Presented at IMSTEC 10, Sydney, November 2010

Treatment in an intense electrical field as a new technique for controlling the microstructure and performance of membranes

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Introduction: Controlling the porous structure of membranes is a main objective of membrane manufacturing. Much research effort has been devoted to the development of new techniques for meeting this objective. The application of strong electrical fields has been used to process or align polymers in different processing technologies such as electro-spinning for fabrication of nanofibers and electro-spraying for fabrication of ultrathin films. The purpose of our reaserch was to study the feasibility of controlling the microstructure of membranes using intense electrical fields.

Materials and methods: Different polymeric membranes such as poly(vinylideneflouride) (PVDF) microfiltration membranes, polyamide reverse osmosis membranes and polysolfune microfiltration membranes were examined. Scanning electron microscpy (SEM) was used to study the effect of treating the polymeric membrane in an intense electrical field of 10 and 100Mv/m. Impedance spectroscopy (EIS) measurents were used to examine the permeability and electrical properties of the membrane before and after poling. Separation performance tests were used to study the effcet of the new technique on the performance of membranes.

Results and discussion: The force generated due to the potential differences across the membrane can strain the polymer chains. By controling the thermal history, that strain can be frozen in and if the glass transition temprature of the polymer of membrane is lower than the application temperature, the structure does not returen to the original state (see Fig.1).

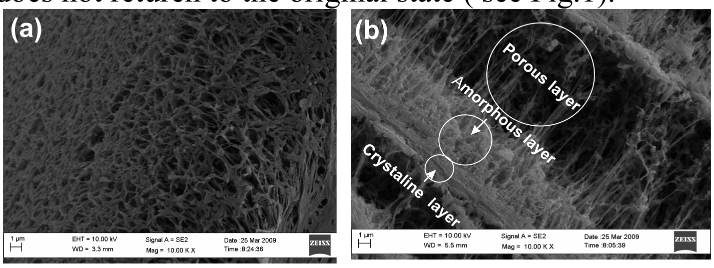

Fig.1. SEM micrograph of PVDF microfiltration : before poling (a), and after poling for 2 hours at 95°C in a intense electrical field (155 MV/m).

The result of separation performance tests at different pressures showed that the poling process improved the separation performance of the PVDF membranes and decreased the MWC (molecular weigh cut off) of the membranes significantly. For example, poling for only 2hr changed the MWC of the PVDF microfiltration membrane from about 500 k Dalton to less than 100 k Dalton which is the typical MWC of an ultrafiltration membrane.

EIS results confirmed the significant effect of electrical poling on microstructure of the membrane and revealed the change in their electrical properties. For example, the electrical impedance of the unpoled PVDF microfiltration membrane was dependant on the concentration of electrolyte solution which is typical of porous films, while the impedance of the poled membrane was independent of the concentration of electrolyte which is the typical behaviour of non-porous films.

References

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