Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary information

Table 3 performs some additional parameters used to process the data comparing the samples.

The coefficients C_i (i = 1 … 4) in the structure factor of the model function (1), as it was mentioned above, are the values of correlations of scattering objects (channels) at several distances. 3-4 distances are needed to fit the scattering curves. The coefficient C_2 has positive values and indicates the average number of channels correlating with the selected channel at the distance R_2. C_1 (negative values) shows inability of individual channels to settle at a distance R_1. Neighbour channels are separated by the polymer matrix, they cannot be situated too close to each other. C_3, also negative, demonstrates existing of negative correlations of channels at larger distance R_3 due to longer-range order in membranes. In some cases 3 terms in structure factor were enough, but generally we needed to introduce the 4th term with positive coefficient C_4 showing correlations of channel positions at the distance R_4. In the case this 4th term was used in fitting, it means correlations of individual channels at larger distances, or correlations of bundles (pairs) of channel.

The number of fitting parameters is too large, making the mathematical solution not evident. But we used some restrictive rules for the parameters to get the unique solution of physical task: $1 \le n < 3$; C_1, $C_3 < 0$; C_2, $C_4 > 0$; 1 nm < $R_1 < R_2 < R_3 < R_4$ < 100 nm.

Table 3. Parameters of samples measured by SANS.

Sample	Number of layers		Total thickness, mm		Neutron transmission	
	BNC	PNPI	BNC	PNPI	BNC	PNPI
SSC-1 dry	8	14	1.56	2.56	0.803	0.717
SSC-2 dry	12	24	1.26	3.19	0.855	0.649
SSC-3 dry	8	7	1.66	1.64	0.806	0.818
SSC-4 dry	10	20	1.28	2.95	0.875	0.745
SSC-1 H	8	14	2.06	3.18	0.497	0.354
SSC-2 H	12	24	1.48	3.85	0.634	0.342
SSC-3 H	8	7	1.82	1.99	0.552	0.566
SSC-4 H	10	20	1.44	3.25	0.727	0.508

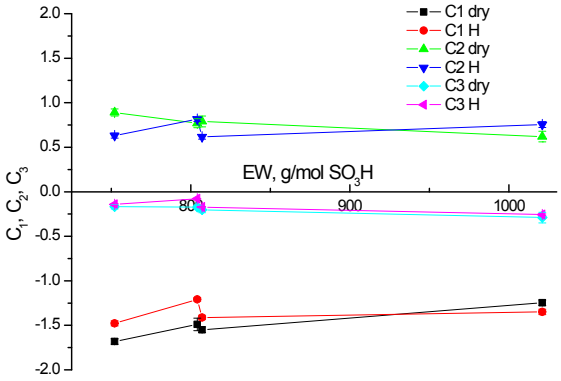

Fig. 9. Correlation coefficients C_1, C_2, C_3 for dry and wet samples vs. equivalent weight. C_1 – repulsive correlation, C_2 – attractive correlation, C_3 – weak/no correlation.

These numbers of parameters and conditions allowed us to achieve the perfect fitting of the complicated curve profiles.

The values of C_1 … C_3 vs. the equivalent weight of samples are shown in fig. 9.

SANS measurements of SSC samples saturated in D_2O have also been carried out to perform the contrast variation. All samples demonstrated rather low contrast to be compared with dry and H_2O-saturated samples, as it was expected for perfluorinated membranes – scattering cross-section is much lower and ionomer peak is poorly performed, not quite enough for correct fitting. As an example, experimental data points for sample SSC-1 in three conditions are shown in fig. 10.

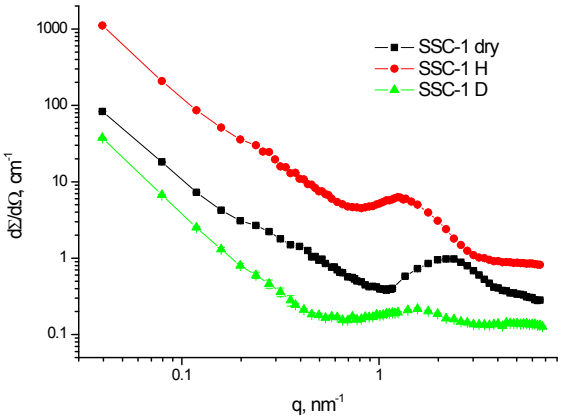

Fig. 10. Scattering cross sections of dry, H_2O-saturated (H) and D_2O-saturated (D) sample SSC-1 vs. momentum transfer.