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Sulfonated Polyetherimide and Its Membranes

Li Qiang SHEN, Zhi Kang XU*, You Yi XU

Institute of Polymer Science, Zhejiang University, Hangzhou 310027

Abstract: Polyetherimide (PEI) was sulfonated by chlorosulfonic acid for the first time. The sulfonated products were characterized by FT-IR, DSC, ion exchange capacity and water sorption measurement. The hydrophilicity of PEI was improved by the sulfonation. The PEI was blended with the sodium salt form of sulfonated PEI (SPEI) to prepare microporous membranes. The morphologies of the membranes were studied with Scanning Electron Microscope (SEM).

Keywords: Polyetherimide, sulfonation, membrane.

Membrane fouling is a main drawback in the use of ultrafiltration membranes. In order to reduce membrane fouling, much research work on hydrophilization of hydrophobic ultrafiltration membrane materials has been carried on[1,2]. In this study, polyetherimide (PEI) was sulfonated for the first time in order to get a hydrophilic membrane material.

Polyetherimide, Ultem® 1000, obtained from General Electric, Co., was sulfonated by chlorosulfonic acid (CSA). After reaction, the sulfonated polyetherimide (SPEI) was soaked in 0.1 mol/L aqueous NaOH solution to convert the product into sodium salt. The SPEI was characterized on a Bruker Vector 22 FT-IR. The Tg of the SPEI was measured using a Peking-Elmer Pyris 1 DSC with a heating rate of 10°C /min. The degree of sulfonation of the product was determined by ion exchange capacity (IEC) measurement.

Table 1 Sulfonation of PEI by chlorosulfonic acid (30°C in 1, 2-dichloroethane)

Reactant mole ratio: CSA/ PEI repeat unit	Reaction time (h)	IEC (m mol/g)	Water sorption (sodium salt form)	Tg (°C)
0	0	0	0	217
0.6	2	2.51	50 %	243
1.2	2	2.60	59 %	232
1.8	2	2.81	Soluble in water	262

The IR spectra of the sulfonated products show absorption peaks at 1028 and 948 cm^{-1}, which confirms the introduction of sulfonate group into PEI backbone[1]. **Table 1** shows the properties of the SPEIs. From the water sorption data, it can be concluded that the hydrophilicity of PEI was improved by the incorporation of sulfonate group. In

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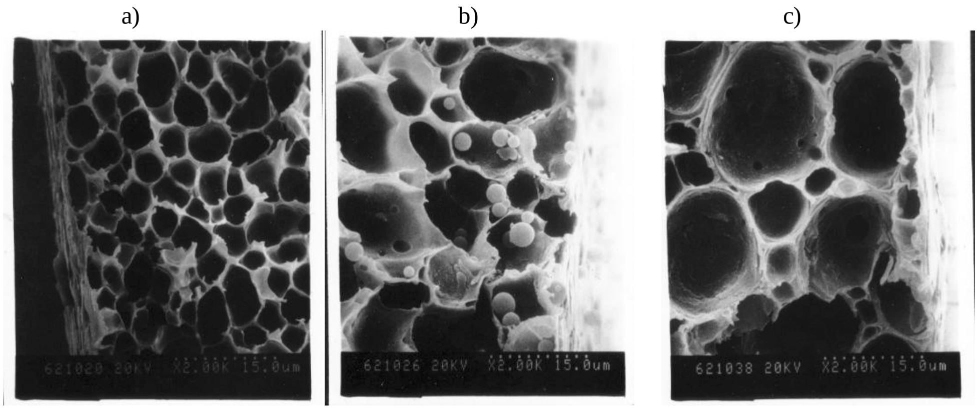
*E-mail: xuzk@ipsm.zju.edu.cn

the water sorption test, it was found that the acid form of SPEI does not absorb water, which indicates that, due to the ionic nature of the sodium salt, hydrophilicity of PEI is improved. Similar phenomenon was also observed in the literature[3]. It was also found that the Tgs of the SPEIs are elevated because of the ionic intermolecular interaction of the polymers, as shown in **Table 1**.

The SPEIs of sodium salt were blended with PEI to form microporous membranes by phase inversion method. A 17 wt % polymer (W_{SPEI}/W_{PEI}=20/80) solution in dimethyl acetamide was used for the preparation of the membranes. Before immersing in ultrafiltrated water at 20°C, the membrane was allowed to stand in 80 % relative humidity air at 20°C for 10 minutes.

Figure 1 shows the cross-sectional morphologies of the blend membranes. It could be seen that the pore size of the membrane increases with increasing the ion exchange capacity (IEC) of the SPEI. This may be the result of the immiscibility of the PEI and SPEI, which can be ascribed to the difference in hydrophilicity between the two polymers.

Figure 1 Cross-sectional morphologies of the blend membranes. a): PEI control; b): IEC of SPEI=2.51 m mol/g; c): IEC of SPEI=2.60 m mol/g.



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