Supporting Information for

Interconnected PVDF-CTFE hydrophobic membranes for MD desalination: Effect of PEGs on phase inversion process

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Experimental

1. Surface pore structure study by image-pro-plus 6.0

During SEM observation, surface topography would significantly affect the brightness in SEM images. Pore edges were highlighted by the secondary electrons, so the deeper the position the darker as it present in SEM images and vice versa. So pores in membrane surface can be recognized by analysis of the grayscale values of the individual pixels based on this understanding. Based on the 10,000× magnified SEM micrographs, the pores in membrane surface was marked in blue as shown in Fig. S2 and Fig. S3 by the image-pro-plus 6.0 software. Then the pore size, SEM roughness index, roundness, area of each pore can be measured automatically. The minimum, maximum, and average pore size were recorded to represent the pore size in membrane surface. The area of all pores and the overall surface can also be calculated, and the area ratio of pores and the whole surface was defined as surface porosity. The standard deviation of grayscale values was used to present the roughness of membrane, which was defined as the SEM roughness index [1]. The mean roundness of surface pores indicating the pore shape was also used here to represent the pore surface structure together with the pore size, porosity, and membrane morphology.

2. Membrane surface morphology study by image J

Grayscale values of the individual pixels in SEM micrographs could also indicate the state of membrane surface and they were obtained by image J software [2, 3]. Then a three dimension graphs was plotted by the intensities of pixels in a grayscale, which can present the 3-D morphology of membrane surface. The number of pixels with same grayscale value was counted and plotted in a histogram. The grayscale distribution can be easily found in the histograms, and it can also indicate the membrane roughness.

3. Surface energy calculation

Based on two of the three contact angles obtained by different liquid, the surface free energy can be calculated by Owens method [4] as follows:

$$\gamma_L(1+\cos\theta) = 2(\gamma_S^d \gamma_L^d)^{1/2} + 2(\gamma_S^p \gamma_L^p)^{1/2} \tag{1}$$

where, γ_S, γ_L, γ_S^d, γ_S^p, γ_L^d, γ_L^p are the surface free energy of the solid and liquid, dispersion force term and polar force term of the solid, dispersion force term and polar force term of the liquid, respectively. γ_L, γ_L^d, γ_L^p of the liquid was shown in Table S1, and the θ was the contact angle. The surface free energy then can be calculated by the matlab 2014b software. Three surface free energy data can be obtained and the average data was reported, along with the standard deviation.

Table and figures

Table S1 Surface energy and polarity nature of the reagents for CA measurement.

Reagent	γ_L^p	γ_L^d	γ_L	γ_L^p/γ_L^d	Polarity
Water	51	21.8	72.8	2.36	Polar
Glycerol	26.4	37	63.4	0.71	Polar
Diiodomethane	2.3	48.5	50.8	0.05	Non-polar

Note: *γ_L is the surface energy of the liquid, γ_L^d and γ_L^p represent the dispersion force term and polar force term of the liquid, respectively.*

Figure S1 3-D graphs and histograms of the grayscale value of each pixels of SEM micrographs of membrane prepared by PEG with different molecular weight.

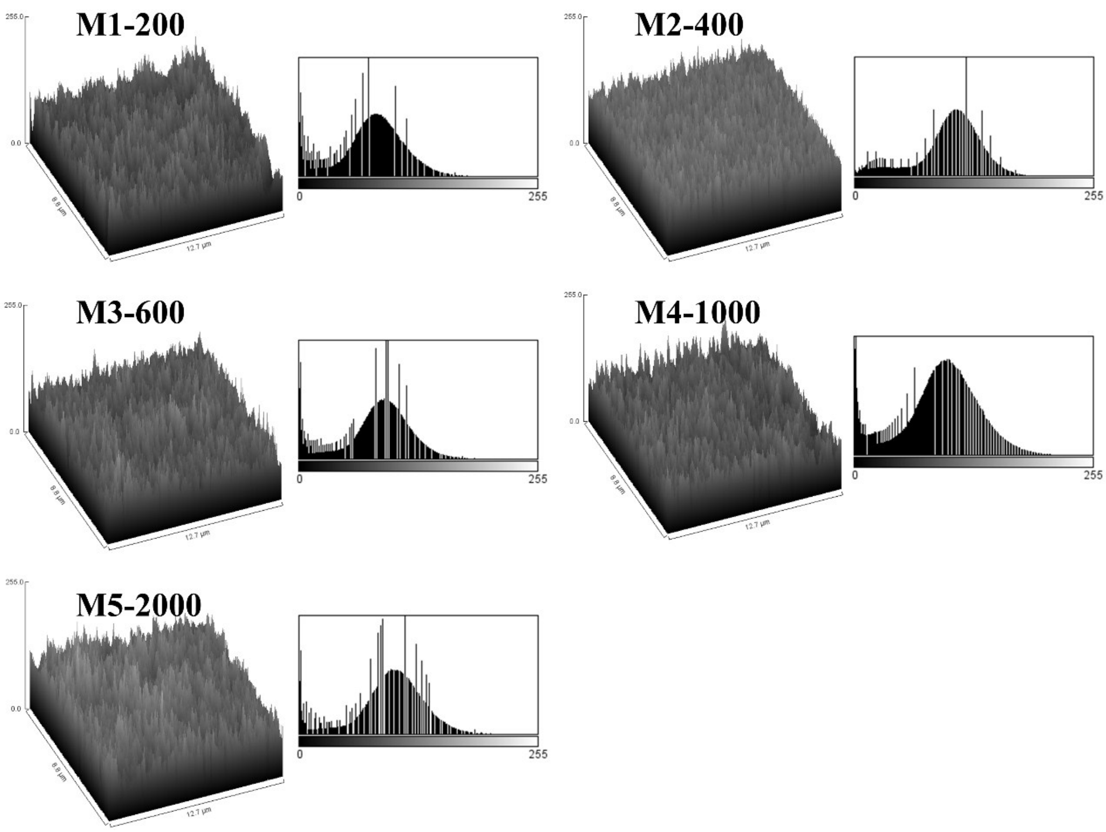


Figure S2 SEM micrographs of membrane prepared by PEGs with different molecularweight for image analysis.

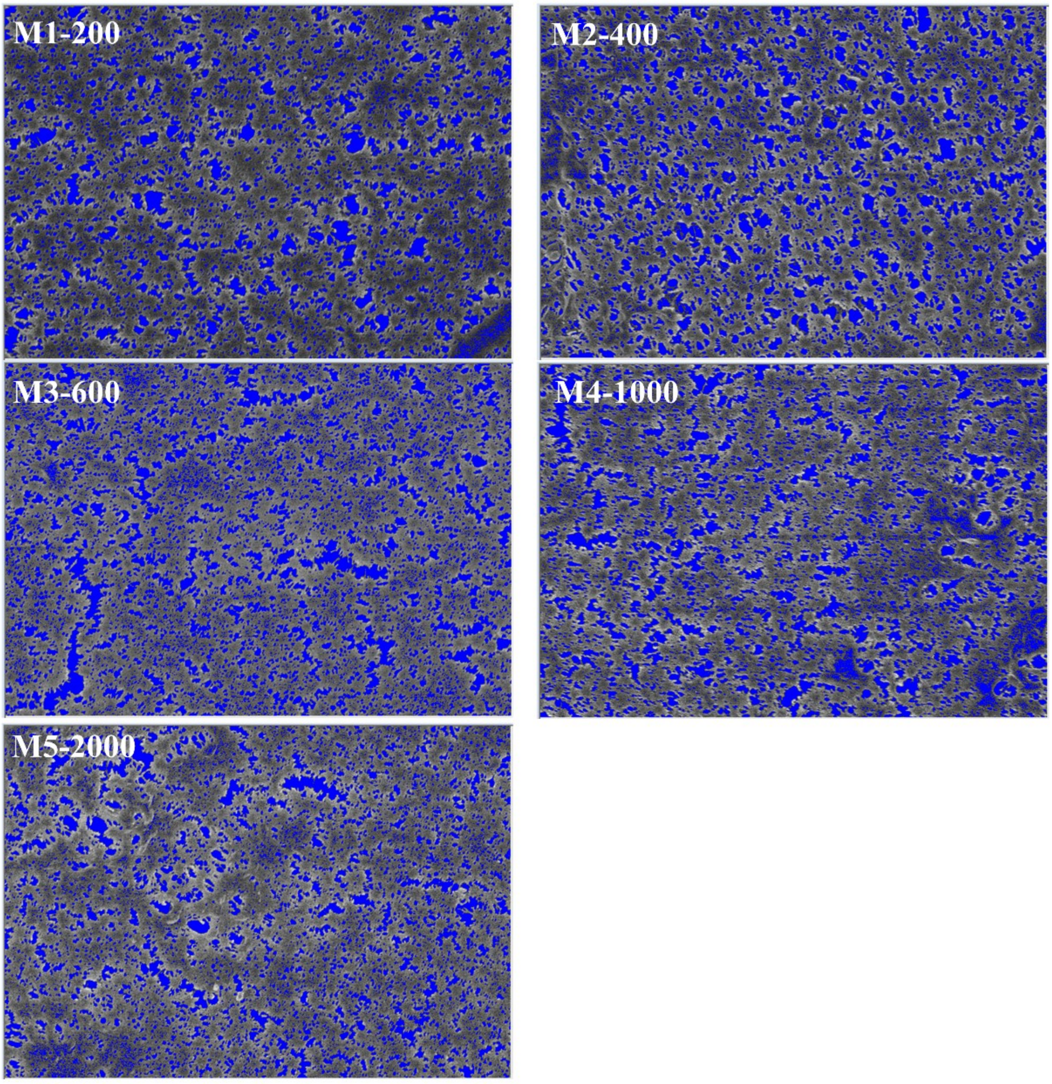
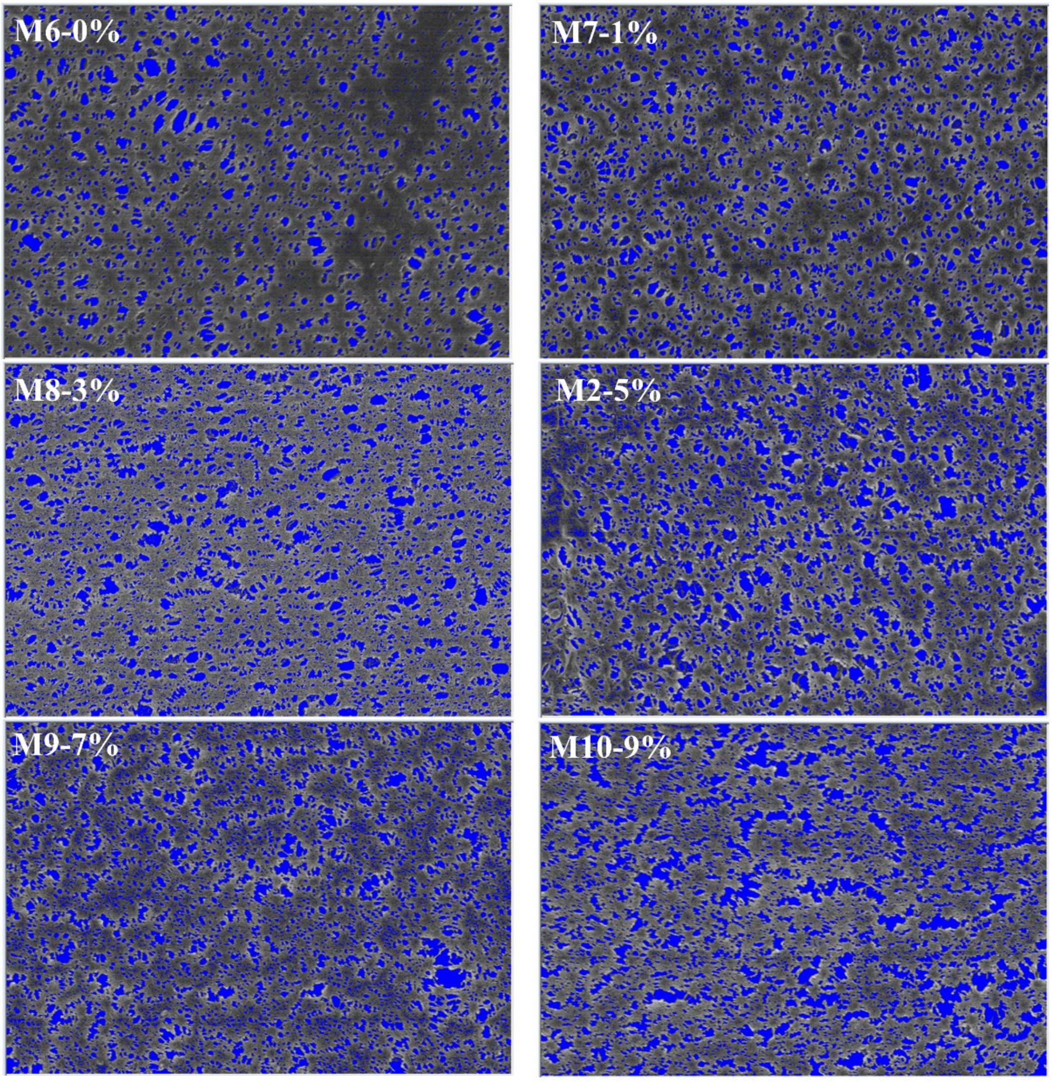


Figure S3 SEM micrographs of membrane prepared by PEG with different dosage for image analysis.



References

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