Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information for

A $MAPbBr_3$:poly(ethylene oxide) composite perovskite quantum dot emission layer: enhanced film stability, coverage and device Performance

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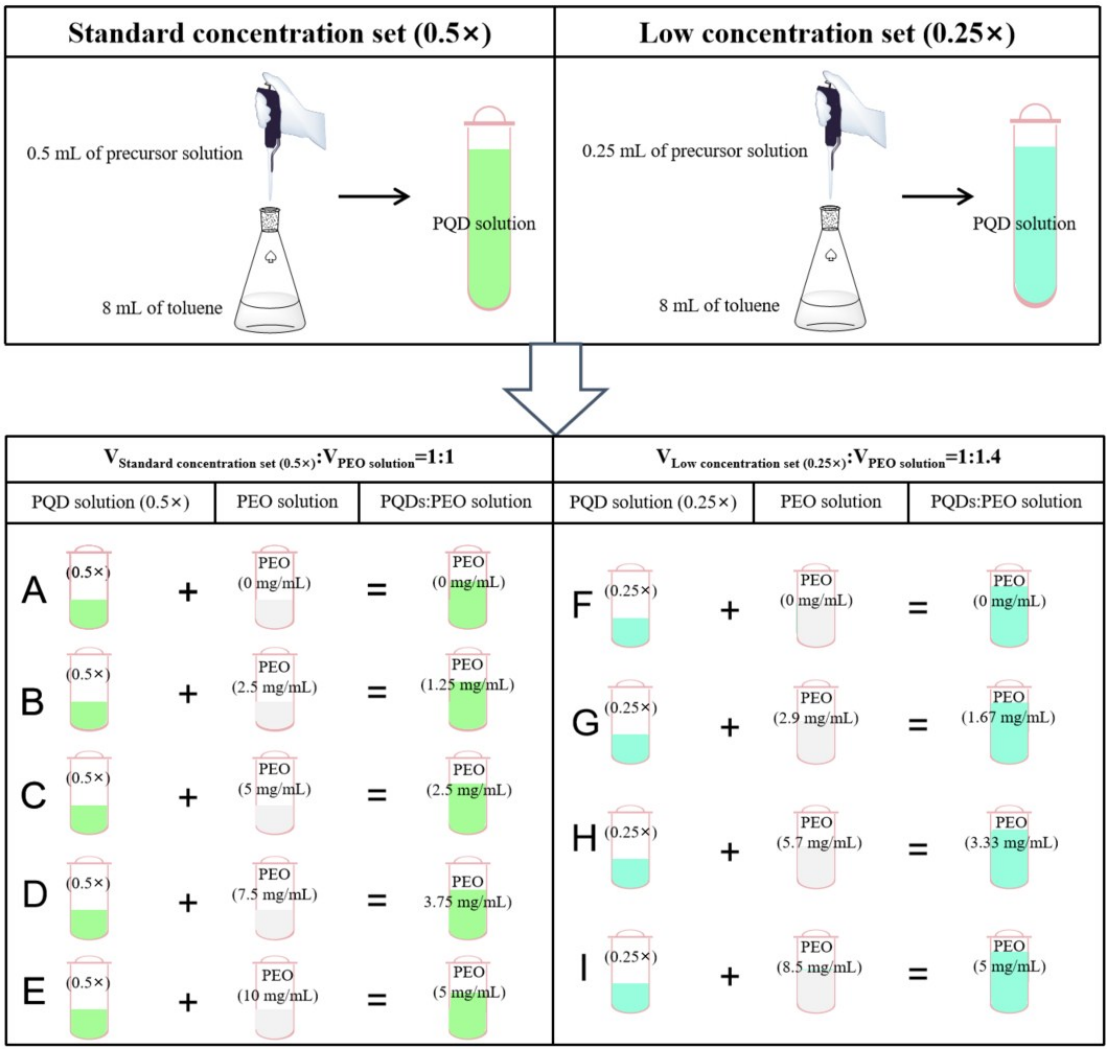

Fig. S1 The PQDs:PEO composite solution preparation details with different PEO mass concentrations.

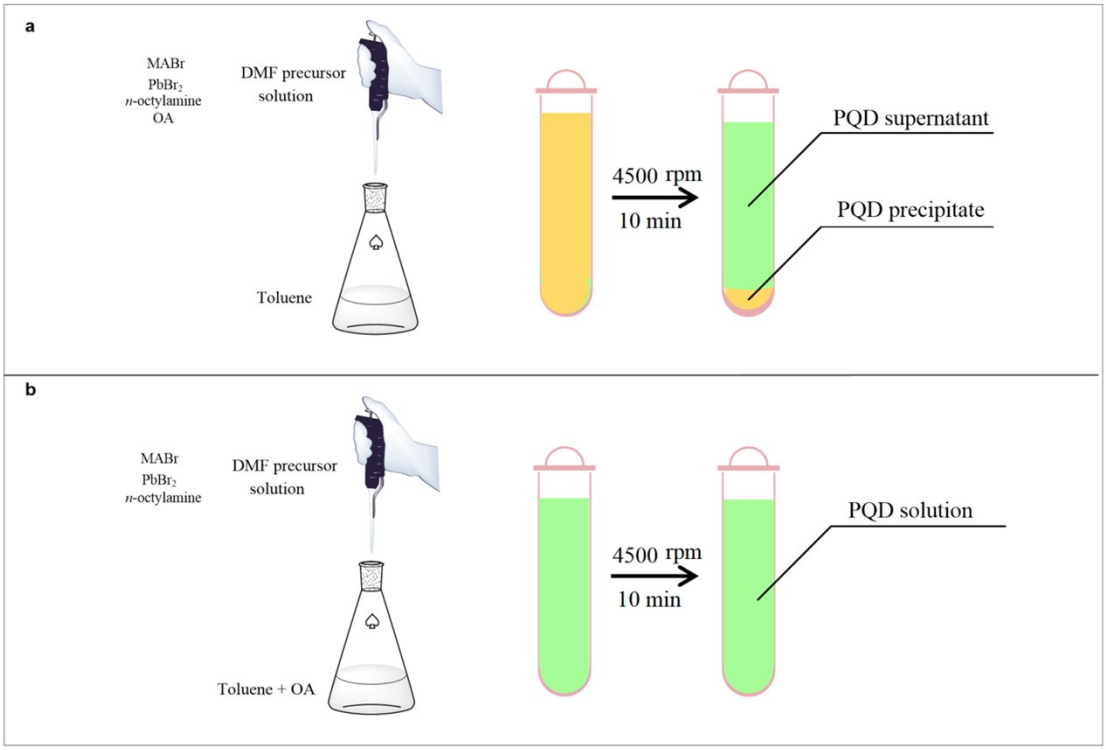

Fig. S2 Schematic diagrams of PQDs prepared by (a) a classical LARP method and (b) our one-step synthesis approach.

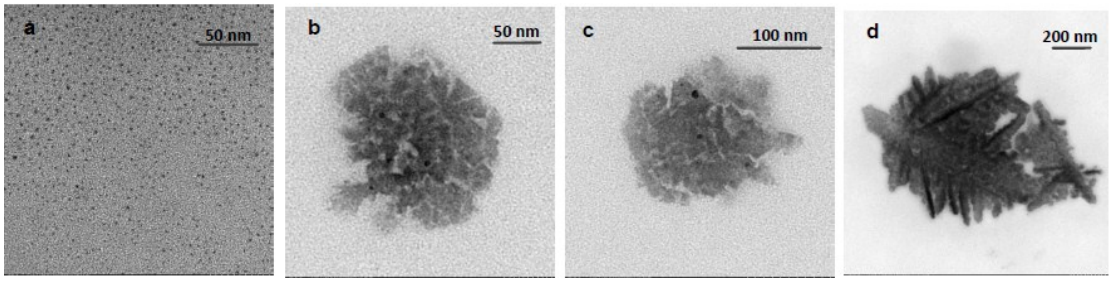

Fig. S3 The TEM images of (a) the PQD supernatant and (b, c and d) the PQD precipitate synthesized by a classical LARP method after a 4500 rpm centrifugation for 10 min.

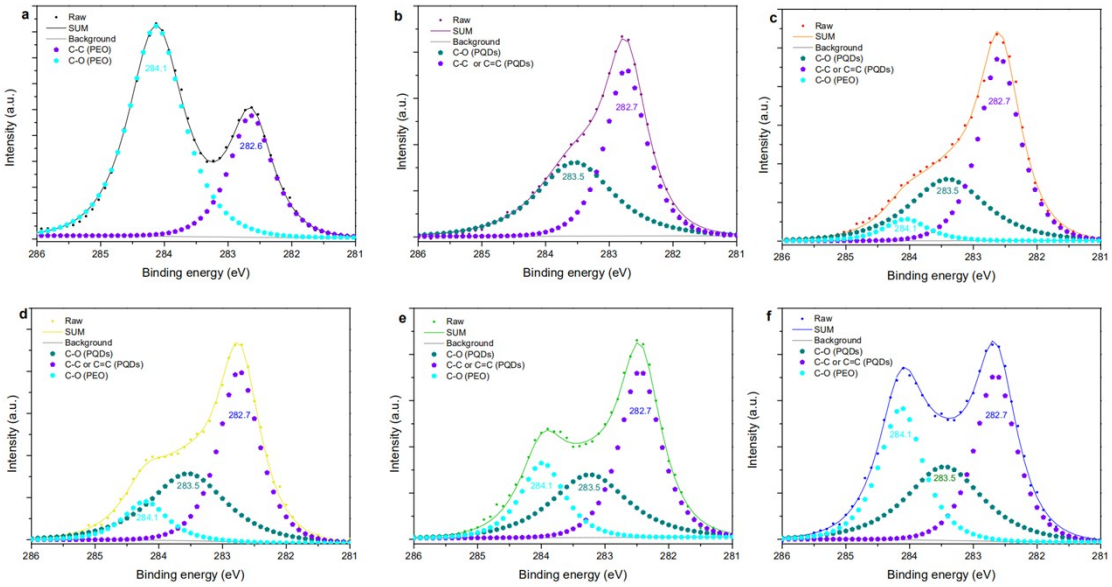

Fig. S4 The C 1s XPS spectra of (a) PEO and PQDs:PEO samples of (b) A, (c) B, (d) C, (e) D and (f) E. The C 1s peaks of PEO can be fitted into two peaks with binding energies of 282.6 and 284.1 eV, representing C–C and C–O, respectively. The C 1s peaks of PQDs can be fitted into two peaks with binding energies of 282.7 and 283.5 eV, representing C–C/C═C and C–O, respectively.

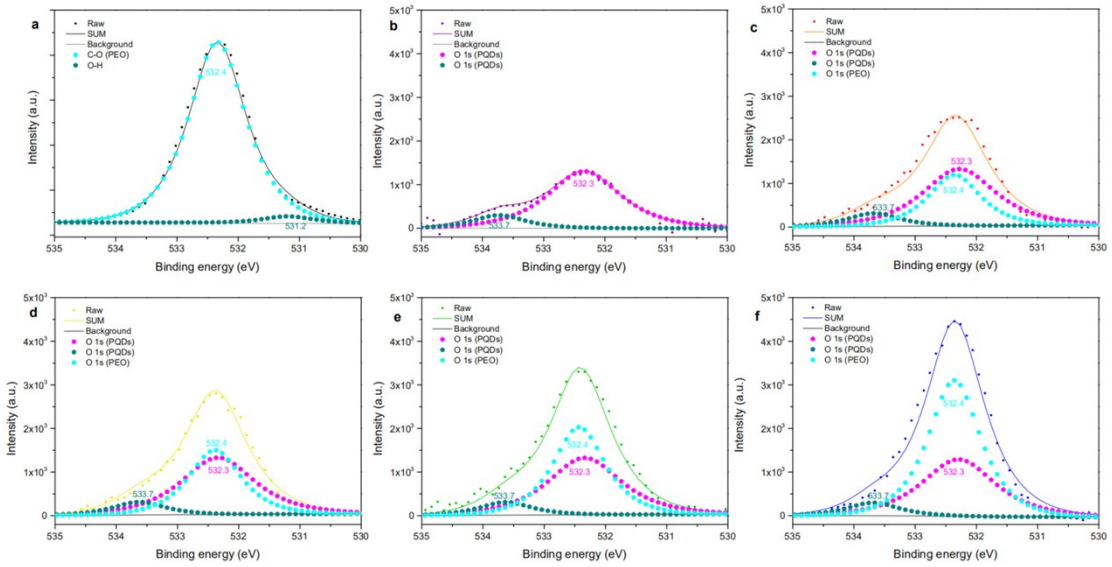

Fig. S5 The O 1s XPS spectra of (a) PEO and PQDs:PEO samples of (b) A, (c) B, (d) C, (e) D and (f) E. The O 1s peaks of PEO can be fitted into two peaks with binding energies of 532.4 and 531.2 eV, representing C–O and O–H, respectively. The higher energy peak at 533.7 eV is from carboxylate species of deprotonated oleic acid, and the lower energy one at 532.3 eV comes from two nonequivalent O atoms of carboxylic acid.

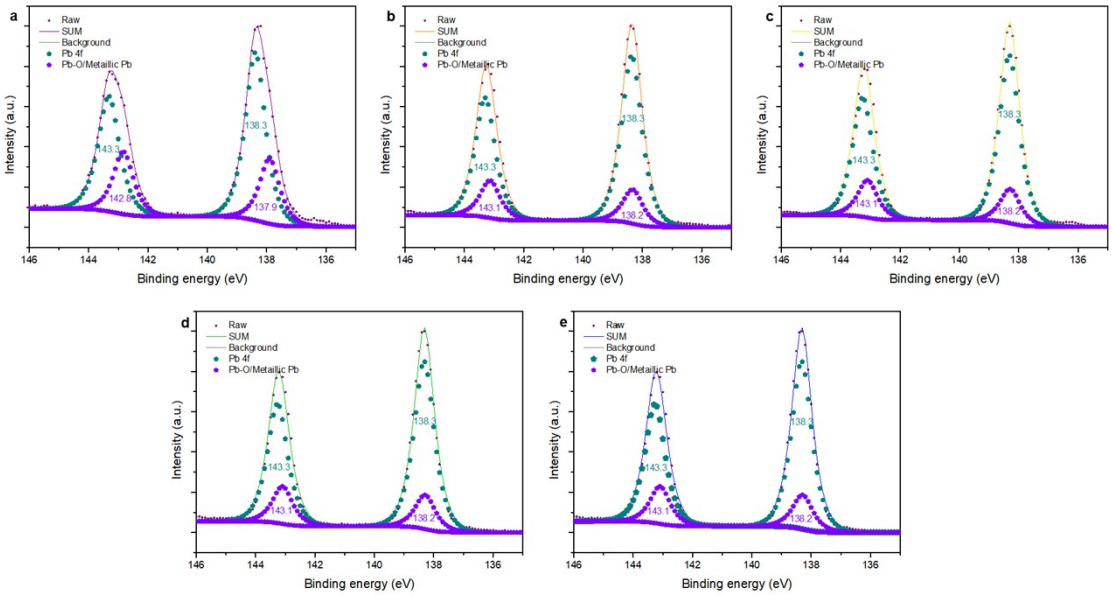

Fig. S6 The Pb 4f XPS spectra of the PQDs:PEO samples of (a) A, (b) B, (c) C, (d) D and (e) E. Pb 4f shows two symmetric peaks of Pb 4f (143.3 and 138.3 eV) and two small peaks (142.8 and 137.9 eV). The addition of PEO causes the red shift of two small peaks to 143.1 and 138.2 eV.

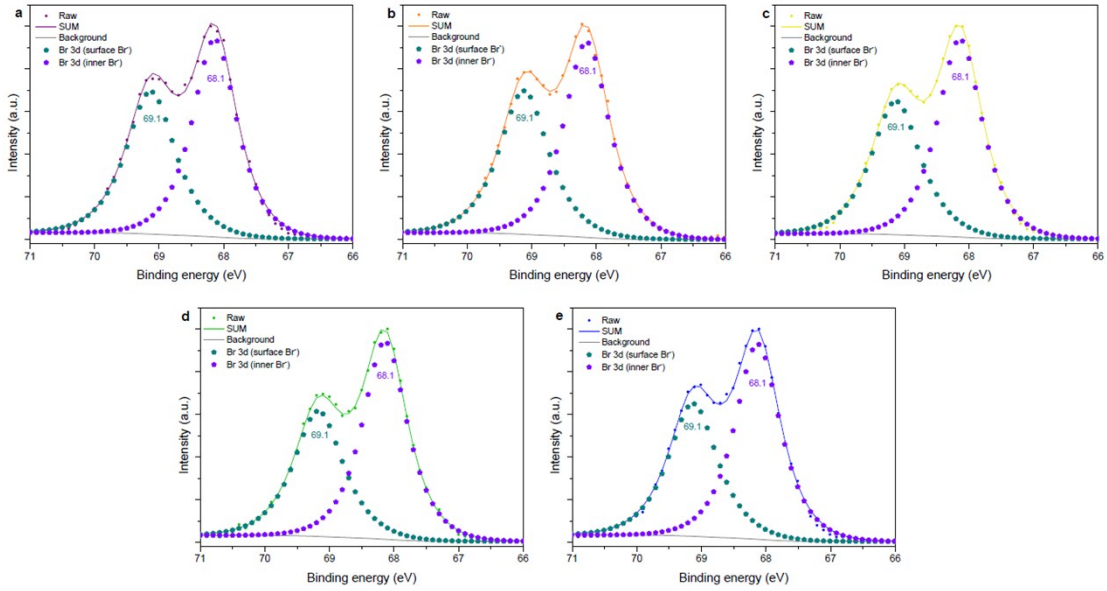

Fig. S7 The Br 3d XPS spectra of the PQDs:PEO samples of (a) A, (b) B, (c) C, (d) D and (e) E . The Br 3d of PQDs can be fitted into two peaks centered at 68.1 and 69.1 eV corresponding to the inner and surface Br ions, respectively.

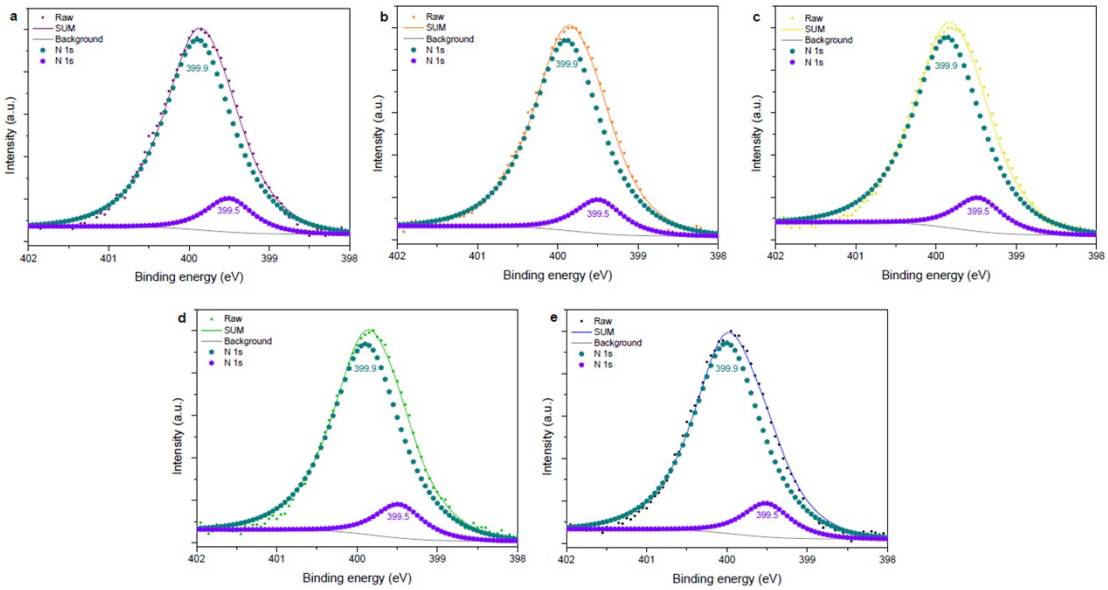

Fig. S8 The N 1s XPS spectra of the PQDs:PEO samples of (a) A, (b) B, (c) C, (d) D and (e) E. The N 1s spectra of PQDs and PQDs:PEO show two peaks with binding energies at 399.9 and 399.5 eV.

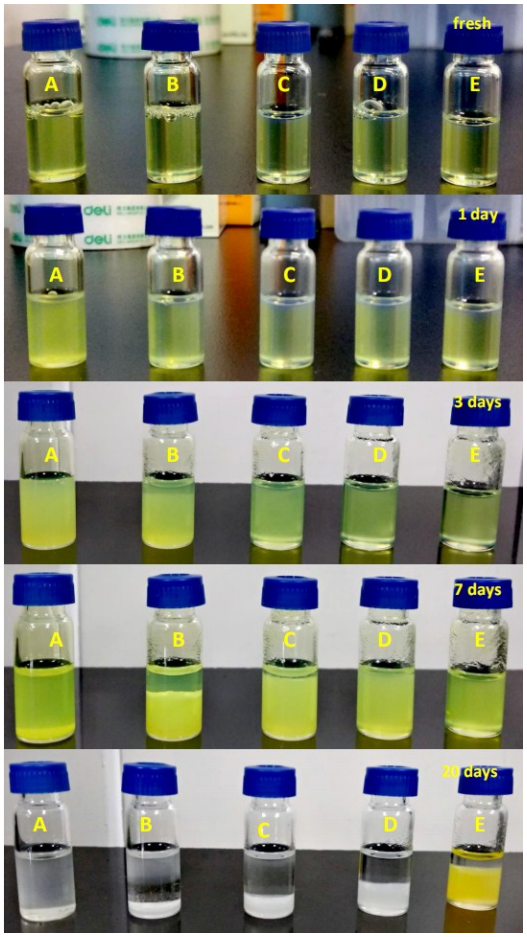

Fig. S9 PQD solution stabilities with different concentrations of PEO.

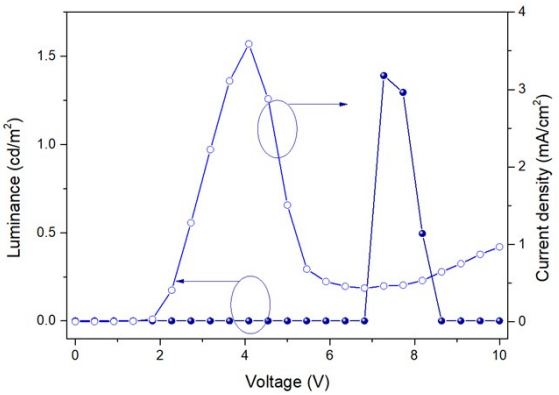

Fig. S10 The luminance and current density curves of device E'.

Table S1 Fitted photoluminescence lifetimes for all samples with a bi-exponential decay model. Here, A_1 and A_2 are fractional intensities, and τ_1 and τ_2 are lifetimes. The average exciton lifetime was calculated with $\tau_{avr}=A_1\tau_1+A_2\tau_2$.

Sample	τ_1 (ns)/A_1 (%)	τ_2 (ns)/A_2 (%)	χ^2	τ_{avr} (ns)
A	6.64/41.44	25.25/58.56	1.186	17.53
B	13.08/50.29	53.69/49.71	1.114	33.26
C	16.68/54.29	63.02/45.71	1.104	37.86
D	18.03/61.04	91.05/38.96	1.098	46.48
E	13.39/51.92	54.86/48.08	1.101	33.32

Table S2 Summarized device performances with different concentrations of PEO. Devices A'–E' were prepared respectively with the perovskite samples A–E based on the standard concentration set (0.5×).

Device	PEO concentration (mg mL^{-1})	L_{max} (cd m^{-2})	CE_{max} (cd A^{-1})	EQE_{max} (%)	V_{on} (V)
A'	0	975	0.44	0.13	3.5
B'	1.25	1 735	0.72	0.21	4.0
C'	2.5	3 597	2.55	0.74	4.5
D'	3.75	5 505	8.30	2.38	4.0
E'	5	-	-	-	-

Table S3 Summarized device performances with different concentrations of PEO. Devices F'-I' were prepared respectively with the perovskite samples F–I based on the low concentration set (0.25×).

Device	PEO concentration (mg mL^{-1})	L_{max} (cd m^{-2})	CE_{max} (cd A^{-1})	EQE_{max} (%)	V_{on} (V)
F'	0	42	0.03	-	3.4
G'	1.67	1 692	1.69	0.56	4.0
H'	3.33	281	0.48	0.16	5.0
I'	5	-	-	-	-

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