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The analysis of adhesion force at the interface of gas diffusion layer and channel in polymer electrolyte membrane fuel cell

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ABSTRACT

The adhesion force of water droplet on the gas diffusion layer (GDL) is modeled based on the droplet deformation. The deformed droplet is represented as an ovoid shape. The adhesion force is calculated based on it and verified by the surface tilting experiment. The model predicts the shape of deformed droplet and adhesion force within 30% error, whereas previous models predict adhesion force with error larger than 30%. The modified model is used to compare the adhesion force among 3 types of GDL having pore gradient. The comparison result is well matched with the water distribution in polymer electrolyte membrane fuel cell (PEMFC) and water detachment phenomena at the GDL. High adhesion force makes more water accumulation at the interface of GDL and gas supplying channel. This makes different boundary condition and changes the water distribution in PEMFC.

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Introduction

Polymer electrolyte membrane fuel cell (PEMFC) requires adequate water management because water distribution affects the efficiency of PEMFC directly. Reactant should be supplied properly to the catalyst layer through gas diffusion layer (GDL) to generate electricity. The diffusivity and permeability of reactant are inversely proportional to the water content in the GDL, so the amount of water must be as low as possible in the GDL. On the other hand, proton should be transported through the membrane to generate the electricity. The proton conductivity of the membrane is directly proportional to the water content, so the amount of water must be controlled as high level in membrane. Therefore the transport of water and its distribution in PEMFC should be comprehended to maximize the performance of PEMFC.

Two crucial factors determine the water distribution in PEMFC. First is structure of porous media. The transport of water is governed by capillary pressure [1], so the structure of the porous media strongly affects the water distribution in the

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