# Moisture-tolerant supermolecule for the stability enhancement of Organic-inorganic perovskite solar cells in ambient air

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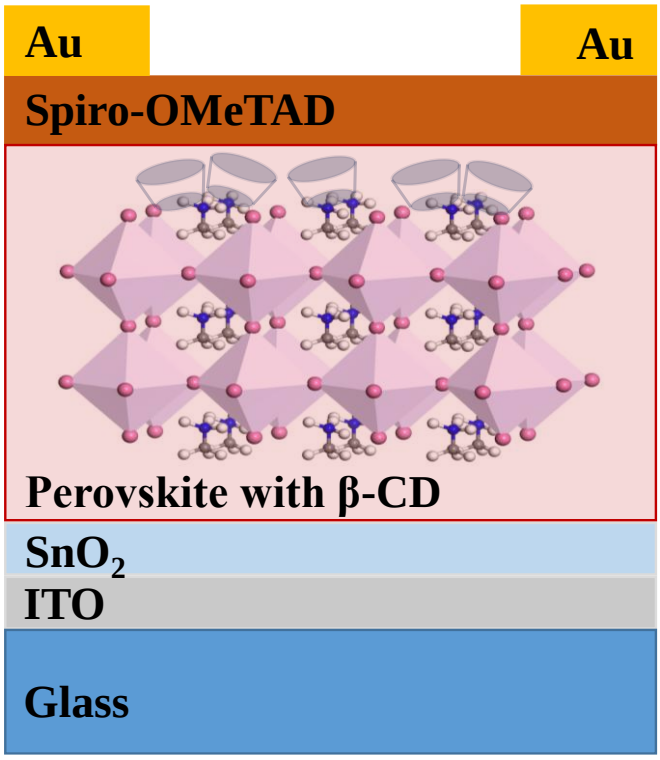



Figure S1. Schematic illustration of the structure of perovskite solar cell with β-CD.

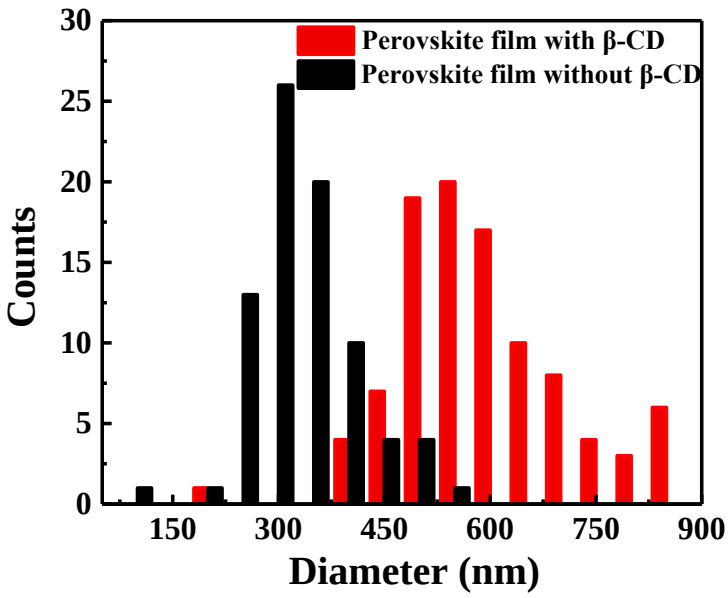



Figure S2. The average-diameter statistics of grains in perovskite films with and without β-CD.

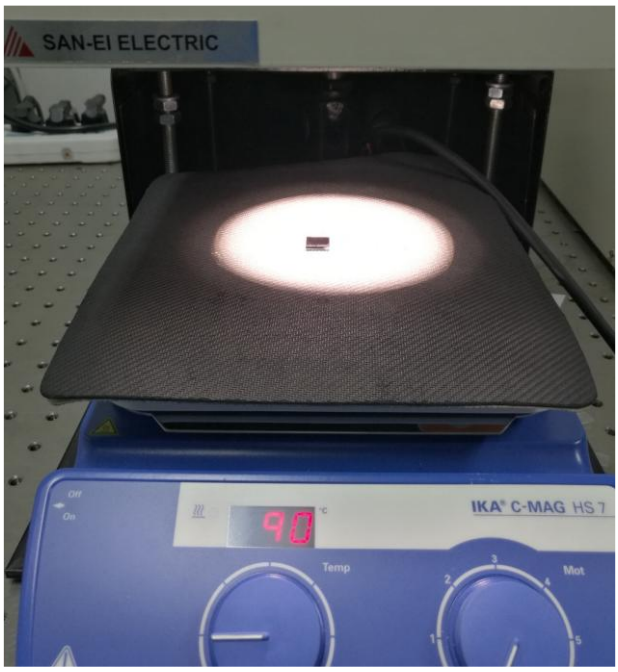



Figure S3. Digital photo of the operating system for the perovskite films.

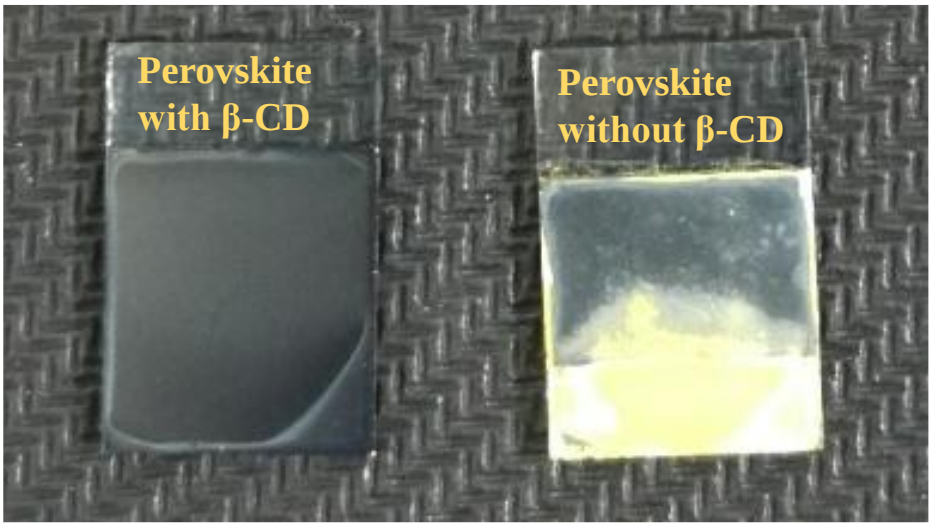
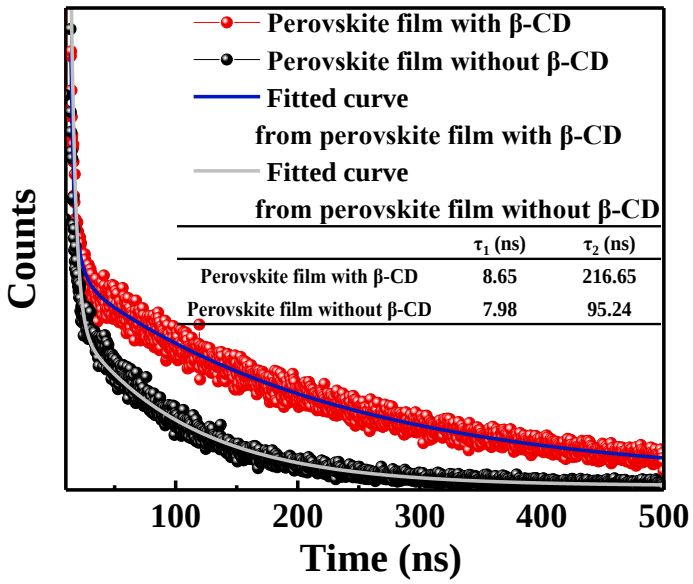



Figure S4. Digital photo of perovskite films with and without β-CD after long-term operation for one week.




| | $\tau_1$ (ns) | $\tau_2$ (ns) |
|---|---|---|
| Perovskite film with β-CD | 8.65 | 216.65 |
| Perovskite film without β-CD | 7.98 | 95.24 |

*Figure S5. Time-resolved photoluminescence spectrometer (TRPL) of perovskite films with and without β-CD. The values of $\tau_1$ and $\tau_2$ represents the decay lifetimes at the fast and slow decay components of the PL decay curves, respectively.*

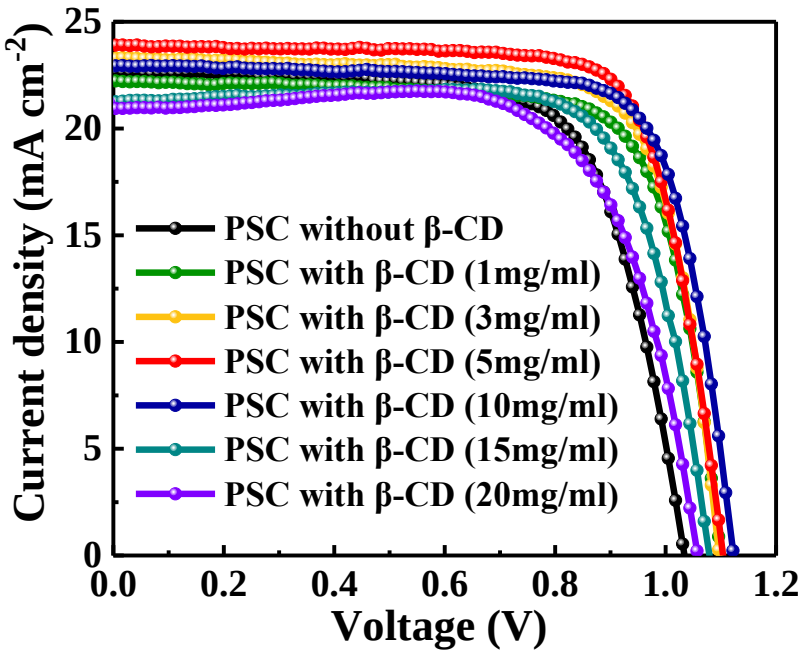



Figure S6. *J-V* curves of PSCs with various concentrations of β-CD in perovskite.

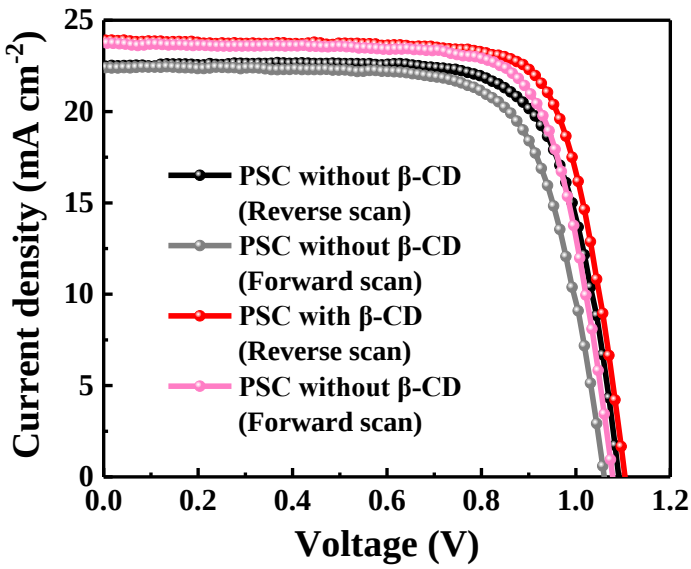



Figure S7. Forward and reverse scanning *J-V* curves from PSCs with and without β-CD.

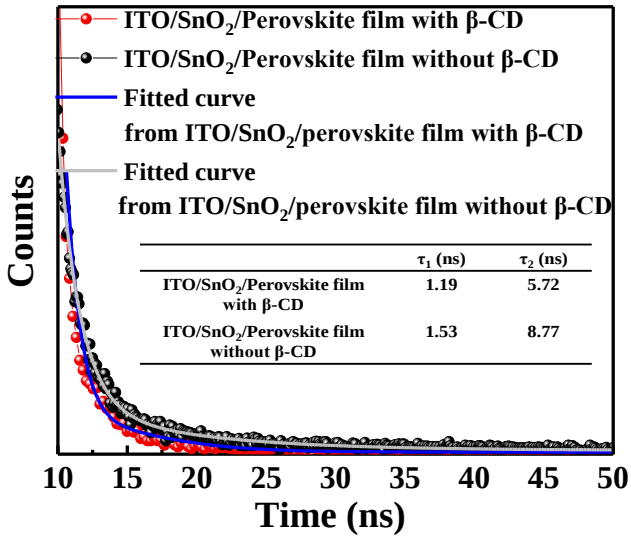



Figure S8. TRPL spectra of perovskite films with and without β-CD. All curves were monitored at 780 nm from the perovskite side. The structure of samples is ITO/$SnO_2$/perovskite. The values of $\tau_1$ and $\tau_2$ represents the decay lifetimes at the fast and slow decay components of the PL decay curves, respectively.

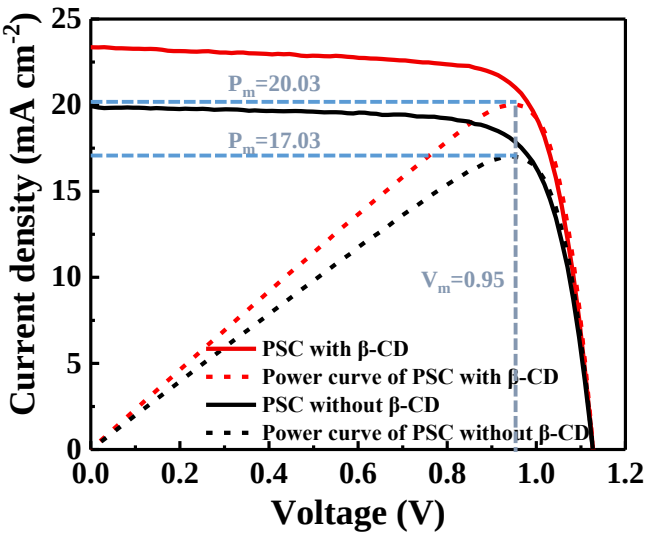



Figure S9. *J-V* curves and the corresponding power curves of PSCs with and without β-CD for the MPP measurement.

Table S1. Average performance of PSCs fabricated by various concentrations of β-CD in perovskite.

| **Concentrations of β-CD in perovskite** | **$J_{SC}$ (mA cm$^{-2}$)** | **$V_{OC}$ (V)** | **FF (%)** | **PCE (%)** |
|---|---|---|---|---|
| **Standard** | 22.55 | 1.02 | 70.40 | 16.19 |

| | | | | |
|---|---|---|---|---|
| **(0 mg/ml)** | | | | |
| **1 mg/ml** | 22.41 | 1.09 | 75.04 | 18.32 |
| **3 mg/ml** | 23.16 | 1.09 | 75.24 | 18.99 |
| **5 mg/ml** | 23.96 | 1.1 | 75.82 | 19.98 |
| **10 mg/ml** | 22.93 | 1.1 | 75.06 | 18.93 |
| **15 mg/ml** | 21.39 | 1.08 | 75.79 | 17.50 |
| **20 mg/ml** | 20.94 | 1.05 | 71.54 | 15.83 |