Supplementary Information

Cross-linked multiblock copoly(arylene ether sulfone) ionomer/nano-ZrO_2 composite anion exchange membranes for alkaline fuel cells

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I. Figures

Fig. S1 ^{1}H NMR spectra of the hydroxyl-terminated hydrophilic oligomer X12.

Fig. S2 ^{1}H NMR spectra of the fluorine-terminated hydrophobic oligomer Y10.

Fig. S3 ^{1}H NMR spectra of MCPAES and BMCPAES.

Fig. S4 SEM cross section images of CLQCPAES and CLQCPAES/nano-ZrO_2 composite membranes: (a,a') CLQCPAES, (b,b') CLQCPAES/2.5%ZrO_2, (c,c') CLQCPAES/5%ZrO_2, (d,d') CLQCPAES/7.5%ZrO_2, and (e,e') CLQCPAES/10%ZrO_2.

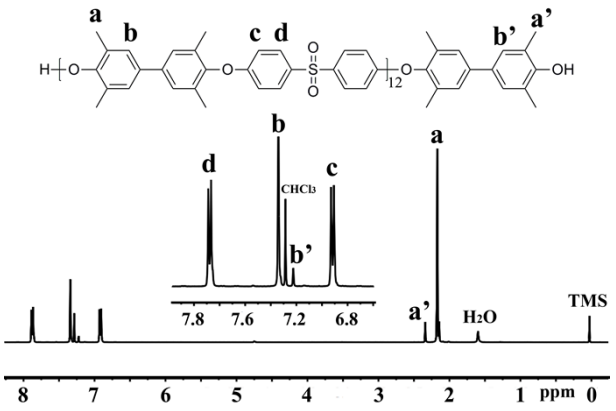

Fig. S1 ^{1}H NMR spectra of the hydroxyl-terminated hydrophilic oligomer X12 (The average oligomer length, which is calculated from the integral ratio of protons **a'** in the hydroxyl terminal biphenyl units to those protons **a** in biphenyl units belonging to repeat units, is 12.0).

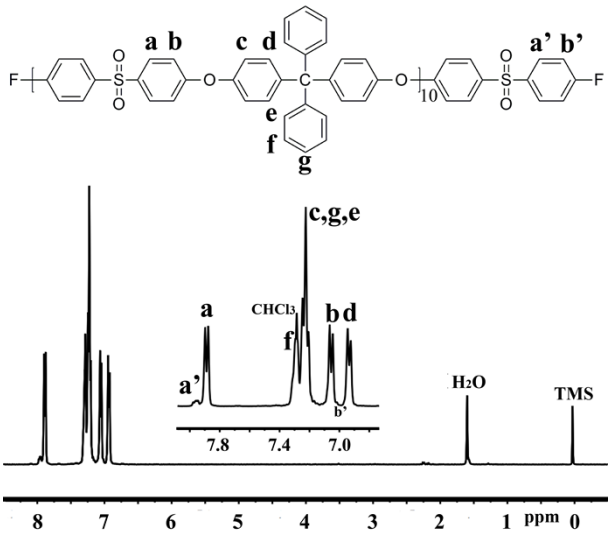

Fig. S2 ^{1}H NMR spectra of the fluorine-terminated hydrophobic oligomer Y10 (The average oligomer length, which is calculated from the integral ratio of protons **a'** in the fluorine-terminal biphenyl sulfone units to those protons **a** in biphenyl sulfone units belonging to repeat units, is 10.0).

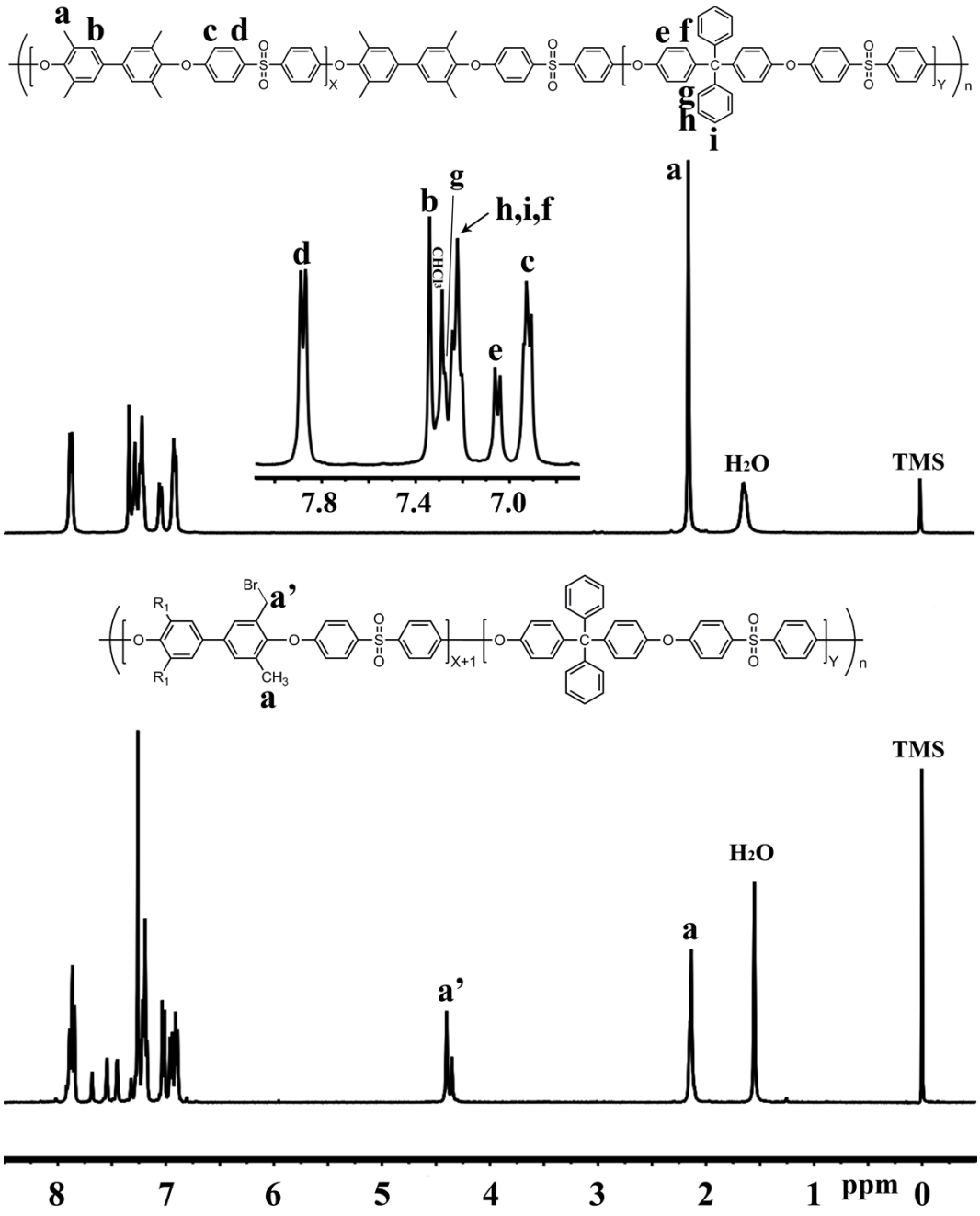

Fig. S3 ^{1}H NMR spectra of MCPAES and BMCPAES (The benzylmethyl bromide groups per repeating unit (DBM), which is calculated by the equation of DBM=$12H_{a'}/(3H_{a'}+2H_{a})$, is 1.87).

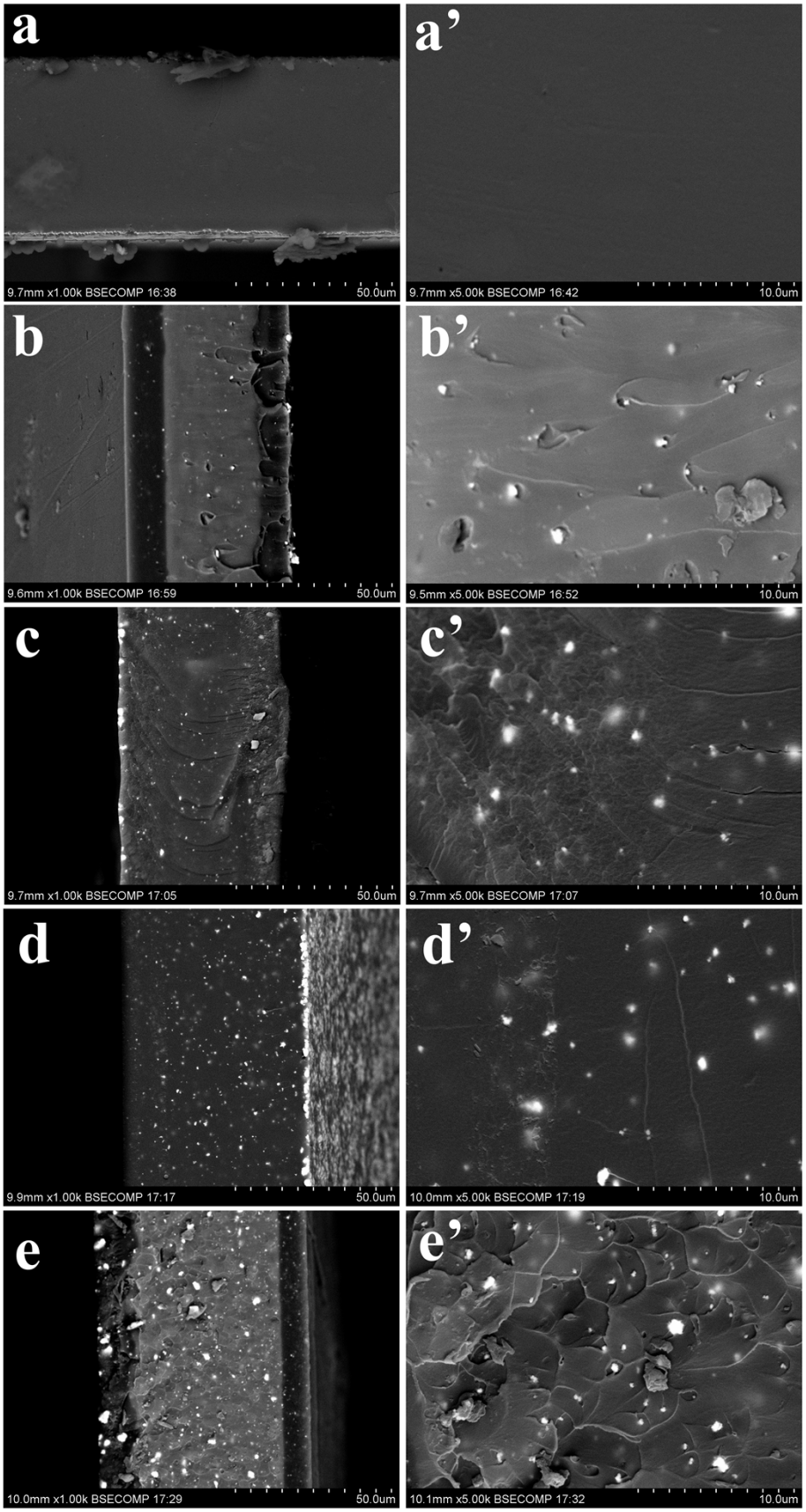

Fig. S4 SEM cross section images of CLQCPAES and CLQCPAES/nano-ZrO_2 composite membranes: (a,a') CLQCPAES, (b,b') CLQCPAES/2.5%ZrO_2, (c,c') CLQCPAES/5%ZrO_2, (d,d') CLQCPAES/7.5%ZrO_2, and (e,e') CLQCPAES/10%ZrO_2.

II. Experimental section

^{1}H NMR spectra were obtained on a Bruker AVANCE 400S with $CHCl_3$ as the solvent and tetramethylsilane (TMS) as the standard. Scanning electron microscope (SEM) cross section images of the CLQCPAES and CLQCPAES/nano-ZrO_2 composite membranes were taken using a Hitachi S-3700N in BSECOMP mode.