Supporting Information

High-Performance UV-Crosslinked PMMA-Based Solid Polymer Electrolyte for Flexible Electro-chromic Devices

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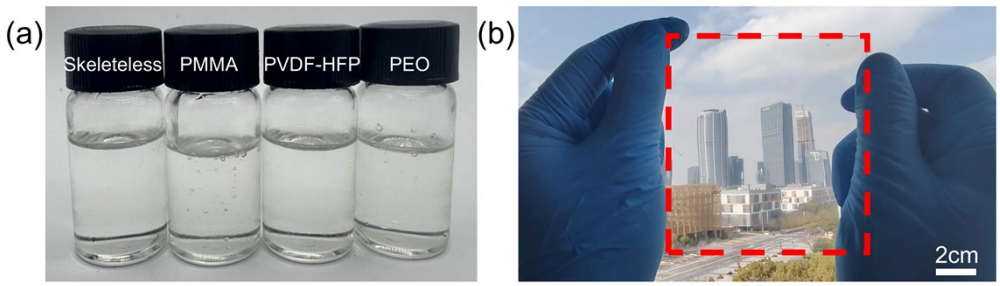

Figure S1. Photographs of the UV-crosslinkable electrolytes with different polymer matrices before and after crosslinking: (a) Skeleton-free, PMMA-based, PVDF-HFP-based, and PEO-based electrolytes before crosslinking; (b) Crosslinked PMMA-based electrolyte.

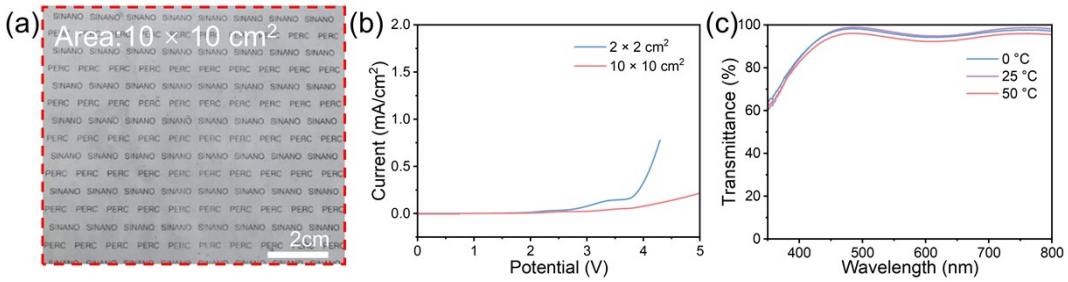

Figure S2. (a) Photograph of a large-area (10 × 10 cm^2) PMMA-based electrolyte film; (b) Electrochemical stability windows of standard-sized (2 × 2 cm^2) and large-area (10 × 10 cm^2) electrolyte films; (c) Optical transmittance of the electrolyte film at different temperatures (0, 25, and 50 °C).

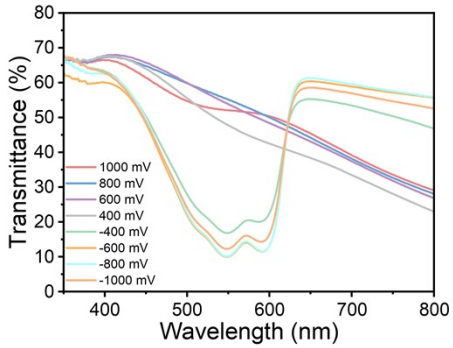

Figure S3. Transmittance spectra of the rigid ECD under different applied voltages.

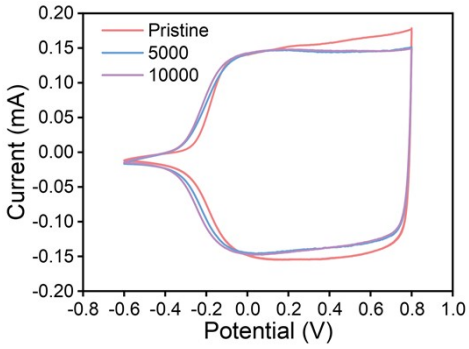

Figure S4. Cyclic voltammetry curves of the rigid ECD after different numbers of cycles.

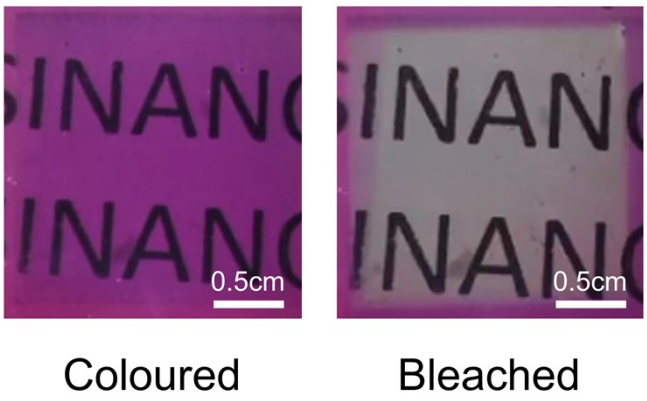

Figure S5. Photographs of the ECP-Magenta ECD in its colored and bleached states, achieved by driving voltages of -0.6 V/0.8 V for 5 s.

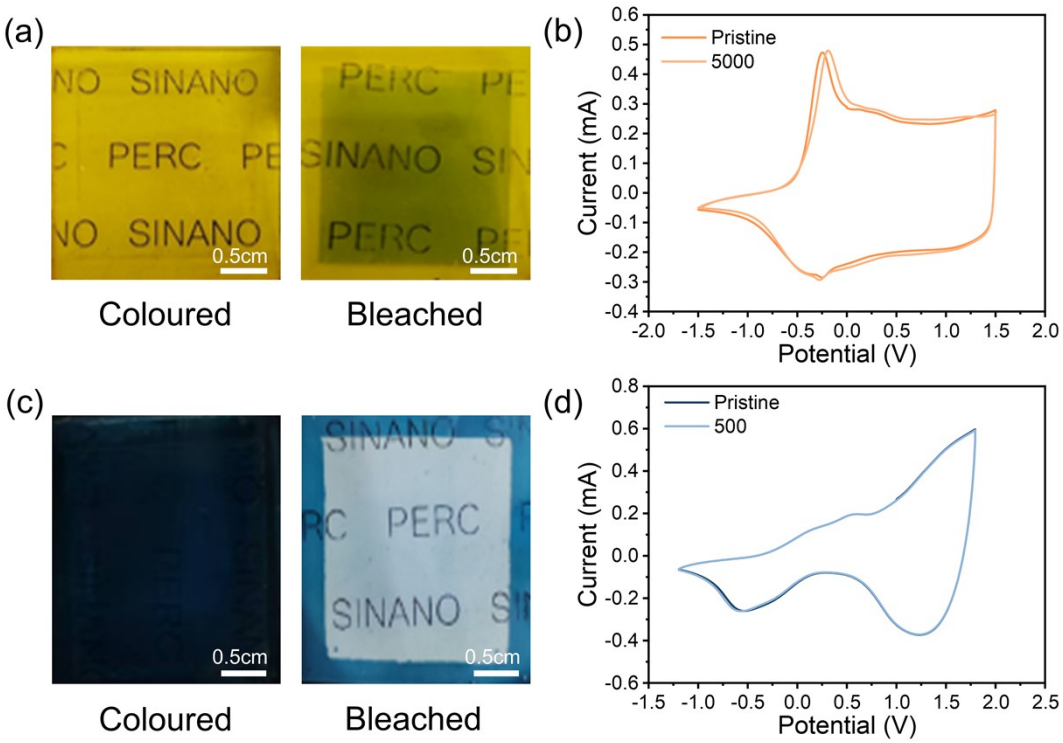

Figure S6. Optical and cycling performance of ECP-Yellow and ECP-Cyan ECDs: (a) Photographs of the ECP-Yellow ECD in its colored and bleached states, achieved by driving voltages of -1.5 V/1.5 V; (b) Cyclic voltammetry curves of the ECP-Yellow ECD before and after 5000 cycles; (c) Photographs of the ECP- Cyan ECD in its colored and bleached states, achieved by driving voltages of -1.8 V/1.2 V; (d) Cyclic voltammetry curves of the ECP-Cyan ECD before and after 500 cycles.

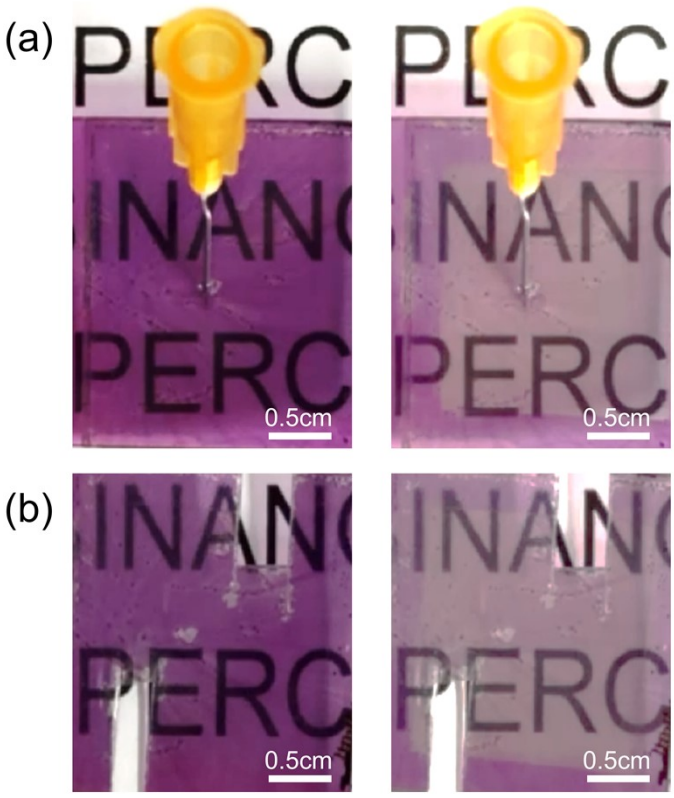

Figure S7. Extreme mechanical abuse tests and large-area fabrication of the FECDs: (a) Photographs of the FECD in its colored and bleached states during the needle puncture test; (b) Photographs of the FECD in its colored and bleached states after the scissor cutting test.

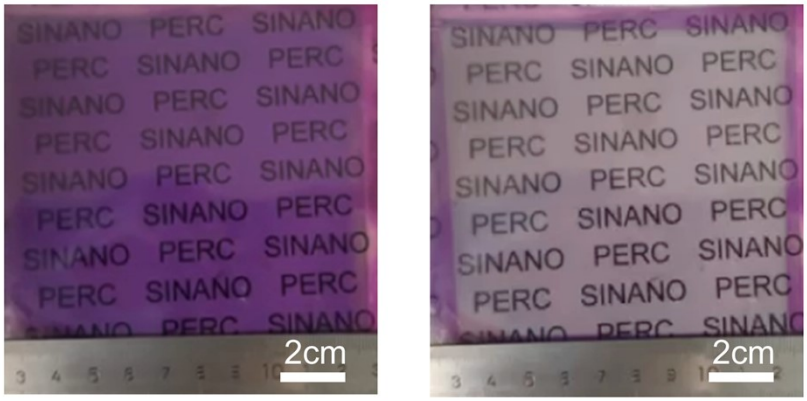

Figure S8. Photographs of the large-area ECD (10 × 10 cm^2) in the colored and bleached states.

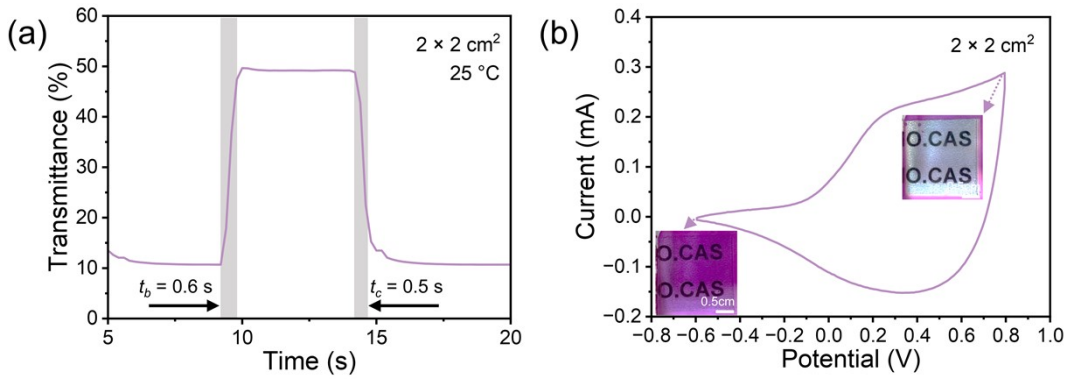

Figure S9. Switching behavior and cyclic voltammetry of the ECD (2 × 2 cm²): (a) Transmittance switching behavior of the ECD at 550 nm with an applied voltage of 0.8 V/–0.6 V, recorded at 25 °C; (b) Cyclic voltammetry curves of the ECD.

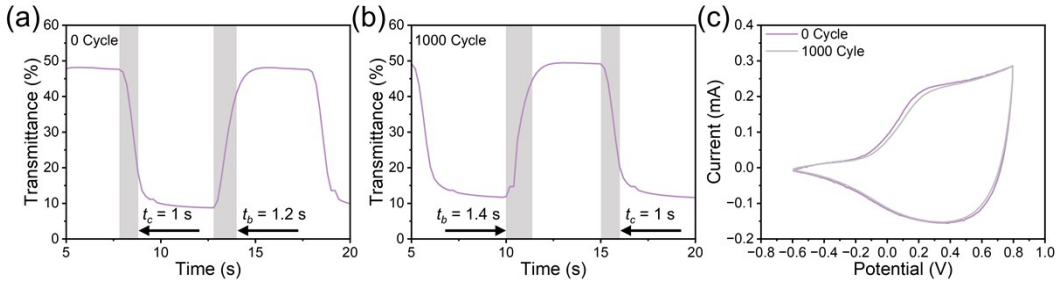

Figure S10. Transmittance switching behavior and cyclic voltammetry curves of the inkjet-printed patterned FECD: (a) Initial transmittance switching behavior of the inkjet-printed patterned FECD at 550 nm under an applied voltage of 0.8 V/–0.6 V; (b) Transmittance switching behavior after 1000 coloring /bleaching cycles; (c) Cyclic voltammetry curves of the inkjet-printed patterned FECD before and after 1000 coloring/bleaching cycles.

Table S1 Comparison of key performance metrics between our work and recently reported electrolyte systems.

Electrolyte composition	ECD area (cm^2)	Optical transmittance	Coloring/bleaching time (s)	Coloration efficiency (cm^2/C)	Long-term cycling stability	Mechanical durability	Process compatibility	Large-area device performance	Effect of temperature on the device	Ref
PMMA + PEGDA	2 × 2	Bleached state: 49% Colored state: 10% ΔT: 39%	0.5/0.6	2200	ΔT decreases by only 6% after 10,000 cycles.	After 2000 bends (bending radius 15 mm), ΔT retention > 90%; puncture-resistant, shear-resistant	Compatible with blade coating (large-area) and jet printing (patterning).	ΔT is 38%, with tc and tb of 0.8 s and 1.0 s (5 × 5 cm^2); ΔT is 37%, with t_c and t_b of 1.2 s and 1.8 s (10 × 10 cm^2).	ΔT of 31%, with t_c and t_b of 1.0 s and 1.2 s (0°C); ΔT of 35, with t_c and t_b of 0.8 s and 1 s (50 °C).	***Our work***
PEO + KH560	1 × 1	Bleached state: 78.5% Colored state: 57.6% ΔT: 20.9%	/	153.3	After 400 cycles, the cyclic voltammetry curve remains consistent.	/	/	/	/	87
PEO + PEGDA	2.5 × 2.5	Bleached state: 75% Colored state: 40% ΔT: 35%	3.48/0.96	93.93	No attenuation of optical modulation at 633 nm after 20,000 cycles.	/	/	/	/	88
PMMA	2.5 × 2.5	/	1/1.7	258	ΔT decreases by only 4% after >12,000 cycles	Optical contrast retention of 96% after 10,000 cycles (under bending).	Spray coating / spin coating	/	/	89
PMA + $NaClO_4$ + PC + $C_8H_{17}IN_2$ + TTA21	Small area (unspecified)	Bleached state: 92% Colored state: 2.7% ΔT: 89.3%	0.7/0.9	109	Attenuation <10% after 3000 cycles.	/	Spin coating, sputtering	10 × 10 cm^2 (rigid): optical transparency ≈90%; optical contrast (ΔT) ≈70%; coloring/bleaching time: 2.1 s/6.3 s.	/	90
PHPA-PMMA	1 × 4	Bleached state: 73.5% Colored state: 32.3% ΔT: 41.2%	10.6/11.5	87	ΔT retention of 95% after 1000 cycles.	/	Blade coating	/	/	63
P(HPA-co-MMA)	1 × 3	Bleached state: 77% Colored state: 4.3% ΔT: 72.7%	7.5/NaN	872	The transmittance of the bleached state decreases by 0.9%, and that of the colored state changes by 1.6% (1000 cycles).	/	Blade coating	/	/	91
PVDF	3 × 4	Bleached state: 80% Colored state: 20% ΔT: 60%	16.6/15.5	99.88	/	Performance retention of 58.8% after 500 bends.	Blade coating	/	Response time (coloring time): at -10 °C no specific value; at 60 °C: 13.6 s. Transmittance: at -10 °C not provided; at 60 °C: 39.1%.	92
$ZnCl_2$ WiSE + ZnI_2	Small area (unspecified)	Bleached state: 71.4% Colored state: 0.7% ΔT: 70.7%	9.5/13.3	54.4	ΔT retention of 88.5% after 100 cycles.	/	Magnetron sputtering	central region: t_c = 44.6 s, t_b = 66.4 s; edge region: t_c = 37.8 s, t_b = 59.4 s (10 × 10 cm^2).	/	93
BPA	10 × 10	Bleached state: 84.58% Colored state: 1.01% ΔT: 83.57%	5.6/5.2	460.3-510.6	Stable after 100 cycles.	/	Blade coating, photolithography	10 × 10 cm^2	/	94