Supplementary Materials: A Composite Membrane with High Stability and Low Cost Specifically for an Iron–Chromium Flow Battery

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1. The calculation of Hansen solubility parameters

1.1. Hansen solubility parameter was defined according to the following Equation (1):

$$\delta^2 = \delta_d^2 + \delta_p^2 + \delta_h^2 \tag{1}$$

δ_d, δ_p, and δ_h represent the contribution of the dispersion force, polar force, and H-bonding.

δ, δ_d, δ_p, and δ_h of H_2O, IPA, DMAc, and PE refer to the Hansen Solubility Parameters Handbook.

1.2. Each of the δ_d, δ_p, and δ_h of mixed solvent in cast solution is a linear function of composition and calculated according to the following Equation (2):

$$\delta_{blend} \equiv [\varphi_{comp1} \times \sigma_{com1}] + [\varphi_{comp2} \times \sigma_{com2}] \tag{2}$$

φ represents the volume fraction for each component.

1.3. Solubility parameter "distance" (Ra) between the mixed solvent and PE was defined according to the following Equation (3):

$$(Ra)^2 = 4(\delta_{D1} - \delta_{D1})^2 + (\delta_{P2} - \delta_{P1})^2 + (\delta_{H2} - \delta_{H1})^2 \tag{3}$$

The experimentally-determined solubility sphere radius (Ro) of PE is 7.9—the reference is from Hansen Solubility Parameters Handbook.

Table S1. The mechanical properties of Daramic and D-DMAc-8 membranes.

Thickness (μm)	Code	Mechanical Property			Puncture Strength (N)
		Elastic Modulus (MPa)	Elongation at Break (%)	Tensile Strength (MPa)	
200 ± 5	Daramic membrane	119.57	49.22	15.08	
200 ± 5	D-DMAc-8 membrane	156.34	50	14.83	4.355

Table S2. The cost of prepared Nafion 115 (126 μm) and D-DMAc-8 membranes per m².

Code	Component	Unit Price ($)	Consumption	Cost ($)
Nafion 115 membrane	Nafion dispersions (D-2020)	2.916 mL-1	630 mL	1837.08
Total				1852.776
	DMAc	0.004993 mL-1	937.5 mL	4.68

D-DMAc-8 membrane	Nafion dispersions (D-2020)	2.916 mL-1	312.5 mL	911.25
	Daramic membrane	31.525 m-2	1 m2	31.525
Total				947.45

Figure S1. The photos of composite membranes by one-step coating way with (**a**) 5 wt% cast solution, (**b**) 10 wt% cast solution, and (**c**) 20 wt% cast solution.
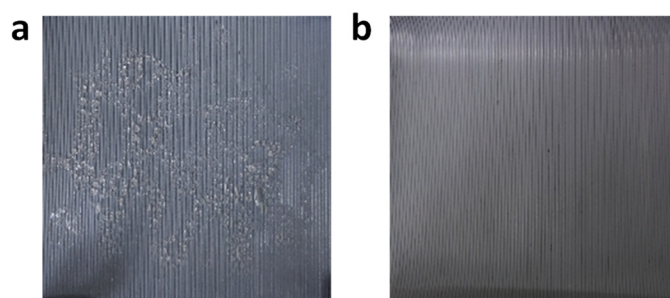

Figure S2. The photos of composite membranes with (**a**) one-step coating way and (**b**) step-by-step coating way.
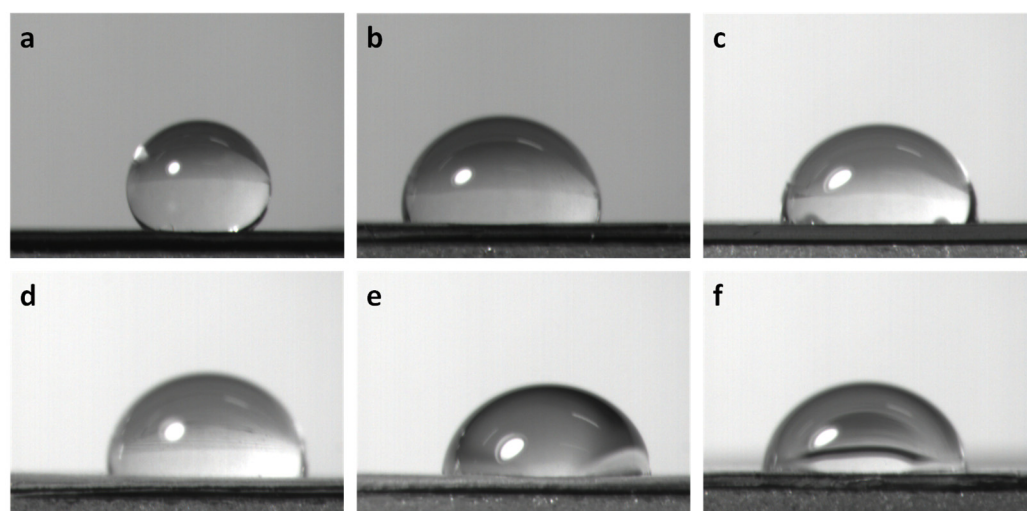

Figure S3. Contact angle of (**a**) D-DMAc-0, (**b**) D-DMAc-2, (**c**) D-DMAc-4, (**d**) D-DMAc-6, (**e**) D-DMAc-8, (**f**) D-DMAc-11 membranes.