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Poly(ether imide)/Naphthalene-Sulfonated Formaldehyde Membranes: Morphology, Thermal and Proton Conducting Properties

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Abstract – Polymer membranes based on poly(ether imide) (PEI) and naphthalene-sulfonated formaldehyde resin (NSF) were prepared and evaluated according morphology and thermal and proton conducting properties. Membranes presented heterogeneous morphology and good chemical stability with proton conductivity varying from 0.03 to 7.01 mS/cm.

Proton conducting polymer materials have received great attention due to their application as solid electrolytes in devices such as fuel cells. These materials can be obtained by preparing polymer blends or composite electrolytes with components presenting potential ion conducting properties, dispersed in a polymer matrix [1]. The proton exchange membrane is a vital part of polymer electrolyte membrane fuel cells (PEMFC) and new materials for this application have been investigated recently [2]. The membrane must have some properties as high electronic resistivity, low reactant permeation, mechanical strength and must be thermal and chemical stable under fuel cell operation conditions [3].

Polymer membranes based on poly(ether imide) (PEI) and naphthalene-sulfonated formaldehyde resin (NSF) were prepared by melt processing the two components in a Haake internal mixer chamber and by casting technique using N-methyl-2-pyrrolidone solutions. Membranes morphology was evaluated by scanning electron microscopy (SEM) showing phase segregation with some degree of interaction between phases (Figure 1). Thermogravimetry analysis (TGA) was used to evaluate thermal properties of membranes showing good thermal resistance, despite the decrease of maximum degradation temperature when increasing amounts of NSF was added to the polyimide matrix. Differential scanning calorimetry (DSC) results showed a small decrease on the glass transition (T_g) of membranes due to the interaction between PEI and NSF.

Proton conductivity of materials was evaluated by alternating current (AC) complex impedance spectroscopy at room temperature. Analysis were performed in a Autolab Potentiostat-Galvaniostat PGSTAT-30, with 10mV alternate voltage and frequency range of 10Hz to 1 MHz. PEI/NSF membranes presented maximum proton conductivity of 7.01 mS/cm (Table 1), when prepared by casting. Membranes based on PEI showed good chemical stability after Fenton's degradation test (Figure 2).

Table 1: Proton conductivity of PEI/NSF membranes

Composition (Casting)	Proton conductivity (mS/cm)	Composition (Melt processing)	Proton conductivity (mS/cm)
PEI/NSF 100/0	0.03	PEI/NSF 100/0	0.04
PEI/NSF 70/30	0.11	PEI/NSF 70/30	0.09
PEI/NSF 50/50	0.91	PEI/NSF 50/50	0.92
PEI/NSF 30/70	7.01	PEI/NSF 30/70	2.02

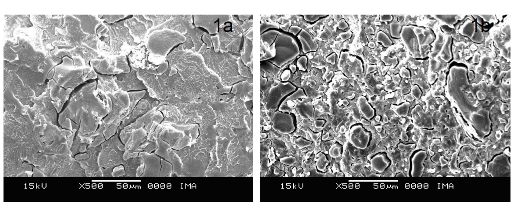

Figure 1: SEM micrographs of fractured surface of PEI/NSF Haake membranes a) 70/30 and b) 30/70.

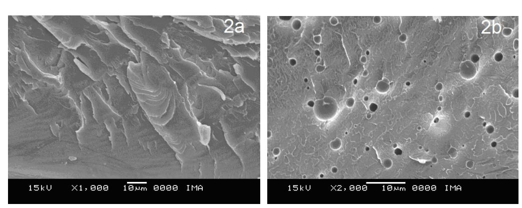

Figure 2: SEM micrographs of fractured surface after Fenton's oxidation test a) pure PEI and b) PEI/NSF 70/30.

References

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