Electronic Supplementary Material (ESI) for Nanoscale.
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Supporting information

Zero- and Two-Dimensional Hybrid Carbon Phosphors for High Colorimetric Purity White Light-Emission

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Experimental Section

Materials

Anhydrous citric acid (CA, ≥97%) , Octadecene (ODE, ≥90%), tetradecylamine(≥96%) and octadecylamine (≥90%) are purchased from Aladdin industrial corporation. Hexadecylamine (HDA, ≥95%) is purchased from Tixiai (Shanghai) Chemical Company. Chloroform (≥99.0%) and acetone (≥99.5%) are purchased from Shanghai Lingfeng Chemical Reagent corporation. Ethanol (≥99.7%) is purchased from Wuxi City Yasheng Chemical corporation. Dialysis bag (200 Da) is purchased from MYM Biological technology company. Blue LED chip is purchased from Guangsheng semiconductor company.

Preparation of zero- and two-dimensional hybrid carbon phosphors

The carbon phosphors are prepared by a thermal treatment of a mixture of carbon source and surface passivator in a three-neck flask. Typically, a mixture of 15 ml octadecene (ODE) and 1.5 g of 1-hexadecylamine (HDA) loaded in a three-neck flask is heated at 180 ℃ for 1.5 hours under a nitrogen flow. Subsequently, 1 g of critic acid (CA) is slowly poured into the reaction flask and then kept for 3 hours. The resulting solution is cooled down to the room temperature naturally. The obtained product is purified by precipitating with acetone and ethanol for three times, respectively. Finally, the final white phosphor powder is dried under vacuum rotary evaporation at 65.The separation of C-dots and nanoplates from the phosphor solution is completed by dialyzing against chloroform solvent through the dialysis membrane (Da=200) for 10 days. The solvent is changed every 12 h.

Fabrication of phosphor-coated white light-emitting devices

25 mg hybrid carbon phosphors are dissolved in 5 ml chloroform solvent. Then, the phosphor solution is drop-coated onto a blue LED chip comprised of a 415 nm excitation light emitting unit, subsequently followed by a facile heat-solidification for 10 minutes. Finally, the above steps are repeated for 3 times.

Characterization

The transmission electron microscope (TEM, HITACHI 7605) and high-resolution transmission electron microscopy (HRTEM, JEOL 2100F) characterizations are performed to observe C-dots and nanoplates. The thickness of the nanoplates is measured by atomic force microscope (AFM, Park XE-70). The size of the nanoplates is measured by scanning electron microscope (SEM, JSM 7800F). Photoluminescence (PL) is performed by an Fluorescence Spectrometer (F-4600) and absorption spectra is measured with a Shimadzu UV-1750 spectrophotometer. X-ray photoelectron spectroscopy (XPS, Thermo escalab 250Xi) is used to confirm elements and chemical composition of the C-dots. The quality of C-dots is measured by Laser confocal microscopic Raman spectrometer (Raman, WITEC Alpha300M+) and X-Ray Powder Diffraction (XRD, Smartlab 3KW). Fourier Transform Infrared Spectroscopy (FTIR, DT-40) spectra is measured by neat on a KBr plate. The quantum yield (QY) of C-dots is measured by Fluorescent life test system (American PTI). The nanoplates size is estimated by dynamic light scattering (DLS, LG, Brookhaven). Commission International d'Eclairage (CIE) coordinates is measured by a spectrophotometer (PR-745).

Absolute PL QY measurement

The absolute PL QY of C-dots solution is measured by the absolute PL QY measurement using a fluorescent life test system spectrometer (PTI from America). Operation step by step is to load a sample firstly, and then choose the excitation wavelength (380 nm) and press the start button to measure the photoluminescence quantum yields in a short period of time. Normally, the result is the mean value of three times measurement.

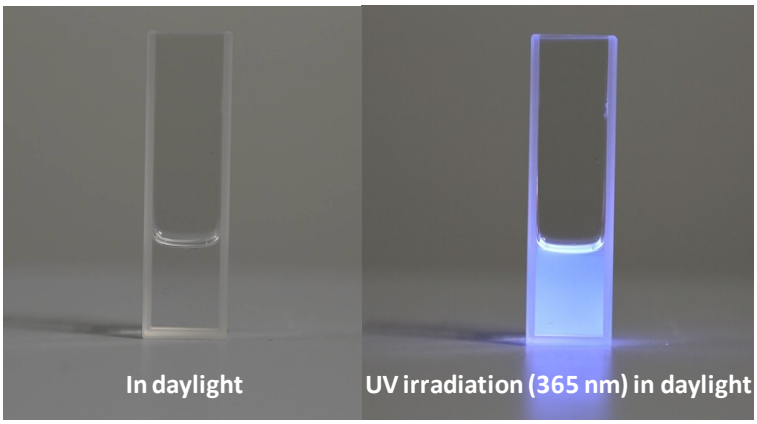

Figure S1. Optical images of C-dots under daylight (left) and UV irradiation (365 nm) in daylight (right).

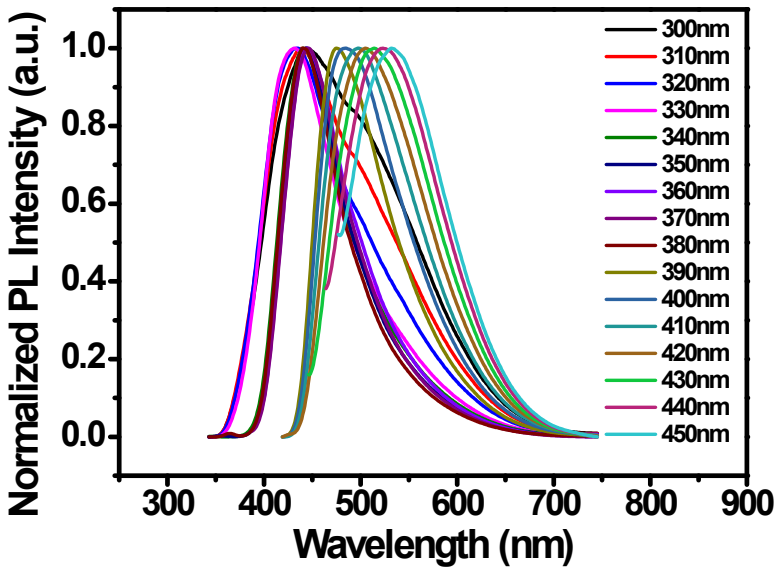

Figure S2. Normalized PL spectrum of as-prepared C-dots.

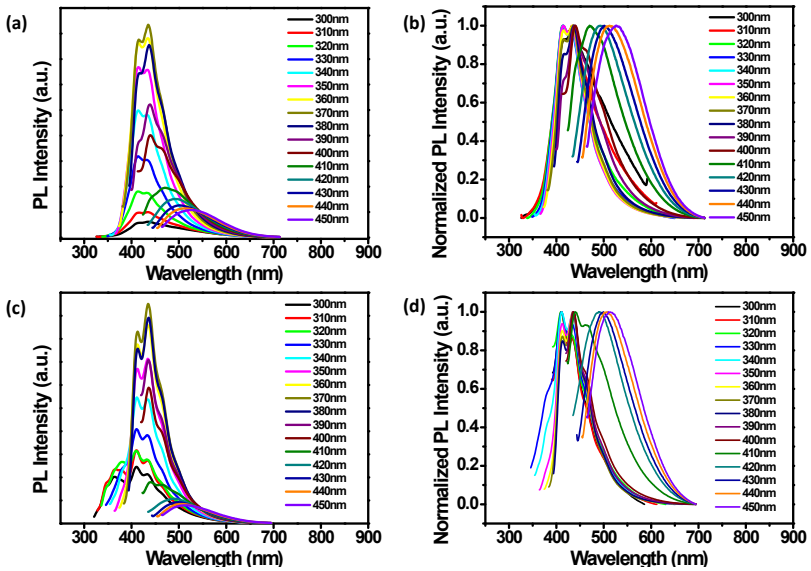

Figure S3. a-b) PL spectra of nanoplates and hybrid phosphor solutions and (c-d) their corresponding normalized PL spectra.

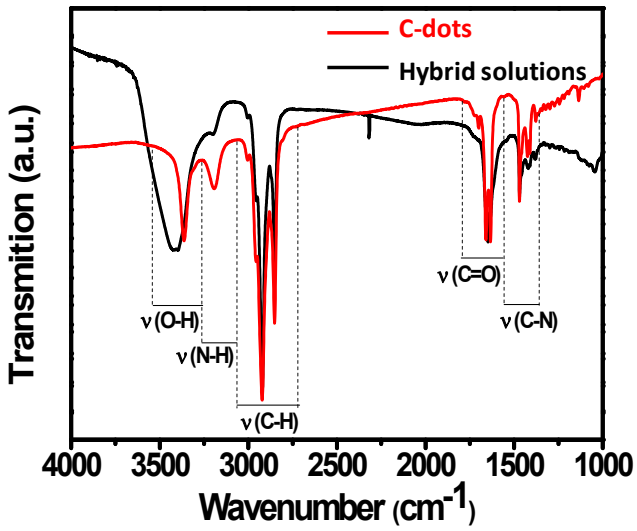

Figure S4. FT-IR spectra of obtained C-dots and hybrid phosphor solutions.

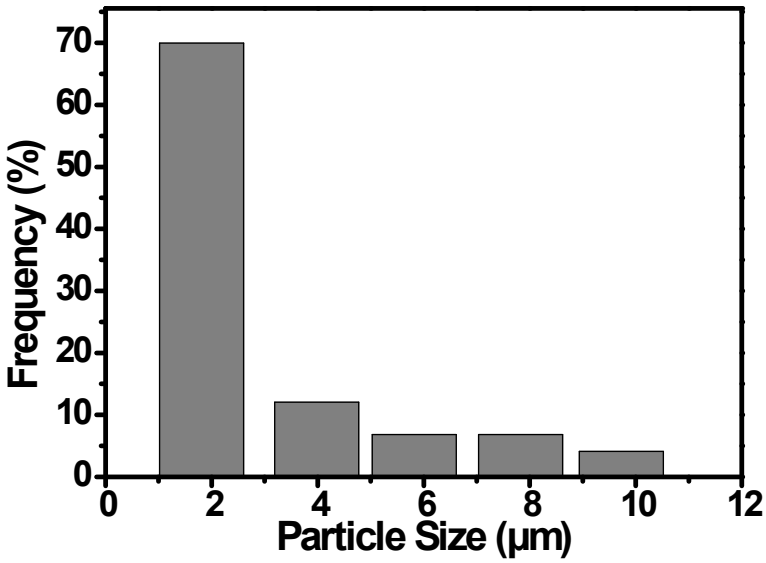

Figure S5. Particle size distribution measured by dynamic light scattering (DLS).

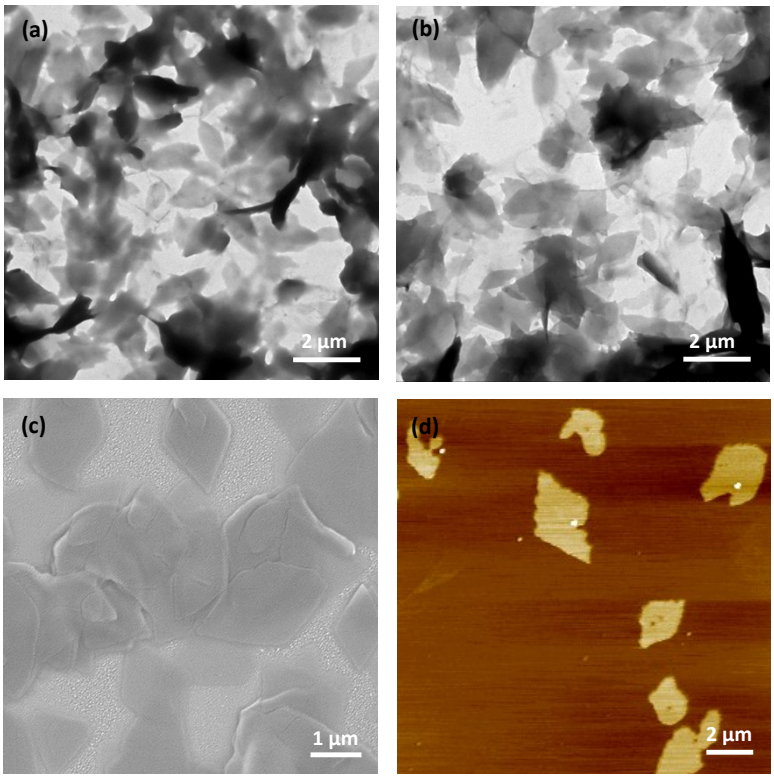

Figure S6. a-b) SEM images of products from HDA under the same hydrothermal treatment without the participation of CA. c-d) SEM and AFM spectra of nanoplates with obvious rupture after removing the C-dots via dialysis for several days, respectively.

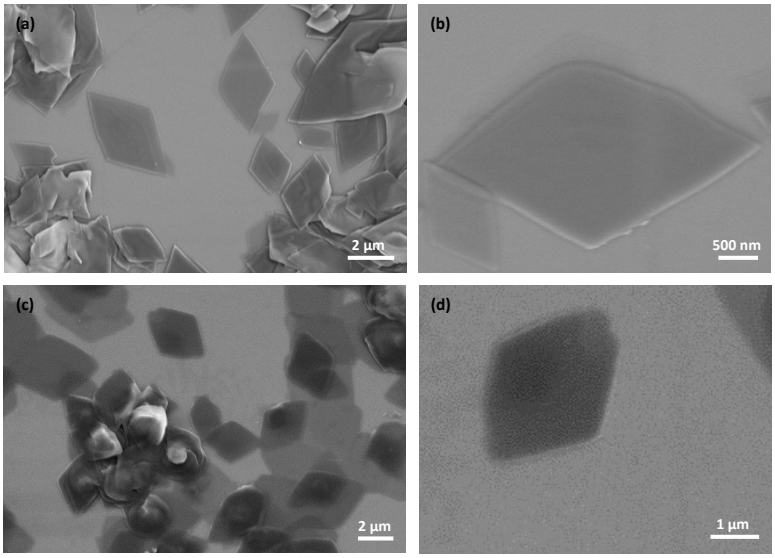

Figure S7. SEM spectra of nanoplates self-assembled by C_{14}-NH_3 (a-b) and C_{18}-NH_3 (c-d), respectively.

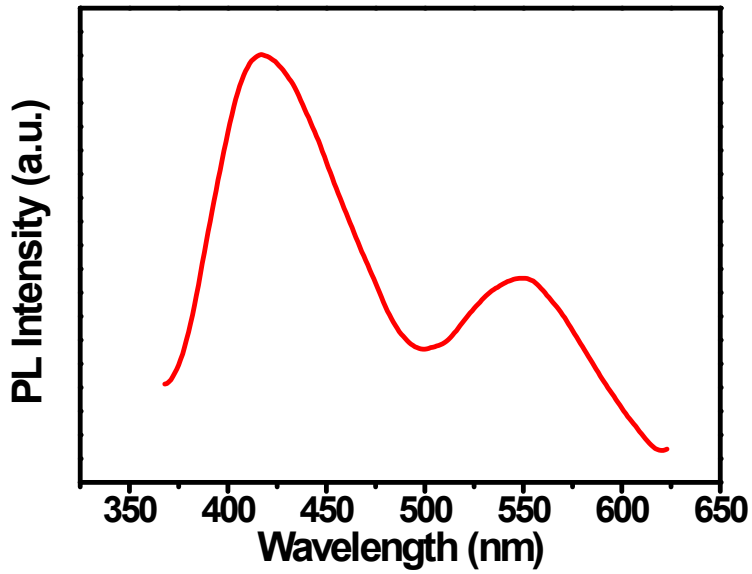

Figure S8. PL spectrum of hybrid carbon phosphors in the solid state when excited at 365 nm.

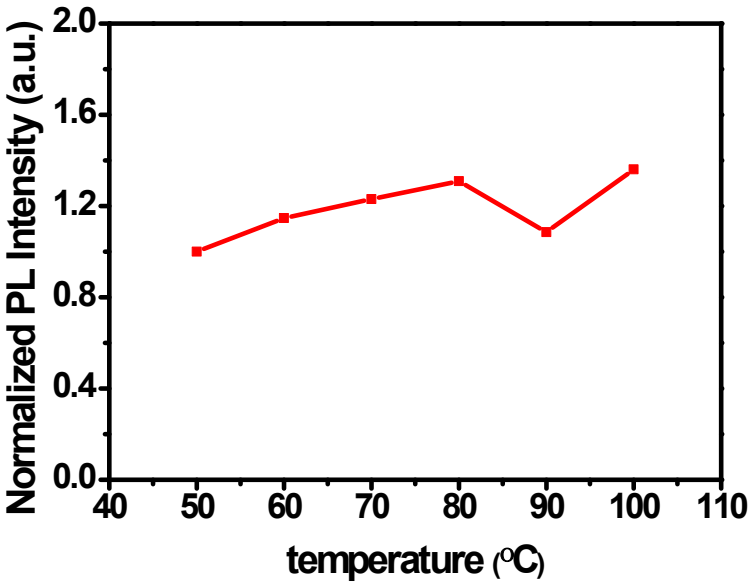

Figure S9. Changes in the emission intensities of hybrid carbon phosphors during the operation at different temperatures.