

Synergistic Enhancement of Near-Infrared Emission in CsPbCl₃ Host via Co-Doping with Yb³⁺ and Nd³⁺ for Perovskite Light Emitting Diodes

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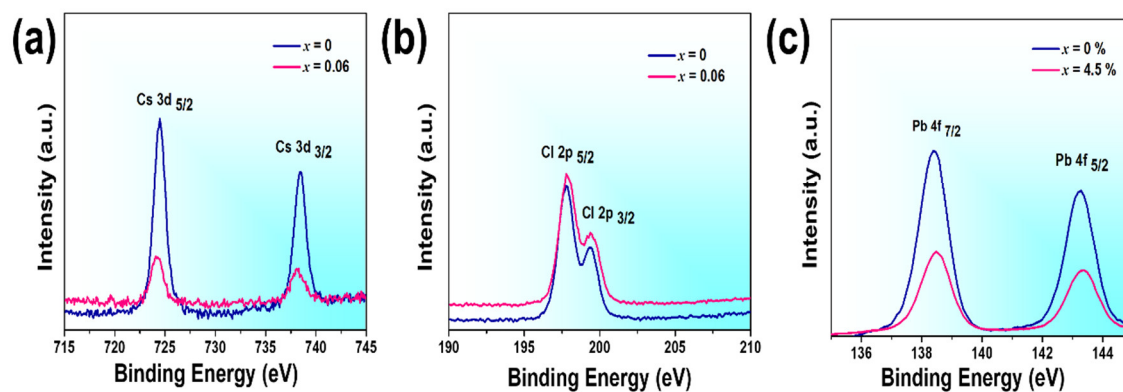


Figure. S1 High resolution XPS graph of $\text{CsPbCl}_3/\text{Yb}^{3+}/_x\text{Nd}^{3+}$ PeNCs ($x = 0, 0.06$) with elements Cs, Cl and Pb respectively.

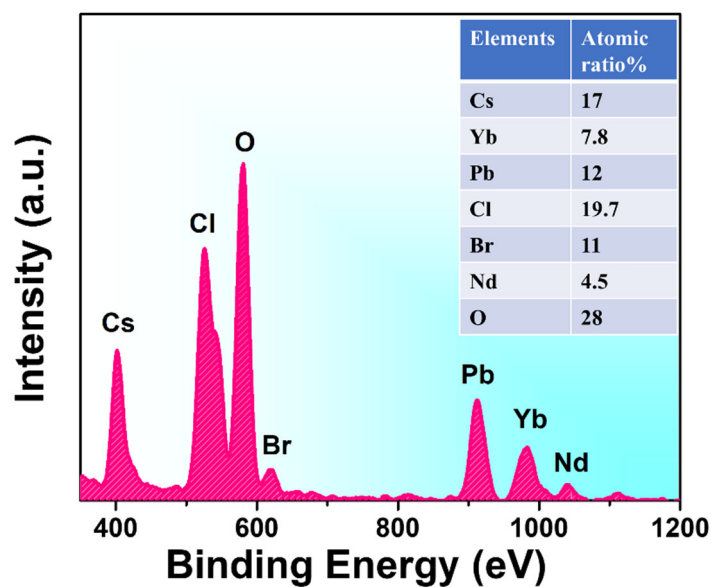


Figure. S2 EDS graph with atomic percentage of each element present in $\text{CsPbCl}_3/\text{Yb}^{3+}/_x\text{Nd}^{3+}$ PeNCs ($x = 0.06$).

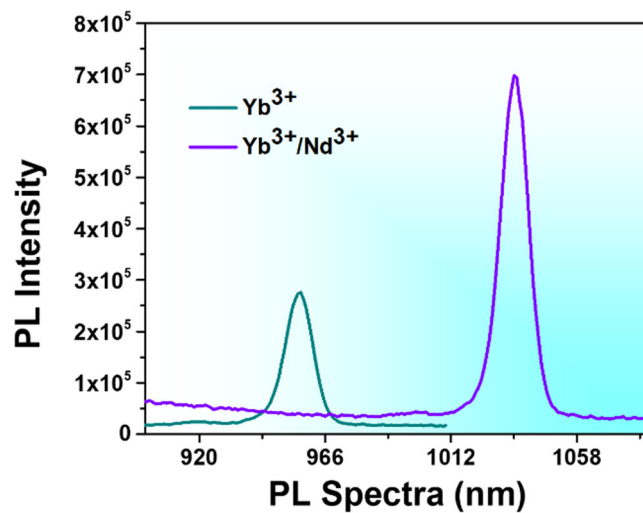


Figure S3. PL spectra of Single doped and Co-doped PeNCs ($x=0, 0.06$)

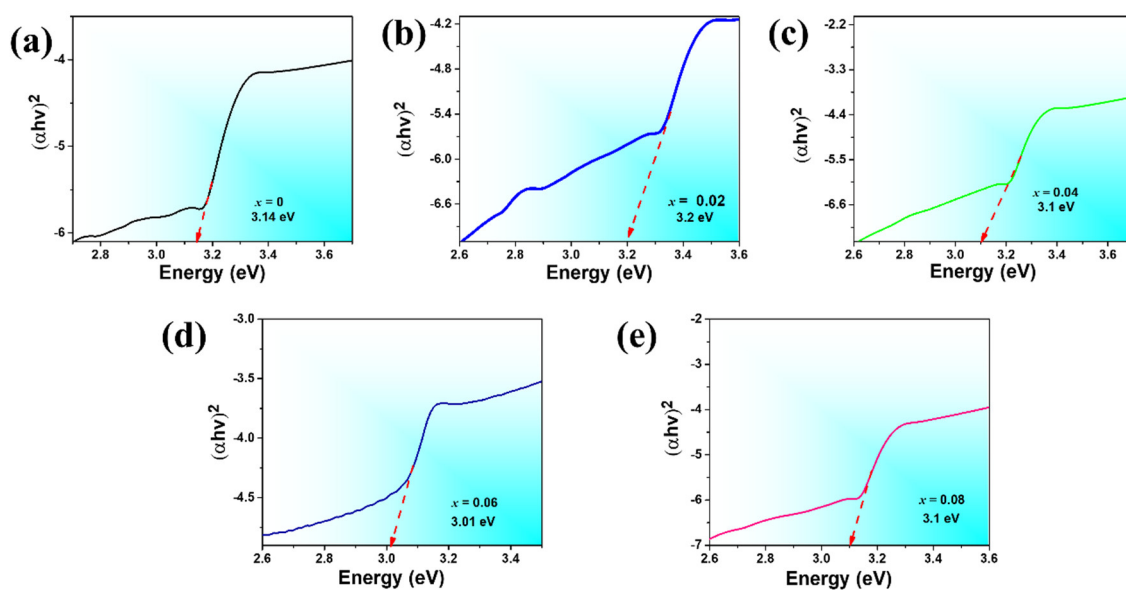


Figure. S4 Tauc Plot representation showing bandgap of CsPbCl₃/Yb³⁺/xNd³⁺ PeNCs ($x=0, 0.02, 0.04, 0.06, 0.08$) respectively.

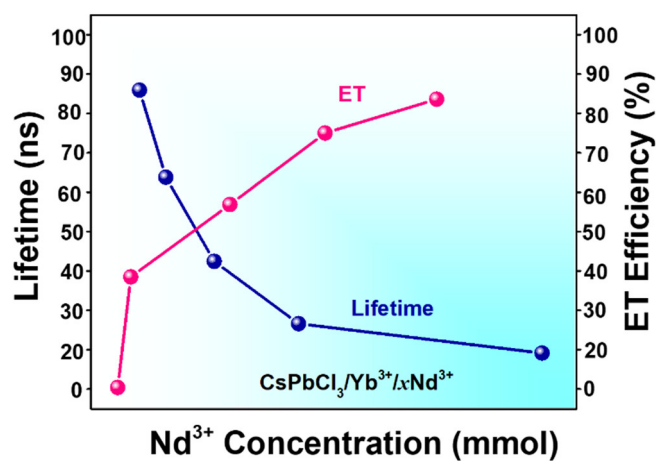


Figure. S5 Lifetime and ET efficiency of CsPbCl₃/Yb³⁺/xNd³⁺ PeNCs ($x=0, 0.02, 0.04, 0.06, 0.08$)

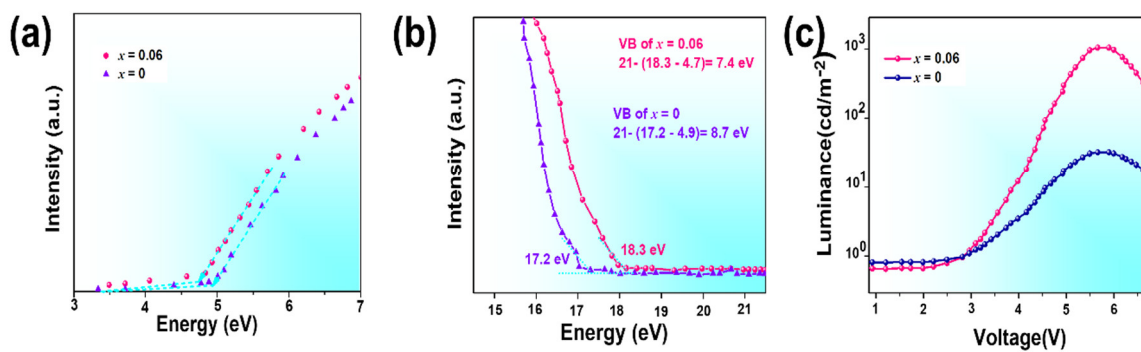


Figure. S6 UPS spectra cut-off region(b) Band-edge region. (c) Luminance Intensity of PeNCs ($x=0, 0.06$)

Table S1 Bi-exponential fitting results of the time resolved PL spectra of CsPbCl₃/Yb³⁺/*x*Nd³⁺ PeNCs treated by different contents of Nd³⁺ (*x*=0, 0.02, 0.04, 0.06 and 0.08) respectively

<i>x</i> = 0	<i>x</i> = 0.02	<i>x</i> = 0.4	<i>x</i> = 0.06	<i>x</i> = 0.08
τ ₁ =15.01 ns	τ ₁ =13.46 ns	τ ₁ =12.24 ns	τ ₁ =11.05 ns	τ ₁ =10.66 ns
B ₁ %=70.53	B ₁ %=88.64	B ₁ %=92.48	B ₁ %=95.44	B ₁ %=96.59
τ ₂ =121.2 ns	τ ₂ =86.2 ns	τ ₂ =79.25 ns	τ ₂ =76.23 ns	τ ₂ =74.64 ns
B ₂ %=30.45	B ₂ %=18.9	B ₂ %=15.46	B ₂ %=14.69	B ₂ %=11.82
τ _{avg} =47.48 ns	τ _{avg} =28.22 ns	τ _{avg} = 23.57ns	τ _{avg} =21.73 ns	τ _{avg} = 19.0 ns