

# Aggregation States of Nafion<sup>®</sup> at Interfaces

Ayanobu Horinouchi

Tanaka Laboratory, Department of Applied Chemistry, Graduate School of Engineering,  
Kyushu University

## Abstract

“Hydrogen” would be a promising energy vector as it is considered to be environmentally benign. Since a solid polymer electrolyte water electrolysis (SPE) system has current density capability with high efficiencies, it is expected to be the central of a future large scale hydrogen production[1]. In the SPE system, the most crucial factor to affect the performance, proton conductivity, is aggregation states of polymer electrolyte at interfaces. This is simply because electrochemical reactions, water molecules produce protons and electrons, take place at the outermost region of the polymer electrolyte.

Thermal molecular motion of polymer chains in a film at the outermost region is generally activated in comparison with that in the internal bulk phase[2]. Thus, surface structure of the polymer can be easily reorganized in response to surrounding environment. In our previous study[3,4], we have examined aggregation states of poly(methyl methacrylate) (PMMA) at the interfaces with N<sub>2</sub> and water using sum-frequency generation (SFG) vibrational spectroscopy. At the N<sub>2</sub> interface, hydrophobic functional groups of PMMA oriented in the plane of the interface. At the water interface, hydrophilic functional groups of PMMA oriented toward the water phase to minimize the interfacial free energy. Taking into account these facts, it can be claimed that aggregation states of the polymer electrolyte in the SPE system can be easily alerted in contact with water. If that is the case, such information should be taken into account for the design and construction for the SPE system.

In this study, Nafion<sup>®</sup> is chosen as a typical polymer electrolyte and then its aggregation states at N<sub>2</sub> and water interfaces were studied by SFG vibrational spectroscopy. In addition, the water structure surrounding Nafion<sup>®</sup> at the interface was also discussed.

## References

1. H. Takenaka, E. Torikai, Y. Kawmi, and N. Wakabayashi, *Int. J. Hydrogen Energy*, **5**, 397-403 (1982).
2. K. Tanaka, A. Takahara, and T. Kajiyama, *Macromolecules*, **33**, 7588-7593 (2000).
3. Y. Tateishi, N. Kai, H. Noguchi, K. Uosaki, T. Nagamura and K. Tanaka, *Polym. Chem.*, **1**, 303-311 (2010).
4. A. Horinouchi, H. Atarashi, Y. Fujii, and K. Tanaka, *Macromolecules*, **45**, 4638-4642 (2012).