Electronic Supplementary Information

Nanocrystals of Divalent Europium-Doped $CsPbCl_3$ Perovskite: A Novel Optoelectronic Material with Dual-Emissions

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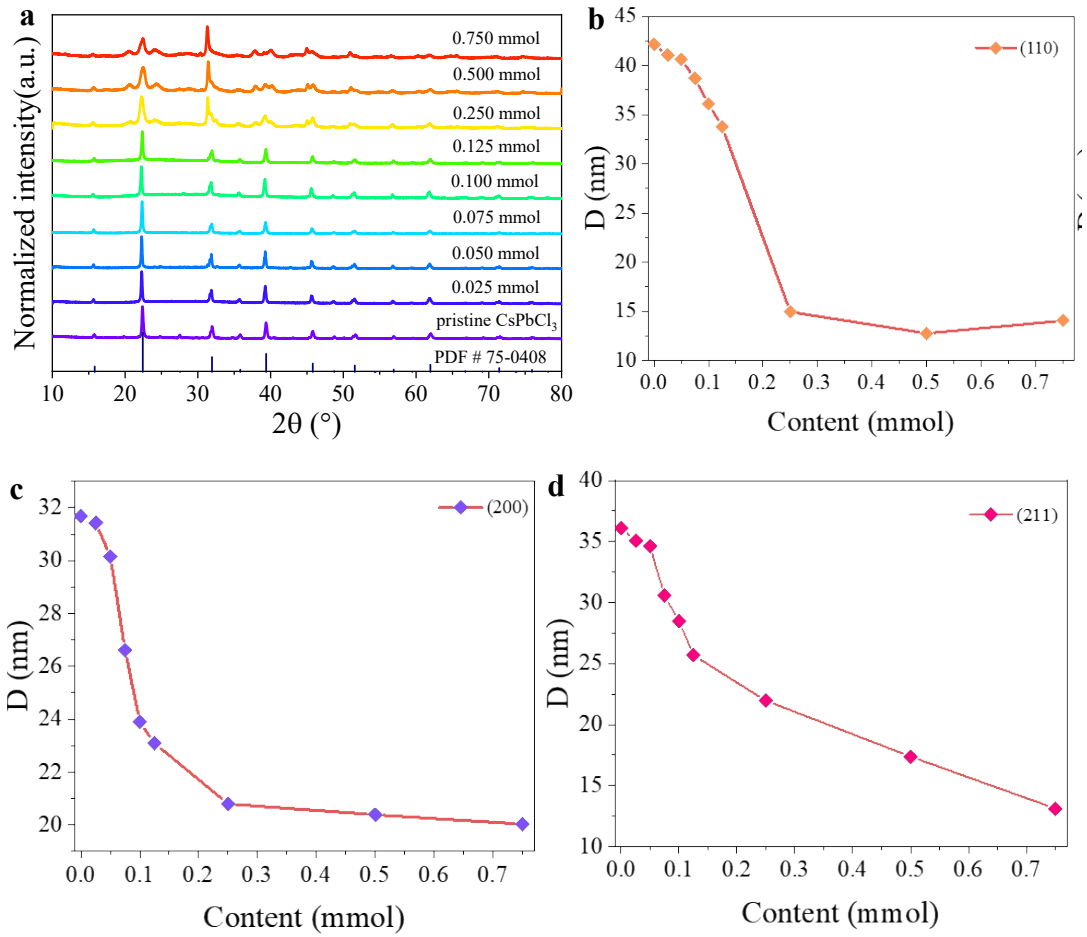


Figure S1 (a) XRD patterns of Eu: $CsPbCl_3$ samples prepared with different Eu doping concentrations. **(b-d)** Crystallite sizes evaluated from XRD results using the Scherrer equation for different crystalline planes.

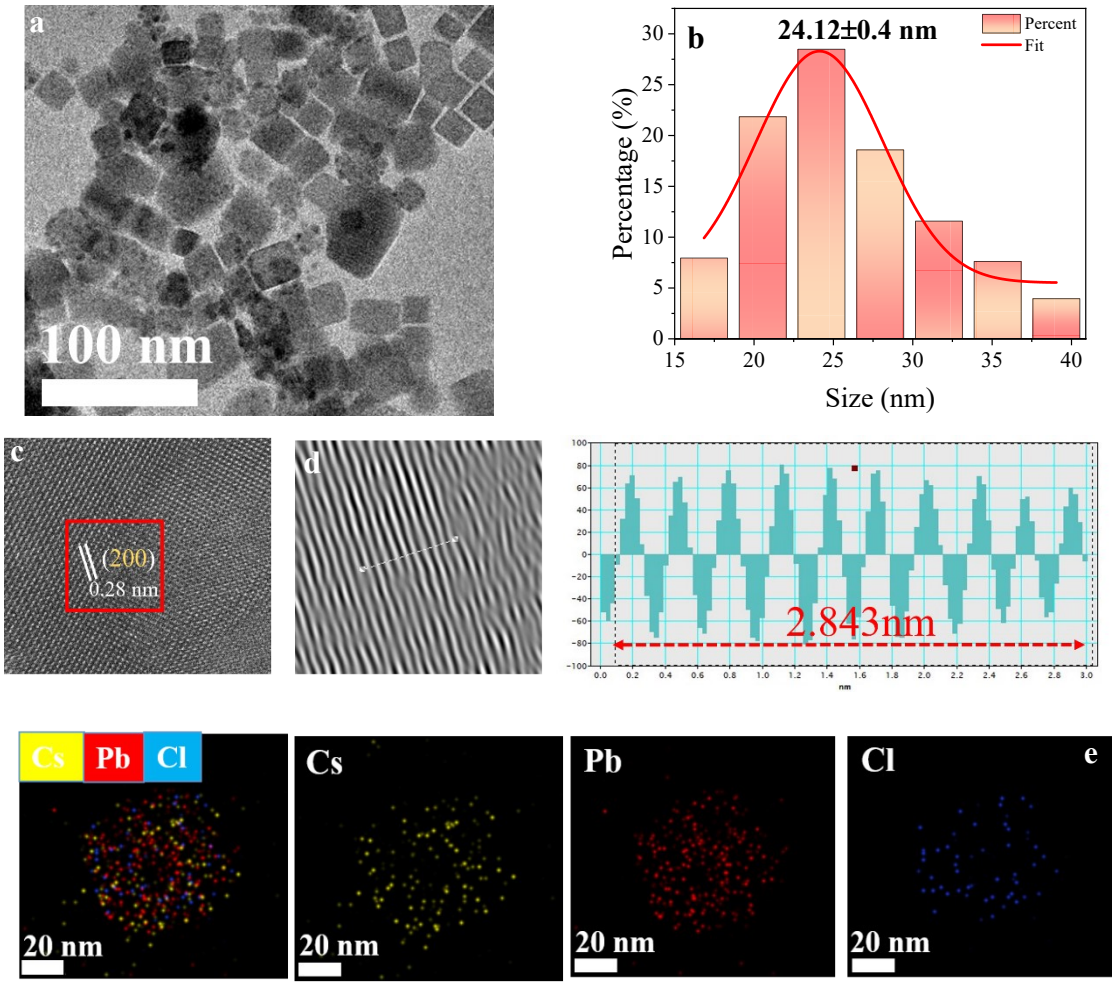


Figure S2 (a) TEM image and **(b)** size distribution of the pristine $CsPbCl_3$ PeNCs. **(c)** HRTEM micrograph and **(d)** the corresponding FFT image showing atomic lattice fringes. **(e)** EDX mapping of the pristine $CsPbCl_3$ PeNCs.

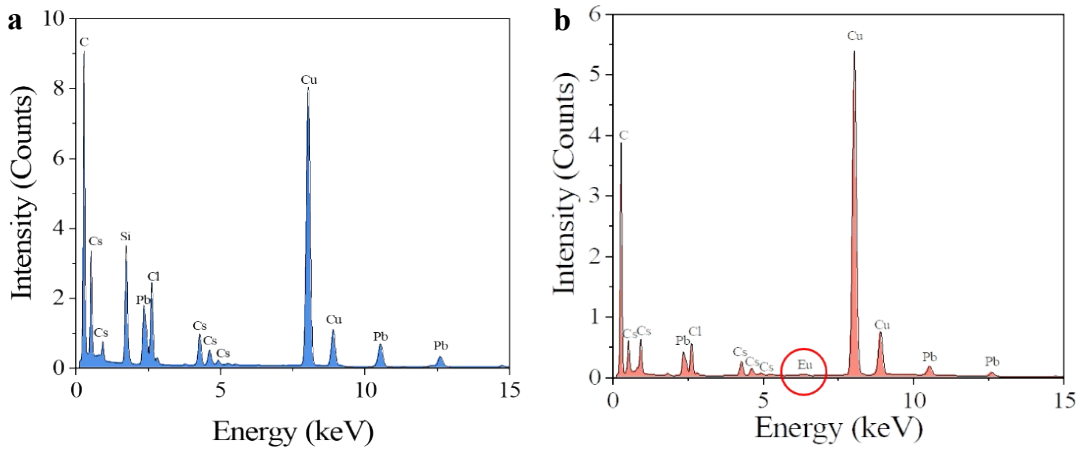


Figure S3 Typical EDX analyses of **(a)** the undoped and **(b)** Eu-doped $CsPbCl_3$ (red circle represents the presence of Eu element).

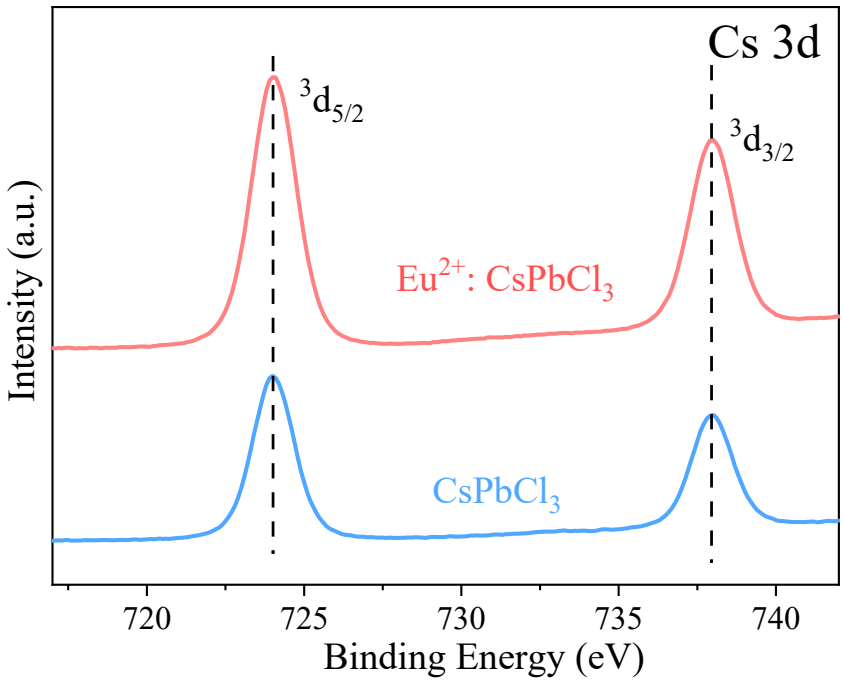


Figure S4 HRXPS profiles of Cs ($3d_{3/2}$, $3d_{5/2}$) energy states from the un-doped $CsPbCl_3$ and Eu-doped $CsPbCl_3$ PeNCs.

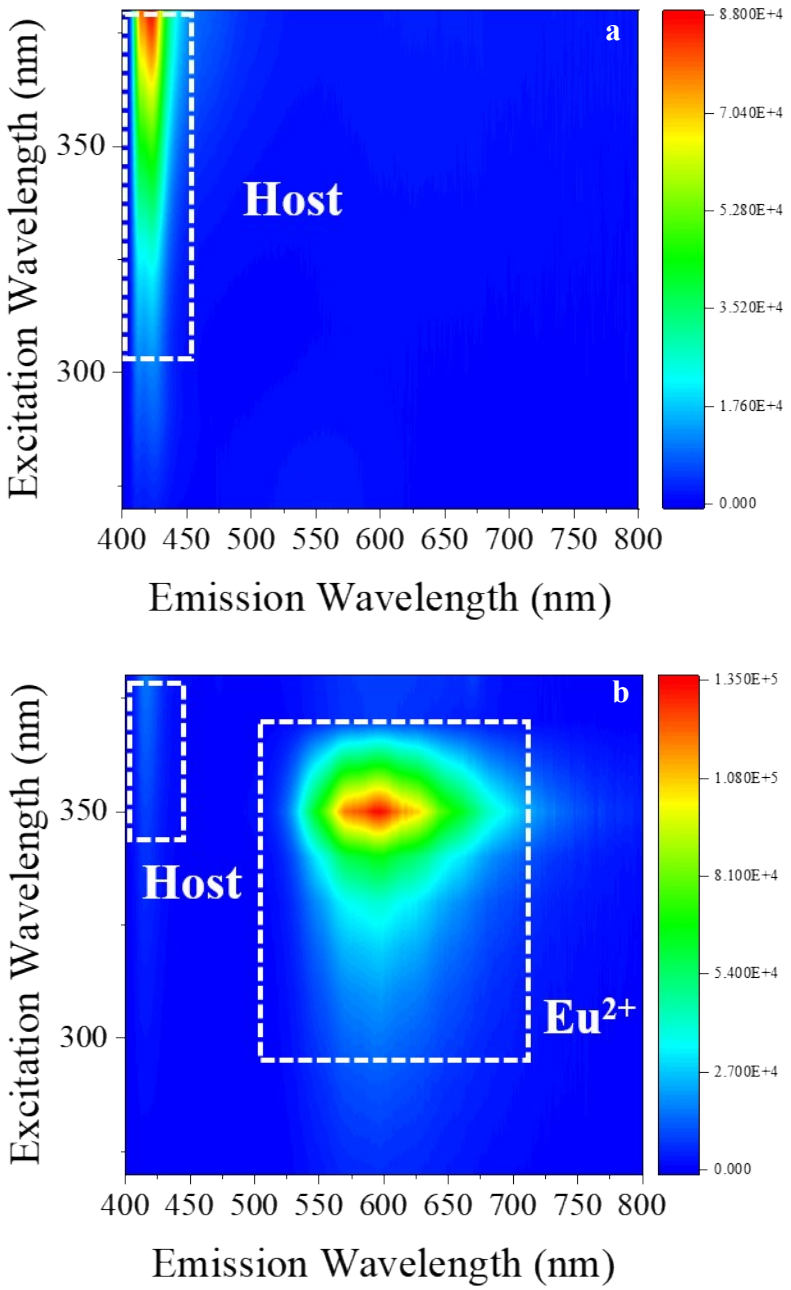


Figure S5 Two-dimensional excitation-emission mapping for **(a)** the $CsPbCl_3$ and **(b)** Eu: $CsPbCl_3$ PeNCs.

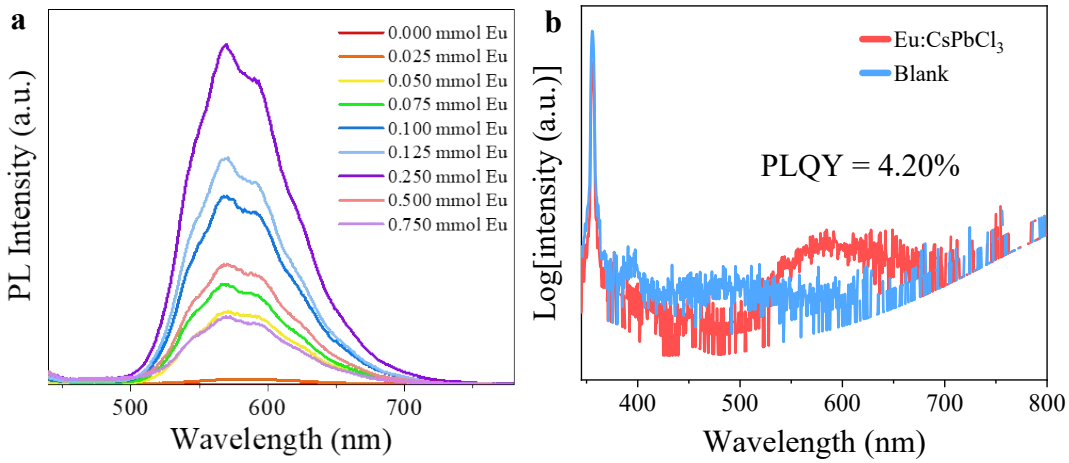
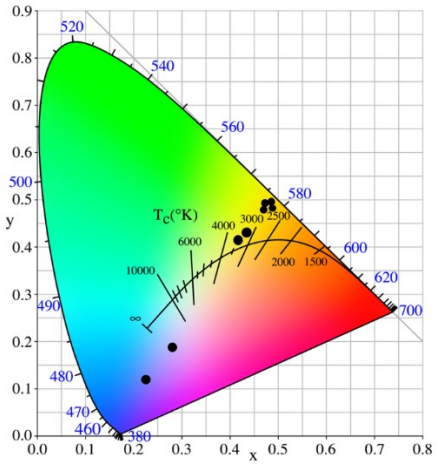


Figure S6 (a) PL spectra for the broadband Eu^{2+} emission of the Eu: $CsPbCl_3$ PeNCs prepared with different amounts of Eu concentrations. **(b)** PL spectra recorded by a FLS1000 spectrofluorometer equipped with an integrating sphere to determine PLQY.



Eu concentration (mmol)	CIE (x, y)
0.000	0.223, 0.120
0.025	0.286, 0.190
0.050	0.487, 0.485
0.075	0.472, 0.484
0.100	0.482, 0.493
0.125	0.474, 0.490
0.250	0.471, 0.480
0.500	0.438, 0.428
0.750	0.422,0.413

Figure S7 CIE color coordinates for the Eu: $CsPbCl_3$ samples, showing that the emitting color of the product changes from blue to orange upon increase of Eu doping content.

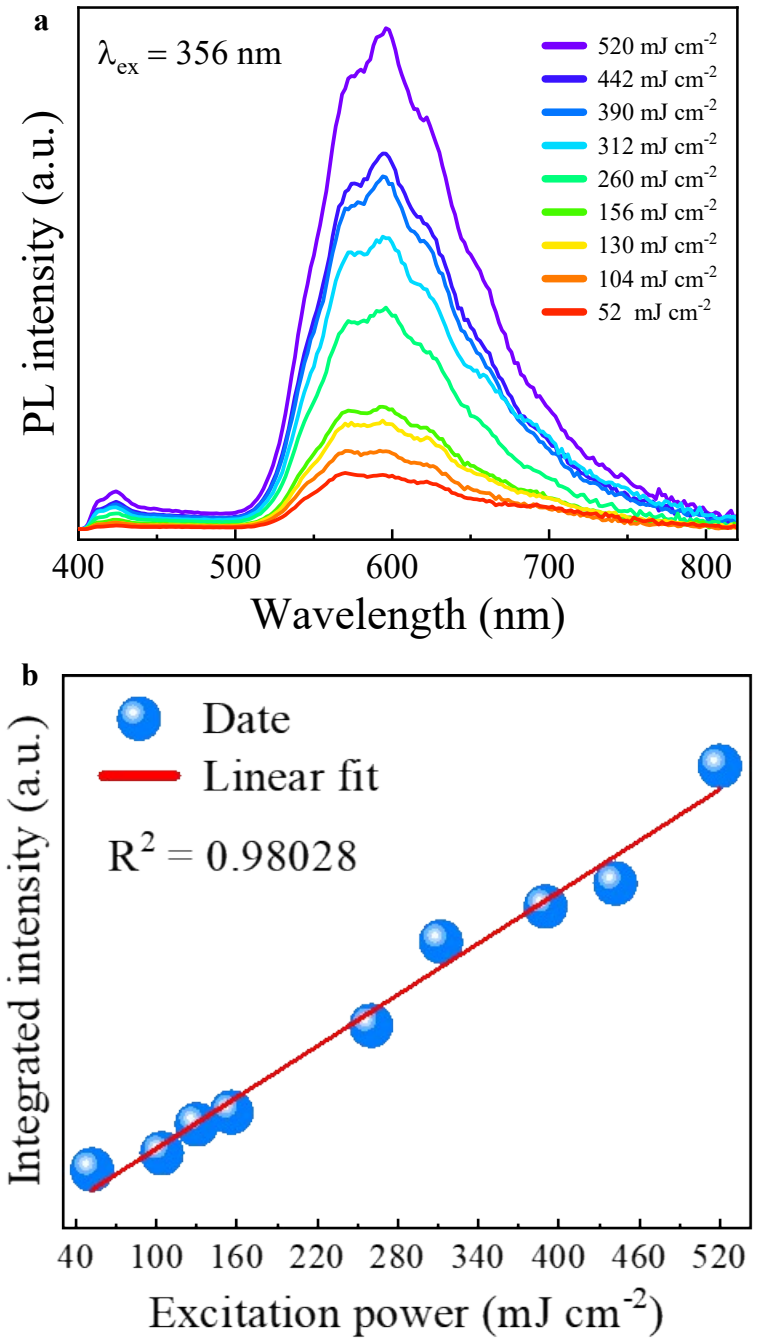


Figure S8 (a) Power-dependent PL spectra of the Eu: $CsPbCl_3$ sample and **(b)** the integrated PL intensity versus excitation power. The red line is a linear fitting.

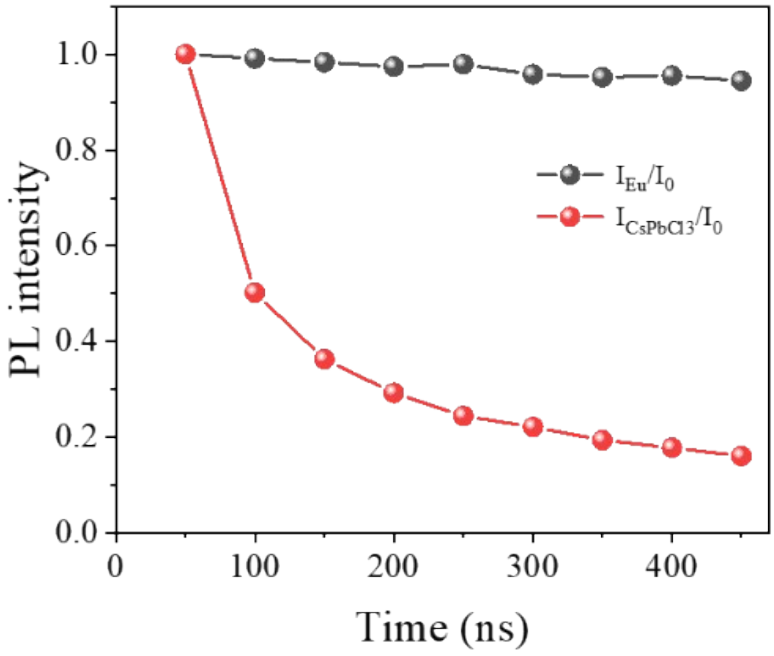


Figure S9 The variation of PL intensity with the elongation of decay time.

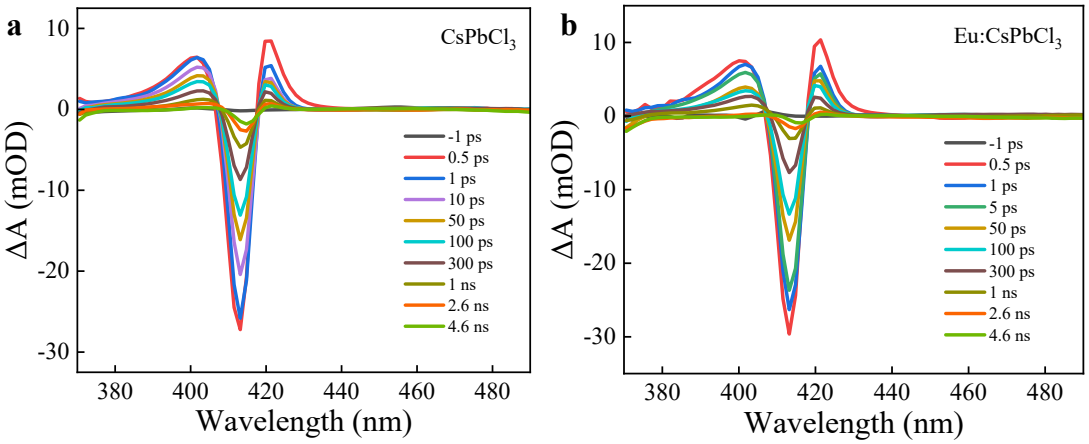


Figure S10 Pump-probe fs-TA spectra of **(a)** the $CsPbCl_3$ and **(b)** Eu: $CsPbCl_3$ PeNCs at different delay times.

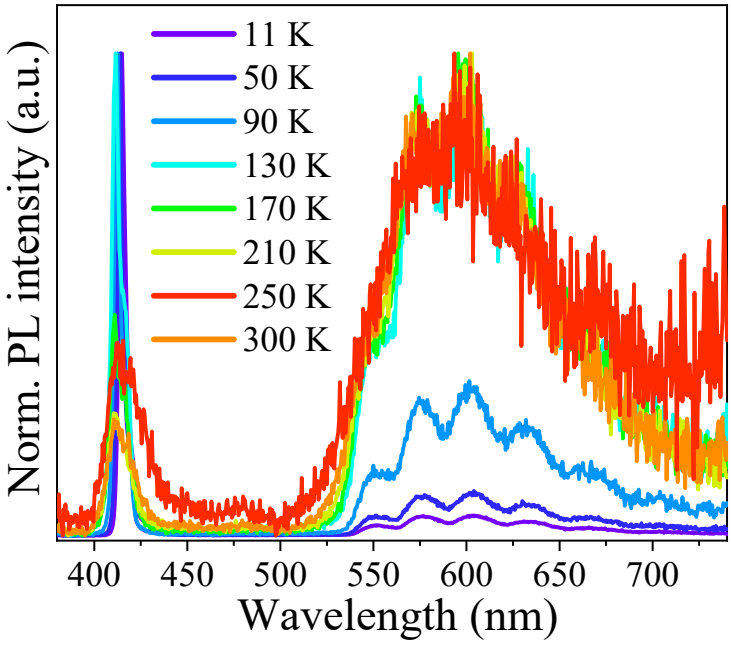


Figure S11 Normalized temperature-dependent (11~300 K) PL spectra of the Eu: $CsPbCl_3$ PeNCs.

With elevation of temperature, host PL (i.e. exciton emission) quenches faster than Eu^{2+} emission owing to low exciton binding energy, which leads to the observed weak host PL and strong Eu^{2+} emission at room temperature.

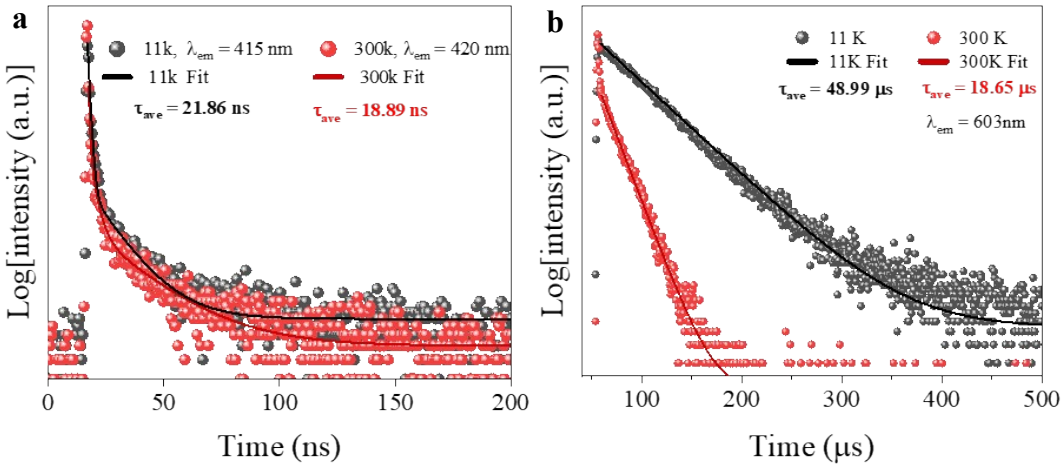


Figure S12 Temperature-dependent PL decay curves for **(a)** the $CsPbCl_3$ and **(b)** Eu: $CsPbCl_3$ PeNCs.

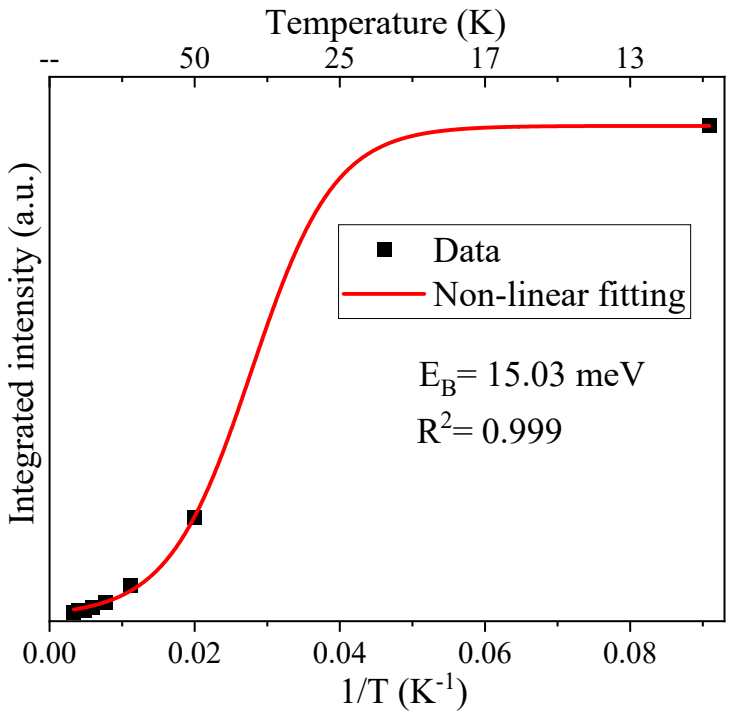


Figure S13 Integrated PL intensity of exciton recombination for the Eu: $CsPbCl_3$ sample as a function of temperature, which is used to evaluate exciton binding energy.

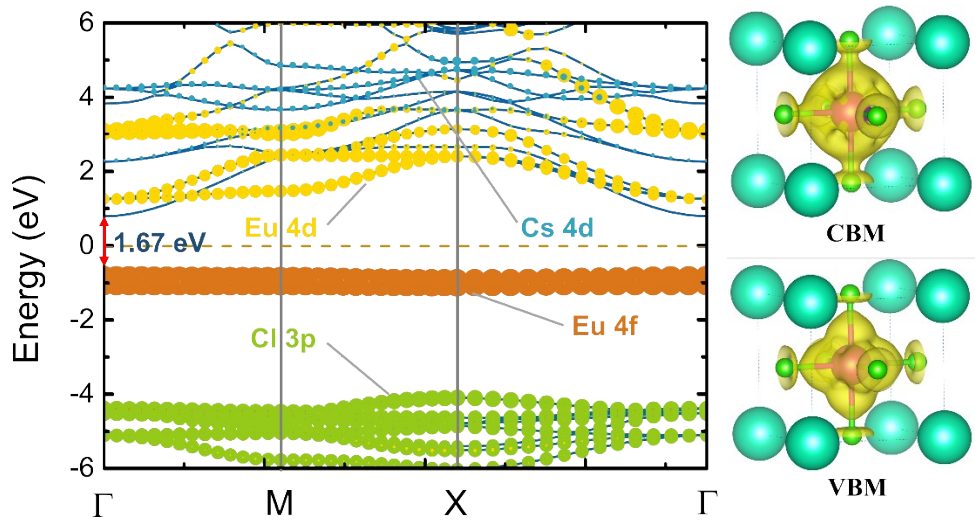


Figure S14 Orbital projected band structures and VBM/CBM orbital arrangements of $CsEuCl_3$. The green, orange, blue, and yellow colors represent the Cl-*3p*, Eu-*4f*, Cs-*4d* and Eu-*4d* states, respectively.

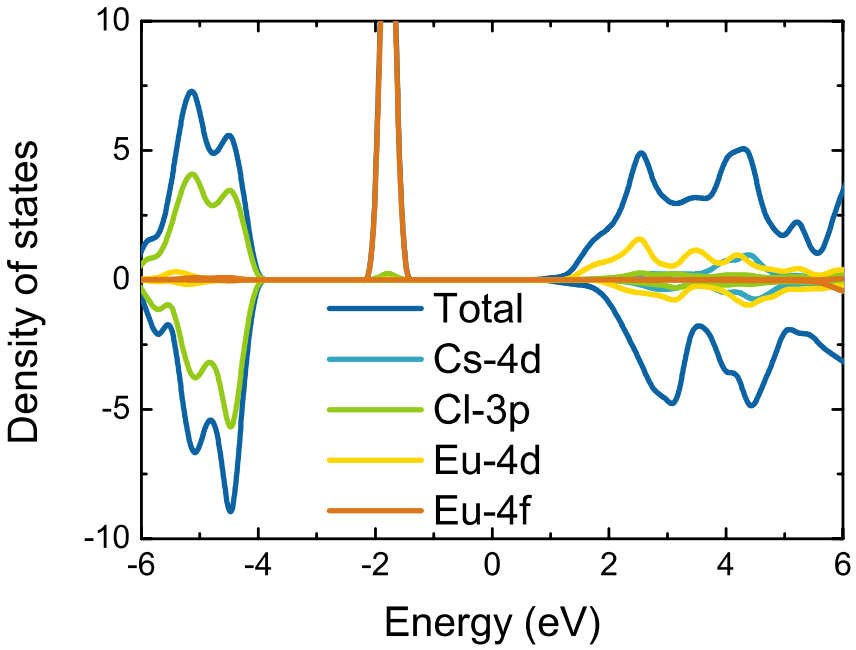


Figure S15 Projected DOS for $CsEuCl_3$.

Table S1 The calculated values of several key parameters for centroid shift and crystal field splitting of Eu: $CsPbCl_3$ PeNCs.

Parameter	**Value**
$R(Eu^{2+})$ (ppm)	117
$R(Pb^{2+})$ (ppm)	118
R(Eu-Cl) (ppm)	286
R(Eu-O) (ppm)	240
χ_{Cs}	0.79
χ_{Pb}	2.33
χ_{av}	1.82
αCl sp (10^{-30} $m^{3)}$	2.46
αo sp (10^{-30} $m^{3)}$	1.78
ε_c (eV)	0.75
ε_{cfs} (eV)	0.81
D (eV)	1.16
E_x (eV)	3.06
E_m (eV)	2.22