nanoparticles varies from 213 to 356 nm. Fig. 2(b) shows the EDAX spectrum of polyethylene glycol capped nanoparticles. This indicate that the nanoparticles are indeed made up of Zn, C and O. The copper peaks appeared in the spectra is due to the copper grid used for the measurement.

FTIR analysis: The FTIR spectrum (Fig. 3) of polyethylene glycol capped *bis*(8-hydroxyquinoline)zinc nanoparticles. The plane ring deformation of 8-hydroxyquinoline is observed at 820 and 911 cm^{-1}. The metal bonding with the quinoline molecules is observed at 1328, 1390, 1577 and 1602 cm^{-1} [8]. The bands at 1468 and 1500 cm^{-1} correspond to the vibrations of the pyridyl and phenyl groups of 8-hydroxyquinoline [9]. The O-H vibration bands were detected at 3057-2601 cm^{-1} [10,11]. The characteristic absorption band of Zn-O was observed at 462 cm^{-1} [12], which further support that the as-prepared product is pure *bis*(8-hydroxyquinoline)zinc: polyethylene glycol.

UV-visible spectral analysis: UV-visible absorption spectrum of polyethylene glycol capped *bis*(8-hydroxyquinoline)zinc nanoparticle is shown in Fig. 4. From this spectrum it is observed that the intense peak at 269 nm with a band gap of 4.61 eV is due to π-π^* transition. The low intense peak observed at 368 nm is is due to n-π^* transition [13,14].

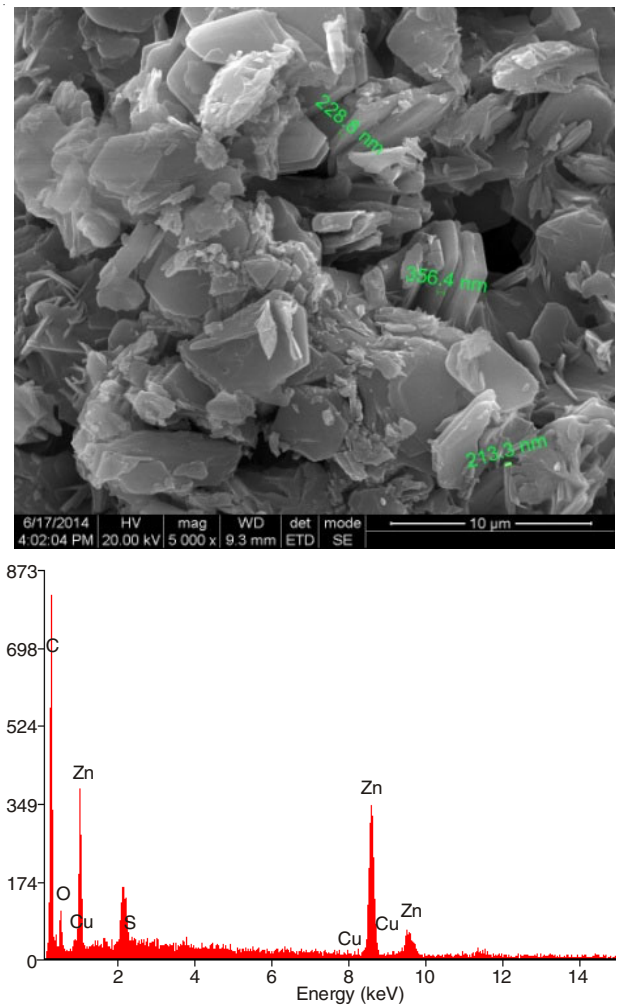

Fig. 2. (a) SEM image and (b) EDAX pattern of *bis*(8-hydroxyquinoline)zinc:polyethylene glycol

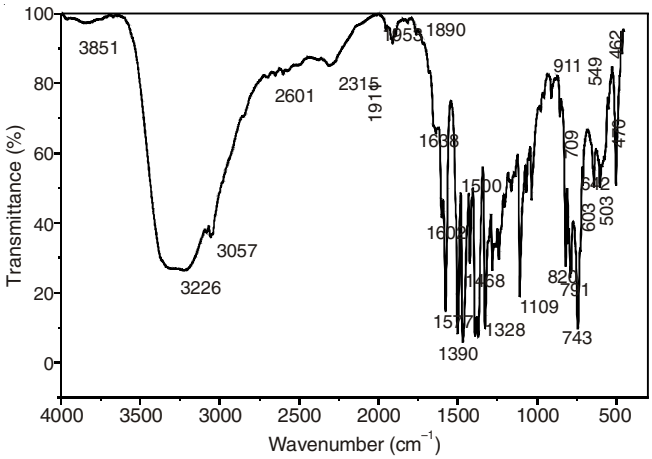

Fig. 3. FTIR spectrum of *bis*(8-hydroxyquinoline)zinc:polyethylene glycol

Photoluminescence analysis: The photoluminescence (PL) emission spectrum of polyethylene glycol capped *bis*(8-hydroxyquinoline)zinc nanoparticles is shown in Fig. 5. The prominent photoluminescence emission peak is observed at 517 nm in green region of the spectrum. It shows that *bis*(8-hydroxyquinoline)zinc: polyethylene glycol is not only suitable for organic light emitting diode (OLED) but also for solid state lighting applications [15].

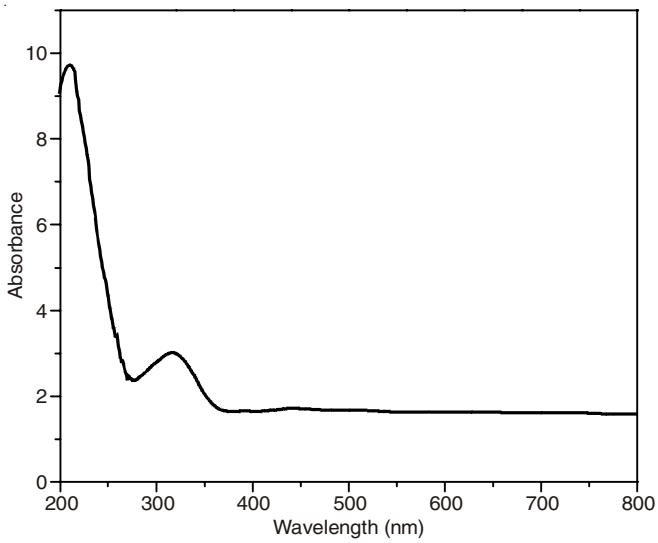

Fig. 4. UV-visible absorption spectrum of *bis*(8-hydroxyquinoline)zinc: polyethylene glycol

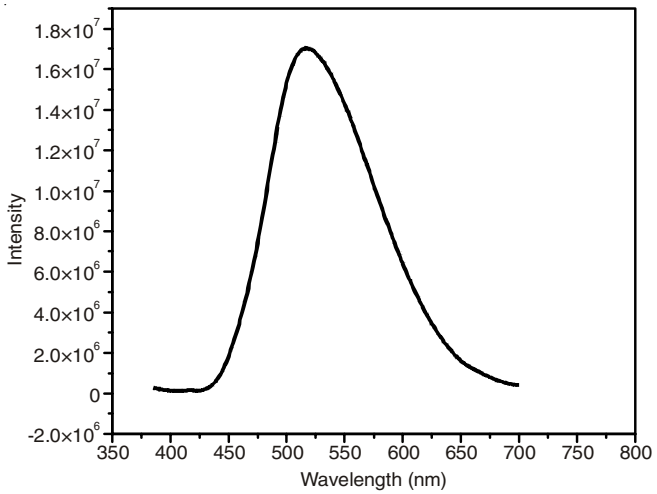

Fig. 5. Photoluminescence spectrum of *bis*(8-hydroxyquinoline)zinc: polyethylene glycol

Conclusion

Simple precipitation method was adopted to synthesize *bis*(8-hydroxyquinoline)zinc particles with polyethylene glycol. The crystalline nature of the particles was evaluated by powder X-ray diffraction analysis. The morphology and compositions of the particles were identified from SEM and EDAX analysis. The band gap of the material is found to be at 4.61 eV. The luminescence of the sample was observed by photoluminescence spectrum.

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