

Electronic supplementary information (ESI)

Highly stable lanthanide-doped CsPbI₃ perovskite nanocrystals with near-unity quantum yield for efficient red light-emitting diodes

Wenlin Xia^a, Zhenwei Ren^{a,*}, Zhishuai Zheng^a, Chengzhao Luo^a, Jie Li^a, Wenchen Ma^a, Xin Zhou^a, and Yu Chen^{a,b,*}

^a*School of Optoelectronic Science and Engineering & Collaborative Innovation Center of Suzhou Nano Science and Technology, Soochow University, Suzhou 215006, China
Email: zhwren@suda.edu.cn; chen_yu@suda.edu.cn*

^b*National University of Singapore Suzhou Research Institute, Dushu Lake Science and Education Innovation District, Suzhou 215123, China*

Table S1. The mole ratio of La/Pb in La-doped CsPbI₃ NCs measured by inductively

La/Pb in the reaction system	5%	10%	15%	20%
Measured by ICP-OES	0.18%	0.51%	0.67%	0.96%

coupled plasma optical emission spectrometry (ICP-OES).

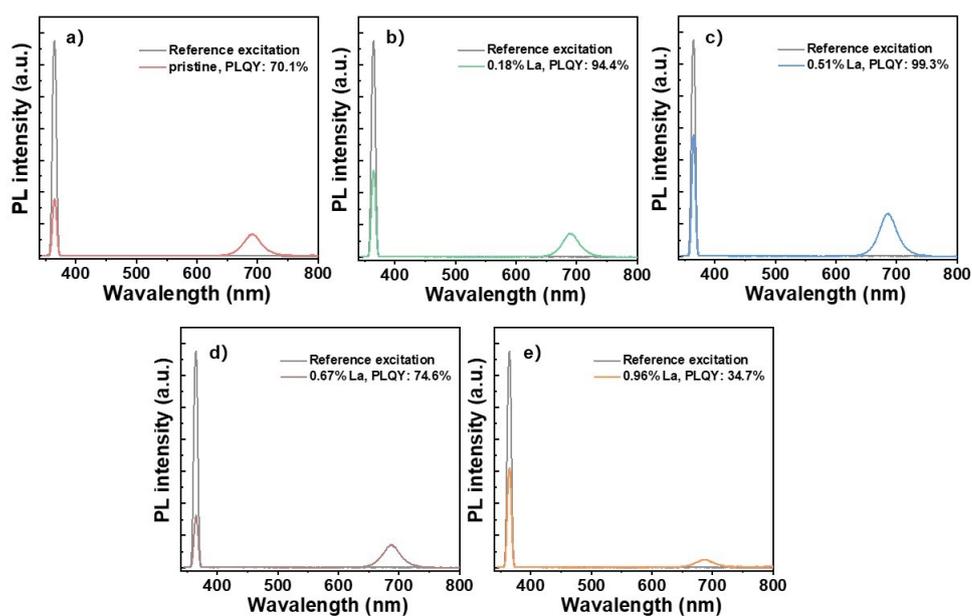


Fig. S1. Photoluminescence quantum yield (PLQY) measurements of a) pristine and La-doped CsPbI₃ NCs with different La ratios: b) 0.18%, c) 0.51%, d) 0.67%, and e) 0.96%.

Table S2. The fitted parameters of TRPL decay curves from the bi-exponential function for pristine and La-doped CsPbI₃ NCs with different doping ratios.

QDs	A ₁	τ ₁ (ns)	A ₂	τ ₂ (ns)	τ _{average} (ns)	χ ²
pristine	1369.97	40.36 (61.58%)	259.75	132.68 (38.42%)	75.82	1.014
0.18%	1011.82	43.89 (56.60%)	173.92	195.70 (43.40%)	109.76	1.003
0.51%	1301.53	82.33 (37.78%)	543.23	324.90 (62.22%)	233.26	1.034
0.67%	995.85	55.82 (59.31%)	139.50	273.32 (40.69%)	144.31	1.088
0.96%	1532.29	31.52 (63.63%)	347.55	79.43 (36.37%)	48.94	0.989

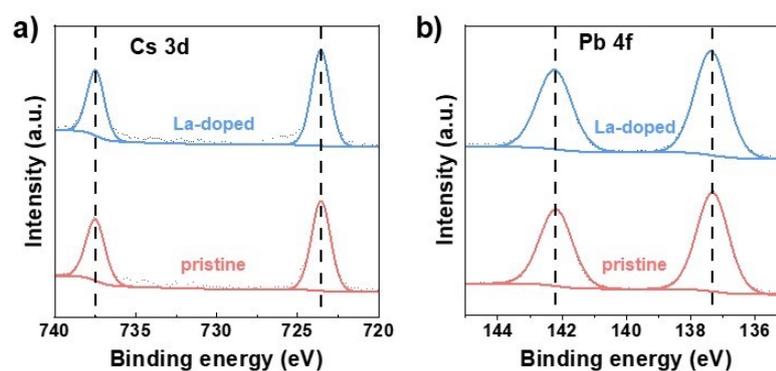


Fig. S2. X-ray photoelectron spectroscopy (XPS) measurements of a) Cs 3d and b) Pb 4f signals for pristine and 0.51% La-doped NCs.

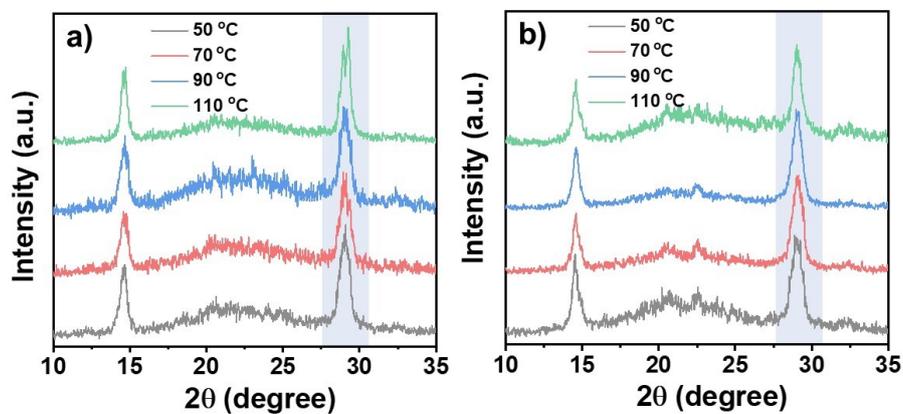


Fig. S3. XRD patterns of a) pristine and b) La-doped CsPbI₃ NCs treated under different temperatures.

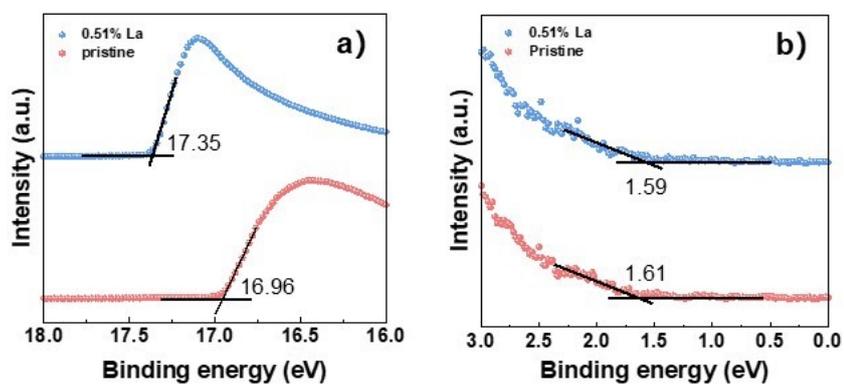


Fig. S4. Ultraviolet photoelectron spectroscopy (UPS) measurements for pristine and La-doped NCs at a) high and b) low binding energy regions.

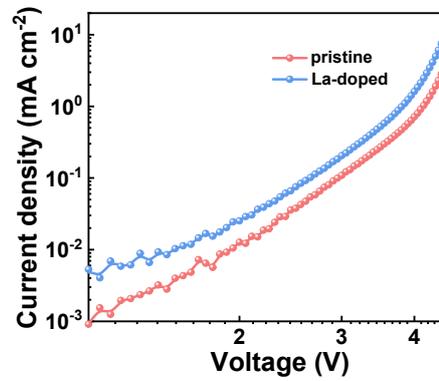


Fig. S5. The space charge-limited current (SCLC) measurements for pristine and La-doped hole-only device with the structure of ITO/PEDOT: PSS/Poly-TPD/NCs/CBP/MoO₃/Al.

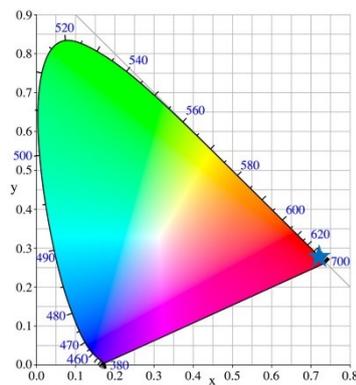


Fig. S6. The CIE chromaticity coordinate at (0.72, 0.28) for the La-doped PeLEDs.

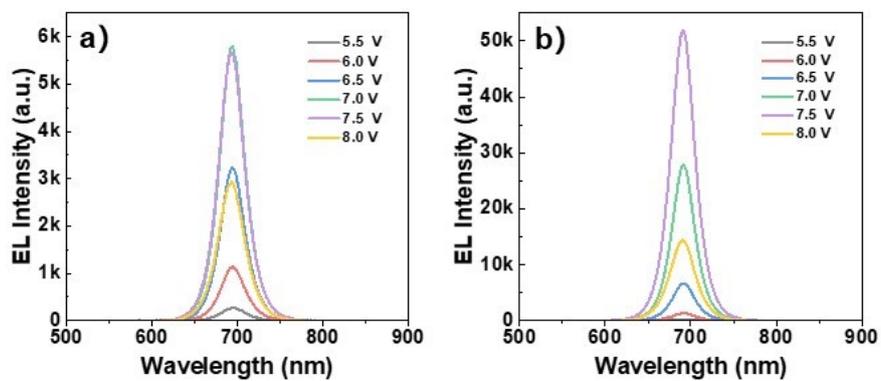


Fig. S7. The EL spectra for a) pristine and b) La-doped PeLEDs at different voltages.