Supporting Information

for Adv. Mater., DOI: 10.1002/adma.202000004

Flexible and Self-Powered Photodetector Arrays Based on All-Inorganic CsPbBr₃ Quantum Dots

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Supporting Information

Flexible and Self-Powered Photodetector Arrays Based on All-Inorganic CsPbBr$_3$ Quantum Dots

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Figure S1. TEM images of pristine CsPbBr$_3$ QDs with different magnification, with scale bar of a) 100 nm, b) 50 nm, c) 20 nm and d) 10 nm, respectively.
**Figure S2.** TEM images of 0.025 CsBr/KBr doped CsPbBr$_3$ QDs with different magnification, with scale bar of a) 100 nm, b) 50 nm, c) 20 nm and d) 10 nm, respectively.
Figure S3. High-magnification TEM images. a) Pristine QDs. b) 0.025 CsBr/KBr treated QDs. The insets are the corresponding FFT patterns. The scale bar is 10 nm.
Figure S4. High-resolution TEM and their corresponding lattice parameters. a) Pristine QDs. b) 0.025 CsBr/KBr assisted QDs. The scale bar is 5 nm.
Figure S5. Size distribution of a) pristine and b) 0.025 CsBr/KBr treated CsPbBr$_3$ QDs.
Figure S6. X-ray photoelectron spectroscopy (XPS) of CsPbBr$_3$ QDs films with different amounts of CsBr/KBr incorporation. a) Survey spectra, and high-resolution scans of the core energy level of b) Cs 3d, c) Pb 4f and d) Br 3d.
Figure S7. The high-resolution XPS scan of K 2p core level of as-prepared pristine and treated perovskites thin film, fitted by CasaXPS.
Figure S8. Contact angle measurements for different colloidal perovskite solutions.
**Figure S9.** XRD measurements with different ratios of CsBr/KBr treatment, ratios from 0.025 to 0.3.
Figure S10. Absorptions plotted using the Tauc method for the a) pristine, b) 0.025, c) 0.075, d) 0.2 and e) 0.3 CsBr/KBr assisted perovskite QD films.
Figure S11. Photoluminescence properties along with CsBr/KBr treatment. a) PL peak positions with slight blue-shift. b) The variation of the corresponding full-width at half-maximum.
Figure S12. Time-resolved photoluminescence (TRPL) decays of a) pristine, b) 0.025, c) 0.075, d) 0.2, and e) 0.3 CsBr/KBr doped CsPbBr$_3$ QDs film, fitted by the bi-exponential fitting function.
Figure S13. The detailed dimension of a single pattern on the flexible photodetector arrays.
Figure S14. Typical logarithmic $I$-$V$ curves of CsPbBr$_3$ QDs based flexible photodetector arrays with different fractions of CsBr/KBr, in dark (black), under illumination of 405 nm (purple), 450 nm (blue) and 520 nm (green) light sources. a) Pristine. b) 0.075, c) 0.2 and d) 0.3 CsBr/KBr treated QDs.
Figure S15. Photocurrents of the five devices with containing different ratios of CsBr/KBr, excited by a) 450 nm and b) 520 nm laser diodes, respectively.
Figure S16. The corresponding $I/I_d$ extracted from the $I$-$V$ curves (Figure 3e and Figure S14) under different illuminations (405 nm, 450 nm and 520 nm), at a bias voltage of a) 0 V and b) -1.5 V.
Figure S17. Responsivity and detectivity of as-fabricated devices along with CsBr/KBr treatment, as a function of applied bias. a) Under 450 nm laser illumination. b) Under 520 nm laser illumination.
Figure S18. The corresponding wavelength-dependent responsivity and detectivity as a function of CsBr/KBr fraction. a) With a bias voltage of -1 V. b) -1.5 V applied bias.
Figure S19. UPS measurements for each sample, showing the binding energy secondary electron cutoffs. a) Pristine. b) 0.025 CsBr/KBr. c) 0.075 CsBr/KBr. d) 0.2 CsBr/KBr. e) 0.3 CsBr/KBr. The corresponding work function ($W_F$) can be determined by taking the difference between the photon energy (21.22 eV) and secondary electron cutoff ($E_{\text{cutoff}}$). $E_{\text{Fermi}} = 0$ eV, using Ag as the metal sample for calibration.
Figure S20. Power-dependent $I$-$V$ curves of 0.025 Cs$^+/K^+$ mediated flexible photodetector arrays. a) Illuminated by 450 nm laser diode, with a power density range from 0.1 mW cm$^{-2}$ to 14.2 mW cm$^{-2}$. B) Under 520 nm laser excitation, with a power density from 0.01 mW cm$^{-2}$ to 3.3 mW cm$^{-2}$. 
Figure S21. The corresponding power fittings under different applied bias, employed 405 nm (purple) and 450 nm (blue) laser diodes as light sources. At a bias voltage of a) -0.5 V, b) -1 V and c) -1.5 V. d) Power exponents with a function of bias voltage.
Figure S22. Time-dependent transient photoresponse under different bias voltage, excited with 450 nm laser illumination.
Figure S23. Wavelength-dependent $I-t$ curve, under 405 nm (purple), 450 nm (blue) and 520 nm (green) laser illumination. a) At -0.5 V and b) -1 V bias.
Figure S24. Photoresponse comparison between pristine (black line) and 0.025 Cs⁺/K⁺ treated (red line) flexible photodetector arrays without external power source under 405 nm laser illumination. a) Transient photoresponse. b) The corresponding response time.
Figure S25. The long-term stability characterizations on CsPbBr$_3$ QDs based flexible photodetector arrays with 0.025 CsBr/KBr treatment. a) The typical logarithmic I-V curves under illumination of 405 nm (purple), 450 nm (blue) and 520 nm (green) lasers. b) The transient photoresponse under self-powered mode after storing in ambient air for 7 months. c) Time-dependent photoresponse under different biases, illuminated with a 405 nm laser diode.
Table S1. Surface roughness extracted from AFM results, where $R_q$ is the root mean square of surface roughness, $R_a$ represents the average value of surface roughness and $R_{\text{max}}$ denotes the maxima peak height of surface roughness.

| Sample          | $R_q$ (nm) | $R_a$ (nm) | $R_{\text{max}}$ (nm) |
|-----------------|------------|------------|------------------------|
| Pristine        | 28.4       | 22.4       | 227                    |
| 0.025 CsBr/KBr  | 17.6       | 13.4       | 139                    |
| 0.075 CsBr/KBr  | 29.2       | 23.5       | 203                    |
| 0.2 CsBr/KBr    | 30.9       | 24.9       | 185                    |
| 0.3 CsBr/KBr    | 36.0       | 27.5       | 262                    |
Table S2. Summarized peak positions, bandgaps, peak intensities and FWHM from PL spectra, along with QDs containing different fractions of CsBr/KBr injection.

| Sample           | Peak (nm) | Eg (eV) | Peak Intensity | FWHM (nm) |
|------------------|-----------|---------|----------------|-----------|
| Pristine         | 524       | 2.366   | 298700         | 26.5      |
| 0.025 CsBr/KBr   | 523       | 2.371   | 575300         | 26        |
| 0.075 CsBr/KBr   | 523.5     | 2.369   | 32800          | 27.5      |
| 0.2 CsBr/KBr     | 522.5     | 2.373   | 397900         | 27        |
| 0.3 CsBr/KBr     | 523.5     | 2.369   | 73310          | 27.5      |
Table S3. Decay constants and their fractions as extracted from the TRPL measurements, using bi-exponential decay fitting: \( I(t) = A_1\exp(-t/\tau_1) + A_2\exp(-t/\tau_2) \).

| Sample                | \( \tau_1 \) (ns) | \( f_1 \) (%) | \( \tau_2 \) (ns) | \( f_2 \) (%) | \( \tau_{ave} \) (ns) |
|-----------------------|-------------------|---------------|-------------------|---------------|-----------------------|
| Pristine              | 0.771             | 40.864        | 7.845             | 59.136        | 4.954                 |
| 0.025 CsBr/KBr        | 0.782             | 27.176        | 10.044            | 72.824        | 7.526                 |
| 0.075 CsBr/KBr        | 0.448             | 27.862        | 10.852            | 72.138        | 7.953                 |
| 0.2 CsBr/KBr          | 0.660             | 45.684        | 7.262             | 54.316        | 4.245                 |
| 0.3 CsBr/KBr          | 0.379             | 60.595        | 4.013             | 39.405        | 1.811                 |