Passivation the Grain Boundaries of $CH_3NH_3PbI_3$ by Carbon Quantum Dots for Highly Efficient Perovskite Solar Cells with Excellent Environmental Stability

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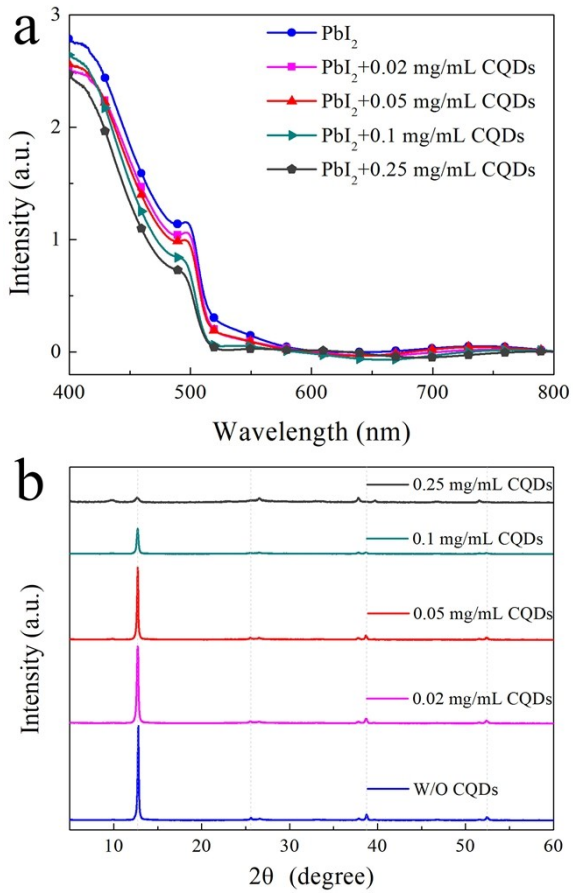

Figure S1. UV-vis absorption spectra and XRD patterns of PbI_2 films with different concentration of CQDs.

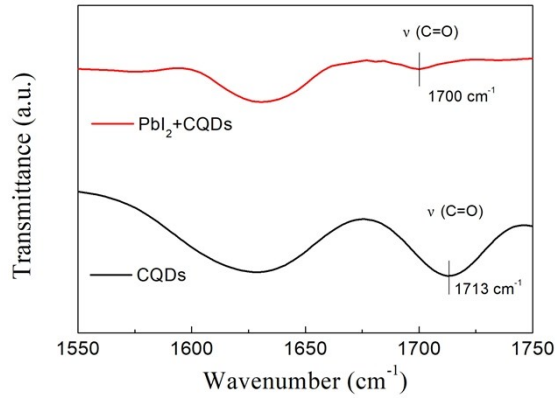

Figure S2. FTIR spectra of CQDs and PbI_2 film with 10 mg/mL CQDs additive.

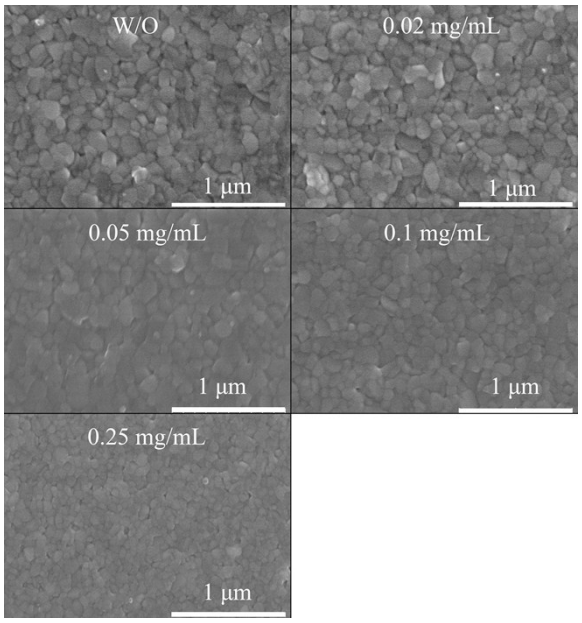

Figure S3. Top-view SEM images of PbI_2 films with different concentration of CQDs.

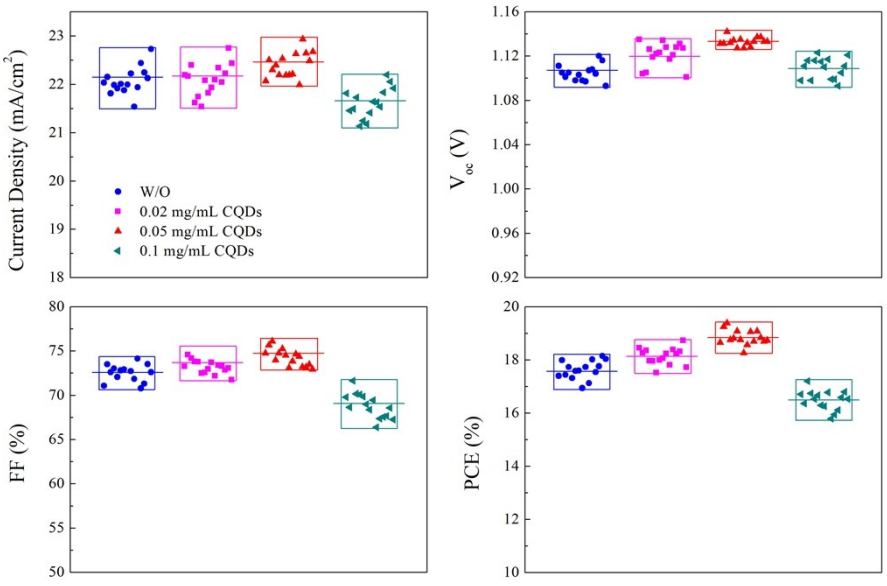

Figure S4. **(a)** J_{sc}, **(b)** V_{oc}. **(c)** FF, and **(d)** PCE distribution of 15 individual PSCs without and with 0.02, 0.05 and 0.1 mg/mL CQDs.

Table S1. TRPL decay fitting parameters of perovskite films with and without CQDs.

	A_1(%)	τ_1(ns)	A_2(%)	τ_2(ns)	A_3(%)	τ_3(ns)	τ_{avg}(ns)
W/O CQDs	12.17	0.76	10.69	24.00	77.13	196.66	154.35
0.05 mg/mL CQDs	4.82	0.86	11.87	37.47	83.31	199.24	170.48

$$\tau_{avg} = \sum_i A_i \tau_i \text{, where} \sum_i A_i = 1$$