Measurement of Thermal Conductivity of Partially Saturated Diffusion Media Under Compression

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Carbon papers are applied as diffusion media in polymer electrolyte fuel cells (PEFCs) with requirements for adequate reactant permeability, product permeability, electronic conductivity, heat conductivity and mechanical strength. Thermal conductivity of the diffusion media in fuel cells places an essential importance for heat transfer and water management in PEMFCs. Various experimental approaches have been employed to measure thermal conductivity of carbon papers[1, 2]. Experimental study of thermal conductivity of diffusion media as a function of both compression and saturation has not yet been fully developed. In this study, measurements of stress-strain relationship and thermal conductivity are performed with high repeatability. Theoretical analysis of thermal conductivity as a function of saturation has been developed to compare with experimental results.

Thermal conductivity of dry diffusion media was measured under different compression pressures by a thermal constants analyzer (Thermtest Inc. Model Hot Disk TPS 2500S). Diffusion media were saturated by immersion in de-ionized water and depressurization to 27.5cmHg by vacuum pump (WELCH^{TM} Model 2561B-50). Diffusion media were initially saturated to high level of saturation and tested when saturation level reaches the normal range[3].

Strain-stress relationships of carbon fiber papers were also developed to compensate for compressed thickness and porosity. Water content has a significant effect on the increment of thermal conductivity of gas diffusion layers (e.g. Mitsubishi MRC105 with 6% PTFE Fig. 2). Thermal conductivity exponentially increases and gradually approaches to theoretical maximal as saturation levels up. The theoretical maximum shown is developed from analytical model that will be shown. Results give some indirect information about the degree of connectedness of the water inside the diffusion media, which will be discussed.

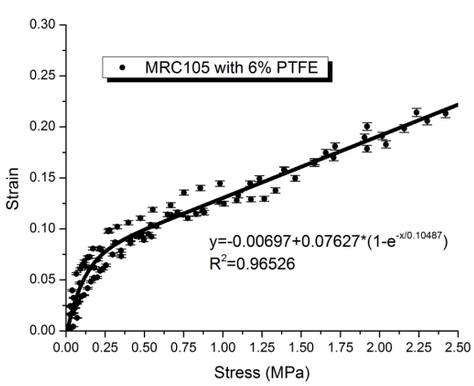

Figure 1. Stress-strain curve of MRC105 with 6% PTFE

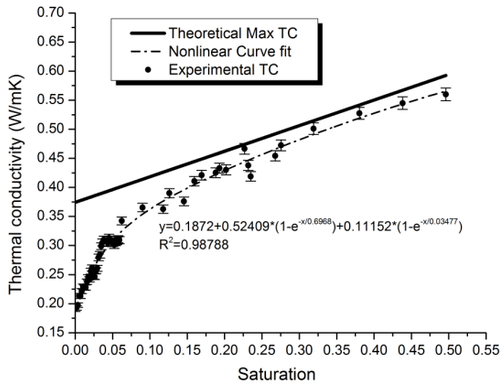

Figure 2. Experimental and theoretical thermal conductivity of saturated MRC105 with 6% PTFE with respect to saturation

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Reference:

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