Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information

"Fishnet-like" Ion-selective Nanochannels in Advanced Membranes for Flow Batteries

Lei Hu,[a,b] Li Gao,[a,b] Changkun Zhang,[c] Xiaoming Yan,*[a,b] Xiaobin Jiang,[b] Wenji Zheng,[a] Xuehua Ruan,[a] Xuemei Wu,[b] Guihua Yu[c] and Gaohong He*[a,b]

[a.]State Key Laboratory of Fine Chemicals, School of Petroleum and Chemical Engineering, Dalian University of Technology, 2 Dagong Road, Panjin, LN 124221, China. Email: yanxiaoming@dlut.edu.cn; hgaohong@dlut.edu.cn

[b.]State Key Laboratory of Fine Chemicals, R&D Center of Membrane Science and Technology, School of Chemical Engineering, Dalian University of Technology, 2 Linggong Road, Dalian, LN 116024, China.

[c.]Materials Science and Engineering Program and Department of Mechanical Engineering, The University of Texas at Austin, TX 78712, USA.

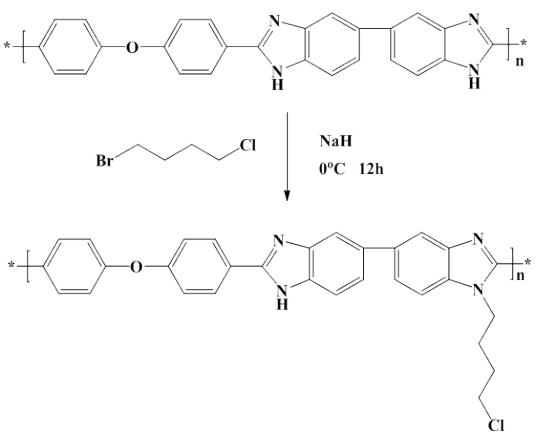

Figure S1. Synthesis of CPBI.

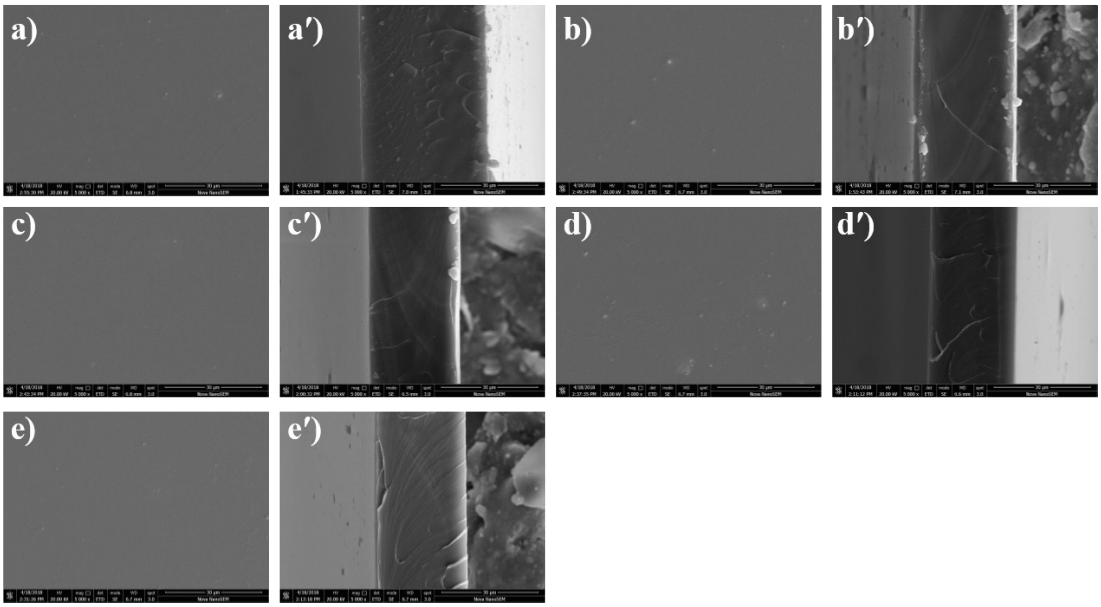

Figure S2. SEM images of membranes: PBI (a: surface, a': cross section); CPBI (b: surface, b': cross section); CPBI-PEI-10 (c: surface, c': cross section); CPBI-PEI-15 (d: surface, d': cross section); CPBI-PEI-20 (e: surface, e': cross section).

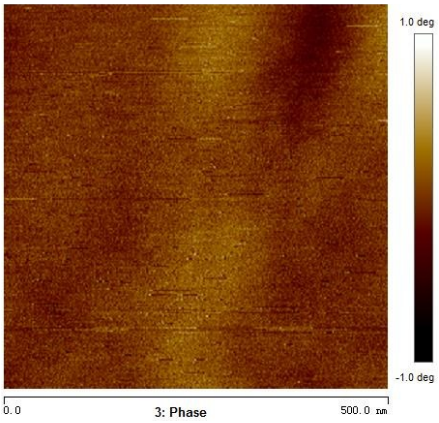

Figure S3. AFM phase image of PBI membrane.

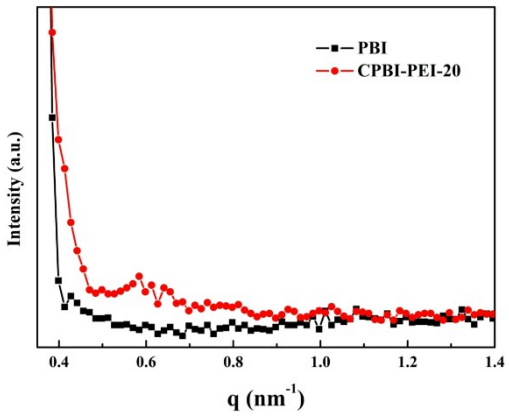

Figure S4. SAXS of PBI and CPBI-PEI-20 membrane.

Table S1. Proton conductivity, VO^{2+} permeability and ion selectivity of the prepared membranes.

Membrane	Proton conductivity[a]	VO^{2+} permeability	Ion selectivity
	mS cm^{-1}	10^{-10} cm^2 s^{-1}	10^{10} mS s cm^{-3}
PBI	35.2	No detected	-
CPBI	39.7	No detected	-
CPBI-PEI-10	63.1	0.5	118.1
CPBI-PEI-15	78.0	2.7	28.8
CPBI-PEI-20	115.9	9.2	12.6
Nafion 212	182.7	552.6	0.3

[a]The proton conductivity is calculated from area resistances of prepared membranes as follow: proton conductivtity = L/Area resistance, where L is thickness of membrane.

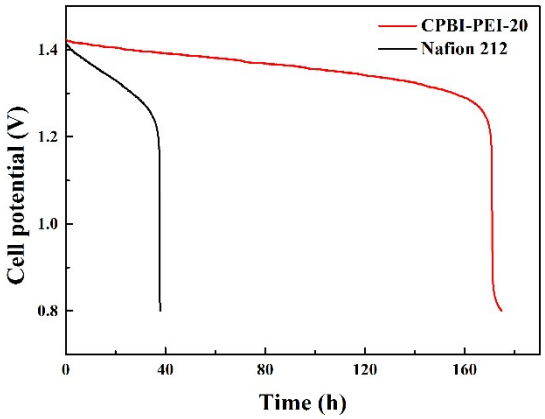

Figure S5. The self-discharge curves using CPBI-PEI-20 and Nafion 212 membranes.

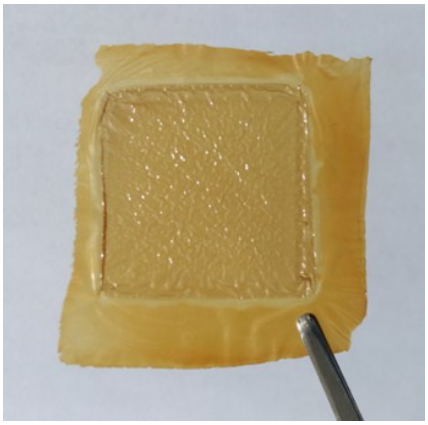

Figure S6. Digital photograph of CPBI-PEI-20 membrane after 2000 charge-discharge cycles at 120 mA cm^{-2}.

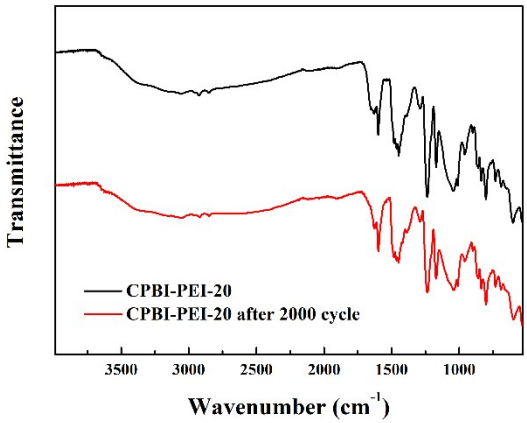

Figure S7. FTIR spectra of CPBI-PEI-20 membranes before and after 2000 charge-discharge cycles at 120 mA cm^{-2}.