Supporting Information for

Hybrid Poly(Ionic Liquid) Membranes with In-Situ Grown Layered Double Hydroxide and Preserved Liquid Crystal Morphology for Hydroxide Transport

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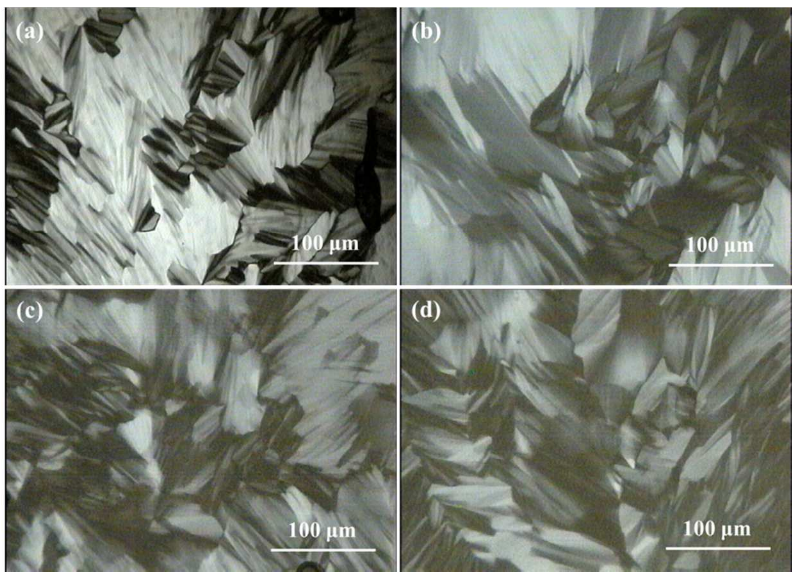

Figure S1. POM images of C_{12}VIMCl aqueous mixture with different concentration of salts: 0 M (a), 0.12 M (b), 0.24 M (c), and 0.36 M (d).

Table S1. Structure parameters for the H_1 phase of C_{12}VIMCl aqueous mixture.

Salt concentration (mol/L)	$[C_{12}VIM][Cl]$ (wt%)	a_0 (nm)	Φ_L	d_H (nm)	d_w (nm)
	60%	4.076	0.583	1.635	0.806
0	70%	3.904	0.685	1.697	0.509
	80%	3.759	0.789	1.753	0.252
	60%	4.121	0.585	1.656	0.809
0.12	70%	3.945	0.687	1.717	0.510
	80%	3.784	0.790	1.766	0.251
	60%	4.121	0.587	1.658	0.804
0.24	70%	3.945	0.689	1.719	0.506
	80%	3.784	0.791	1.768	0.248
	60%	4.121	0.589	1.661	0.798
0.36	70%	3.945	0.691	1.722	0.502
	80%	3.784	0.793	1.770	0.245

Φ_L is the volume fraction of hydrophobic alkyl chain in the surfactant molecular. a_0 is the lattice parameter. d_H is the radius of cylinder unit in the H_1 phase. d_w is the thickness of water channel in the LC phase.

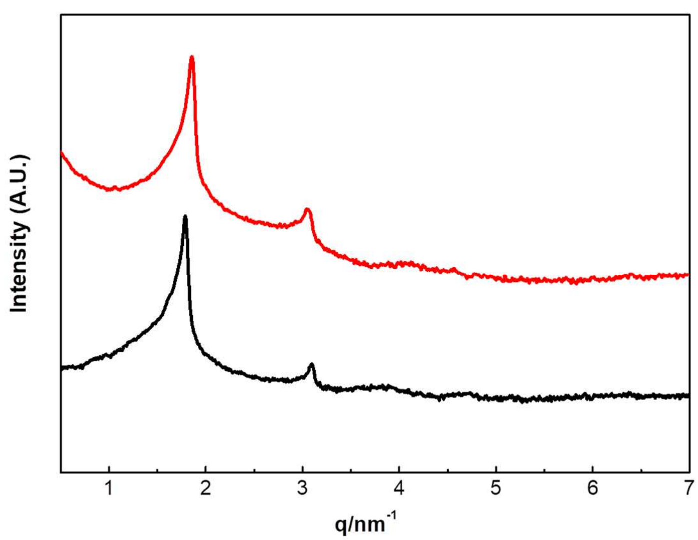

Figure S2. SAXS patterns of LC samples with 70% C_{12}VIMCl in 0.36 M salt solution (black) and after coprecipitation for 96 h (red).

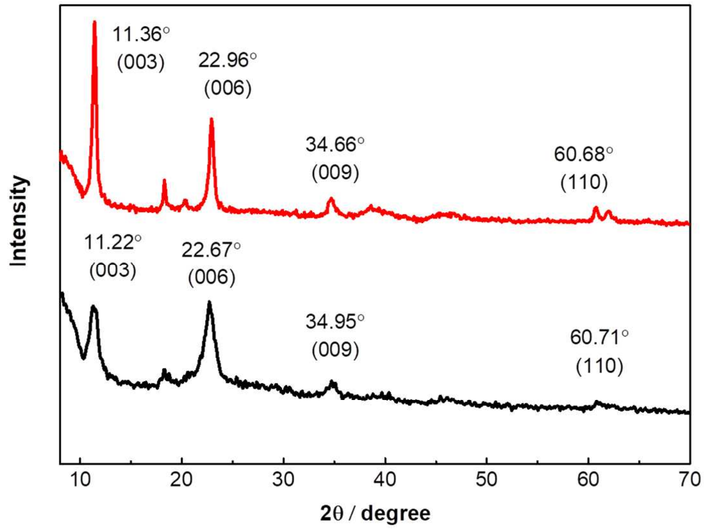

Figure S3. XRD patterns of LDHs synthesized in hexagonal LC with 0.36 M salt solution (black) and synthesized from coprecipitation in solution without LC template (red).

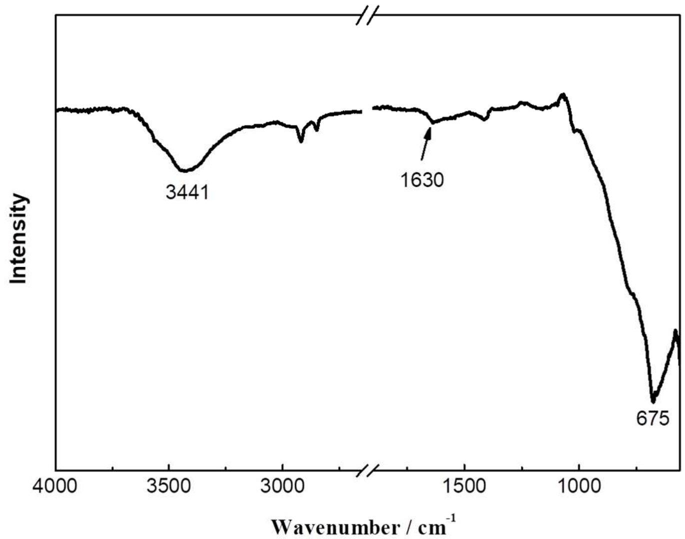

Figure S4. FT-IR spectrum of LDH synthesized in hexagonal LC with 0.36 M salt solution.

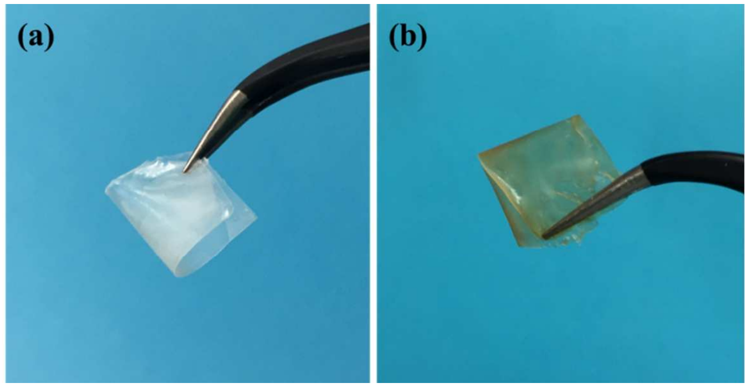

Figure S5. The photograph of the membrane: (a) in Cl^{-} form; (b) in OH^{-} form.

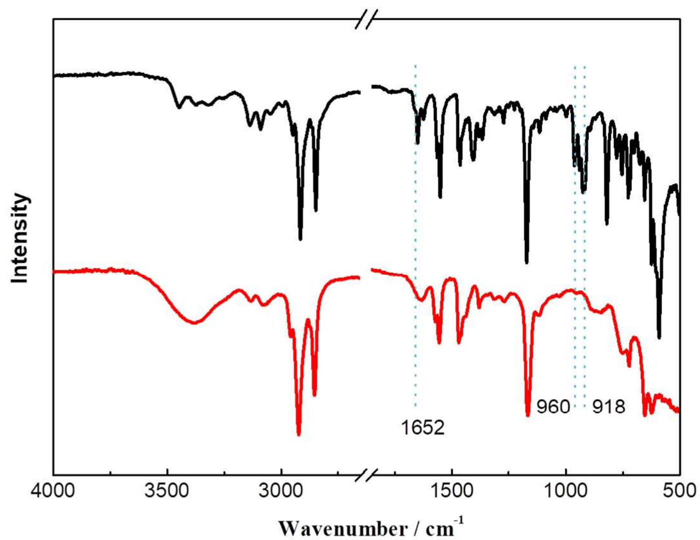

Figure S6. Comparative FT-IR spectra of the LC sample (black) and the polymerized LC membrane (red).

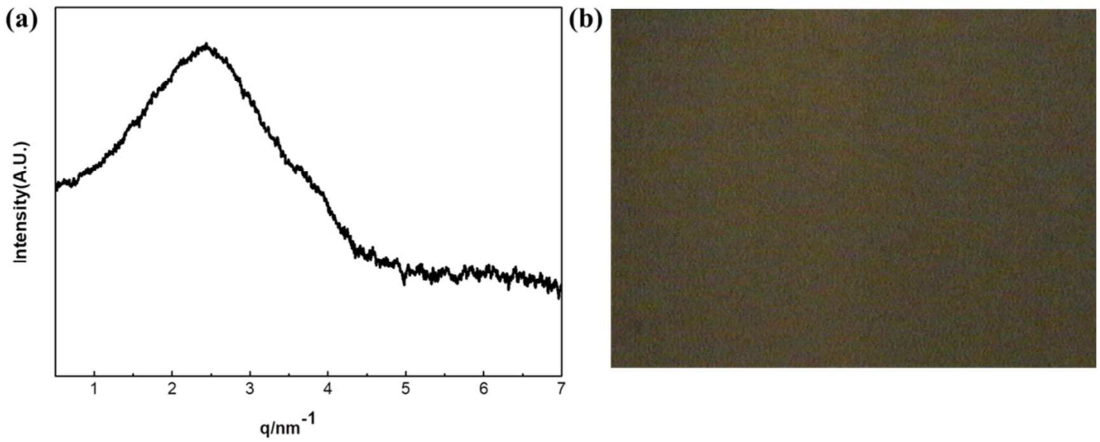

Figure S7. SAXS pattern (a) and POM image (b) of the AEM obtained by in-phase photopolymerization of 70% C_{12}VIMCl ethanol solution (AEM-ethanol-70%).

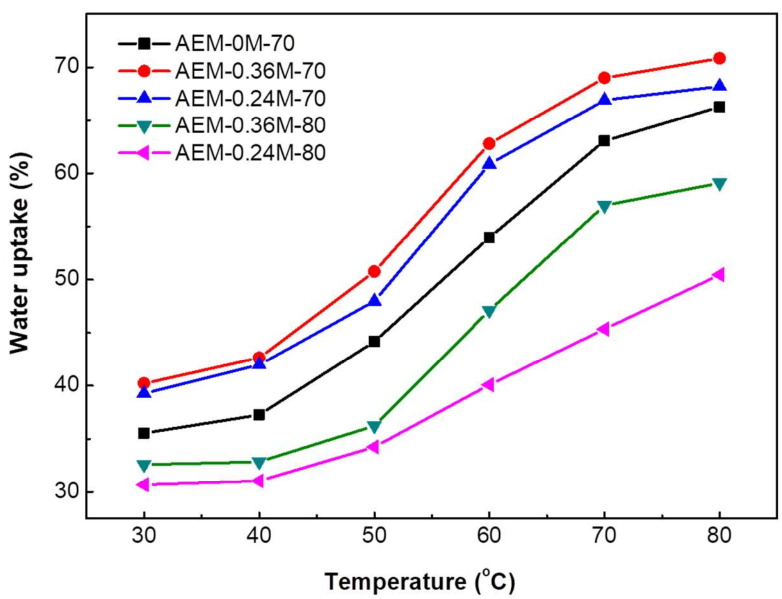

Figure S8. The water uptake of the membranes in OH^{-} form at varied temperatures.

Table S2. Water uptake (WU), swelling degree (SD), and conductivities of recently reported AEMs. In each referenced paper, we choose the AEMs with similar IEC values for comparison with our results.

IEC (mmol/g)	WU (%)	SD (%)	Conductivity (mS/cm)	Ref
2.13	22.1	10.6	49.79 (80°C)	This work
2.61	107.2	N	82 (80°C)	1
2.16	109	N	89.0 (80°C)	2
1.95	145	30.5	55.0 (80°C)	3
1.76	43.7	7.1	13.2 (60°C)	4
2.24	51	30	70.2 (80°C)	5
2.27	87.3	19	33.2 (60°C)	6
1.92	95	51	41 (60°C)	7
2.07	47	13.5	68 (80°C)	8
2.0	55	N	60 (70°C)	9

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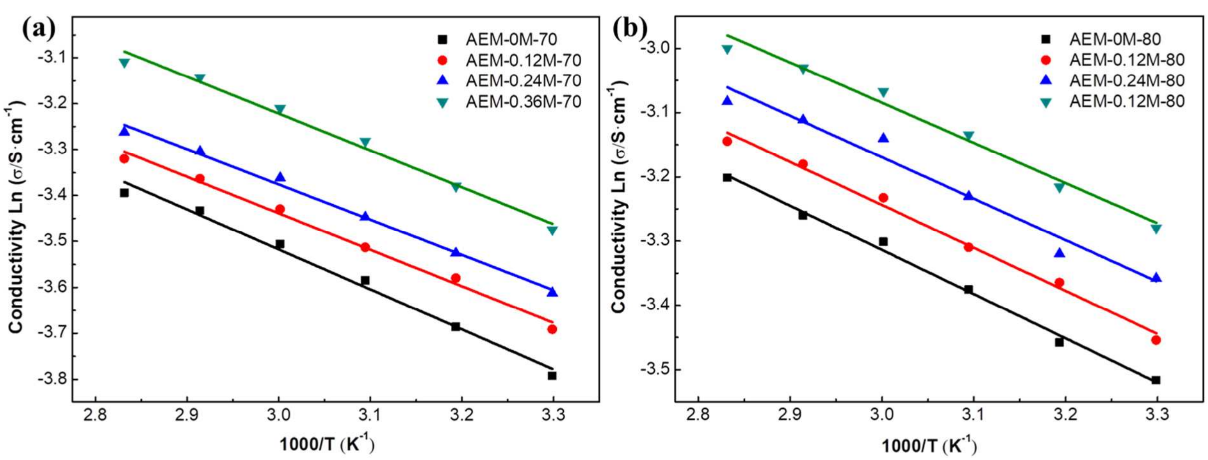

Figure S9. Arrhenius plots of ionic conductivities of the membranes in OH^- form with different LDH contents: (a) the C_{12}VIMCl content is 70 wt%; (b) the C_{12}VIMCl content is 80 wt%.

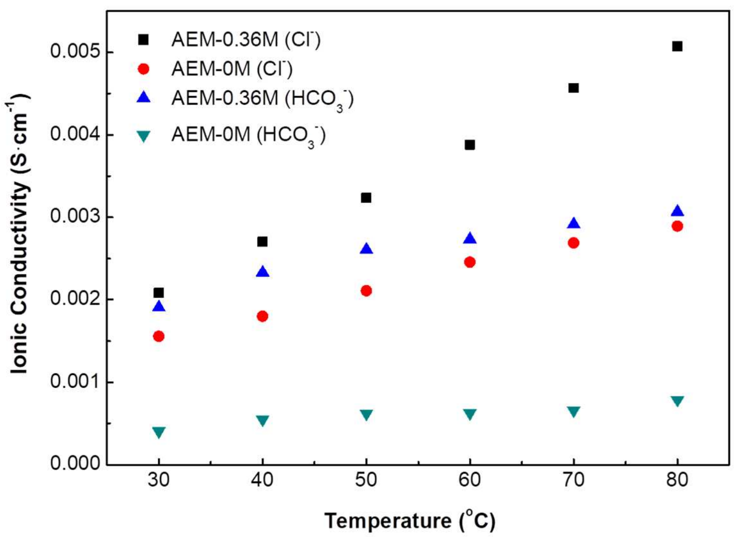

Figure S10. The conductivities of membranes obtained by in-phase photopolymerization of C_{12}VIMBr in the H_1 phase (70%) in Cl^- and HCO_3^- form as a function of temperature.

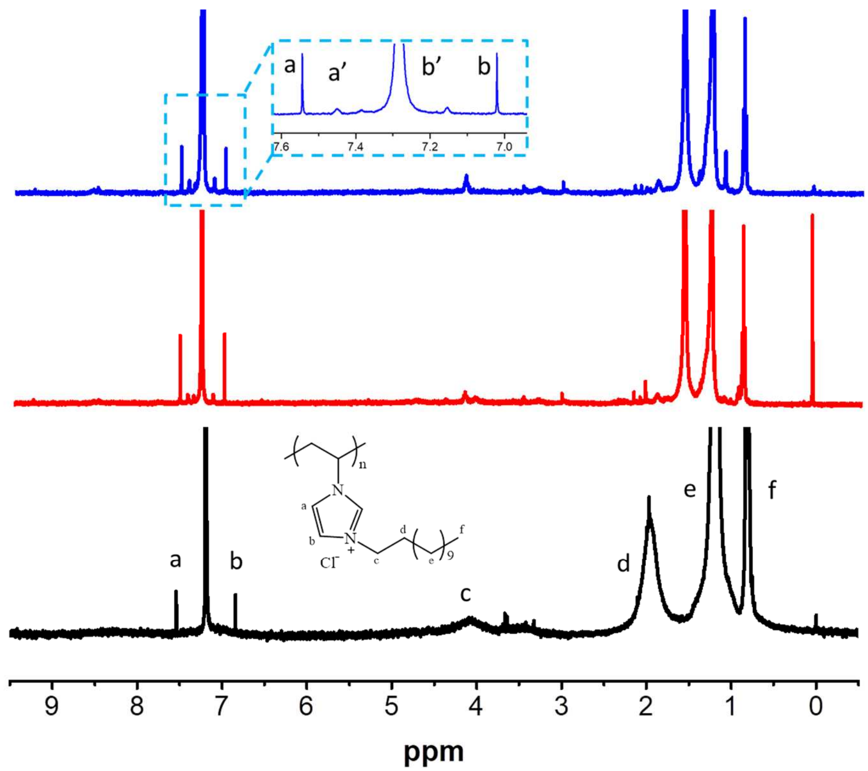

Figure S11. ^{1}H NMR spectra ($CDCl_3$) of AEM-0.36M-70 before (black) and after the accelerated alkaline stability test by exposure to 2 M KOH aqueous solution at 80 ^oC for 96 h (red) and 120 h (blue).