Supplementary Information

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Experimental details

Materials.

The cesium carbonate (Cs$_2$CO$_3$, 99.99%), oleic acid (OA, 85%), oleyamine (OLA, 80-90%), 1-octadecene (ODE, >90%), LiF (99.99%) were purchased from Aladdin. The lead(II) bromide (PbBr$_2$, 99.99%), Poly (3,4-ethylenedioxythiophene)/poly (styrenesulfonate) (PEDOT: PSS,4083), N, N'-Bis(3- methylphenyl)-N, N'-bis(phenyl) benzidine (poly-TPD), and 1,3,5-Tris(1-phenyl-1Hbenzimidazol-2-yl) benzene (TPBi) was purchased from Xi'an Polymer Light Technology Corp, and the n-hexane and ethyl acetate purchased from Shanghai Chemical Industrial Company. All the reagents were used without further purification.

Synthesis of CsPbBr$_3$ NCs of Diverse Shapes

All syntheses were performed in air and without any pre-dried chemicals or solvents. During the synthesis of Cs-OA, 0.4 g Cs$_2$CO$_3$ dissolved in 1.5 mL OA and 15 ml ODE in a 20 ml vial on a hotplate set to 100 °C. After the Cs$_2$CO$_3$ was completely dissolved, the vial was moved to a room temperature, and the solution was allowed to cool. The PbBr$_2$ (1 mmol) was dissolved in 10 mL ODE, OA (0.5 ml for CsPbBr$_3$ NWs, 1ml for CsPbBr$_3$ 1DSCs, 1 ml for CsPbBr$_3$ NSs ) and OLA ( 1 ml for CsPbBr$_3$ NWs, 1 ml for CsPbBr$_3$ 1DSCs, 0.5 ml for CsPbBr$_3$ NSs ) in a 30 mL vial on a hotplate set at 120 °C. After the Cs$_2$CO$_3$ was completely dissolved. 1 mL of Cs-OA was swiftly injected. After about 30 seconds the reaction turned turbid white, depending on the required thickness, was quickly cooled down after 0-300 s to RT with a cold water bath. In addition, PbI$_2$ (0.5 mmol) replaced PbBr$_2$ (0.5 mmol) to synthesize CsPbBr$_{1.5}$I$_{1.5}$ at 170. PbCl$_2$ (0.5 mmol) replaced PbBr$_2$ (0.5 mmol) to synthesize CsPbBr$_{1.5}$Cl$_{1.5}$ at 200°C. 1 ml TOP was added to dissolve PbCl$_2$.

Isolation and Purification
First, equal volume ethyl acetate was added to the crude solution of 1DSCs. The solutions were first centrifuged at 5000 rpm for 5 min to remove excess by-products. Then, the supernatant was discarded and the aggregated QDs were redispersed in toluene.

**Device Fabrication**

Patterned ITO coated glass was successively cleaned with soap, deionized water, ethanol, chloroform, acetone, and isopropanol and treated with UV and ozone for 10 min. A 40 nm PEDOT:PSS film was spin-coated onto ITO glass at 3000 rpm for 45 s and annealed in air at 120°C for 30 min. Then the substrate was transferred into a glovebox, and 40 nm poly-TPD (dissolved in chlorobenzene at a concentration of 10 mg/mL) was spin-coated onto the PEDOT:PSS film at a speed of 4000 rpm for 40 s and annealed at 110 °C for 30 min. The perovskite NCs (~15 mg mL⁻¹) active layer was spin-cast from their colloidal solution at 2000 rpm for 45 s. TPBI (40 nm), LiF (1 nm), and Al (150 nm) layers were sequentially deposited by thermal evaporation in a vacuum deposition clamber (1×10⁻⁵Torr). The Al cathode was deposited through a shadow mask defining device area of 2 mm×2 mm.

**Measurement and characterization**

The transmission electron microscopy (TEM) studies were carried out using JEOL JEM-2100 at 200 kV. The energy dispersive spectrometer (EDS) patterns were investigated by field emission scanning electron microscope (FESEM, FEI Quatan FEG 250) equipped with an energy dispersive spectrometer. X-ray photoelectron spectroscopy (XPS) spectra were measured by an X-ray photoelectron spectrometer (Thermo Fisher ESCALAB Xi+). The
photoluminescence (PL) spectra and fluorescence lifetimes were recorded on an Edinburgh Instruments FLS9 spectrometer. The ultraviolet-visible (UV-Vis) absorption spectra were recorded by PE Lambda 950. The x-ray diffraction (XRD) patterns were obtained using the DB-ADVANCE X-ray diffraction analyzer diffractometer. The particle size distribution studies were carried out using Zetasizer Nano ZSE.
**Introduce and discuss some equations**

There are three main equations corresponding to these reaction, Firstly, is a tri-exponential fitting function:

\[ I = A_1 \exp\left(-\frac{t}{\tau_1}\right) + A_2 \exp\left(-\frac{t}{\tau_2}\right) + A_3 \exp\left(-\frac{t}{\tau_3}\right) \quad \text{Equation 1} \]

Where \( A_1, A_2 \) and \( A_3 \) are constants, \( t \) is time, and \( \tau_1, \tau_2, \tau_3 \) represent the decay lifetimes.

The average lifetime (\( \tau_{\text{ave}} \)) can be calculated as follows:

\[ \tau_{\text{ave}} = \frac{A_1 \tau_1^2 + A_2 \tau_2^2 + A_3 \tau_3^2}{A_1 \tau_1 + A_2 \tau_2 + A_3 \tau_3} \quad \text{Equation 2} \]

Third, is a Gibbs-Thomson equation, which can written as

\[ C_n = C_b e^{\exp\left(\frac{2\rho V_m}{rRT}\right)} \quad \text{Equation 3} \]

In which \( C_n \) and \( C_b \) are the solubility of the nanoparticle and the corresponding bulk solid; \( \sigma \) is the specific surface energy; \( V_m \) is the molar volume of the material; \( R \) is the gas constant and \( T \) is the absolute temperature.

**Introduce one tables**

Table 1 Tri-exponential fitting parameters of time-resolved PL decay curves for 1DSCs at different reaction time.

<table>
<thead>
<tr>
<th></th>
<th>( A_1(%) )</th>
<th>( \tau_1(\text{ns}) )</th>
<th>( A_2(%) )</th>
<th>( \tau_2(\text{ns}) )</th>
<th>( A_3(%) )</th>
<th>( \tau_3(\text{ns}) )</th>
<th>( \tau_{\text{ave}}(\text{ns}) )</th>
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<tr>
<td>10 seconds</td>
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<td>7.0920</td>
<td>60.08</td>
<td>24.3774</td>
<td>17.3866 ns</td>
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<tr>
<td>60 seconds</td>
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<td>1.3896</td>
<td>20.48</td>
<td>7.3471</td>
<td>76.43</td>
<td>38.5696</td>
<td>31.0263 ns</td>
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<tr>
<td>300 seconds</td>
<td>3.19</td>
<td>1.5231</td>
<td>18.90</td>
<td>7.5081</td>
<td>77.91</td>
<td>40.0838</td>
<td>32.6969 ns</td>
</tr>
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</table>
Fig. S1 TEM images of the self-assembled 1DSCs of (a) CsPbCl$_{1.5}$Br$_{1.5}$ and (b) CsPbBr$_{1.5}$I$_{1.5}$. 
Figure S2 (a) UV-visible absorption (red line) and photoluminescence (green line) spectra of CsPbBr$_3$ NCs. The photoluminescence spectrum was collected at 365 nm excitation wavelength. (b) Crystal structure of cubic CsPbBr$_3$. (c) High-resolution TEM image of CsPbBr$_3$ NWs. (d) Time-resolved PL decay curves of CsPbBr$_3$ NCs.
Figure S3 TEM images of CsPbBr$_3$ NCs: (a) NWs. (b) NSs. (c) Structure collapse of NWs and NSs.
Figure S4 TEM images of randomly dispersed thick CsPbBr$_3$NSs: (a) Low resolution. (d) High resolution. TEM images of 1DSCs with the same orientation as the NWs: (b, e) c-1DSCs. (c) s-1DSCs. (f) bent 1DSCs.
Figure S5 TEM images of CsPbBr$_3$ 1DSCs: (a) initial 1DSCs. (b) Ethanol-treated 1DSCs within 5 min. (c) Ethanol-treated 1DSCs within 1 hours. UV-visible absorption (red line) and photoluminescence (green line) spectra of CsPbBr$_3$ NCs: (d) initial 1DSCs. (e) Ethanol-treated 1DSCs within 5 min. (f) Ethanol-treated 1DSCs within 1 hours.
Figure S6 TEM images of CsPbBr$_3$ NCs: (a) Randomly dispersed NSs. (b) s-1DSCs. (c) Mutual vertical s-1DSCs. (d) c-1DSCs.
Figure S7 (a) TEM images of the c-CsPbBr$_3$ 1DSCs: (a) Low resolution. (b) High resolution.
Figure S8. High-resolution XPS spectra of CsPbBr$_3$ NCs: (a) Cs 3d. (b) Pb 4f. (c) Br 3d. (d) EDS spectra of CsPbBr$_3$ NCs.
Figure S9 (a) Photoluminescence spectrum of CsPbI₃ NCs. (b) TEM image of CsPbBr₃ NSs.
Figure S10 (a) LED device structure. (b) Flat band energy level diagram. (c) Current density (left) and luminance as a function of voltage (right). (d) Current efficiency (left) and external quantum efficiency (right) as a function of luminance.