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Supplementary information

Hollow Doughnut Shape Mesoporous Silica Nanoparticles for Reduction of the Thermal Expansion Coefficient of Poly(ether sulfone) Films

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Table S1. Peak position in FT-IR and FT-Raman

Peaks	Wavenumber (cm^{-1})	Raman Shift (cm^{-1})	Materials
Si-O-Si	1057	890, 593	hd-MSN and hd-MSN-NH_2
Si-C		819	hd-MSN-NH_2
N-H	1608		hd-MSN-NH_2
C-H	2882, 2942, 2976		hd-MSN-NH_2
N-H	3332		hd-MSN-NH_2
Si-OH	3402		hd-MSN
C-S	716	630, 662, 731	PES and sPES
C-H phenyl	1010	788	PES and sPES
C-N vibration	1071		PES and sPES
O=S=O symmetric stretch	1104, 1149	1071, 1105	PES and sPES
C-O-C asymmetric stretch	1235	1146	PES and sPES
O=S=O asymmetric stretch	1295, 1322	1292	PES and sPES
C=C in benzene ring stretch	1485, 1578	1599, 1577	PES and sPES
C-H stretch	3066, 3098	1201	PES and sPES
SO_3H	1026		sPES
O-H	3589		sPES
C-N		1540	Sulfonamide bond
N-H	1671	1677	Sulfonamide bond

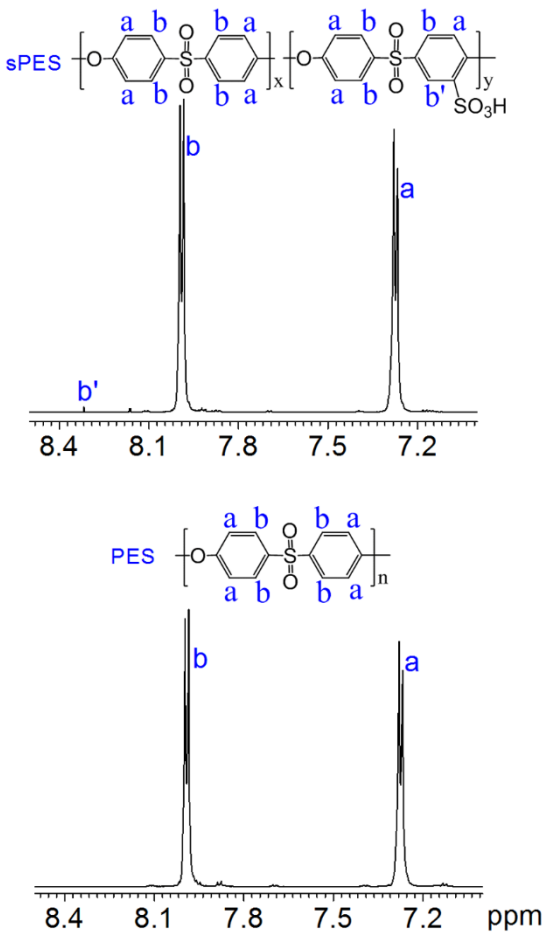

Fig. S1 ^{1}H NMR spectra of PES and sPES.