

Analysis of Electrochemical Characteristics of Organic–Inorganic Hybrid Titanophosphate Membranes

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We report the determination and analysis of the proton conductivities of organic–inorganic hybrid titanophosphate membranes. Organic–inorganic hybrid titanophosphate membranes are new electrolytes produced for fuel cells by the Institute for Chemical Research at Kyoto University, and they have high proton conductivities at high temperature^{1,2}. However, many of the characteristic of these membranes are unknown. We determined and analyzed the proton conductivities of these membranes using electrochemical impedance spectroscopy. First, we developed a device for measuring the proton conductivities of the membranes (Figure 1).

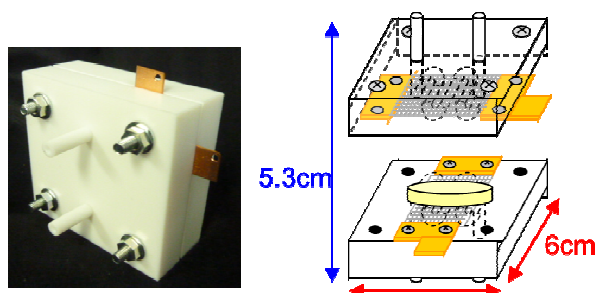


Figure 1. A device for measuring the proton conductivities of the membrane.

This device enabled us to perform tests at high temperatures. We verified the device performance using Nafion115. The device performance showed the same tendencies for the reference and a sample, as shown in Figure 2, so we judged the device to be suitable for use in experiments on electrolytes. Next, we estimated the equivalent circuits of the organic–inorganic hybrid titanophosphate membranes using this device. Based on the equivalent circuits, we evaluated the resistances that indicated proton conductivity and calculated the proton conductivities of these membranes. We clarified the temperature and hygroscopic characteristics of the proton conductivity by calculating the proton conductivities at various temperatures and humidities.

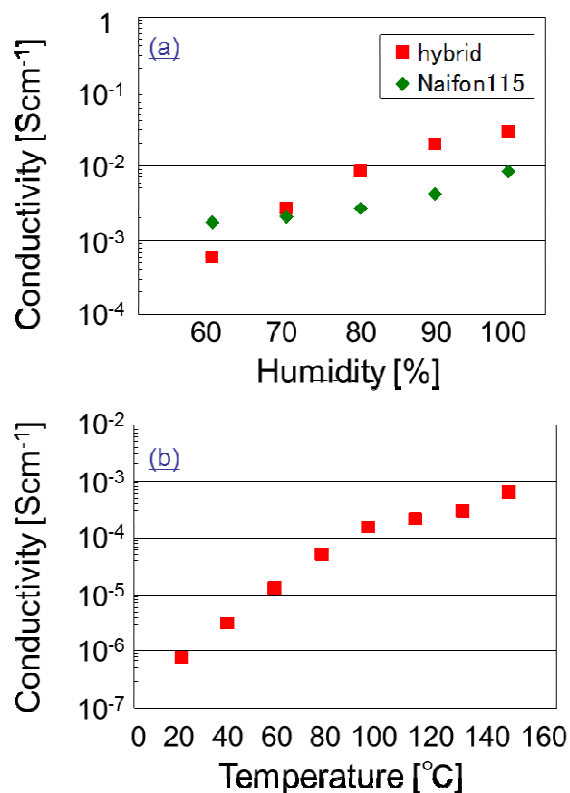


Figure 2. Proton conductivities of hybrid membranes and Nafion115 plotted against (a) humidity@26°C and (b) temperature@21% humidity.

We found that the conductivity increased with increasing temperature and humidity. In particular, the hygroscopic characteristics of the proton conductivities of these membranes are the same as those of Nafion115.

[¹] Y. Tokuda, S. Nishioka, Y. Ueda, H. Koyanaka, H. Masai, M. Takahashi, and T. Yoko, Organic–inorganic hybrid titanophosphate proton conductive membranes with graded monomer conversion, *Solid State Ionics* 206, 22-27, 2012-01.

[²] Y. Tokuda, S. Nishioka, Y. Ueda, H. Koyanaka, H. Masai, M. Takahashi, and T. Yoko, Preparation of proton-conductive organic–inorganic hybrid titanophosphate membranes, *Solid State Ionics*, Available online 2 March 2012.