일반강연 II-7

AFM을 이용한 폴리술폰막의 표면구조와 상분리현상에 관한 연구

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Surface structure and phase separation mechanism of polysulfone membranes by AFM

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1. Introduction

Asymmetric polymeric membranes prepared by the phase transition technique usually have either a top layer consisting of closely packed nodules or pores dispersed throughout the membrane surfaces. In this study, we present AFM image of a polysulfone membrane which show a clear evidence for the nodular structure and porous structure resulted from different phase separation mechanisms; spinodal decomposition and nucleation and growth. The surface morphology obtained by SEM and AFM was also compared.

2. Experimental

Membranes were prepared via phase transition method. 20wt% polysulfone solution was cast on a glass plate with a doctor blade at room temperature. The casted polysulfone solution on glass plate was immediately immersed in the nonsolvent bath consisting of pure water (sample 1) and of 20/80 mixture of water/NMP by weight (sample 2). In the present studies a Nanoscope IIIa MultiMode AFM together with an Extender Electronics Module both by Digital Instruments was used. Tapping mode was employed at the cantilever' s resonance frequency using a probe and cantilever unit composed of silicon.

3. Results and Discussion

To compare sample 1 (path a, 20wt% polysulfone solution immersed into the nonsolvent bath consisting of pure water) and sample 2 (path b, 20wt%

polysulfone solution immersed into the 20/80 mixture of water/NMP by weight), we define quench depth as a length between the dope composition and nonsolvent bath composition in the phase diagram. In the case of sample 1 (deep quench condition), the diffusion rate of nonsolvent and solvent are so fast that the composition may proceed into the unstable area without nucleation which resulted in spinodal structure. On the other hand, sample 2 (shallow quench condition), the diffusion rate of nonsolvent and solvent is relatively slow and the composition may not reach the unstable area before phase separation and phase separation mechanism is confined to nucleation and growth of polymer poor phase resulted in porous structure.

4. Conclusions

Polymeric membrane structure obtained from phase transition technique is closely related to phase separation mechanisms. Especially for amorphous polymer like polysulfone, liquid-liquid phase separation is very important to determine the membrane morphology. We obtained two membranes which have a totally different structure. Membrane prepared from pure water as a nonsolvent shows nodular structures of about 25nm nodule size which is believed to be the result from spinodal decomposition. Membrane prepared from mixed nonsolvent bath (20/80 water/NMP in weight) has the porous structure of mean radius of about 146nm and this morphology is the result of nucleation and growth of the polymer-poor phase.

The pore diameters obtained from AFM are larger than those from SEM and seem to be more accurate because the potential of altering the membrane pore structure during sample preparation in SEM measurement is eliminated.

5. References

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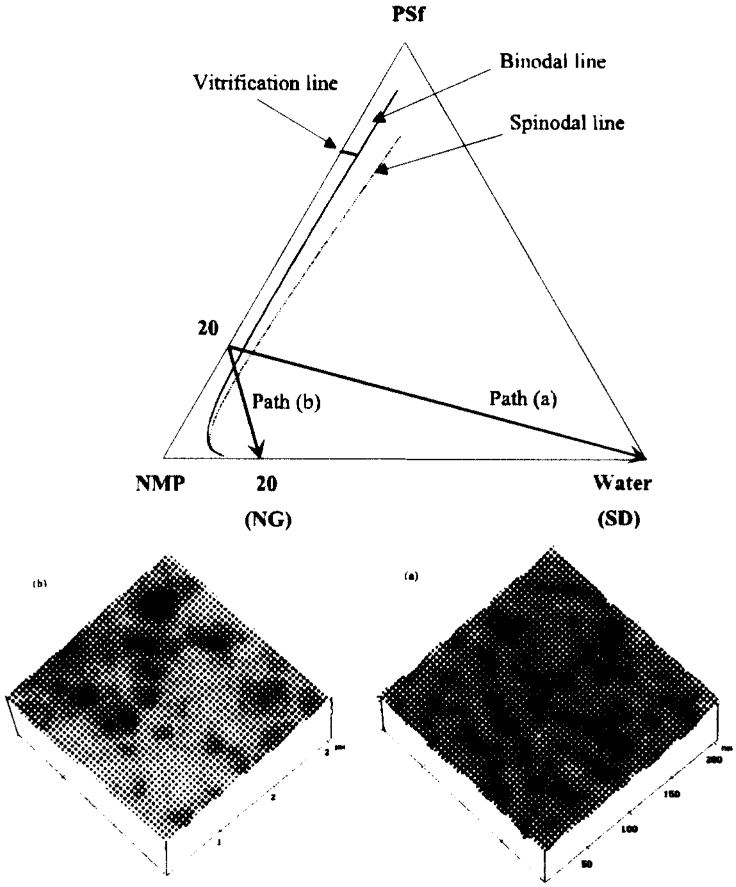

Fig. Ternary phase diagram for PSf/NMP/water system showing binodal line, spinodal line and vitrification line at 15℃ and three dimensional tapping mode AFM images of polysulfone membrane ; (a) sample 1 and (b) sample 2.