Electronic Supplementary Material (ESI) for RSC Advances.

Effect of pore-directing agents and silanol groups in mesoporous silica nanoparticles as Nafion fillers on the performance of DMFCs

Ciao-Wei Yang[a], Kuei-Hsien Chen[b], and Soofin Cheng[a, *]

[a]Department of Chemistry, National Taiwan University, Taipei 10617, Taiwan

[b]Institute of Atomic & Molecular Sciences, Academia Sinica, Taipei 10617, Taiwan

Supporting information

Table S1 The average thicknesses (μm) from five points of various membranes after drying at room temperature overnight.

Membrane	Ave Thickness (μm)	Membrane	Ave Thickness (μm)
N117	198±2	**recasting**	201±10
1%-Ex-SBA-15n	200±7	**1%-S-SBA-15n**	188±5
2.5%-Ex-SBA-15n	201±5	**2.5%-S-SBA-15n**	199±2
5%-Ex-SBA-15n	211±6	**5%-S-SBA-15n**	213±9
10%-Ex-SBA-15n	212±7	**10%-S-SBA-15n**	223±7
15%-Ex-SBA-15n	228±11	**15%-S-SBA-15n**	224±6
20%-Ex-SBA-15n	236±12	**20%-S-SBA-15n**	231±5
1%-Ex-MSN	177±4	**1%-S-MSN**	186±4
2.5%-Ex-MSN	199±6	**2.5%-S-MSN**	197±9
5%-Ex-MSN	195±14	**5%-S-MSN**	210±8
10%-Ex-MSN	210±4	**10%-S-MSN**	216±4

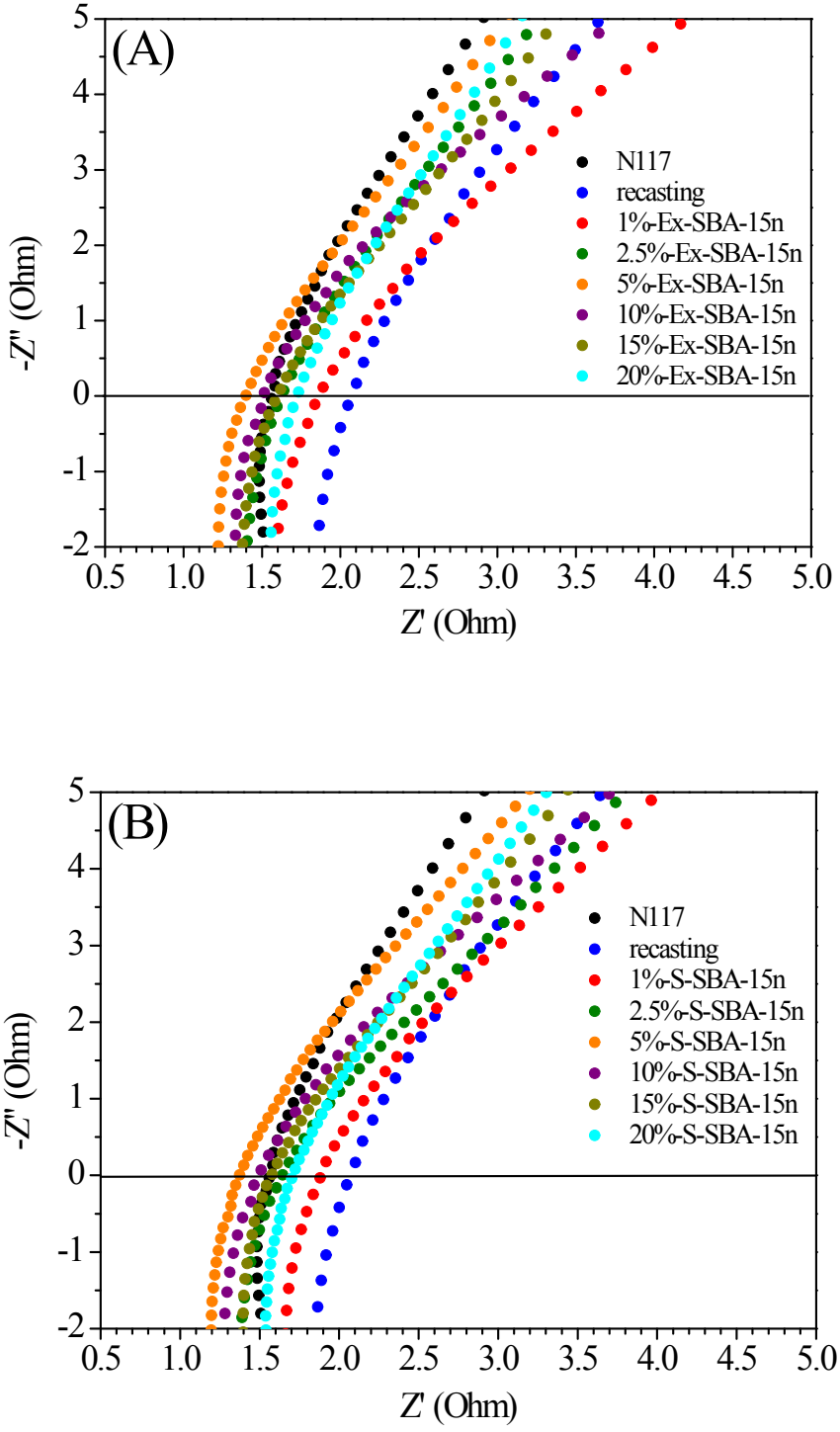

Fig. S1 Nyquist plot of (A) x%-Ex-SBA-15n and (B) x%-S-SBA-15 with different loadings in comparison to those with Nafion®117 and recasting Nafion membranes at 60 °C and 90% percentage humidity.

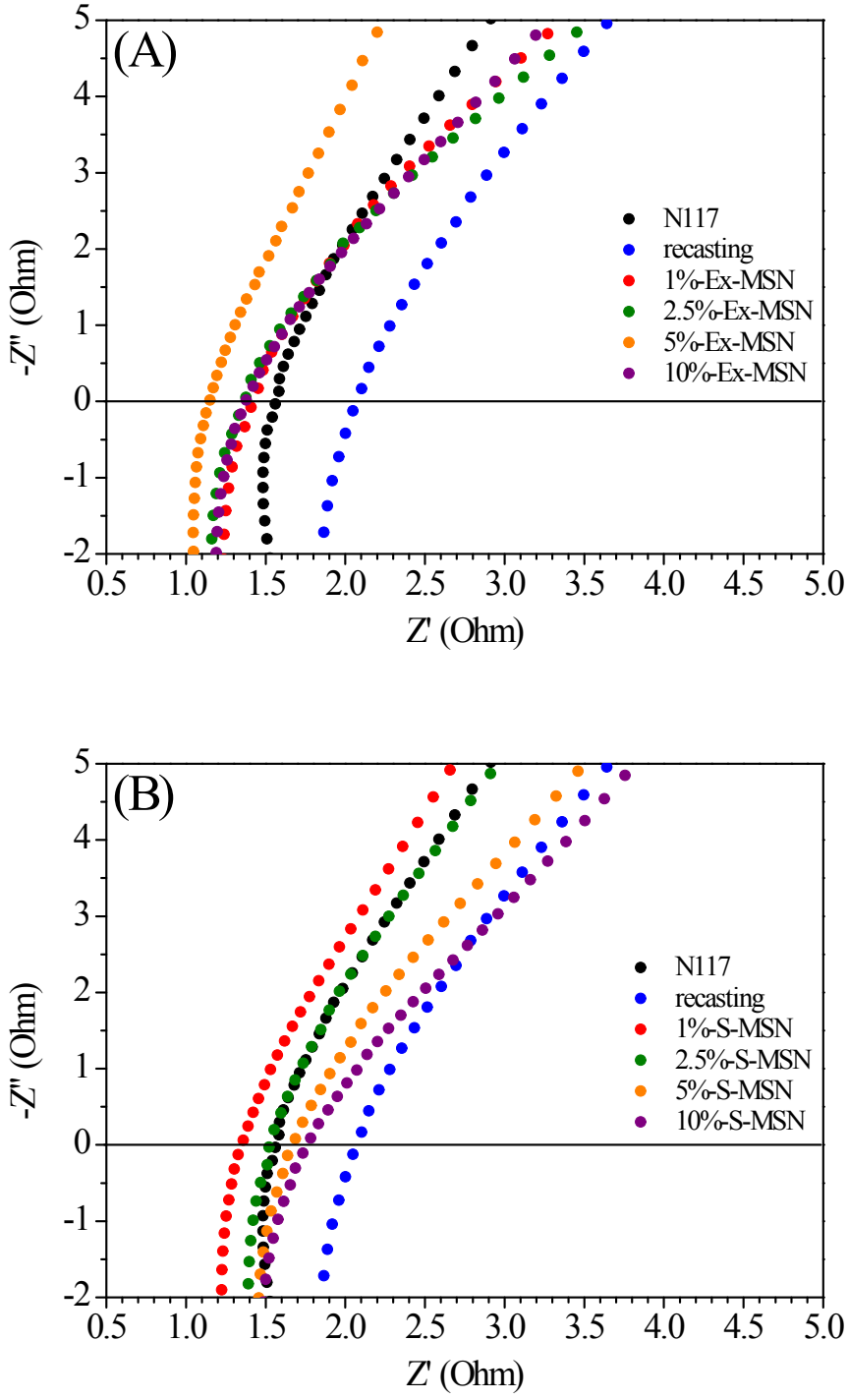

Fig. S2 Nyquist plot of (A) x%-Ex-MSN and (B) x%-S-MSN with different loadings in comparison to those with Nafion®117 and recasting Nafion membranes at 60 °C and 90% percentage humidity.

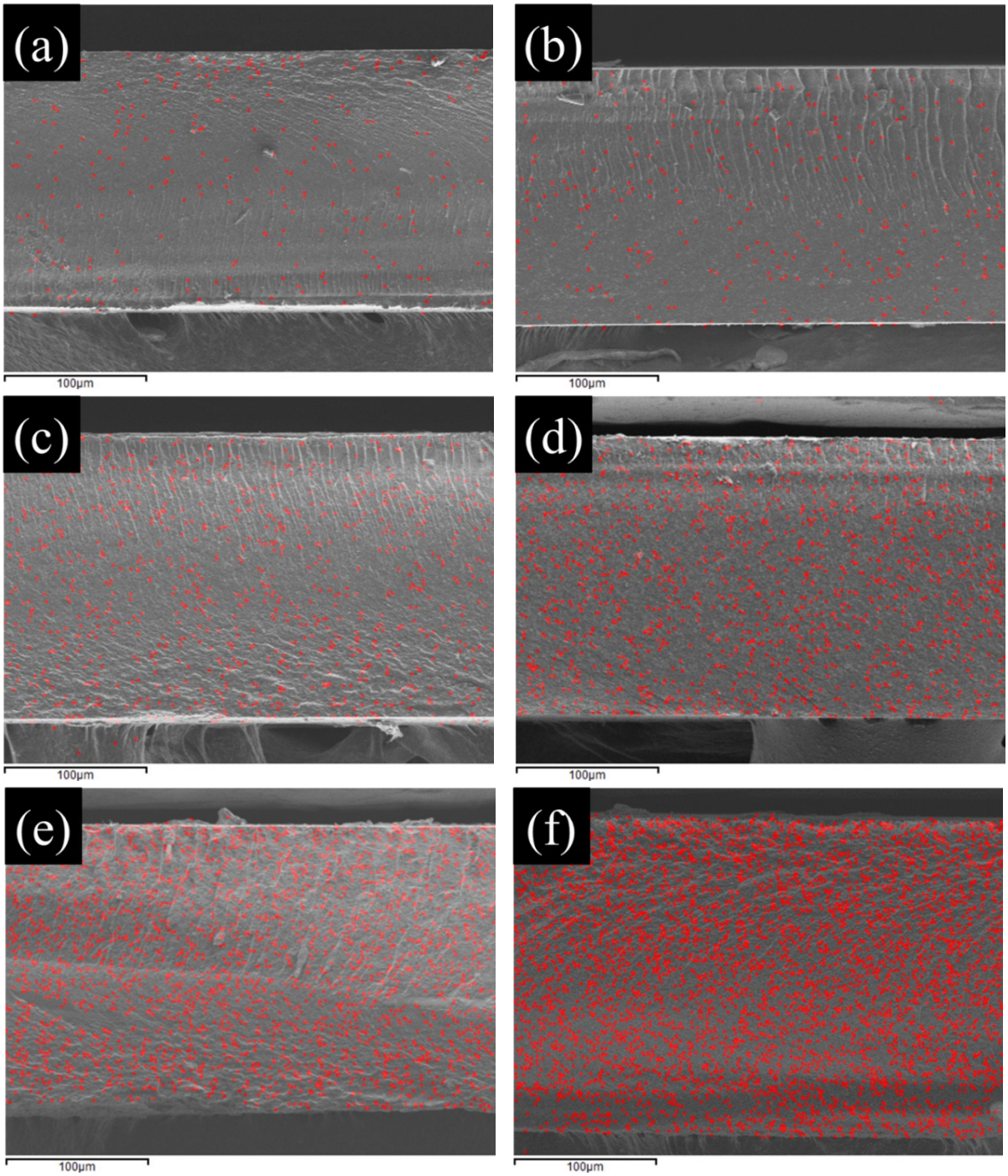

Fig. S3 Mapping photographs of silicon in the cross-sections of composite membranes with different loadings of Ex-SBA-15n (a) 1%, (b) 2.5%, (c) 5%, (d) 10%, (e) 15% and (f) 20%.

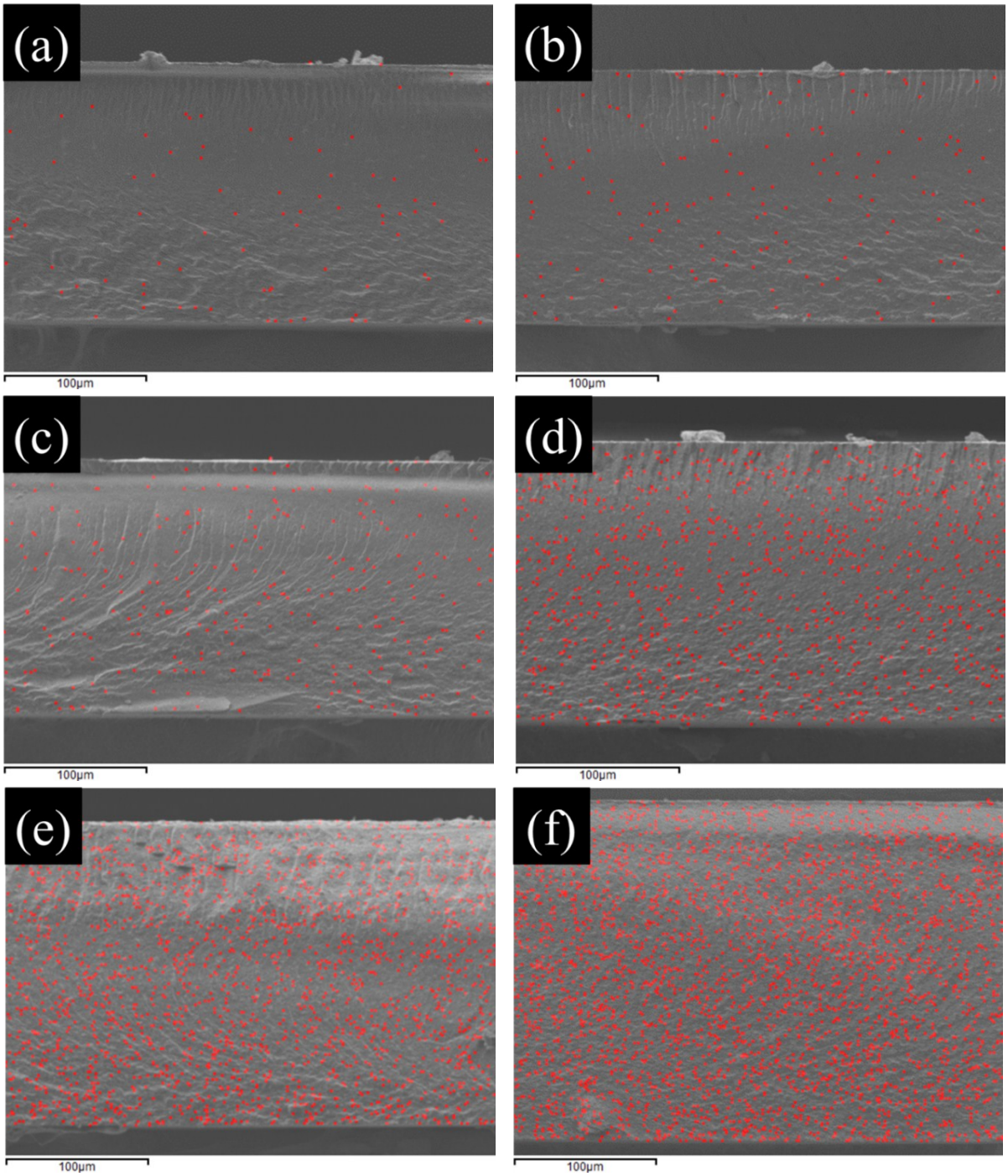

Fig. S4 Mapping photographs of silicon in the cross-sections of composite membranes with different loadings of S-SBA-15n (a)1%, (b) 2.5%, (c) 5%, (d) 10%, (e) 15% and (f) 20%.

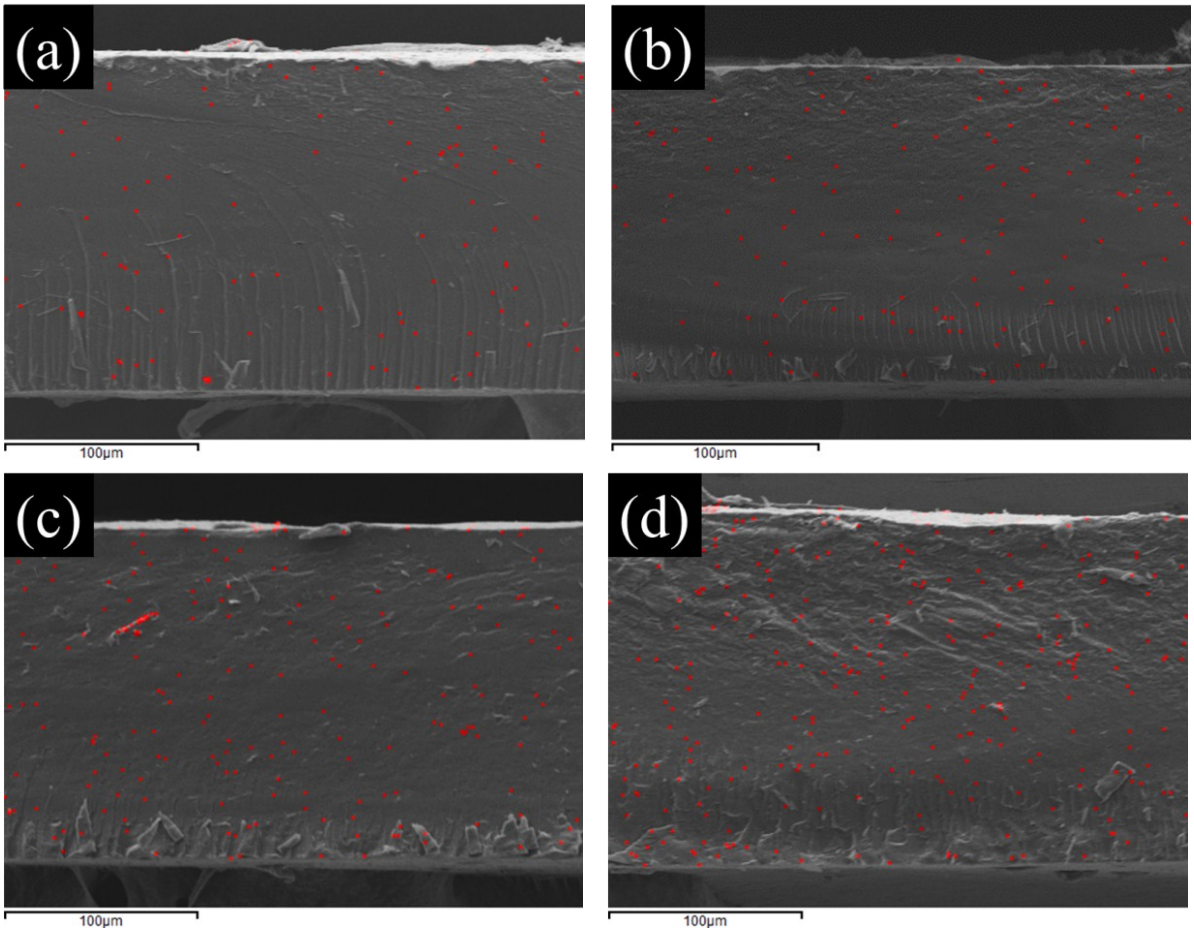

Fig. S5 Mapping photographs of silicon in the cross-sections of composite membranes with different loadings of Ex-MSN (a) 1%, (b) 2.5%, (c) 5% and (d) 10%

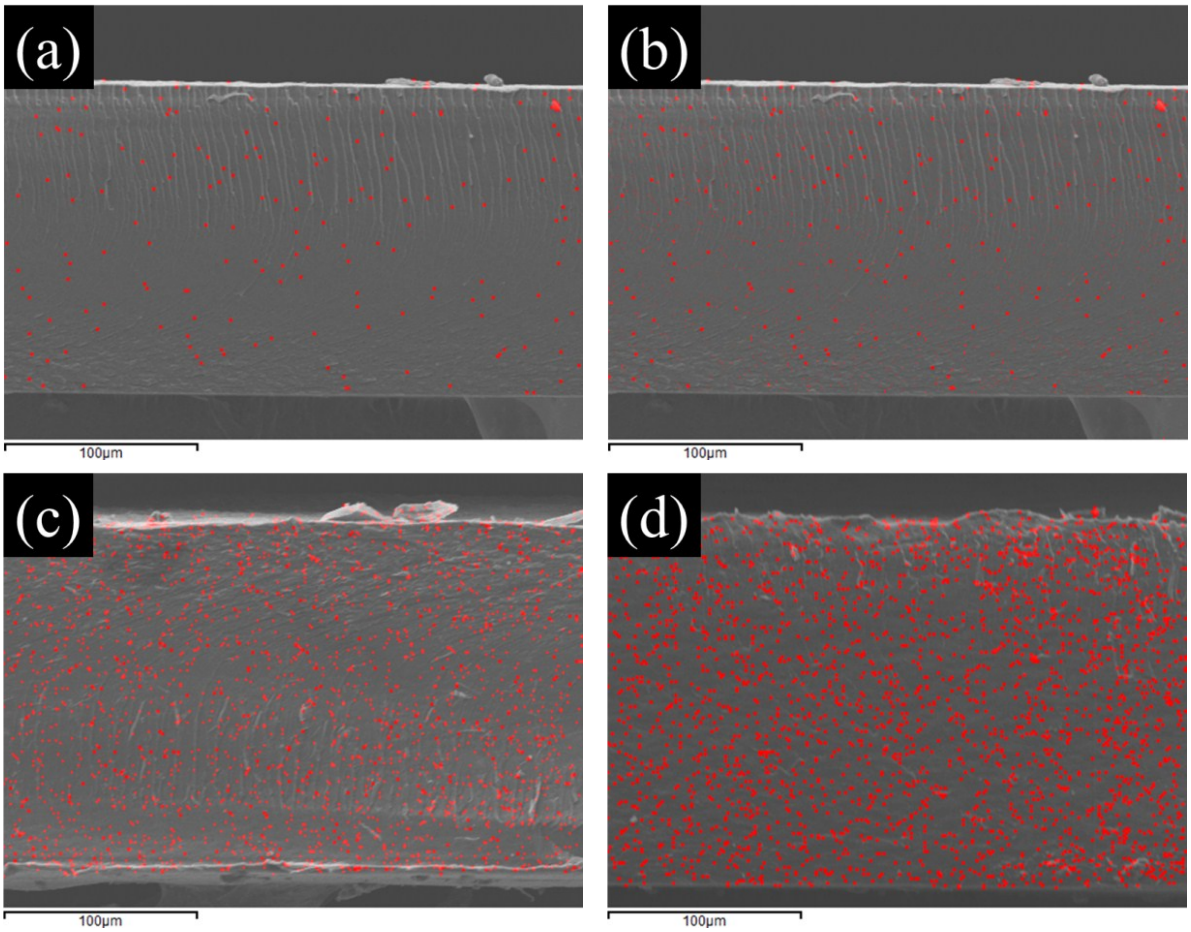

Fig. S6 Mapping photographs of silicon in the cross-sections of composite membranes with different loadings of S-MSN (a) 1%, (b) 2.5%, (c) 5% and (d) 10%.

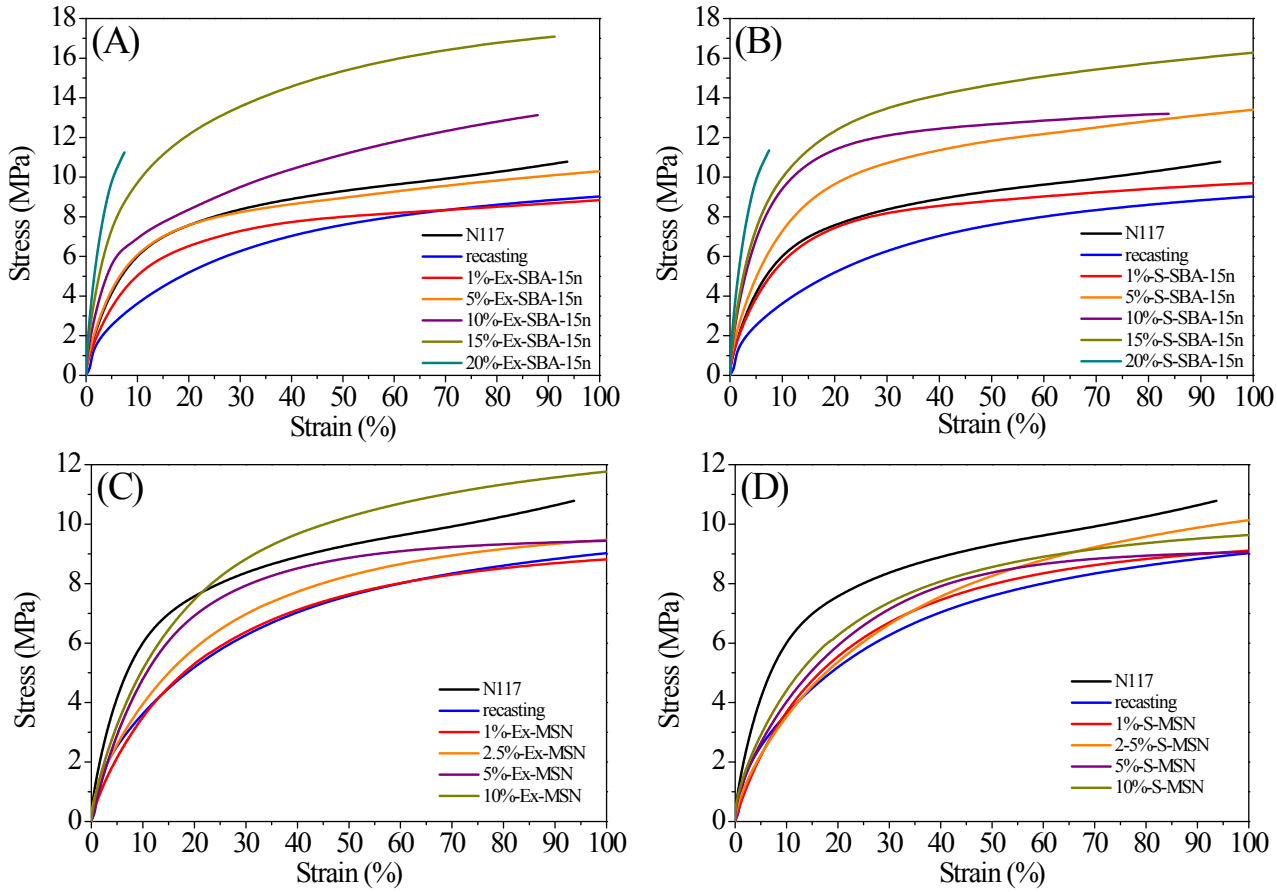

Fig. S7 Stress–strain curves of Nafion membranes with different loadings of (A) Ex-SBA-15n, (B) S-SBA-15n, (C) Ex-MSN and (D) S-MSN in comparison to those of Nafion® 117 and recast Nafion membranes.

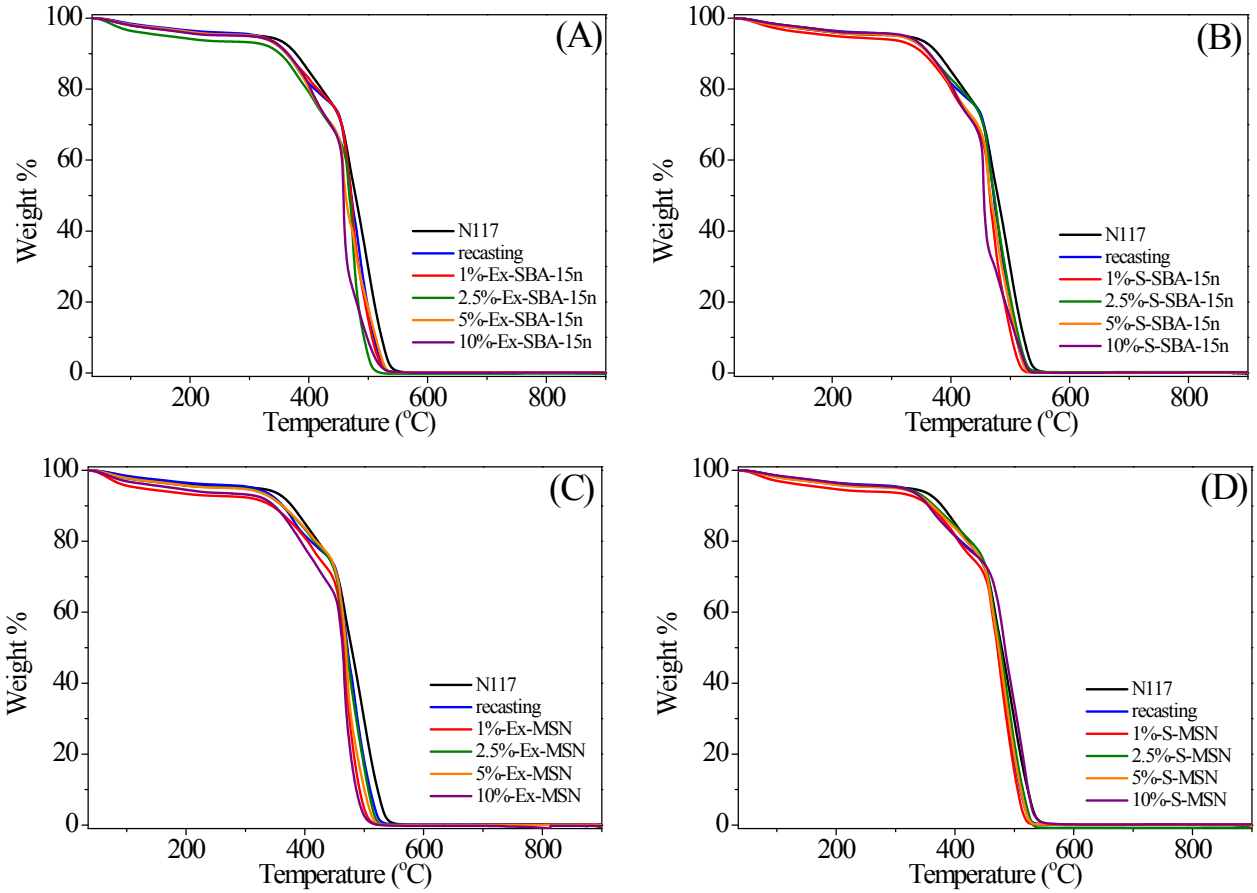

Fig. S8 TGA curves of Nafion membranes with different loadings of (A) Ex-SBA-15n, (B) S-SBA-15n, (C) Ex-MSN and (D) S-MSN in comparison to those of Nafion® 117 and recast Nafion membranes.

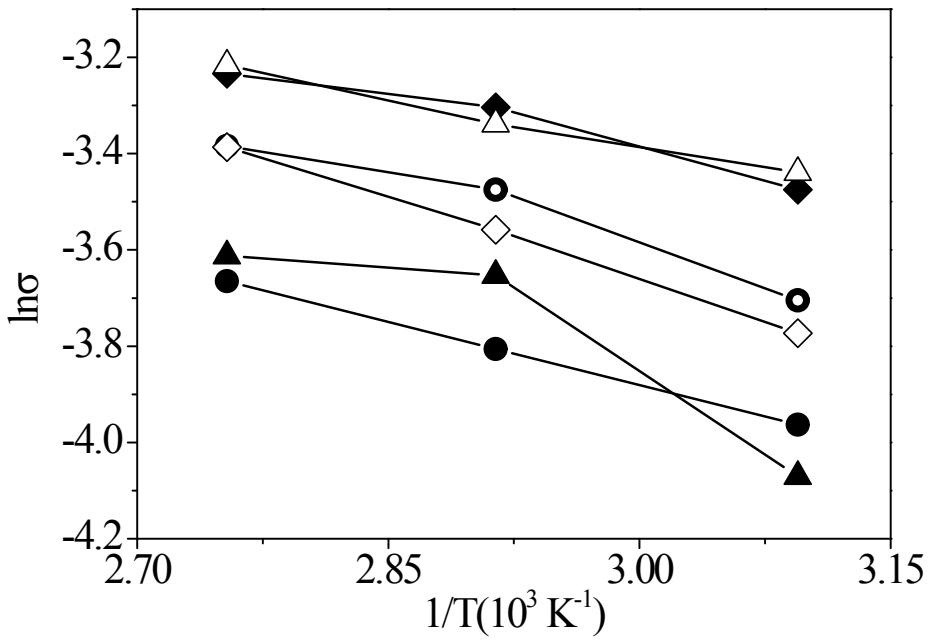

Fig. S9 Temperature dependence of the proton conductivities for Nafion 117 (∾), recasting Nafion membrane (ஜ), 5%-Ex-SBA-15n (◇), 5%-S-SBA-15n (◆), 5%-Ex-MSN (❒) and 5%-S-MSN (▲) composite membranes.