Electronic Supplementary Material (ESI) for RSC Advances

Supplementary Information

1. Synthesis of quantum dots

a) All chemicals were purchased from Sigma-Aldrich. In order to synthesize quantum dots, we used: CdO (99%), oleic acid (90%), 1-octadecene (ODE, 90%), trioctylphosphine (TOP, 90%), Octadecylamine (90%), Se (99%), Zinc (II) diethyldithiocarbamate (ZnDDTC, 98%).

b) Synthesis of CdSe nanocrystals

CdSe nanocrystals were synthesized by conventional synthesis route based on hot injection method. In detail, CdO (3.2mmol) was mixed with oleic acid (3ml) and octadecylamine (1.5ml) in 1-octadecene (50ml). The mixture was heated and distilled in vacuum at 120^{o}C for 30 minutes. Subsequently, distilled mixture was heated up to 300^{o}C for complete dissolution of precursors under Ar atmosphere. Separately, elemental Se powders (0.8mmol) were mixed with TOP (2mmol) and transparent solution was obtained after reaction at room temperature. Preparation of Se-TOP solution was performed in Ar-filled glove box and the transparent Se-TOP solution was rapidly injected into Cd-oleate mixture at 300^{o}C and reacted for 5 minutes.

c) Synthesis of CdSe/ZnS core/shell nanocrystals

After synthesis of CdSe nanocrystals at 300^{o}C, the resulting mixture were cooled to 225^{o}C. Furtherly, ZnDDTC (4mmol) was dissolved to the mixture of 1-octadecene (10ml) and TOP (10ml). The ZnDDTC solution was injected to as synthesized colloidal CdSe solution at 225 ^{o}C for 10 minutes and further reacted for 30 minutes to form ZnS shell layers. After completion, the mixture was cooled to room temperature and nanocrystals were precipitated by centrifugation after addition of hydrophilic solvent such as acetone and ethanol. In this process, the supernatant was discarded and precipitates were re-dispersed in toluene.

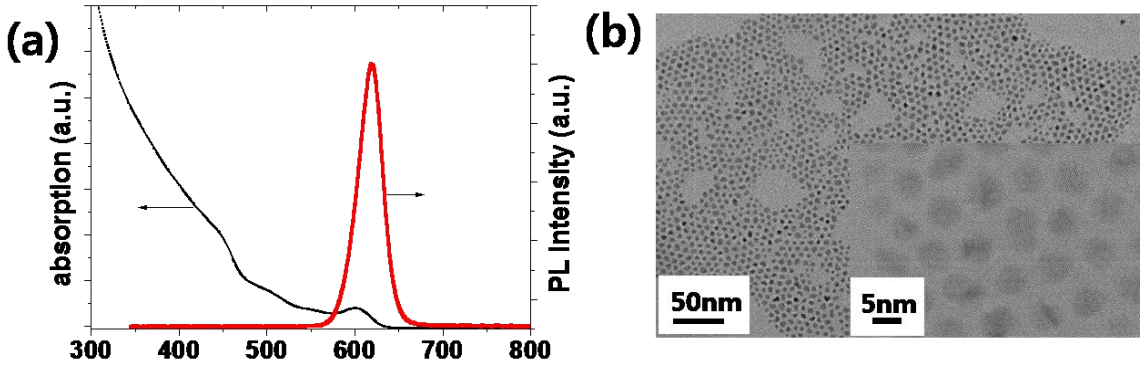

Figure S1. (a) Optical spectra and (b) TEM images of CdSe/ZnS QDs

2. Synthesis of QD-SiO_2 nanocomposites

* Spray drying of colloidal CdSe/ZnS QD solution

CdSe or CdSe/ZnS nanocrystals dispersed in toluene were sprayed ultrasonically at 250^{o}C as a rate of 1cc/min. In this study, a ultrasonic nozzle (Sono-Tek, USA) working at 120kHz was employed for spray drying of QDs and spray-dried QDs were collected and dispersed in ethanol. As-synthesized QDs as well as spray-dried QDs were easily dispersed in toluene and no significant change in nanocrystal was observed as shown in Fig. S2.

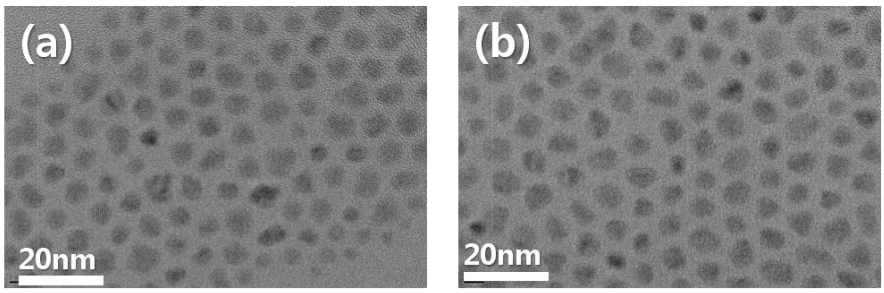

Figure S2. TEM observation of CdSe/ZnS QDs: (a) as-synthesized, (b) spray-dried and dispersed in toluene

* SiO_2 layer formation on self-assembled QDs

Silica layers were formed by hydrolysis and condensation of tetraethylorthosilicate (TEOS). Practically, we added 2.5ml of TEOS to 500ml of ethanol-based colloidal solution containing spray-dispersed QDs. Subsequently, we added 2.5ml of aqueous NH_4OH solution as described in Fig. S3(a). After some time interval, the colloidal solution was centrifuged and re-dispersed in ethanol. Sometimes, 3-aminopropyltriethoxysilane (APS) were added to silanize surface of QDs before encapsulation with TEOS (Scheme described at Fig. S3(b)).

Separately, we added APS prior to spray drying as described in Fig. S3(c) in order to control loading of QDs inside nanocomposites.

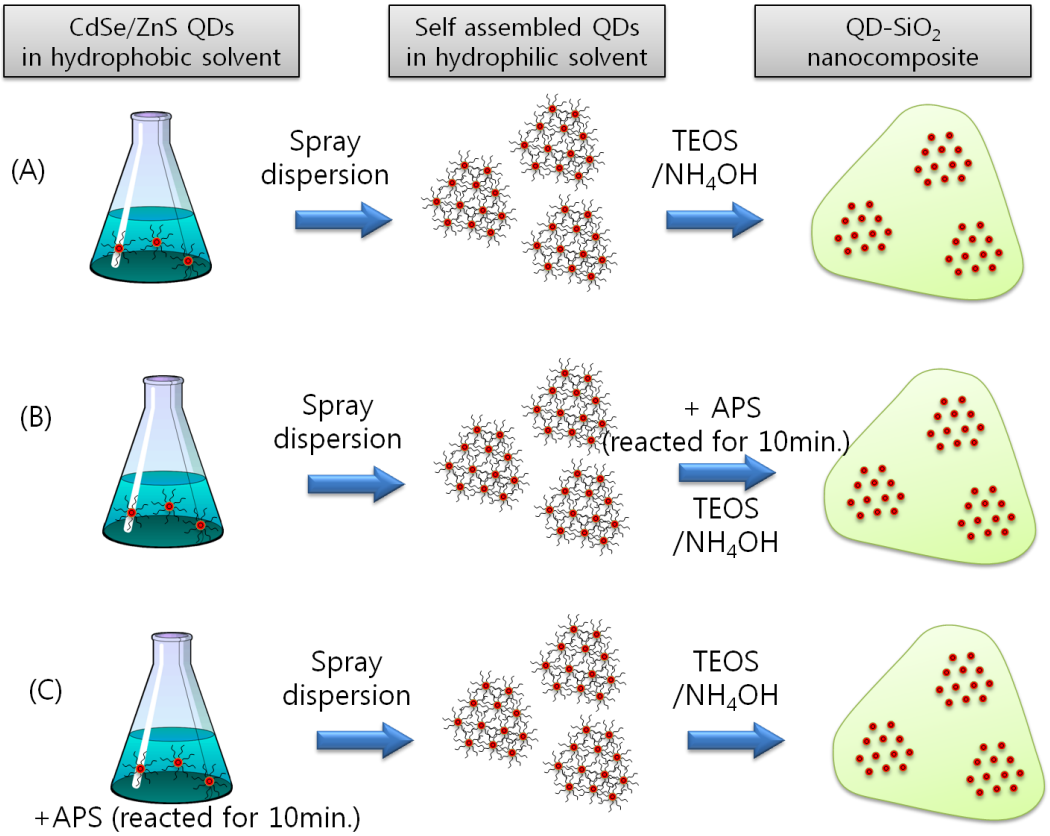

Figure S3. Synthesis route of QD-silica nanocomposites

4. Preparation of composites on top of a white LED

QD-SiO_2 nanocomposite powders were mixed with OE6636 resin (Dow corning) for LED packaging. After removal of pores and solvent in vacuum for 2 hours, the mixture was dropped on teflon mold. A white LED (SuperFluxLED 3phi, BTWH-R3-114HWC, Ningbo Bright Industry) was used and dome-type packaging on LED chip was removed for further processing.

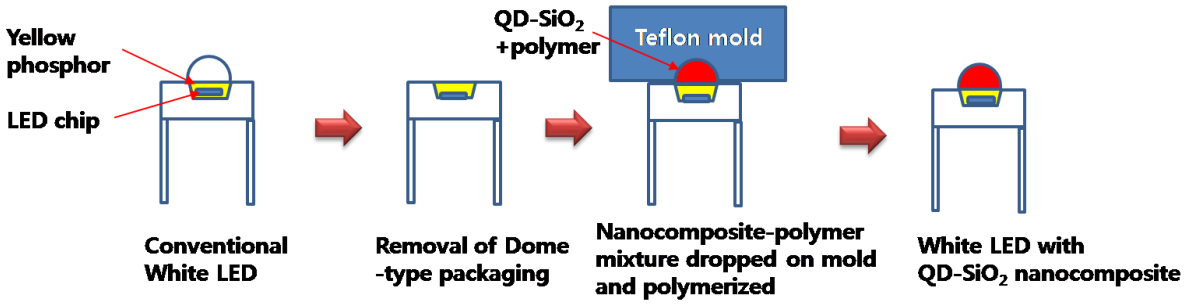

Figure S4. Schematic illustration for preparation of a white LED with QD-SiO_2 nanocomposite