플라즈마 중합법에 의해 제조된 다양한 이온교환기 분포를 가진 이온교환막의 특성분석

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Characterization of ion-exchange membrane with various fixed charge distribution prepared by plasma-induced graft polymerization

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The performance of ion-exchange membrane depends on its chemical nature and the conditions of the surrounding liquid medium. The former includes the type of a membrane (cationic or anionic), the amount of fixed charges and its distribution. The latter includes the operating condition and the flow field near the liquid membrane interface. Increasing fixed charge in a membrane can improve the performance of an ion-exchange membrane [1]. A particular distribution of fixed charge groups inside the membrane plays a significant role. Many researchers have studied the effect of fixed charge distribution on the performance of ion-exchange membrane [2-11]. However, since preparation of ion-exchange membrane with nonuniform or uniform fixed charge distribution (Fig. 1) is difficult, most of the studies have been carried out only theoretically without experimental investigation.

Graft polymerization is a good method to prepare morphologically controlled ion-exchange membrane (ion-exchange membrane with nonuniform or uniform fixed charge distribution) [12]. It was reported that the membrane morphology with the plasma-induced graft polymerization could be controlled by solvent, plasma discharge power, pressure of gas and pore size [13,14]. Therefore, plasma induced graft polymerization can be used to prepare ion exchange membranes with various fixed charge distribution by controlling the membrane morphology.

The objectives of this study are: (1) to prepare cation-exchange membrane (sulfonated GMA-g-PP membrane) with nonuniform or uniform fixed charge distribution (Fig. 2) by the use of plasma-induced graft polymerization (Fig 3) for cation exchange membrane and (2) to evaluate and compare their properties. The prepared membranes with various fixed charge distribution were characterized in terms of physical and electrochemical properties such as transport number, ion exchange capacity, water content, membrane electric resistance, I-V relation and chronopoteniometric reponses. Also, the chemical structure and morphology of the prepared membrane were investigated using microscopic Fourier transform infrared spectroscopy mapping method, field emission scanning electron microscopy (FESEM).

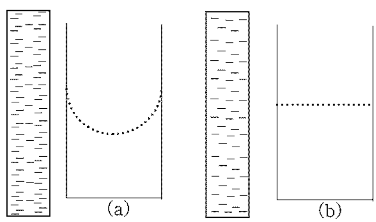

Fig 1. Nonuniformly charged membrane(a) and uniformly charged membrane (b)

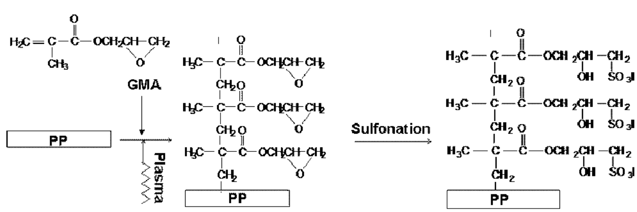

Fig. 2. Preparation scheme for cation-exchange membrane

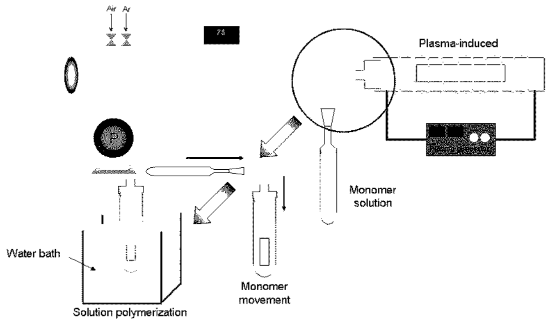

Fig. 3. Apparatus for plasma graft polymerization

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References

[1] H. Reiss and I. C. Bassignana, Critique of the mechanism of superselectivity in ion exchange membranes, J. Membr. Sci., 11, 219-229 (1982)

[2] C. Servey and H .Reiss, Ion transport in inhomogeneous ion exchange membrane, J. Membr. Sci., 23, 11-27 (1985)

[3] Raima Larter 'Enhancement of membrane transport by spatial nonuniformity', J. Memb. Sci., 28, 165-181 (1986)

[4] William H. et al., 'Enhancement of membrane transport of ions by spatially nonuniform electric fields', J. Am. Chem. Soc., 109, 2582-2585 (1987)

[5] Salvador et al. 'Effect pf a macroscopic fixed charge inhomogeneity on some membrane transport of properties' , J. Colloid and Interface., 145, 433-440 (1991)

[6] Jose A. Manzanares, et al., 'Transport phenomena and asymmetry effect

in membranes with asymmetric fixed charge distribution', J. Phys. Chem. 95, 5620-5624 (1991)

[7] Jos A. Manzanares et al., Current efficiency enhancement in membranes with macroscopic inhomogeneities in the fixed charge distribution, J. Chem. Soc. Trans., 88, 2355-2364 (1992)

[8] Artjom V. Sokirko et al., The permselectivity of membrane systems with an inhomogeneous distribution of fixed charge groups', J. Colloid and Interface Sci. , 168, 32-39 (1994)

[9] S. Koster, 'Influence of the layer fixed charge distribution on the performance of an ion-exchange membrane', J. Membr. Sci. 108, 177-183 (1995)

[10] J.P. Hsu and K.C. Ting, 'Current efficiency of an ion selective membrane: Effect of fixed charge distribution', J. Electrochem. Soc., 45, 1088-1092 (1998)

[11] Jyh-Ping Hsu et al., 'Current Efficiency of an Ion-Exchange Membrane: Effect of Piecewise Continuous Fixed Charge Distribution', J. Phys. Chem. B, 104, 3492 -3495 (2000)

[12] Pineri, M., in "Coulombic Interaction in Macromolecular Systems" (A. Eisenberg and F. E. Bailey Eds). p. 159 ACS Symp. Ser. No. 302, Amer. Chem. Soc., Washington, DC, 1986

[13] T. Yamaguchi et al., Evidence and mechanisms of filling polymerization by plasma-induced polymerization, J. Polym. Sci. Part A, 34, 1203-1208 (1996)

[14] Y. J. Choi, S. H. Moon, T. Yamaguchi, S. Nakao, New morphological control for thick, porous membranes with a plasma graft-filling polymerization, J. Polym. Sci. Part A: Polym. Chem. 41 (2003) 1216.