Electronic Supplementary Material (ESI) for Nanoscale.

Supporting information

Considerably enhanced exciton emission of $CsPbCl_3$ perovskite quantum dots by introduction of potassium and lanthanide ions

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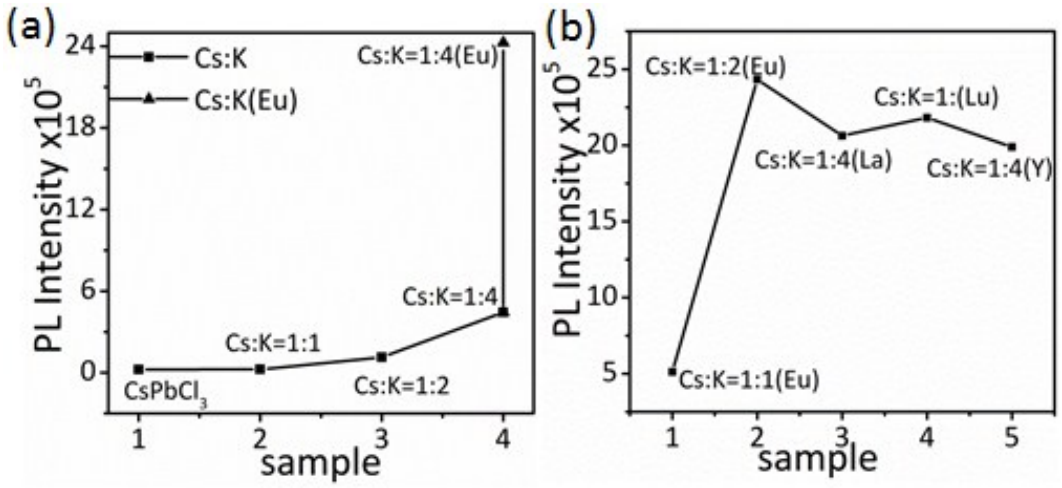

Figure S1. *(a) The PL spectra of the $Cs_xK_{1-x}PbCl_3$ and $Cs_xK_{1-x}PbCl_3:Eu^{3+}$ QDs. (b) The PL spectra of the $Cs_xK_{1-x}PbCl_3$: RE^{3+} (RE=Eu^{3+},La^{3+}, Lu^{3+}, Y^{3+}) QDs.*

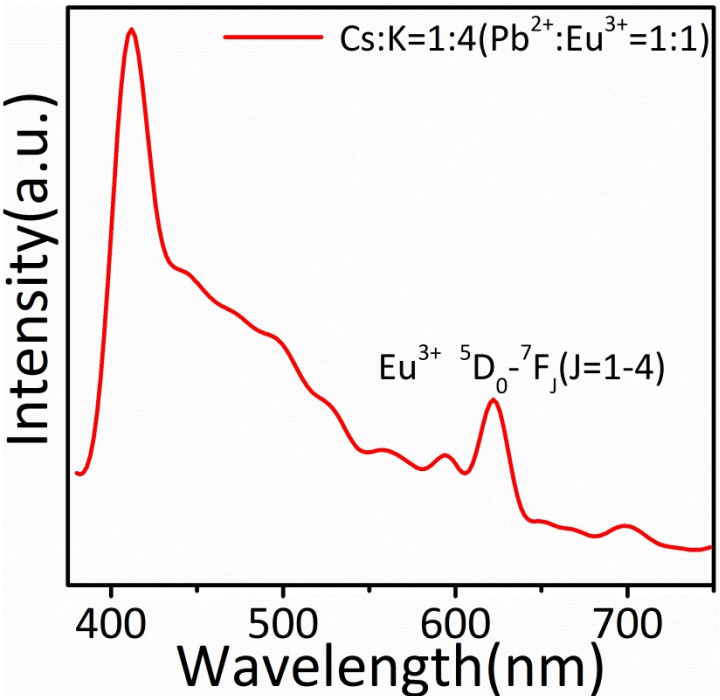

Figure S2. *The PL spectrum of the $Cs_xK_{1-x}PbCl_3$: Eu^3 (Cs:K=1:4) QDs.*

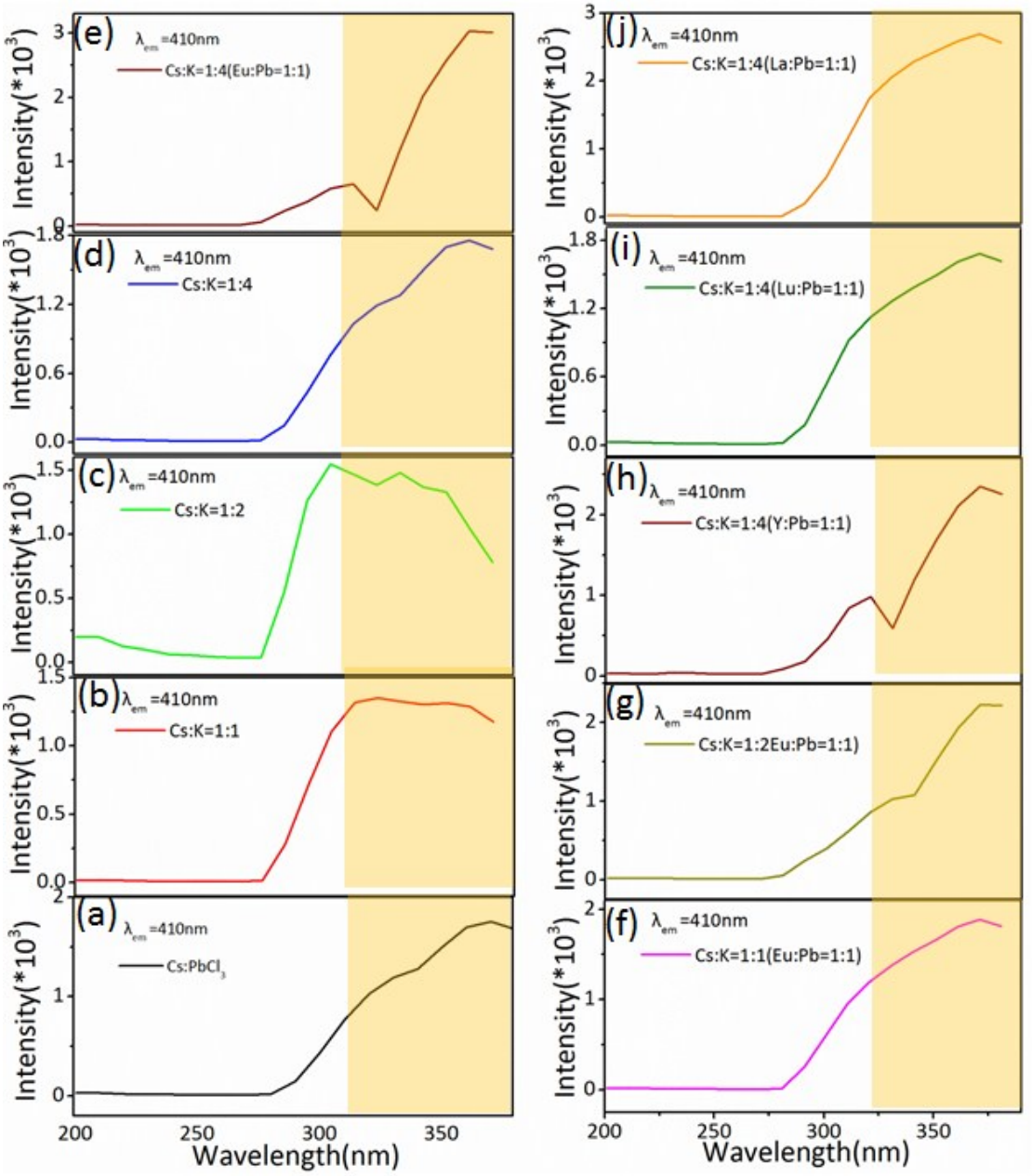

Figure S3. *The PL Excitation spectra of the $Cs_xK_{1-x}PbCl_3$ and $Cs_xK_{1-x}PbCl_3$: RE^{3+} (RE=Eu, La, Lu, Y) QDs.*

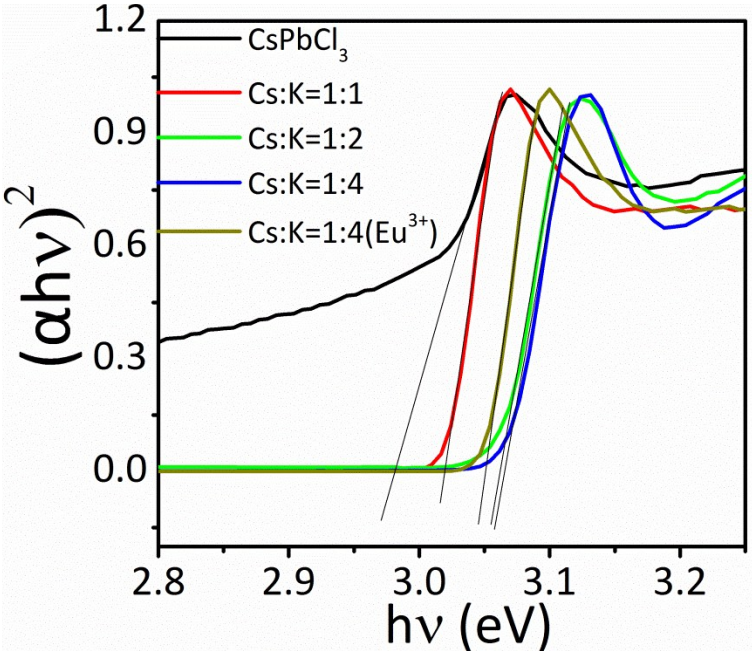

Figure S4. *The tauc plots of the $Cs_xK_{1-x}PbCl_3$ (Cs:K=1:0, Cs:K=1:1, Cs:K=1:2, Cs:K=1:4)and Eu^{3+}doped $Cs_xK_{1-x}PbCl_3$ (Cs:K=1:4) QDs.*

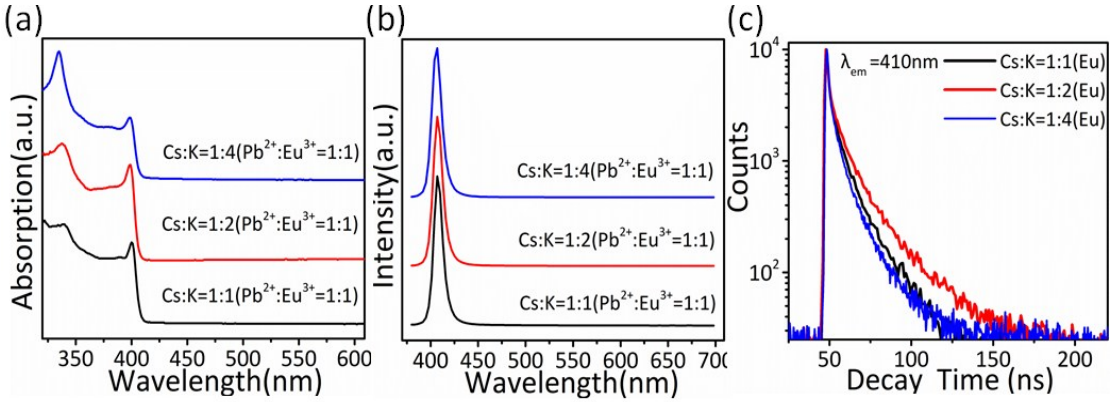

Figure S5. *(a) The absorption spectra of Eu^{3+}doped $Cs_xK_{1-x}PbCl_3$ (Cs:K=1:1, Cs:K=1:2, Cs:K=1:4) QDs. (b) The PL spectra of Eu^{3+}doped $Cs_xK_{1-x}PbCl_3$ (Cs:K=1:1, Cs:K=1:2, Cs:K=1:4) QDs. (c) The fluorescent decay dynamics of Eu^{3+}doped $Cs_xK_{1-x}PbCl_3$ (Cs:K=1:1, Cs:K=1:2, Cs:K=1:4) QDs.*

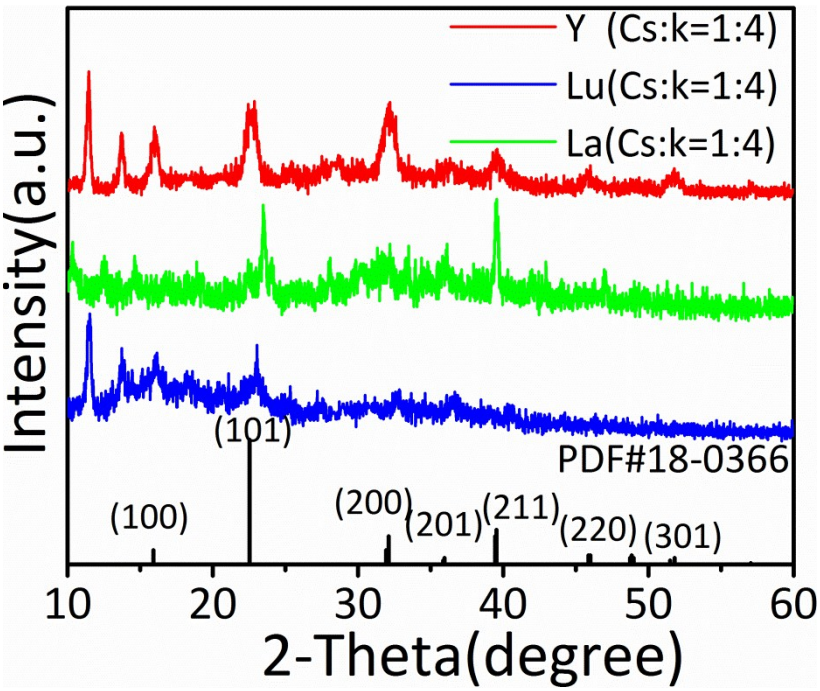

Figure S6. *XRD patterns of* lanthanide ions *($La=Y^{3+},Lu^{3+},La^{3+}$) doped $Cs_xK_{1-x}PbCl_3$ (Cs:K=1:4)QDs.*

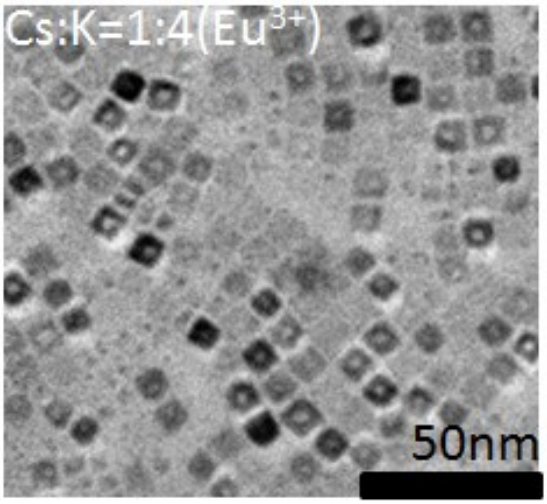

Figure S7. *The representative TEM images of Eu^{3+}doped* $Cs_xK_{1-x}PbCl_yBr_{3-y}$ *(Cs:K=1:4)QDs.*

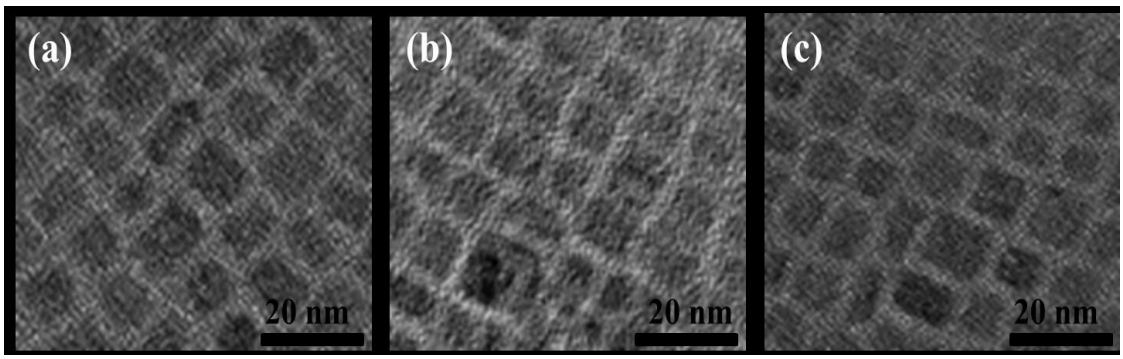

Figure S8. *The representative TEM images of the samples with different temperatures 185, 200 and 220°C.*

Table.S1 *The average lifetime of different perovskite QDs under excitation at 365 nm. The monitoring position are all at 410nm.*

Sample Lifetime	A_1(%)	τ_1(ns)	A_2(%)	τ_2(ns)	τ_{ave}
$CsPbCl_3$	56.33	1.89	43.67	9.86	8.28
$CsPbCl_3$(Cs:K=1:1)	54.23	2.37	45.77	12.55	10.69
$CsPbCl_3$(Cs:K=1:2)	52.22	2.10	47.78	15.33	13.60
$CsPbCl_3$(Cs:K=1:4)	47.82	1.65	52.18	14.19	12.98
$CsPbCl_3$:Eu(50%)(Cs:K=1:1)	42.53	3.00	57.47	16.04	14.45
$CsPbCl_3$:Eu(50%)(Cs:K=1:2)	24.81	1.96	75.19	15.78	15.24
$CsPbCl_3$:Eu(50%)(Cs:K=1:4)	23.86	1.68	76.32	10.97	10.55
$CsPbCl_3$:La(50%)(Cs:K=1:4)	52.48	1.95	47.52	10.76	9.29
$CsPbCl_3$:Lu(50%)(Cs:K=1:4)	48.96	3.28	51.04	16.28	14.17
$CsPbCl_3$:Y(50%)(Cs:K=1:4)	69.01	1.55	30.99	14.92	12.41

Note: lifetimes are acquired by fitting the decay curves from the function of $I(t) = I_1 \exp(-t/\tau_1) + I_2 \exp(-t/\tau_2)$; the average lifetimes were got by $\tau_{ave} = a_1\tau_1^2 + a_2\tau_2^2 / (a_1\tau_1 + a_2\tau_2)$