

## Supplementary Information

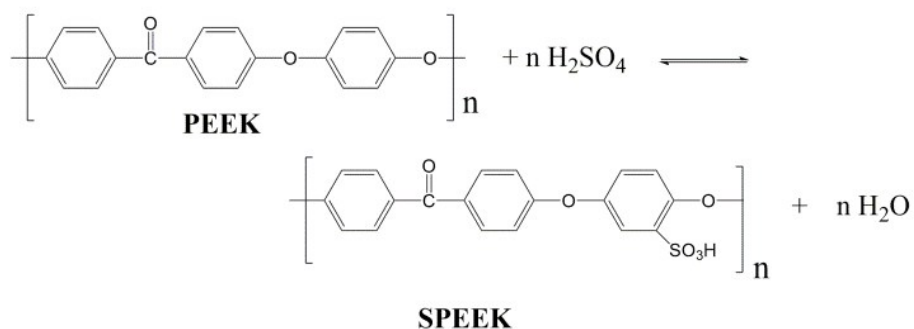
### **Zwitterions Threaded Metal-Organic Framework Membranes for Direct Methanol Fuel Cells**

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#### **Materials and Chemicals**

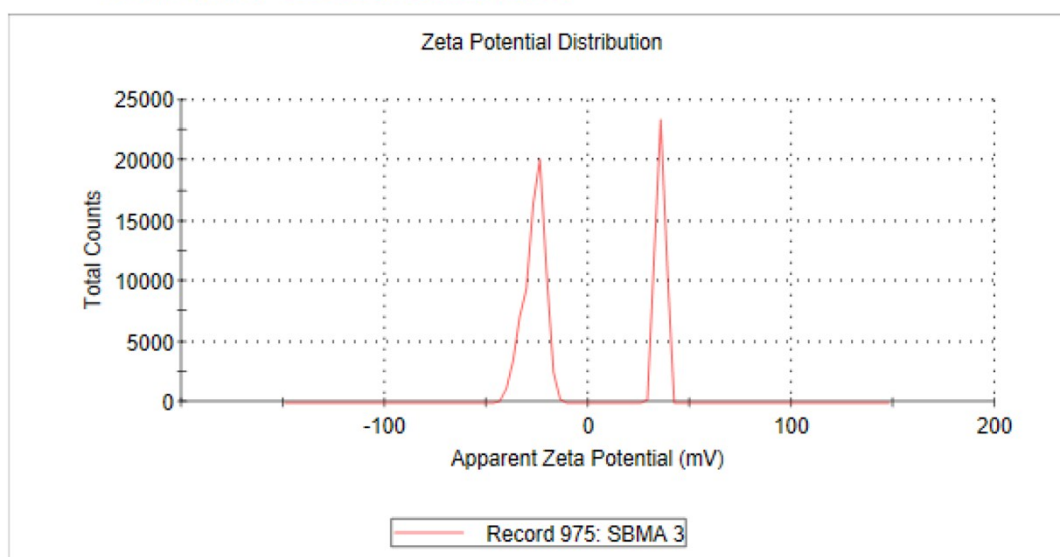
Zinc nitrate ( $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ) and 2-aminoethanol ( $\text{NH}_2\text{-CH}_2\text{CH}_2\text{OH}$ ) were purchased from ACROS Chemicals. 2-methylimidazole (2-mIm)( $\text{C}_4\text{H}_6\text{N}_2$ ) and sulfobetaine methacrylate (SBMA) were purchased from Sigma-Aldrich. Methanol, ethanol, DMF,  $\text{H}_2\text{SO}_4$  and HCl were purchased from Sinopharm Chemical Reagent Co. Ltd. Anodic aluminum oxide (AAO) membranes with a pore size ca. 200 nm and porosity of 50% were purchased from Whatman International Ltd. Poly(vinylidene fluoride) (PVDF) membranes with pore size ca. 200 nm were purchased from Merck Millipore. Nafion membranes were purchased from DuPont. Ultrapure water of 18.2 M $\Omega$  produced by a Millipore direct-Q system was used throughout the experiments.

## Supporting Figures

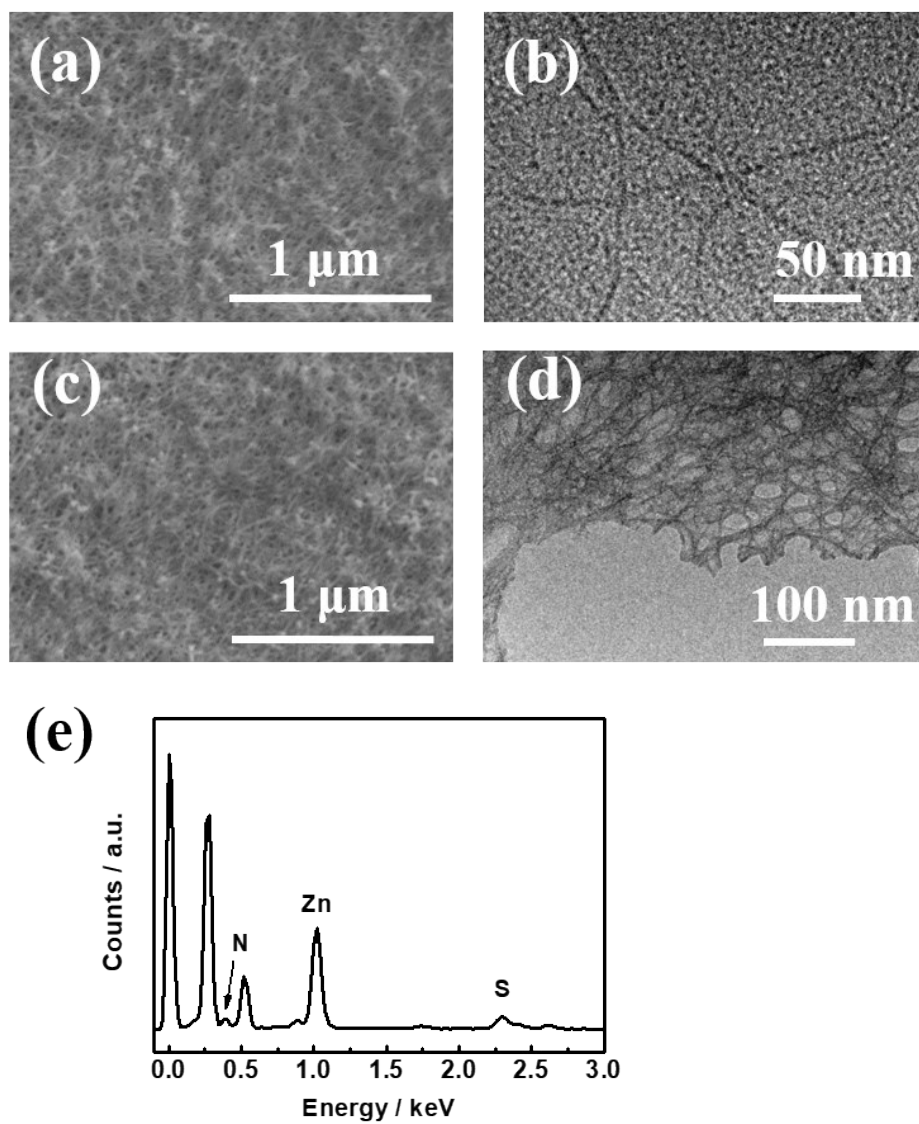


**Scheme S1.** Sulfonation of PEEK through its reaction with the concentrated sulfuric acid.

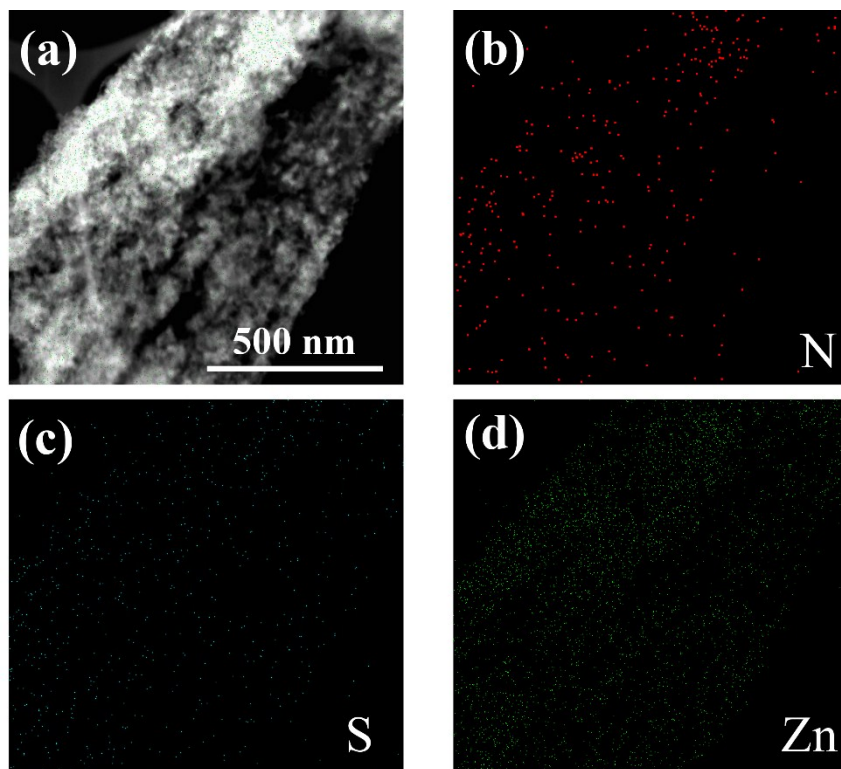
	Mean (mV)	Area (%)	St Dev (mV)
<b>Zeta Potential (mV): -2.21</b>	<b>Peak 1: -26.6</b>	60.7	5.24
Zeta Deviation (mV): 30.6	Peak 2: 35.5	39.3	2.35
Conductivity (mS/cm): 0.0341	Peak 3: 0.00	0.0	0.00
<b>Result quality See result quality report</b>			



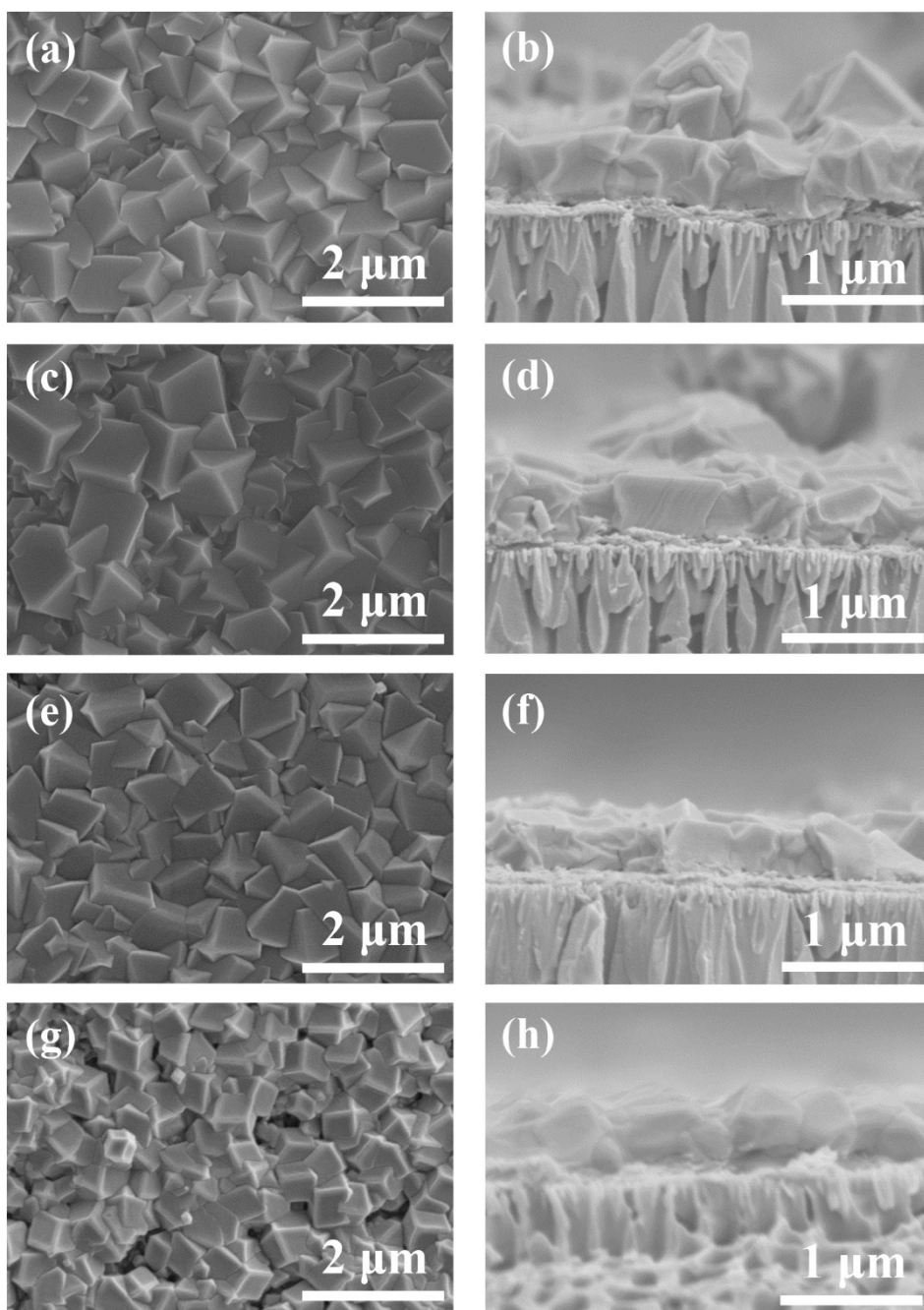
**Figure S1.** The zeta potential of SBMA molecules.



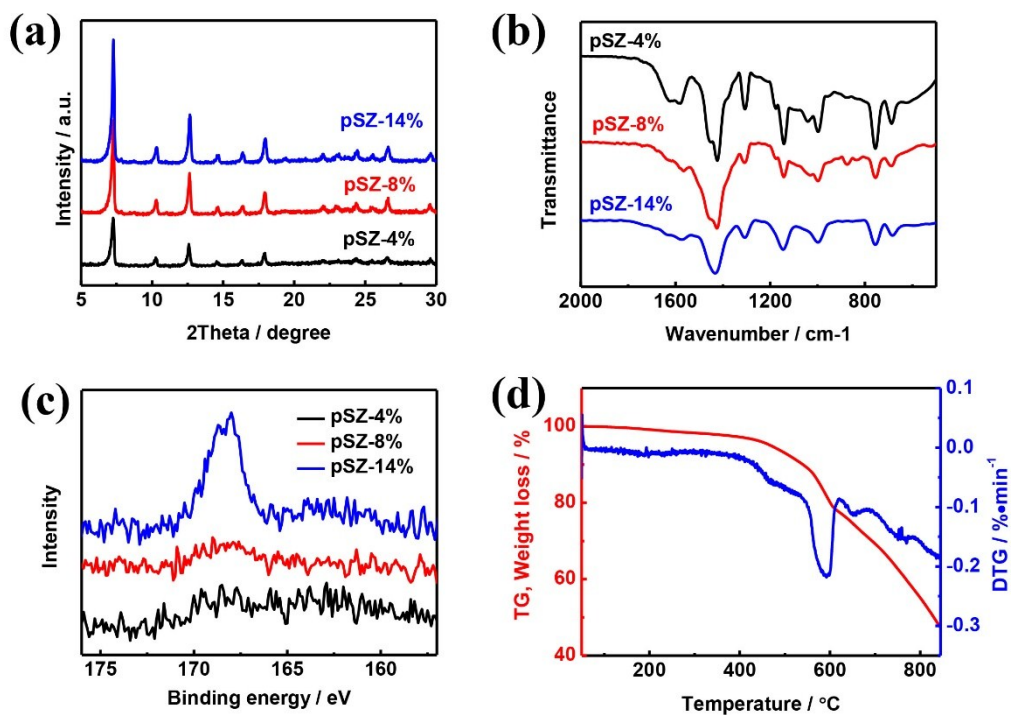
**Figure S2.** The (a) SEM and (b) TEM images of ZHNs. The (c) SEM and (d) TEM images of SBMA@ZHNs. (e) The EDS of (a).



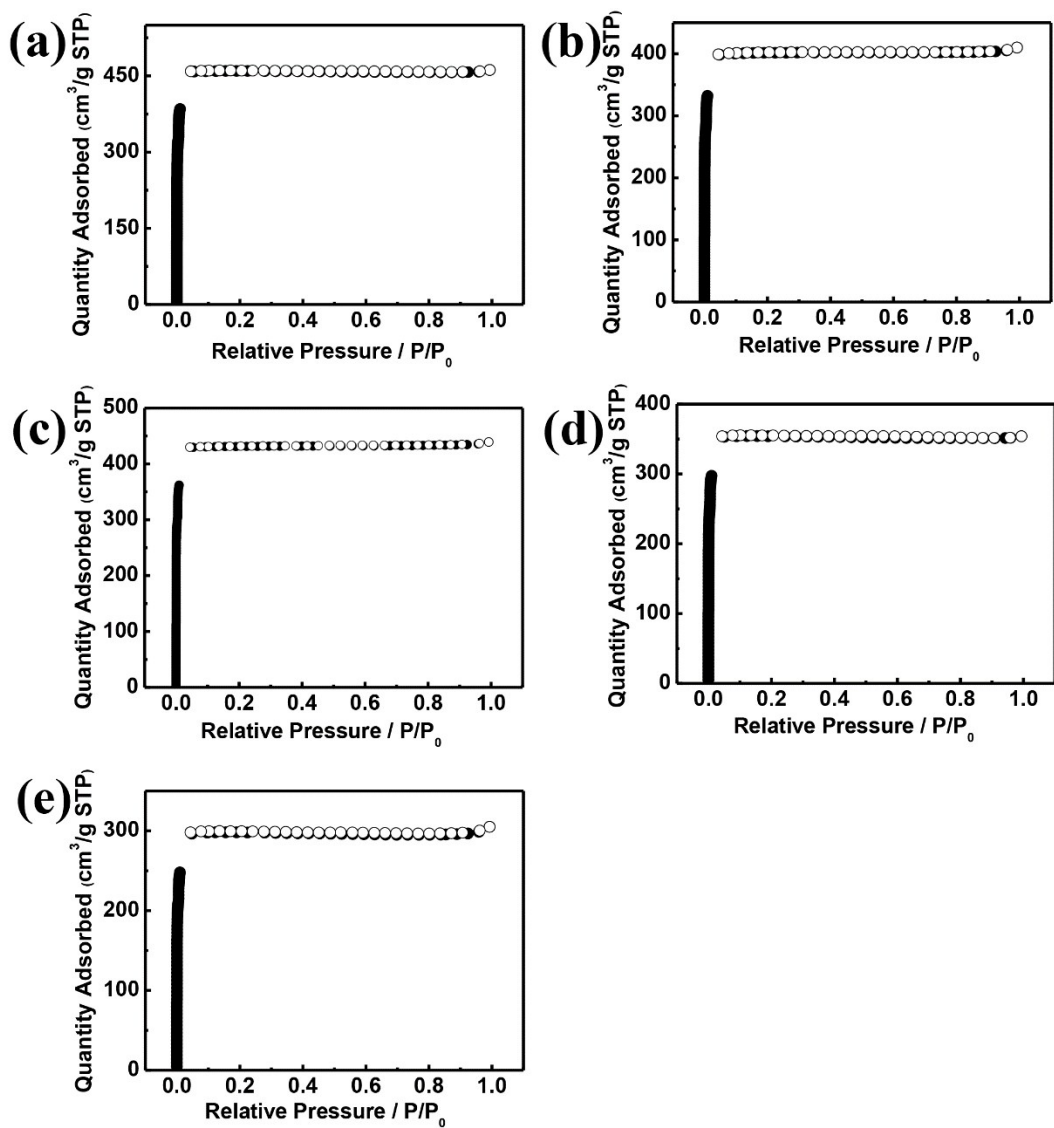
**Figure S3.** (a) The STEM image of cross-section of pSZ-11%. (b) N element, (c) S element and (d) Zn element EDS mapping of (a).



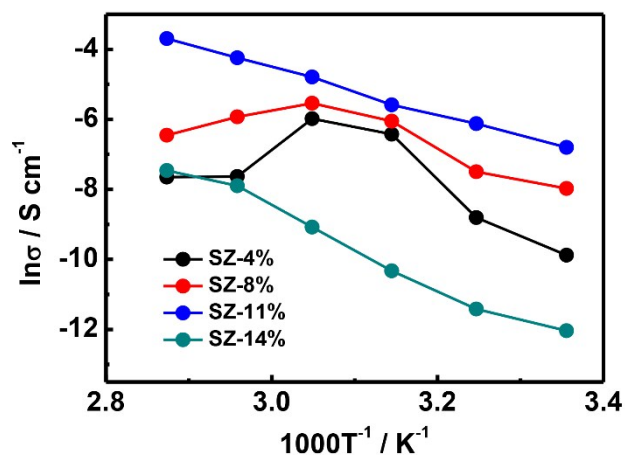
**Figure S4.** The surface and the cross-section SEM images of (a-b) ZIF-8; (c-d) pSZ-4%; (e-f) pSZ-8%; and (g-h) pSZ-14%, respectively.



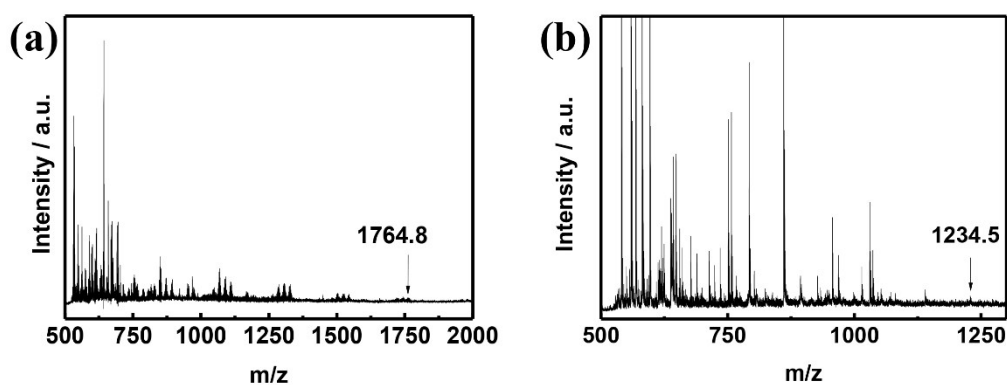
**Figure S5.** (a) XRD patterns, (b) FTIR spectra and (c) S2p spectra of pSZ membranes. (d) TG curve of the ZIF-8 membrane.



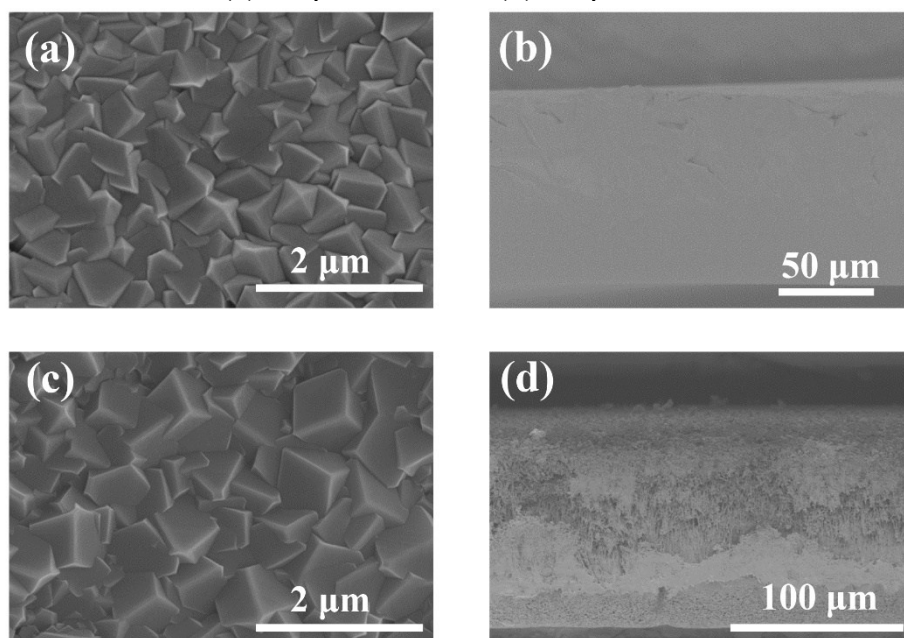
**Figure S6.**  $N_2$  sorption isotherms at 77 K of (a) ZIF-8, (b) pSZ-4%, (c) pSZ-8%, (d) pSZ-11% and (e) pSZ-14%.



**Figure S7.** The proton conductivity of SZ membranes at different temperatures.

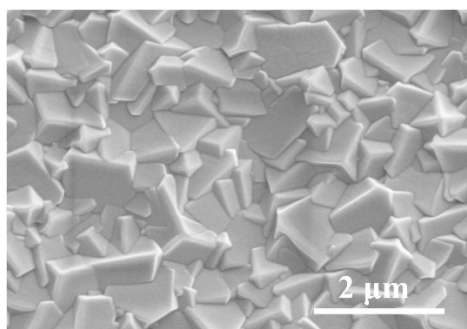


**Figure S8.** The TOF-MS of (a) the pSZ-11% and (b) the pSZ-8% membrane.



**Figure S9.** The surface and the cross-section SEM images of (a-b) pSZ-11%-SPEEK and (c-d) pSZ-11%-PVDF, respectively.





**Figure S10.** The SEM image of the surface of the pSZ-11% after DMFC performance test.

### Supporting table

**Table S1.** The proton conductivity, methanol permeability and selectivity of pSZ-11%, SPEEK and Nafion at 65°C.

	$\sigma$ (S cm <sup>-1</sup> )	P (cm <sup>2</sup> s <sup>-1</sup> )	Selectivity ( $\sigma/P$ , S s cm <sup>-3</sup> )
pSZ-11%	$1.72 \times 10^{-2}$	$6.72 \times 10^{-9}$	$2.56 \times 10^6$
SPEEK	$6.38 \times 10^{-2}$	$1.54 \times 10^{-5}$	$4.14 \times 10^3$
Nafion	$1.28 \times 10^{-1}$	$1.27 \times 10^{-5}$	$1.01 \times 10^4$