Electronic Supplementary Information

Investigation of Potassium Doping and Defect Healing Mechanism in Core–Shell CsPbBr₃/SiO₂ Quantum Dots

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Figure S1. TEM images of (a) 10% and (b) 20% K⁺ doped core–only CsPbBr₃ QDs and (c) their PL spectra.



Figure S2. (a) PLQYs, (b) PL spectra, and (c) XRD patterns of the core–only CsPbBr₃ QDs according to the K⁺ doping concentration.



Figure S3. TEM images of the K⁺ doped core–only CsPbBr₃ QDs.



Figure S4. Size distribution of the K⁺ doped core–only CsPbBr₃ QDs.



Figure S5. (a) XRD patterns and (b) PL spectra of the core–shell CsPbBr₃/SiO₂ QDs according to the K⁺ doping concentration.



Figure S6. TEM-EDS result of 3% K⁺ doped core-shell CsPbBr₃/SiO₂ QDs.



Figure S7. TEM images of the K⁺ doped core–shell CsPbBr₃/SiO₂ QDs.



Figure S8. Size distribution of the K^+ doped core-shell CsPbBr₃/SiO₂ QDs.



Figure S9. XRD patterns of (a), (b) core–only and (c) core–shell CsPbBr₃ QDs according to the K⁺ doping concentration. (d) *d*–spacing variation of core–only and core–shell CsPbBr₃ QDs according to the K⁺ doping concentration.



Figure S10. PLQY behavior of the K⁺ doped core–only CsPbBr₃ QDs according to air exposure time.



Figure S11. PL decay curves of core–shell CsPbBr₃/SiO₂ QDs according to K⁺ doping concentration and air exposure time (The monitored wavelength was the λ_{max} of the PL emission for each K⁺ doped core–shell CsPbBr₃/SiO₂ QDs. PL decay curves were fitted to a threeexponential function to investigate the exciton dynamics of the PQDs in solution).



Figure S12. (a–c) Pb 4f XPS spectra of the K⁺ doped core–shell CsPbBr₃/SiO₂ QDs before and after air exposure. The air exposure time is 60 min. (d) C 1s XPS spectrum for reference.



Figure S13. (a) Tauc plots of K⁺ doped core–shell CsPbBr₃/SiO₂ QDs obtained from the UV–Vis spectra. (b–d) UPS spectra of the K⁺ doped core–shell CsPbBr₃/SiO₂ QDs.



Figure S14. Current vs. voltage characteristics of the hole-only devices of (a) undoped, (b) 1% K⁺ doped ore–only CsPbBr₃, (c) undoped, and (d) 1% K⁺ doped core–shell CsPbBr₃/SiO₂ QDs.



Figure S15. PL emission of (a) core–shell CsPbBr₃/SiO₂ QDs and (b) 1% K⁺ doped core–shell CsPbBr₃/SiO₂ QDs according to air exposure time.

Sample	K [at%]	Cs [at%]	Pb [at%]
K ⁺ 0%	-	41.25	58.75
K ⁺ 1%	0.54	41.41	58.05
K ⁺ 2%	0.74	43.22	56.03
K ⁺ 3%	2.09	41.50	56.40

Table S1. ICP results of K⁺ doped core–only CsPbBr₃ QDs.

Table S2. PL lifetime of core–shell CsPbBr₃/SiO₂ QDs according to K⁺ doping concentration and air exposure time.

Sample	$\tau_{_{1}} [ns] (f_{_{1}})$	$\tau_{2}^{2} [ns] (f_{2}^{2})$	$\tau_{3}^{}$ [ns] ($f_{3}^{}$)	χ²	$ au_{ave}$ [ns]
K⁺ 0%, 0 min	6.83 (0.60)	1.36 (0.29)	20.03 (0.11)	1.054	6.70
K⁺ 0%, 60 min	6.80 (0.62)	1.38 (0.29)	20.80 (0.09)	1.090	6.49
K⁺ 1%, 0 min	8.00 (0.60)	1.81 (0.32)	25.18 (0.08)	1.103	7.39
K ⁺ 1%, 60 min	8.23 (0.62)	1.86 (0.30)	24.59 (0.08)	1.086	7.63
K⁺ 2%, 0 min	8.00 (0.61)	1.91 (0.31)	25.33 (0.08)	1.114	7.50
K ⁺ 2%, 60 min	8.28 (0.63)	2.00 (0.30)	26.63 (0.07)	1.109	7.68
K⁺ 3%, 0 min	8.22 (0.61)	1.83 (0.29)	23.91 (0.10)	1.090	7.94
K⁺ 3%, 60 min	8.53 (0.63)	1.91 (0.30)	26.43 (0.07)	1.102	7.80

The monitored wavelength was the λ_{max} of the PL emission for each K⁺ doped core–shell CsPbBr₃/SiO₂ QDs. PL decay curves were fitted to a three-exponential function to investigate the exciton dynamics of the PQDs in solution. The intensity-weighted average exciton lifetime (τ_{ave}) was ($f_1\tau_1 + f_2\tau_2 + f_3\tau_3$)/($f_1 + f_2 + f_3$), where f_1 , f_2 and f_3 are fractional intensities and τ_1 , τ_2 and τ_3 are lifetimes. χ^2 is the reduced chi-squared value.

Reference	Doping Conc. (%)	Doping Mechanism	
Adv. Opt. Mater. 2020, 8 , 2000742 (QDs)	1, 3, 5	Interstitial	Experiment
Adv. Funct. Mater. 2020, 30 , 1908760 (QDs)	2.4, 4.0, 8.0	Surface passivation	Experiment
<i>Sol. RRL</i> 2018, 2 , 1800164 (Thin film)	4, 8, 12, 16, 20	Substitution	Experiment
Nano Lett. 2017, 17 , 2028–2033 (Thin film)	2.5, 5, 7.5, 10	Substitution	Experiment
<i>Adv. Mater.</i> 2018, 30 , 1707350 (Thin film)	0.5, 1, 2, 4, 8	Interstitial & substitution	DFT calculation
Our work (QDs)	1, 2, 3	Interstitial & substitution	Experiment

Table S3. Reported results about K⁺ doping in halide perovskite materials.