

## DNA/poly(benzimidazole) composite 고분자 전해질막

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## DNA/poly(benzimidazole) composite polymer electrolyte membranes

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### Introduction

Polymer electrolyte membrane fuel cells (PEMFCs) have received much attention due to their environment-friendly transportation application [1-2]. Proton-conducting polymers is the key material for PEMFC and Nafion®, the perfluorinated ionomer, has been applied nearly exclusively as proton conductor in membrane fuel cells [3-4] up to now. However, Perfluorinated polymer electrolyte membranes such as Nafion suffer serious disadvantages such as high cost, poor hydrophilicity, fuel crossover, low proton conductivity at low humidity and high temperature [5]. Futhermore, the conductivity of Nafion decreases above the boiling temperature because of a loss of the sorbed water in the membranes. In order to increase the utilization of expensive Pt catalysts, operation at high temperature is the desire for PEMFC, therefore, a new polymer electrolyte membranes which maintain their properties at high temperature has been studied. In recent years, complexation of basic polymer with strong acids has been receiving much attention as a membrane candidate for fuel cells [6-8]. Development of a cheaper proton-conducting polymer that performed as much as the electrochemical performance of perfluorinated ionomers as well as their mechanical, thermal, and electrochemical stability has been tried.

This paper describes the preparation and characterization of a *proton-conducting* membranes consisting of poly(benzimidazole) (PBI) as the basic compounds with DNA as the acidic compounds. The reason of using DNA is that the structure of DNA is a long double helix and each strand is composed of an ordered combination of four nucleotides having phosphoric acids.

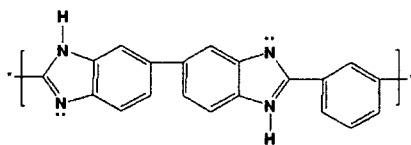
### Experimental

Deoxyribonucleic acid (DNA), sodium salt, was purchased from Aldrich Company. DNA solutions may be prepared by dissolving the thread-like lyophilized material in water of buffer. TE buffer (pH 8.0) is commonly used to prepare DNA solutions. The %G-C content for DNA from salmon testes is reported to be 41.2% and

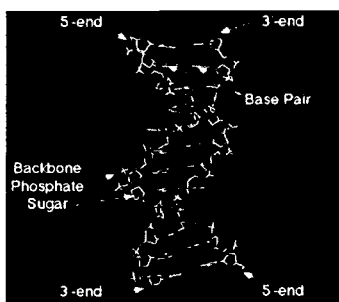
the molecular weight (MW) of DNA is  $1.3 \times 10^6$  (approximately 2000 bp). A solution of DNA in water was added to a solution of PBI in *N,N*-dimethylacetamide (DMA) with various ratio of PBI and DNA. The mixture solution was poured into petri dish and treated with cross-linking through UV-cross linker and then dried in convection oven at 50 °C. DNA/PBI membranes was immersed for 24 hours in order to substitute  $\text{Na}^+$  of DNA into  $\text{H}^+$  form. Membranes were rinsed with deionized water several times and kept in deionized water before the characterization.

## Results and discussion

The polymers used for the preparation of the acid-base blends presented in this study are shown in Fig. 1. The phosphoric acid groups would interact with the N of PBI by formation of hydrogen bridges. These acid-base complexed membranes presented in Table 1 show reasonably high proton conductivities even for the membranes having very low amount of DNA.



a) Acidic polymer



b) Basic polymer

Figure 1. Basic and acidic polymers for the acid-base blends.

Table 1. The proton conductivity of DNA-PBI membranes

The membrane (PBI:DNA, wt%)	The proton conductivity (S/cm)
7:3	2.20E-03
125:1	4.34E-04
Nafion 119	7.13E-02

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## References

1. F. M. Gray, *Polymer Electrolytes*, The Royal Society of Chemistry, Cambridge, 1997.
2. L. J. M. J. Blomen, *Fuel cell systems*, Plenum, New York, 1993.
3. T. A. Zawodzinski Jr.; C. Derouin; S. Radzinski, *J. Electrochem. Soc.*, 1993, 140, 1041.
4. K. W. Lux; J. S. Wainright; R. F. Savinell; V. Landau, *Pro. Electrochem. Soc.*, 1994, 94, 302.
5. S. R. Samms; S. Wasmus; R. F. Savinell. *J. Electrochem. Soc.*, 1996, 143, 1498.
6. J. S. Wainright; J.-T. Wang; D. Weng; R. F. Savinell; M. Litt, *J. Electrochem. Soc.*, 1995, 142, 121.
7. J.-T. Wang; J. S. Wainright; R. F. Savinell; M. Litt, *J. Appl. Electrochem.*, 1996, 26, 751.
8. J.-T. Wang; S. Wasmus; R. F. Savinell, *J. Electrochem. Soc.*, 1996, 143, 1233.