Development of an Infrared Soret Forced Rayleigh Scattering Instrument Using a Single Crystal Diamond Window in a Sample Cell for Measurement of Diffusion Coefficients of Aqueous Solutions in Polymer Electrolyte Membranes

Hiroaki Matsuura [C, S]
School of Integrated Design Engineering, Keio University, Yokohama, Kanagawa, Japan
matsuura@naga.sd.keio.ac.jp

Daichi Tokuda and Yuji Nagasaka
Department of System Design Engineering, Keio University, Yokohama, Kanagawa, Japan

We have been developing an experimental apparatus for the measurement of diffusion coefficients of aqueous solutions in a polymer electrolyte membrane (PEM), based on the optical holographic grating technique which we call the infrared Soret forced Rayleigh scattering (IR-SFRS). Mass transport in PEM significantly affects the performance of fuel cell systems (e.g., methanol crossover). Although evaluation of mass transport in PEM is important for the development of direct alcohol fuel cells, there is no established method to measure the diffusion coefficient of aqueous solutions in membranes. In the IR-SFRS technique, mass transport induced by the heating laser with the wavelength of λ = 9.7 μm is observed by the probing laser of λ = 639 nm on the order of milliseconds. The window for the sample cell should transmit both lasers. In addition, the window should be resistant to acids to measure solutions in a Nafion membrane which has sulfonic acid groups. A polycrystalline diamond window was used in our previous study, but the large scattered light from the window was a problem in the measurement. In the present study, we have introduced a single crystal diamond window which generates lower scattered light. We designed a new sample cell to use the single crystal diamond with the size of 4.5 × 4.5 × 0.5 mm. To evaluate the validity of the measurement system, experiments were carried out on aqueous methanol solutions at a temperature T = 298.2 K. We also carried out experiments on aqueous methanol solutions in a Nafion membrane at T = 298.2 K.