Supplementary Information

Green Solvents for All Functional Layers Enable Scalable Ambient-air Fabrication of Perovskite Solar Modules

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Content

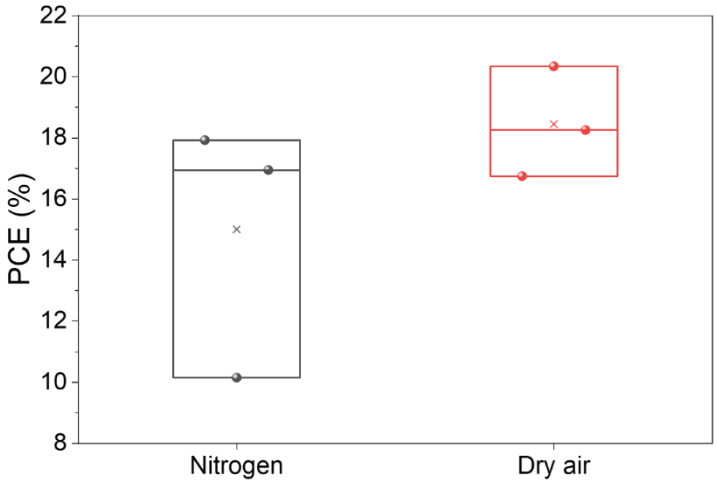

Figure S1. PCE statistics of DMSO-C3 PSMs (10.23 cm^2) quenched using nitrogen and dry air in step ii'. The mean is marked with a cross.

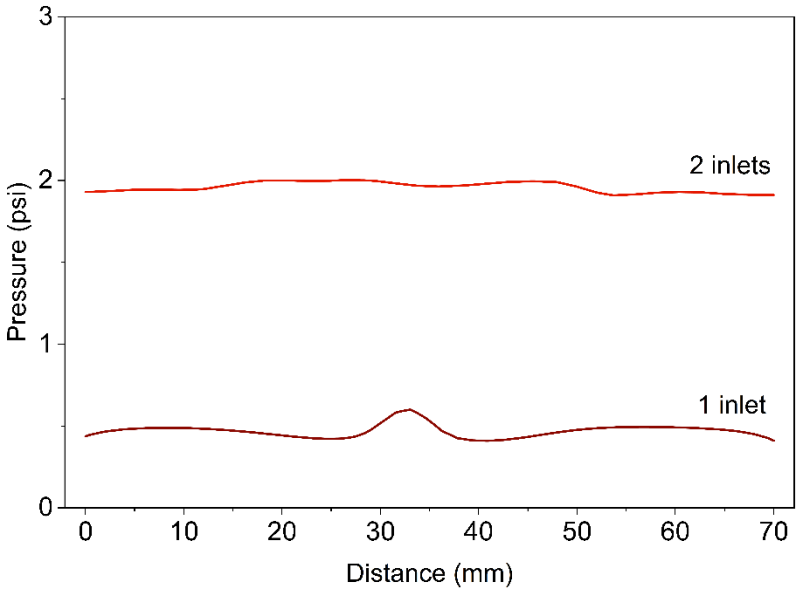

Figure S2. Pressure distribution along the substrate for a different number of air-funnel inlets. 1-D plot taken from a 2-D finite-element simulation model.

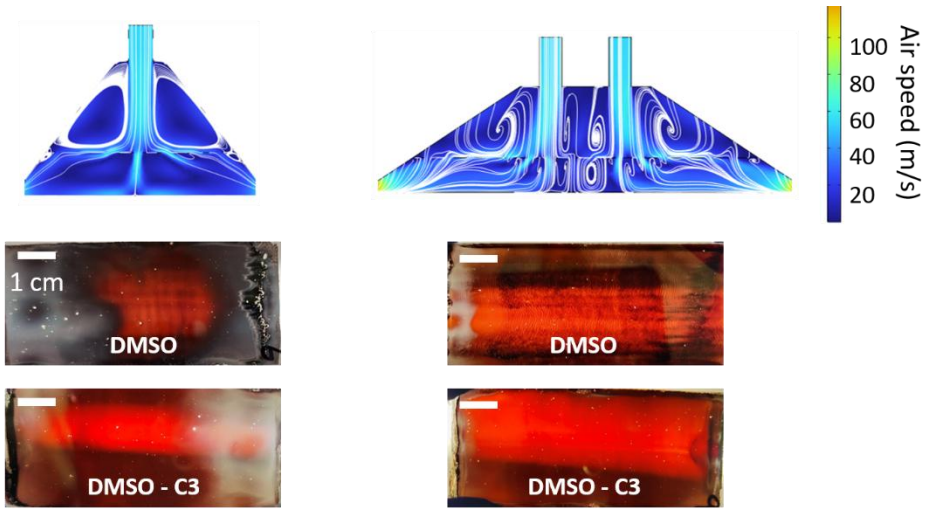

Figure S3. Drying effectiveness for a different number of air inlets. The color scale shows simulated air speed, while white strips represent the simulated air flow direction. Films are photographed from the back, when put against a fluorescent light.

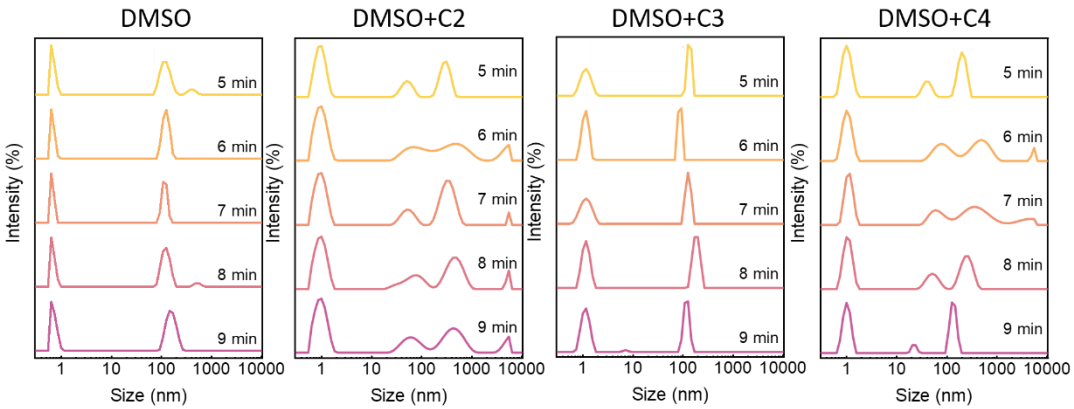

Figure S4. DLS particle size distributions for DMSO and DMSO-alcohol perovskite inks.

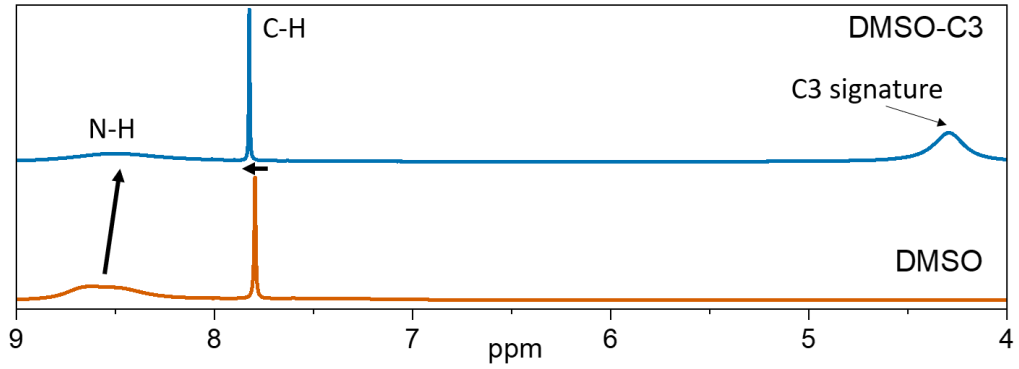

Figure S5. ^{1}H NMR in deuterated DMSO (DMSO-d6) and deuterated DMSO-C3.

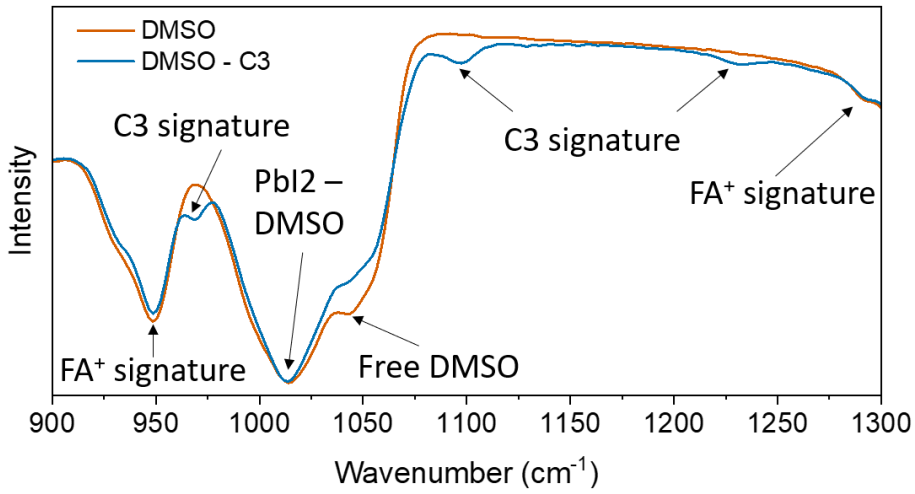

Figure S6. FTIR spectra of the precursor solutions in DMSO and DMSO-C3.

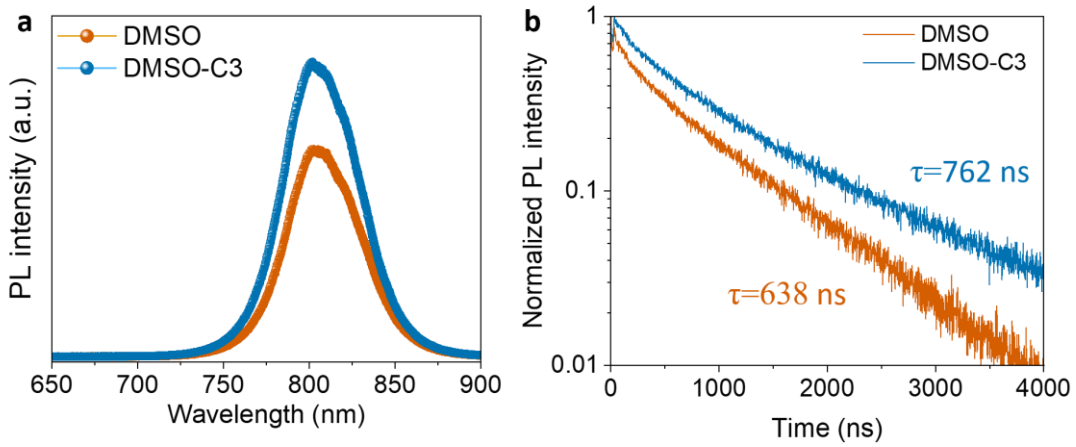

Figure S7. Photoluminescence signals of the films on glass. a) Steady-state PL spectra. **(b)** Time-resolved PL traces with carrier lifetimes as calculated from the fitted exponential curves.

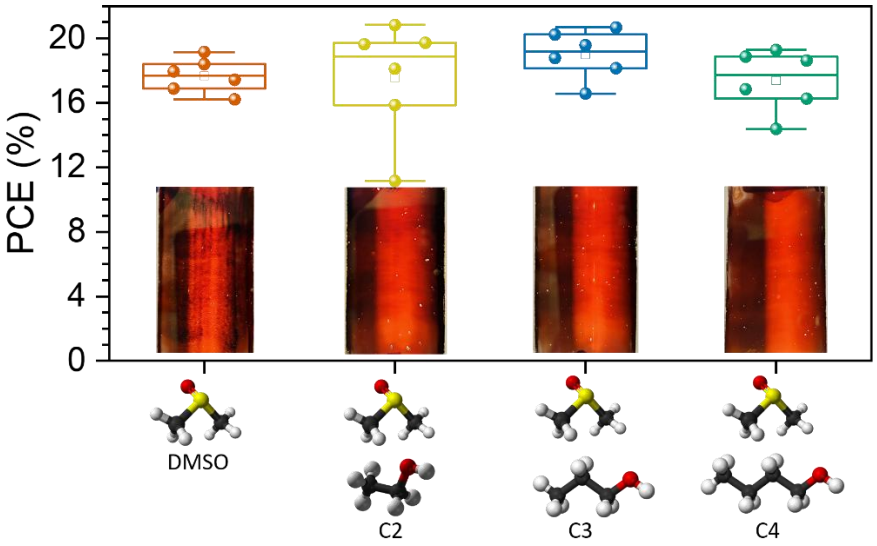

Figure S8. Alcohol length optimization in DMSO-alcohol solvent systems. PCE data was acquired across 5 experiments screening all compositions. Films are seen from the back against a fluorescent lamp.

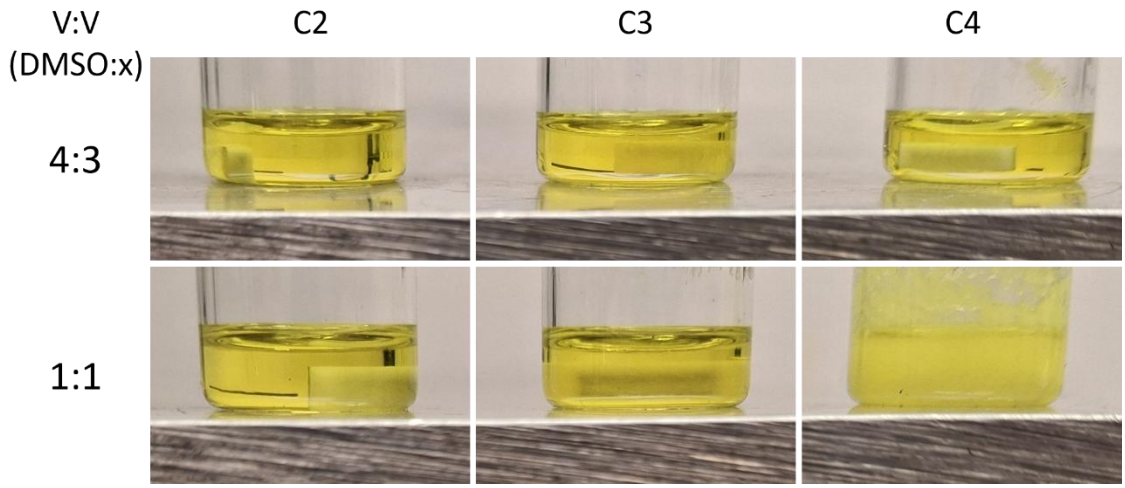

Figure S9. Precipitation in DMSO/alcohol perovskite inks.

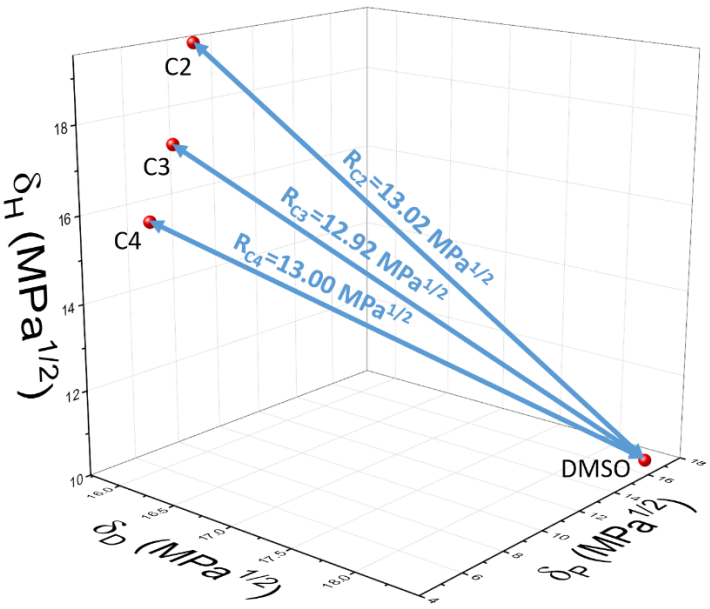

Figure S10. Location of solvents used for perovskite inks in the Hansen solubility space with the corresponding distances between DMSO and alcohols. δ_P, δ_D and δ_H are the Hansen Solubility Parameters, which represent the contributions of polar, dispersion, and hydrogen bonding forces, respectively, to a substance's total cohesive energy.

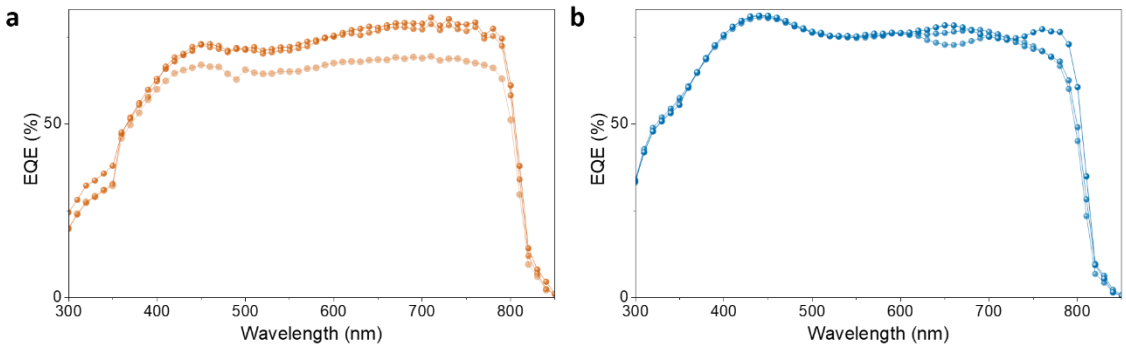

Figure S11. EQE spectra of the 3 central subcells of our champion PSMs. (a) DMSO only. **(b)** DMSO-C3.

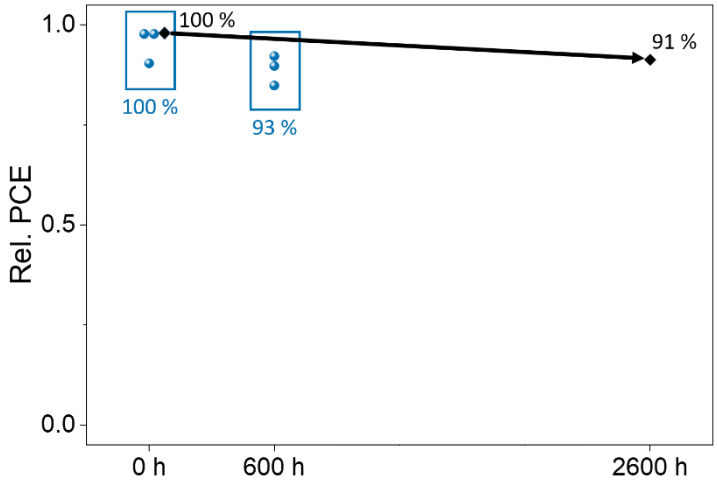

Figure S12. Shelf life of unencapsulated DMSO-C3 PSMs (10.23 cm2) under different ambient conditions. Blue circles represent PSMs stored in dry (~30%RH) ambient air conditions. Black rhombuses represent a PSM stored in inert atmosphere. PCE values are relative to the most efficient PCM at 0h for the PSMs stored in dry air, and relative to the only PCM at 0h for the PCM stored in inert atmosphere.

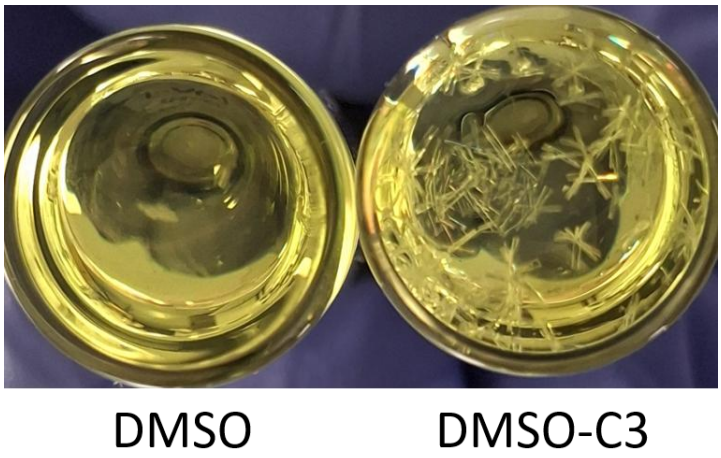

Figure S13. 1.23 M ink stability at room temperature. The DMSO ink in the photo was fully processed in ambient air. The DMSO-C3 ink was dissolved at 60 °C. Both inks were left in ambient air and room temperature overnight after being dissolved.

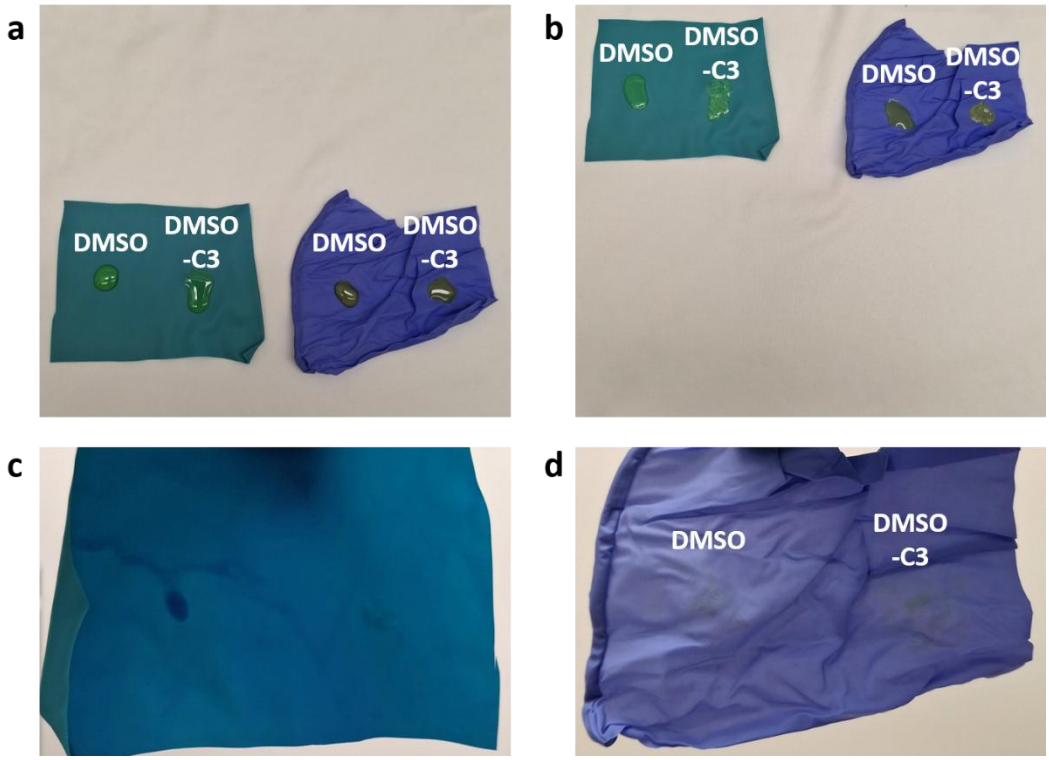

Figure S14. Permeability of chemical-resistant and nitrile gloves. (a) Beginning of the experiment. 100 µL of DMSO and DMSO-C3 inks on pieces of chemical-resistant nitrile/neoprene, and nitrile gloves. **(b)** 20 hours after the beginning of the experiment. **(c)** Back side of the chemical-resistant glove piece after 20 hours of experiment**.** The darker patterns are part of the material. **(d)** Back side of the nitrile glove pieces after 20 hours of experiment**.**

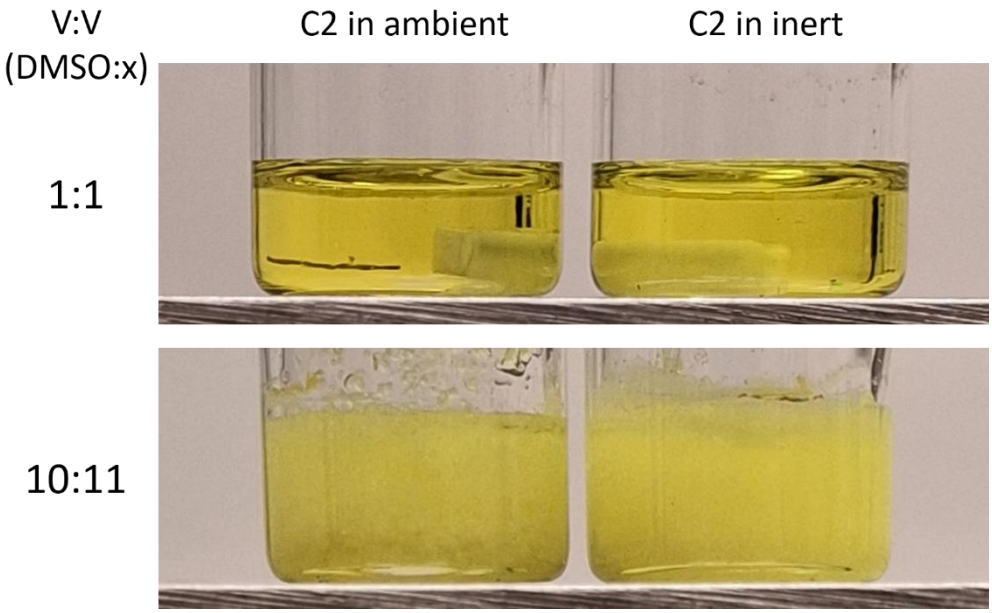

Figure S15. Precipitation points of C2 stored in different conditions when added to the DMSO ink.

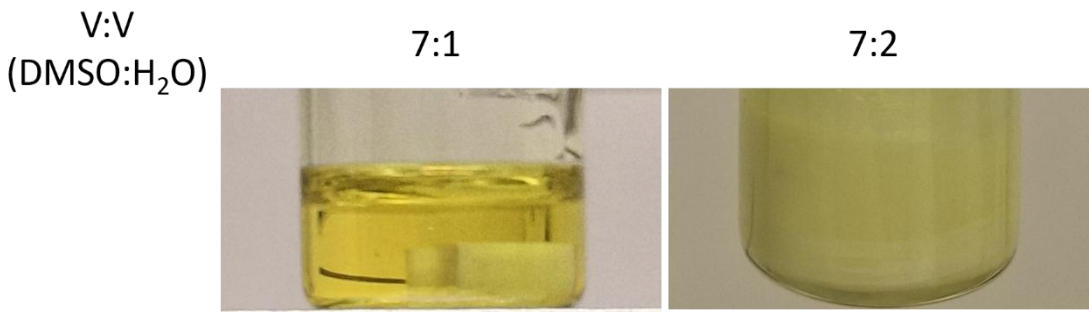

Figure S16. Precipitation points of water when added to the DMSO ink.

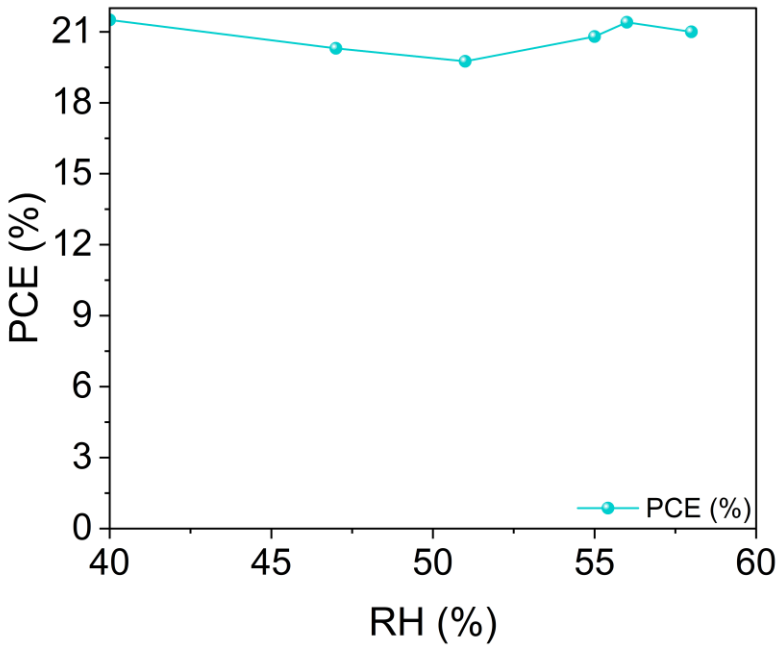

Figure S17. Champion DMSO-C3 PSMs under different ambient relative humidities.

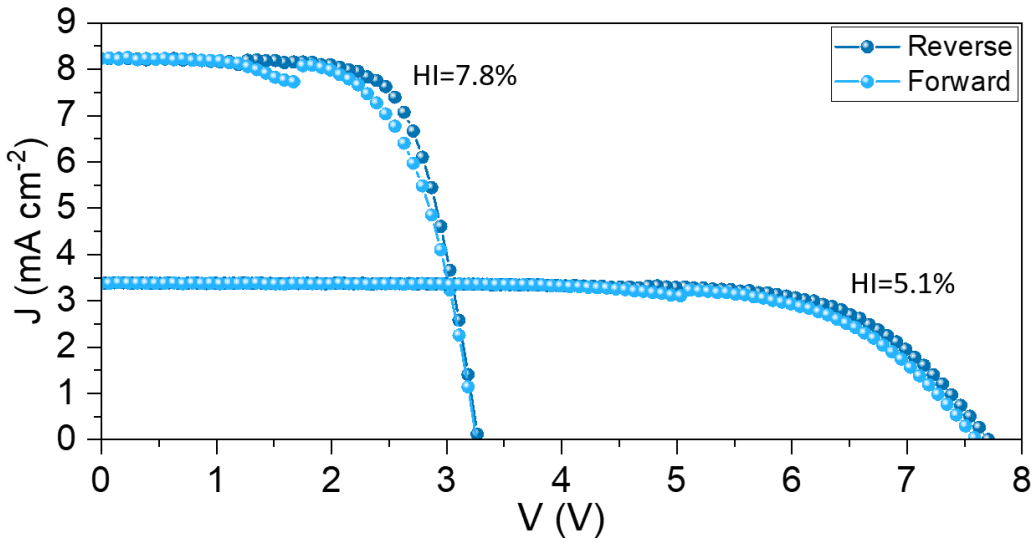

Figure S18. JV curves of 7-cell and 3-cell DMSO-C3 PSMs, scanned in forward and backward directions, with the corresponding Hysteresis Index.