

The Development of a Soret Forced Rayleigh Scattering Method for Mass Diffusion Coefficient Determination of Methanol/Water Solutions in a Polymer Electrolyte Membrane

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Methanol crossover through the ionomer membrane is presently a key problem in direct methanol fuel cells (DMFC). For this reason, membrane technology is trying to obtain a new methanol impermeable polymer electrolyte membrane (PEM), and it would be necessary to develop methods to check the diffusion properties of methanol in new materials for the PEM.

In the present paper, the possibility of applying the Soret forced rayleigh scattering method (S-FRSM) to measure the mass diffusion coefficient of methanol/water solutions in PEM was studied. In S-FRSM, an interference of two pulsed laser beams heats a sample, and the Soret effect induces a concentration modulation within a binary liquid mixture. The concentration distribution decays after the heating by mass diffusion, and the mass diffusion coefficient can be determined using the intensity change of the diffracted probing light from the concentration grating. This method has the advantages of high-speed and an anisotropic and in situ measurement. Therefore, it has possibility of being an effective tool for evaluating the PEM.

In the development of the apparatus, we adopted a high power CO₂ laser as the heating source, since methanol/water solutions have strong absorption features in the wavelength band of this laser. After the completion of the interference optical system, we measured the diffusion coefficient of methanol/water 80 wt. % solutions at room temperature to confirm the validity of the sensing system. The measured value was approximately consistent with the values determined by other conventional techniques, such as the Taylor dispersion technique, and therefore the applicability of this method was validated. Then we tried to apply S-FRSM to methanol/water solutions in the Nafion membrane.