Study on Zeolite/Poly(tetrafluoroethylene) Composite Membranes for Application to Fuel Cell

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Polymer electrolyte membrane fuel cells (PEMFC) based on proton conducting polymers are generally considered to be the most viable approach for mobile applications. However, there is one serious problem in the current PEMFC system; platinum, which is widely used as an electrode, suffers poisoning by the presence of trace CO in a reformed fuel. One way to overcome such a problem is to operate the fuel cell at the higher temperature (> 373 K). Here we wish to report the conductivities of zeolite/PTFE composite membranes in the presence of water vapor at 348-423 K.

Zeolite/PTFE composite membranes were synthesized according to the method reported by Połtarzewski et al.[1] The thickness of resulting composite membranes was in the range 190-860 μm. Electrical conductivity measurement was carried out by AC impedance method in the frequency range from 0.1 to 100 kHz.

The effect of the zeolite structure on the conductivity of zeolite/PTFE composite membrane was investigated in the temperature range from 348 to 423 K. The results are illustrated in Fig. 1. The zeolite in a sodium form was used and all the membranes contained 80 wt% of zeolite powder. The conductivity depends on the zeolite structure; the order of conductivity is Na-FAU[Y] > Na-FAU[X] > Na-LTA > Na-MFI ≈ Na-MOR > (SiO_2) at 423 K. This result implies that the conductivity of membrane with hydrophilic zeolites such as FAU[Y], FAU[X], and LTA zeolites was higher than that with hydrophobic ones such as MOR and MFI.

The conductivity was measured for FAU[Y]/PTFE membrane with the different cation introduced into zeolite and the different content of zeolite. Among the H-, Li-, Na-, and K-FAU[Y]/PTFE membranes, the membranes containing Li ion-exchanged zeolites showed the highest conductivity. The dependence of conductivity on the content of zeolite indicates that the maximum value of conductivity was achieved for membrane with 80wt% of zeolite content (Fig. 2).

Figure 3 shows the conductivity of zeolite/PTFE membranes as a function of the amount of adsorbed water that can be estimated from the TGA results. It is clear that the conductivity was strongly dependent on the amount of water adsorbed on membranes, regardless of both zeolite content and zeolite structure. This correlation indicates that the conductivity is controlled primarily by the amount of water adsorbed.

The fuel cell performance was investigated for zeolite/PTFE membrane. When the following cell,

CH_3OH, Pt | Na-FAU[Y](80)/PTFE | Pt, O_2+H_2O,

was operated at 433-473 K, *ca.* 0.4 V of open circuit voltage was obtained. The decrease in the zeolite content resulted in the increase in the open circuit voltage (*ca.* 0.6 V for Na-FAU[Y](50)/PTFE membrane).

Reference

[1] Z. Połtarzewski, W. Wieczorek, J. Przyłuski, and V. Antonucci, *Solid State Ionics*, 1999, **119**, 301.

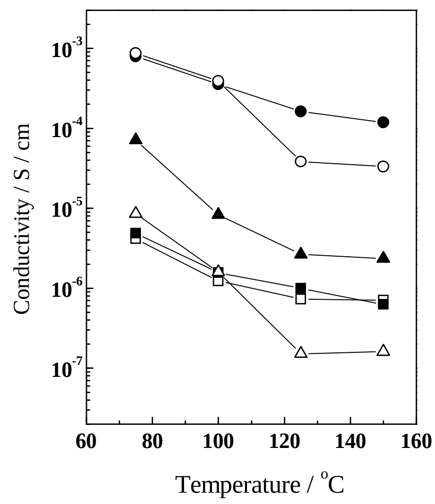

Figure 1. Temperature dependence of conductivity of Na-zeolite/PTFE composite membranes. ●, FAU[Y]; ○, FAU[X]; ▲, LTA; Δ, (SiO_2); ■, MFI; □, MOR.

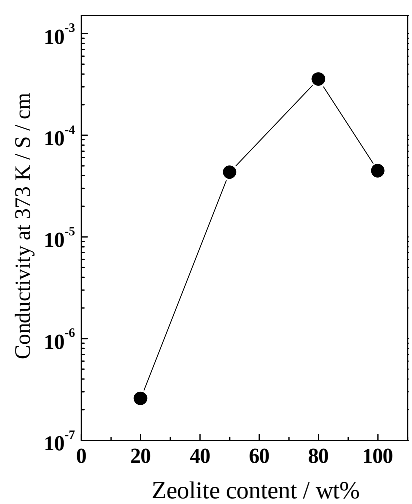

Figure 2. Conductivity of Na-FAU[Y]/PTFE composite membrane as a function of zeolite content.

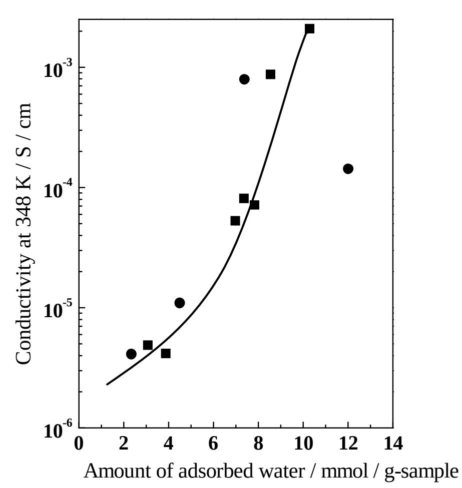

Figure 3. Conductivity of zeolite/PTFE membranes with different zeolite structure (■) and different zeolite content (●) versus the amount of adsorbed water determined by the TG weight loss in the range 293-523 K.