Electronic Supplementary Material (ESI) for Soft Matter.

Supporting Information

Grafting polysiloxane onto ultrafiltration membranes to optimize surface energy and mitigate fouling

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Table S1 summarizes the elemental compositions of the coating layers on a silicon wafer measured by XPS. Three spots were evaluated for each sample, and the mean values are reported. The uncertainty in the Si/C ratio is the standard deviation of three measurements.

Table S1. Elemental compositions (atomic%) of the coating layers on Si wafer determined using XPS.

Samples	C 1s	O 1s	N 1s	Si 2p	Si/C
PDA	72.13	18.29	7.79	1.78	0.025 ± 0.002
PDA/PSi-1	69.71	17.01	7.55	5.72	0.082 ± 0.001
PDA/PSi-2	65.23	18.67	5.72	10.38	0.159 ± 0.006

The Si/C and N/C ratio can be used to calculate the mass content of the PSi-NH_2 in the coating layer. Assuming there is n_A mole of PSi-NH_2 and n_B mole of PDA in the coating layer, the following equations can be derived:

$$\frac{Si}{C} = \frac{12n_A}{30n_A + 8n_B} \quad \text{(S1)}$$

$$\frac{N}{C} = \frac{2n_A + n_B}{30n_A + 8n_B} \quad \text{(S2)}$$

Each PSi-NH_2 molecule contains 10 Si, 2 N, and 30 C, and each dopamine contains 1 N and 8 C.

Figure S1 also compares the high-resolution peak of Si 2p for a bare Si wafer and those coated with PDA, PDA/PSi-1, and PDA/PSi-2. The wafer exhibits a characteristic peak of element Si (99 eV). On the other hand, all the coated samples do not exhibit the peak of 99 eV because the dense PDA layer (≈18 nm) is thicker than the escape depth of the photoelectrons. Moreover, the PDA/PSi-1 and PDA/PSi-2 show a peak at 102 eV, characteristic to organic Si (e.g. PDMS) confirming the effective deposition of PSi-NH_2 on the PDA layer.[1, 2] Interestingly, the PDA coated sample also shows a small peak at 102 eV, presumably due to contamination of the surface by PDMS.

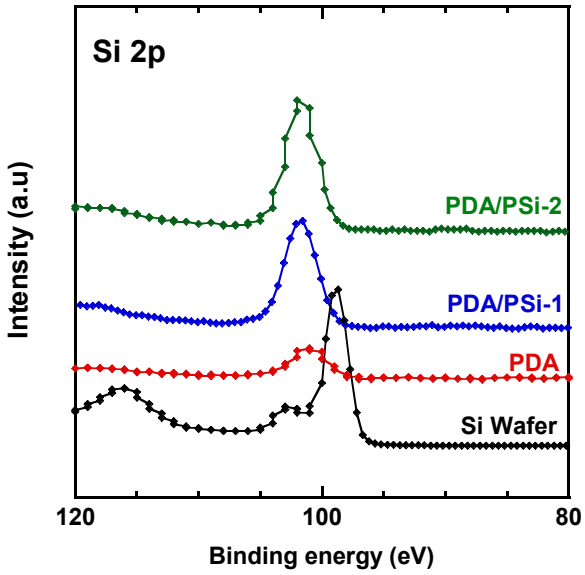

Fig. S1 High-resolution spectra of Si 2p peak for PDA, PDA/PSi-1, and PDA/PSi-2 coating on Si wafer.

Table S2 presents the surface energy (γ, mN/m) along with the dispersive (γ^D) and polar (γ^P) component of the surface energy for three probe liquids (water, glycerol, and diiodomethane) and the membranes. The values of three probe liquids were obtained from literature, while those of membranes samples are calculated using Eqs.1 and 2 in the manuscript.

Table S2. Surface energies of the liquids and membranes.

Sample	γ (mN/m)	γ^P (mN/m)	γ^D (mN/m)
Water[3, 4]	72.8	51.0	21.8
Glycerol[3, 4]	63.4	24.6	38.8
Diiodomethane[3, 4]	50.8	3.6	47.2
PSf	42.3	25.8	16.5
PSf/PDA	51.6	28.8	22.8
PSf/PDA/PSi-2	20.4	10.3	10.1
PSf/PDA/PSi-4	19.1	6.8	12.3
PSf/PDA/PSi-6	17.3	5.1	12.2

Figure S2 presents the fouling characterization for PSf/PDA, PSf/PDA/PSi-2, PSf/PDA/PSi-4, and PSf/PDA/PSi-6 when challenged using 2 g/L sodium alginate solution. For PSf/PDA/PSi-6, the J_{TH} value cannot be determined because the TMP was above the limit of the apparatus to reach high water flux required. Interestingly, although PSf/PDA/PSi-2 and PSf/PDA/PSi-4 show lower pure water permeance than PSf/PDA (750 LMH/bar), they show J_C and J_{TH} values comparable to those of PSf/PDA. This also suggests that the PSi-NH_2 grafting improves the antifouling

performance because membranes with lower pure water permeance are expected to exhibit lower J_C and J_{TH} values.

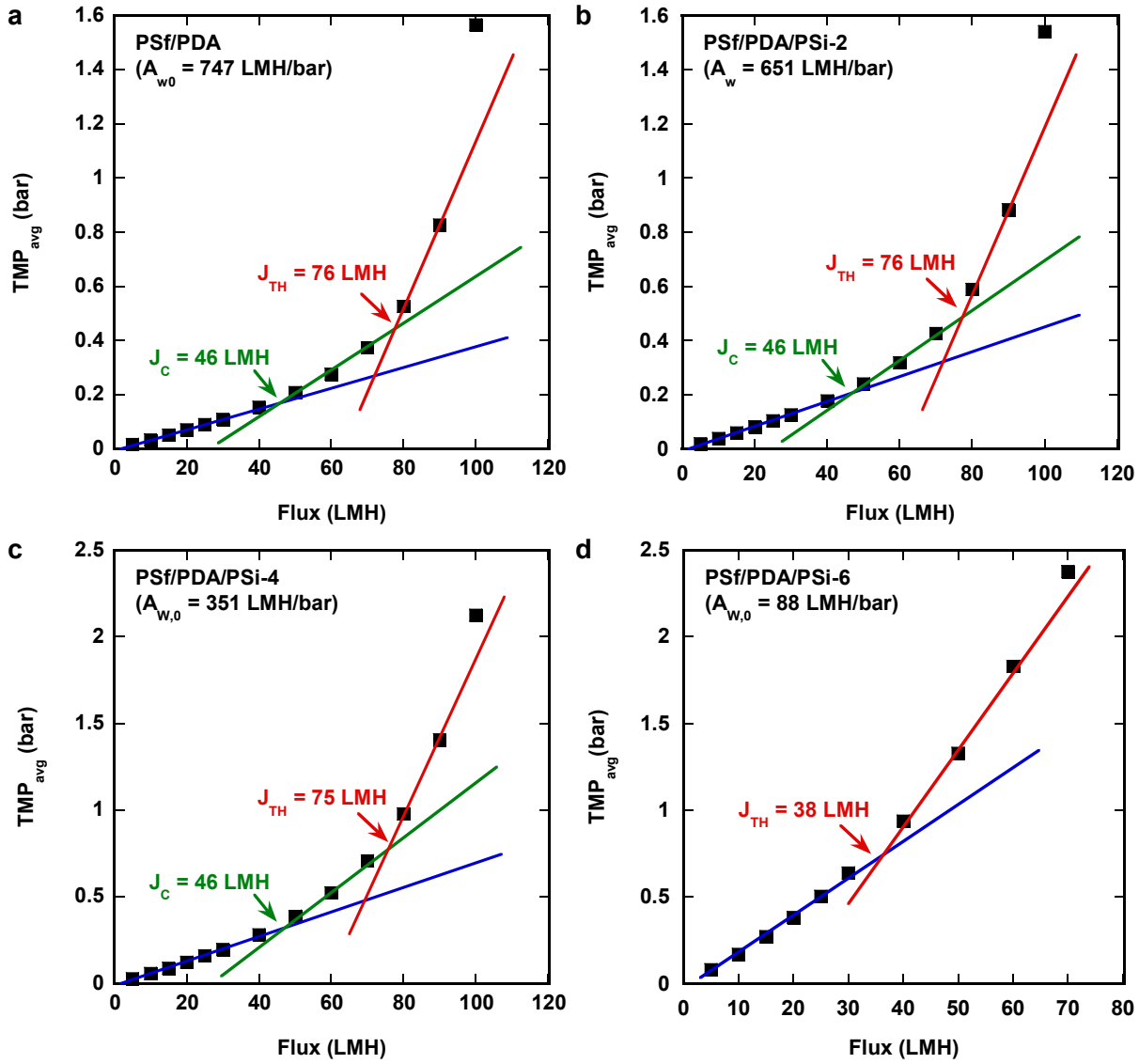

Fig. S2 TMP_{avg} at each permeate flux for (a) PSf/PDA, (b) PSf/PDA/PSi-2, (c) PSf/PDA/PSi-4, and (d) PSf/PDA/PSi-6 when challenged with 2 g/L sodium alginate at ≈ 23°C with *Re* ≈ 1500 and a crossflow velocity of 0.38 m/s.

References

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