

Effect of fuel permeability on MEA performances using quaternized multiblock copolymers

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An anion exchange membrane fuel cell using hydrazine hydrate liquid fuel has been developed and the concept vehicle powered by Precious Metal free Liquid Feed Fuel Cell (PMLFC) was shown at the 42nd Tokyo Motor Show.¹

For the realization of the fuel cell vehicles, breakthrough is necessary for anion exchange membranes. Especially, it is important to overcome the counteracting relationship of high ion conductance and low fuel permeability.

Our approach to develop the advanced anion exchange membranes is anion conductive quaternized aromatic multiblock copolymers, poly(arylene ether)s (QPEs).²

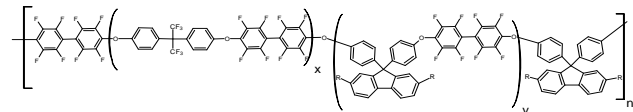
Multiblock copolymers afford controlled hydrophobic/hydrophilic phase separation in nanoscale. The molecular structure and appearance of synthesized membrane are shown in Scheme.1 and Fig. 1, respectively. The membranes containing quaternized ammonio-substituted fluorene groups were synthesized via block copolycondensation of fluorene-containing oligomers and linear hydrophobic oligomers.

In this paper, ion conductivity, fuel permeability, and MEA performance of the QPE membranes were evaluated.

Relationship between ion conductivity and fuel permeability of the QPE membranes with different block lengths is shown in Fig. 2. It is interesting that QPE membranes which consist of shorter hydrophilic block length showed lower permeability.

The non-PGM catalysts performances were evaluated using Rotating Ring Disk Electrode (RRDE). The linear sweep voltammograms of ORR are shown in Fig. 3. The QPE ionomers work as a polymer electrolyte and Fe-N-C non-PGM catalysts showed comparable ORR performance to platinum catalysts.

MEA consists of the QPE membranes and ionomers were fabricated with non-PGM catalysts and subjected to performance evaluation. The MEA performance of direct hydrazine fuel cells showed enough high power density for the automotive applications.



Scheme 1. The molecular structure of the investigated QPE (R =H or CH₂N⁺(CH₃)₃OH).



Fig. 1. Appearance of synthesized QPE membrane

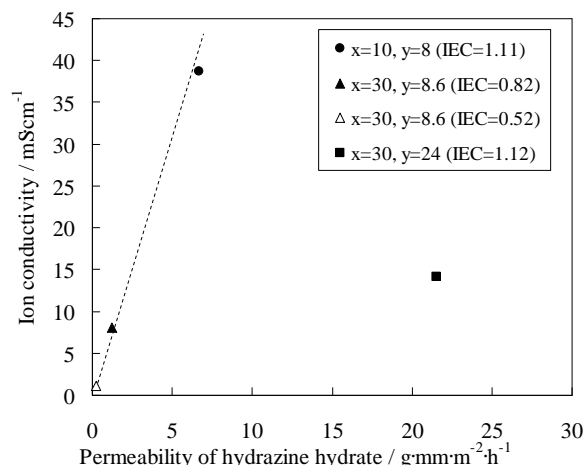


Fig. 2. The relationship between ion conductivity and permeability of hydrazine hydrate for the QPE membranes with different block length of hydrophobic(x) and hydrophilic(y) component.

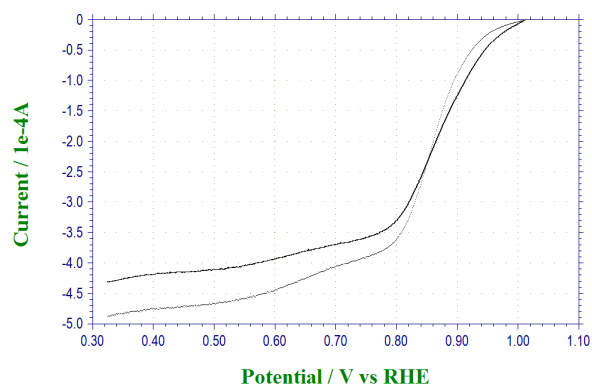


Fig. 3. The linear sweep voltammograms of ORR on Fe-N-C (black line) and PtC (gray line) electrodes in oxygen-saturated 1M KOH aqueous solution. Tested at 5 mVs⁻¹, 1600 rpm and 30 °C.

References

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- [2] M. Tanaka, K. Fukasawa, E. Nishino, S. Yamaguchi, K. Yamada, H. Tanaka, B. Bae, K. Miyatake, and M. Watanabe, *J. Am. Chem. Soc.* 2011, **133**, 10646–10654