Electronic supplementary information (ESI) for

Down-conversion monochrome light-emitting diodes with the color determined by the active layer thickness and concentration of carbon dots

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Chemicals. N-(β-aminoethyl)-γ-aminopropylmethyldimethoxysilane (AEAPMS, 97%), anhydrous citric acid, and polymethylmethacrylate (PMMA) were purchased from Sigma-Aldrich. Other solvents and reagents were from Beijing Chemical Factory. All chemicals were used directly without further purification.

Synthesis of CDs. CDs were synthesized by an established process with minor modifications. 10 mL of AEAPMS were placed in a 100 mL three-neck round-bottom flask, degassed by applying vacuum for 30 min, and heated up under nitrogen atmosphere. When the temperature reached 240 ºC, 0.5 g of anhydrous citric acid was quickly added under vigorous stirring, the reaction mixture solution was kept at this temperature for 1 min, and then was cooled down to room temperature naturally. The final CD products was purified by precipitation with petroleum ether for three times, and redispersed in chloroform solvent with a desired concentration of 366 mg/mL.

Fabrication of monochrome light-emitting diode. For the fabrication of monochrome LED, a UV-LED chip with the peak wavelength centered at 385 nm was used. The two threads on the UV-LED were connected to a power supply. To make different thickness LEDs, 0.5 mL CDs (366 mg/mL) were added into 3 mL of a transparent PMMA/chloroform solution (15% by weight). The obtained mixture was coated onto the UV-LED chips drop by drop. The ultimate LEDs were then cured at room temperature for 30 min. Similar procedures were followed to make other LEDs with the same thickness but different concentrations. For these, 1 mL of the
transparent PMMA/chloroform solution (15% by weight) was mixed with 366 mg/mL CDs with different volumes (S1: 15 ml, S2: 5 ml, S3: 2.5 ml, S4: 1 ml, S5: 0.3 ml).

**Materials Characterization.** Absorption spectra were recorded using Shimadzu UV-3600 UV-visible spectrophotometer. Photoluminescence (PL) spectra were obtained by an Edinburgh Instrument FLS920P fluorescence spectrometer. The absolute PL quantum yields of the liquid sample were measured by a fluorescence spectrometer (FLS920P, Edinburgh Instruments) equipped with an integrating sphere with its inner face coated with BENFLEC®. A Philips TF-F20 transmission electron microscope operated at 200 kV was employed to obtain images for researching the morphology of the CDs. 10 μL of a CD ethanol solution was carefully placed onto the mesh and dried at ambient condition. To obtain IR spectra, AEAPMS and CDs ethanol solution dropped onto the KBr pellet and the transmittance of each resulting pellet was taken on an FTIR spectrophotometer (IFS-66V/S).

**Device Characterization.** The electrical characterization of the monochrome LEDs was measured using a Keithley 2400 source meter. The PL emission spectra and luminance of the devices (cd/m²) were measured by a PR650 spectrometer. The emission spectra of the monochrome LEDs at different working time intervals were determined by a Zolix Omni-λ300 Monochromator /Spectrograph. All measurements were performed under dark condition.
Figure S1. The PL QY of CDs measured for different excitation wavelengths.

Figure S2. FTIR spectra of AEAPMS and CDs. The CDs contain the -OH, Si-O-Si, Si-O-CH, Si-CH$_2$, C=O, NH and CH groups.
Figure S3. Brightness of the CD-LEDs with different thickness of the CD active layer emitting blue, green, yellow, orange, and red light.

Figure S4. The luminous efficiency vs. current density of the LEDs with different thickness of the CD active layer.
Figure S5. Emission intensity of the LEDs with different thickness of the CD active layer measured at different working time intervals.

References