

Supplementary Information

Low-temperature Direct Synthesis of Perovskite Nanocrystals in Water and Their Application in Light-Emitting Diodes

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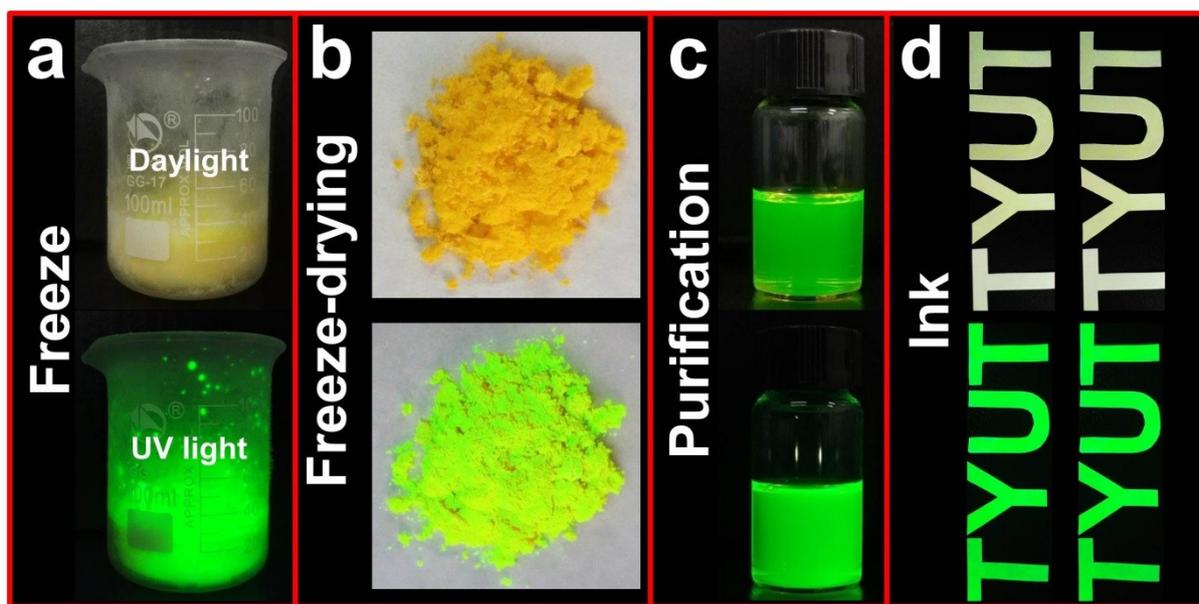


Fig. S1 a) Frozen state of the aqueous solution contained CsBr, PbBr₂ and surfactant. b) Fluffy CsPbBr₃ powder by freeze-drying. c) CsPbBr₃ NCs solution purified from CsPbBr₃ powder. d) “TYUT” painted by the CsPbBr₃ NCs solution. All the photographs at the first row were taken under daylight, and all the photographs at the second row were taken under UV light.

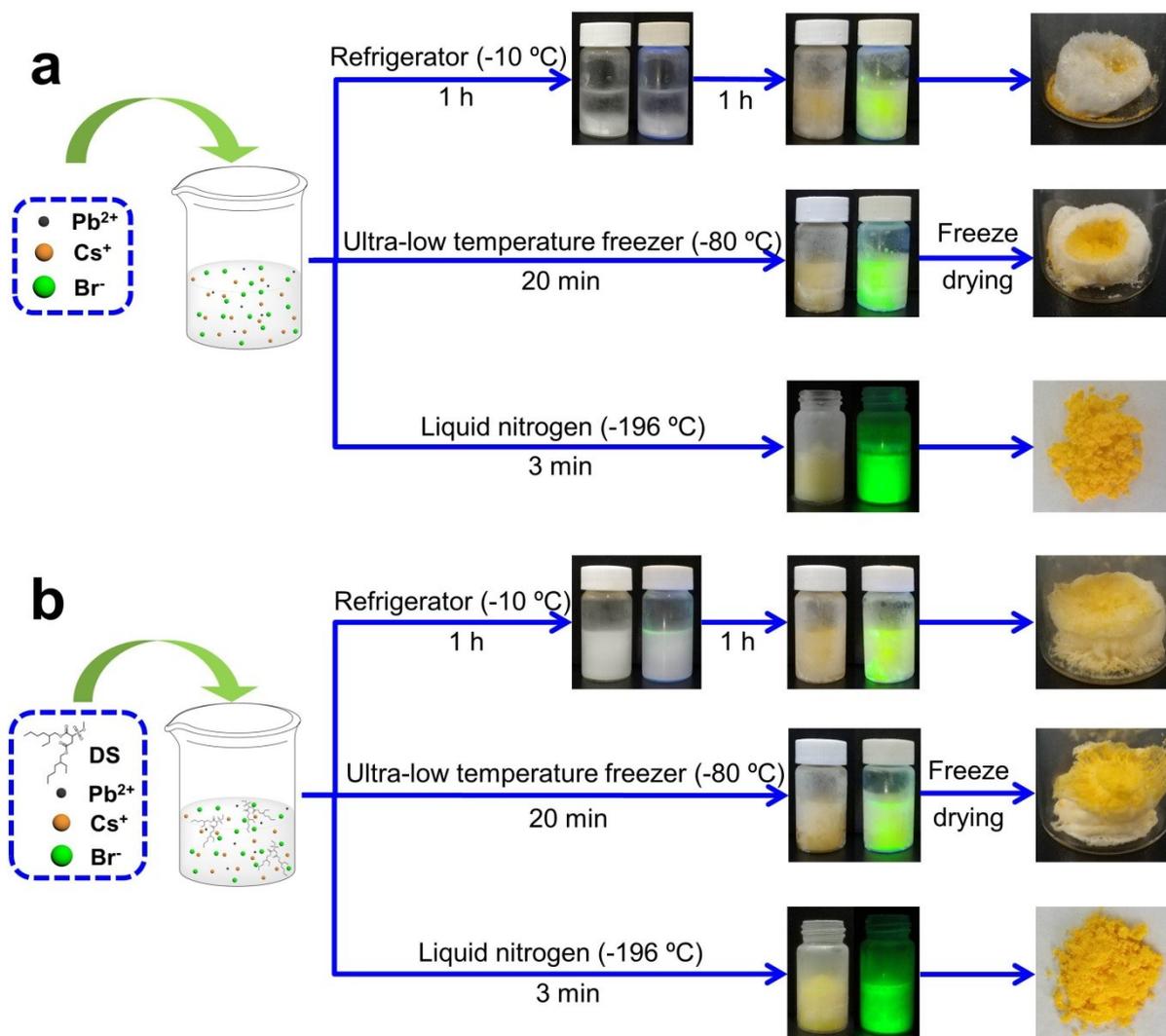


Fig. S2 a) Schematic illustrations for the freeze-drying process of the precursor solution with no surfactant by three different freezing ways (refrigerator (-10 °C), ultra-low temperature freezer (-80 °C) and liquid nitrogen (-196 °C)). b) Schematic illustrations for the freeze-drying process of the precursor solution with surfactant by three different freezing ways. The left photographs in each group were taken under daylight, and the right photographs were taken under the UV light.

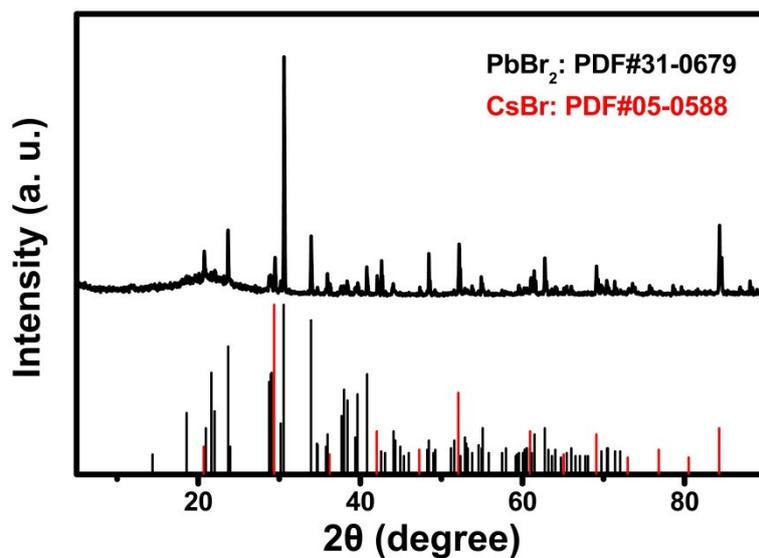


Fig. S3 XRD pattern of the white solid frozen by the refrigerator for an hour.

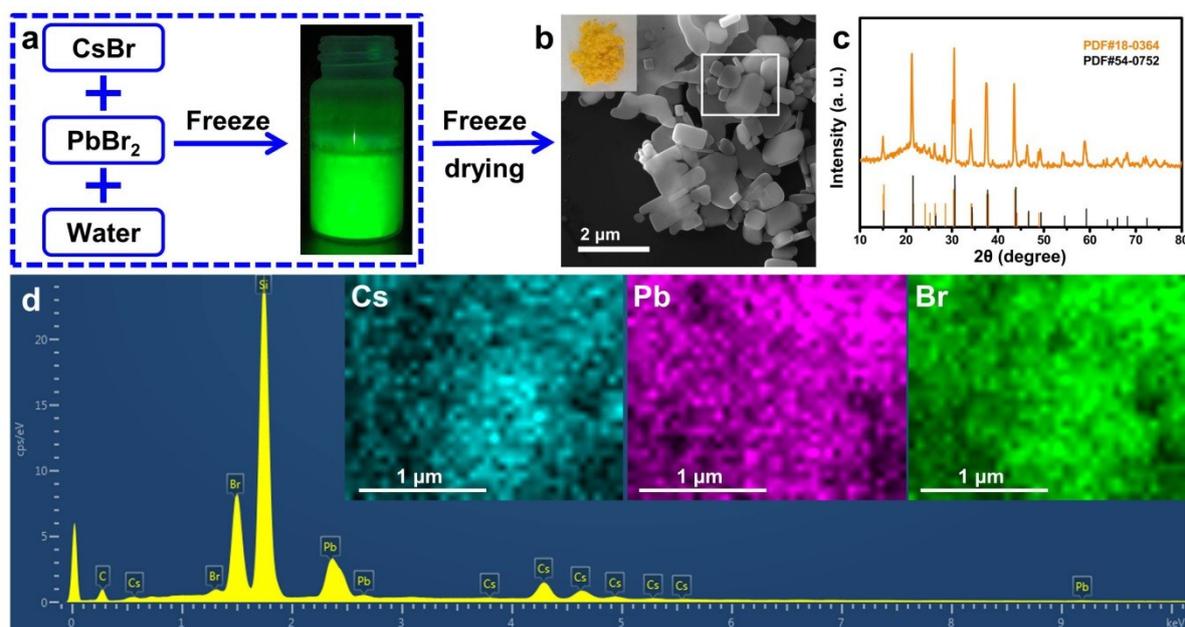


Fig. S4 a) Illustration of frozen solid under UV light. b) SEM image of surfactant-free CsPbBr₃ powder. The inset shows the photograph of orange CsPbBr₃ powder without fluorescence. c) XRD pattern of surfactant-free CsPbBr₃ powder. d) EDS of Fig. S4b. The inset shows the elemental mapping for the selected part of Fig. S4b.

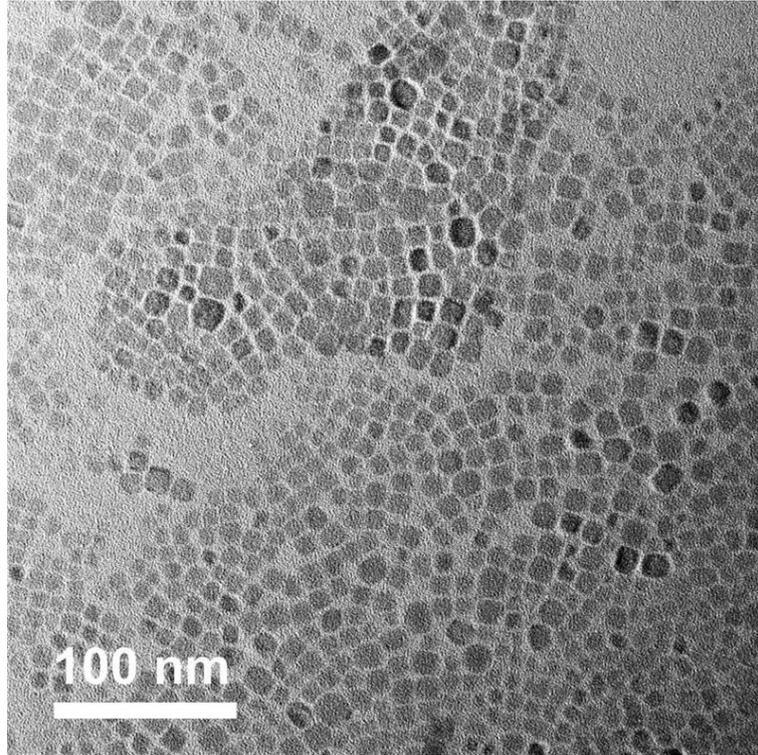


Fig. S5 Low magnification TEM image of CsPbBr₃ NCs.

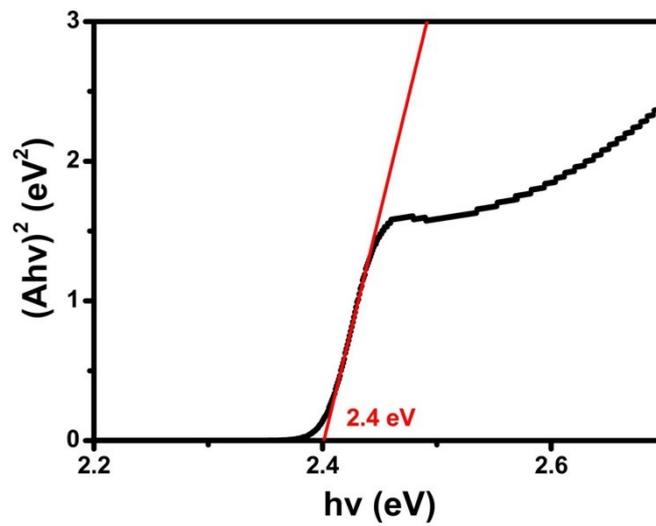


Fig. S6 Tauc plot of CsPbBr₃ NCs. A is the absorption value Abs, h is the Planck constant and ν is the frequency.

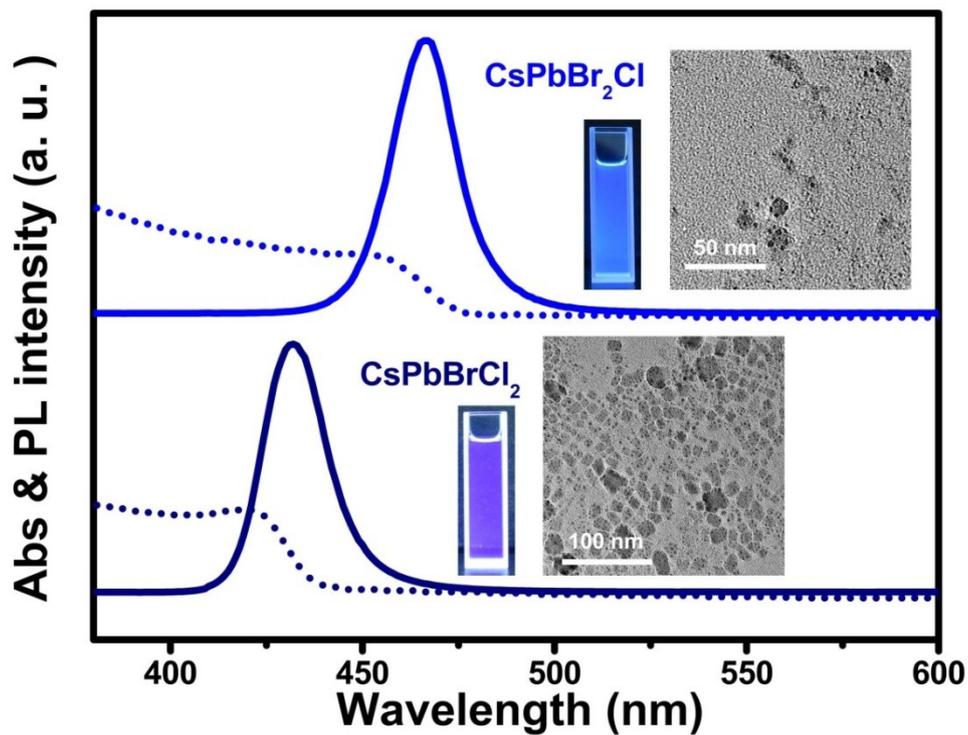


Fig. S7 Absorption and PL spectra of CsPbBr₂Cl NCs and CsPbBrCl₂ NCs. Insets show photographs of the prepared NCs in hexane under 365 nm UV light and their TEM images.

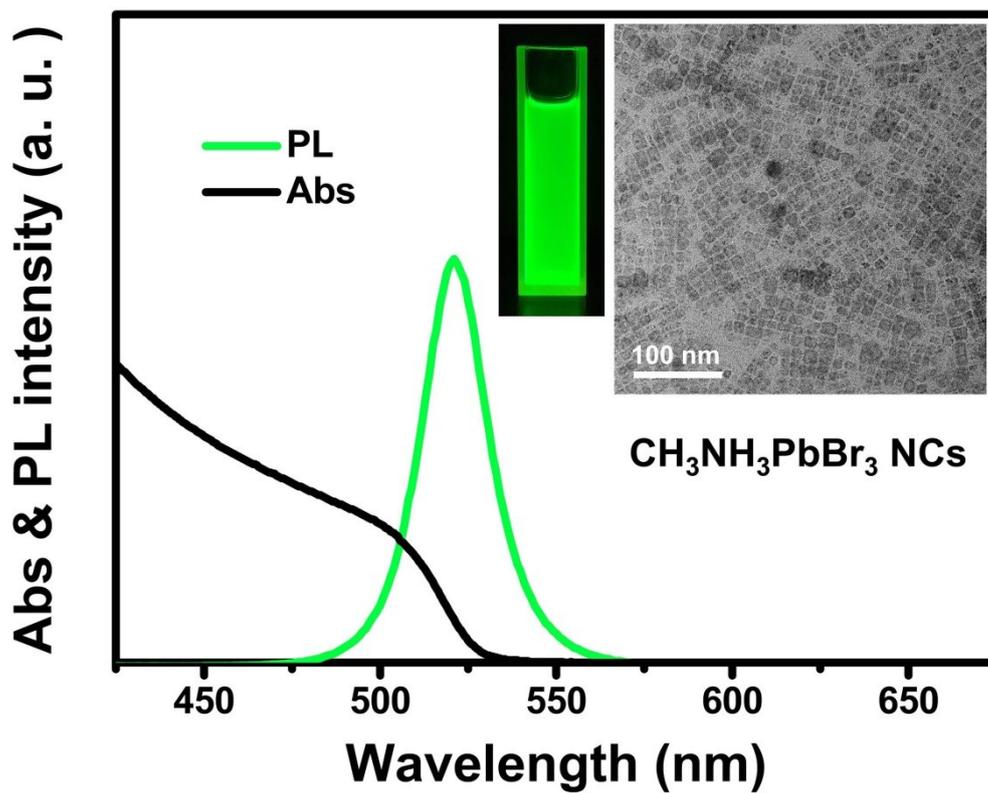


Fig. S8 Absorption and PL spectra of $\text{CH}_3\text{NH}_3\text{PbBr}_3$ NCs. Insets show photograph of $\text{CH}_3\text{NH}_3\text{PbBr}_3$ NCs in hexane under 365 nm UV light and TEM image.

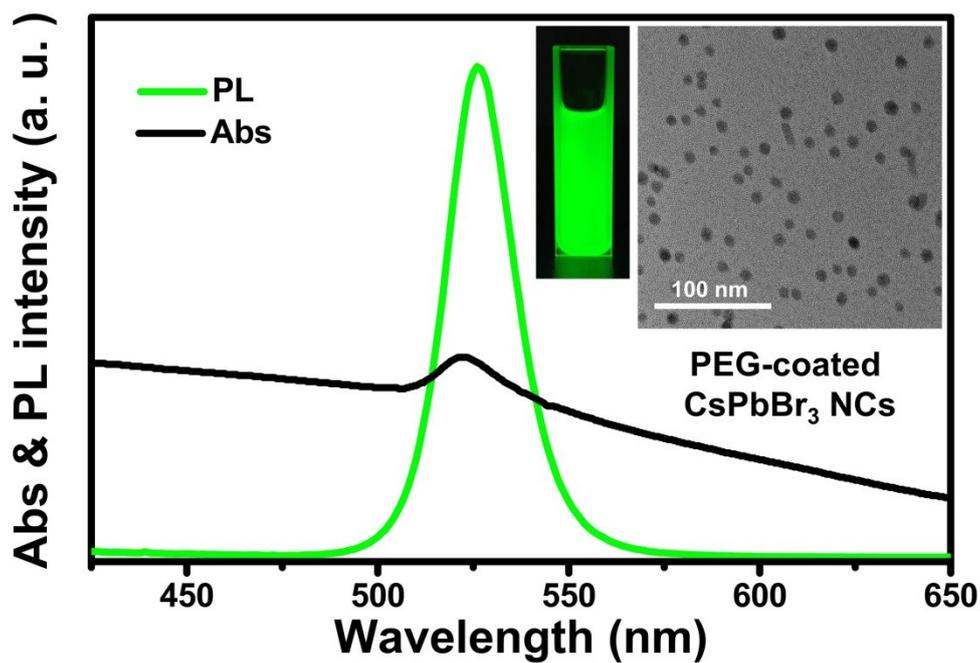


Fig. S9 Absorption and PL spectra of PEG-coated CsPbBr₃ NCs. The emission peak is 526 nm. Insets show photograph of PEG-coated CsPbBr₃ NCs in hexane under 365 nm UV light and TEM image.

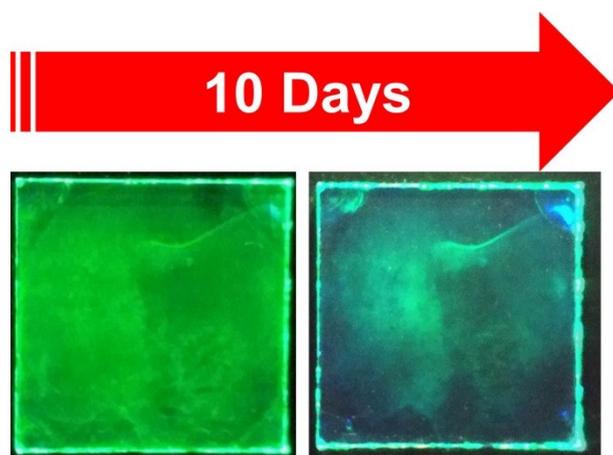


Fig. S10 Photographs of CsPbBr₃ NCs thin film stored in the ambient (25 °C and humidity of 20 %).

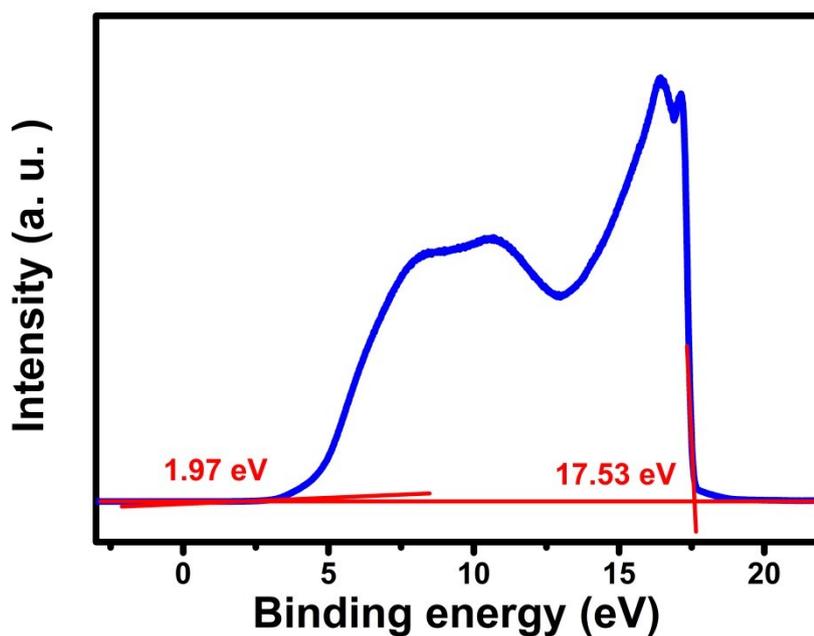


Fig. S11 UPS spectra of CsPbBr₃ NCs.

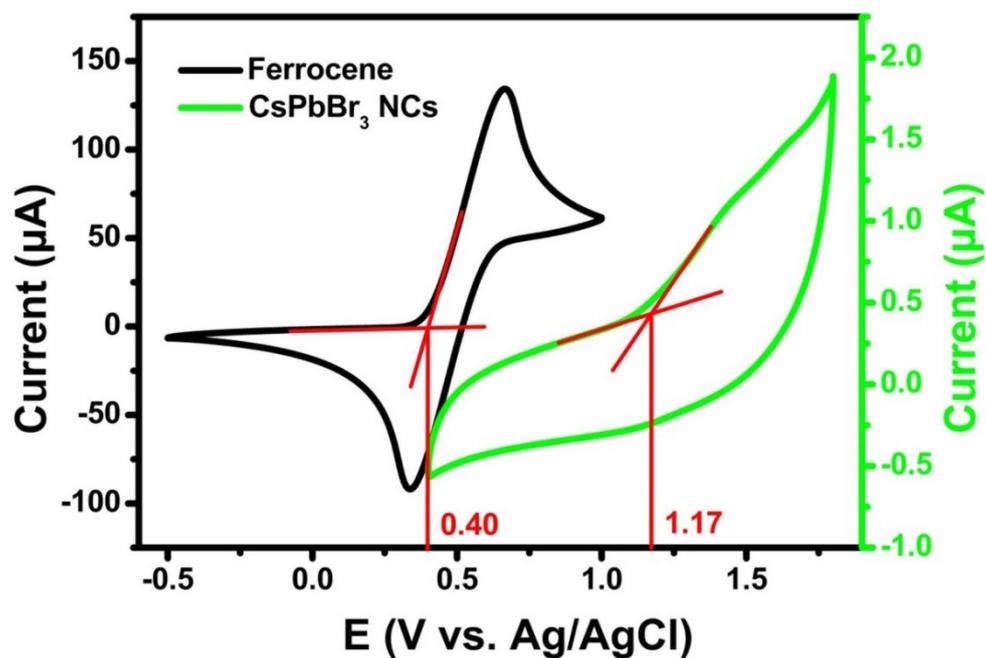


Fig. S12 Cyclic voltammogram of ferrocene and CsPbBr₃ NCs in dichloromethane with tetrabutylammonium hexafluorophosphate.

$$E_{VB} = -[E^{OX} - E(\text{Fc}/\text{Fc}^+) + 4.7] \text{ eV} = -(1.17 - 0.40 + 4.7) \text{ eV} = -5.47 \text{ eV}$$

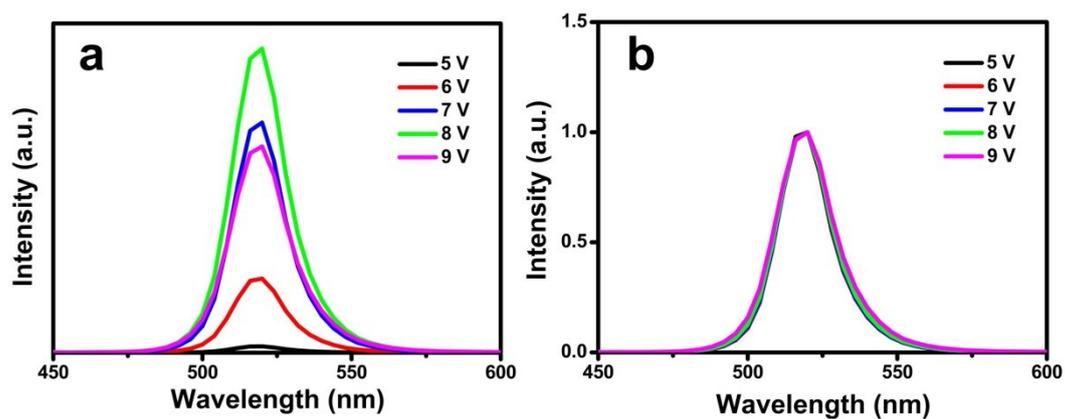


Fig. S13 a) EL spectrums of CsPbBr₃ NCs LED at different voltage (5-9 V). b) Normalized EL spectrums of CsPbBr₃ NCs LED at different voltage (5-9 V).