SHIMADZU

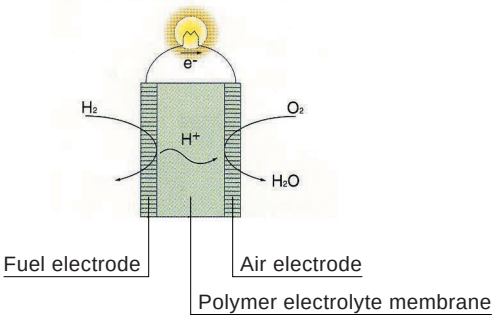
Application News

Thermal Analysis No.T143

Comprehensive Evaluation of Polymer Electrolyte Membrane (PEM) Using Thermal Analysis

■ Introduction

Polymer electrolyte membrane fuel cells feature the advantages of low operating temperature and high power generation per unit volume, and it is therefore not surprising that they are used in various applications including home use, automobiles, as well as portable electric applicances.
The body of a polymer electrolyte membrane fuel cell consists of the fuel electrode (anode) - polymer membrane - air electrode (cathode) as the minimum cell unit, with many of these cells stacked in multi-cell configurations.
This Application News presents a comprehensive evaluation of a polymer electrolyte membrane (PEM), one of the important factors affecting the performance of fuel cells.



Protons generated at the fuel electrode migrate to the air electrode, passing through the polymer electrolyte membrane.

■ Analysis of Melting of Water in PEM Using DSC-60

Fig.1 shows the results of measurement of the water melting process in polymer electrolyte membranes containing different percentages of water. At the 6.7% water content, no water melt peak was observed. The peak at -23.8˚C in the 8.5% water content PEM can probably be attributed to melting of water clusters in the membrane. At water concentrations of 12.6% and greater, a two stage peak is observed, attributable to the melting of bound water clusters and free water, respectively. In addition, it is evident that as the water content increases, the peak on the high measurement side, associated with the free water, increases.

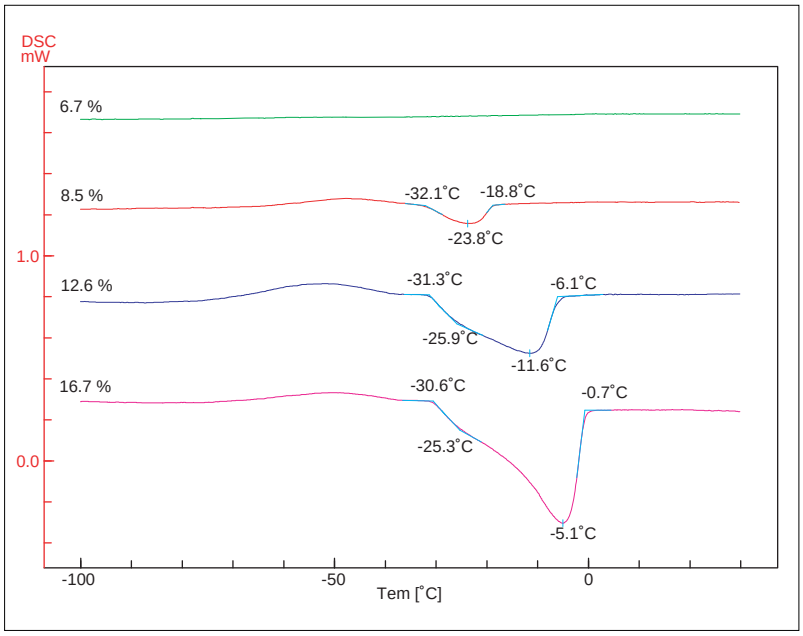


Fig.1 Melting of Water in Polymer Electrolyte Membrane

■ Evaluation of Thermal Resistance of PEM Using DTG-60

Fig. 2 shows the heating process of a polymer electrolyte membrane to 600˚C using the DTG-60. This suggests that decomposition occurs in 3 stages; deanhydration up to 250˚C, detachment of the sulfonic acid group starting in the vicinity of 316˚C, and decomposition of the main chain starting in the vicinity of 409˚C.

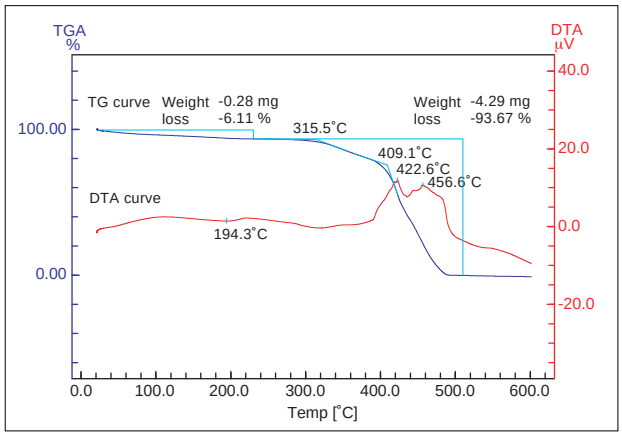


Fig.2 TG-DTA Curve of Polymer Electrolyte Membrane

■ Measurement of Thermal Expansion and Stress-Strain of PEM Using TMA-60

Fig. 3 shows the results of thermal measurement up to 200˚C under tensile-load conditions. The degree of expansion changed greatly above 87˚C. Fig. 4 to 6 show the stress - strain curves when the sample temperatures reached 60˚C, 70˚C, and 80˚C, respectively. After the sample temperature stabilized, the tensile load was increased in increments of 2 g/min, after which it was decreased using the same increments until the load returned to 0 g. The higher the temperature, the more pronounced was the hysteresis phenomenon, with the stress decreasing at the same strain.

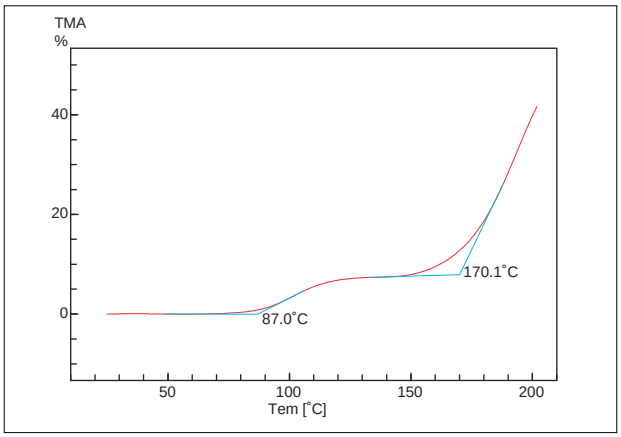


Fig.3 Thermal Expansion Measurement

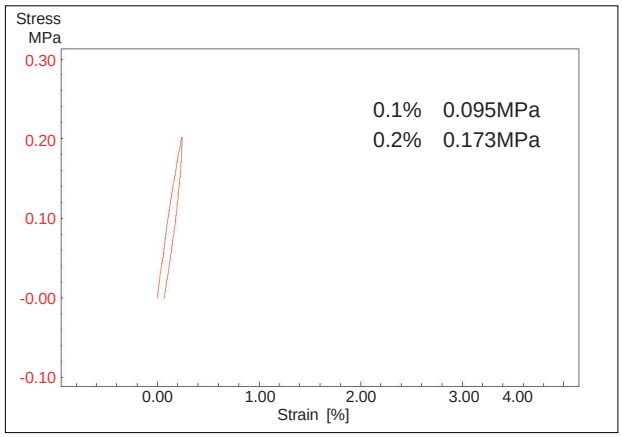


Fig.4 Stress - Strain at 60˚C

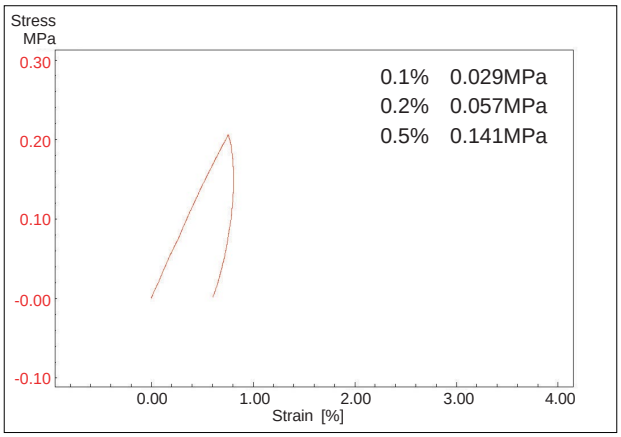


Fig.5 Stress - Strain at 70˚C

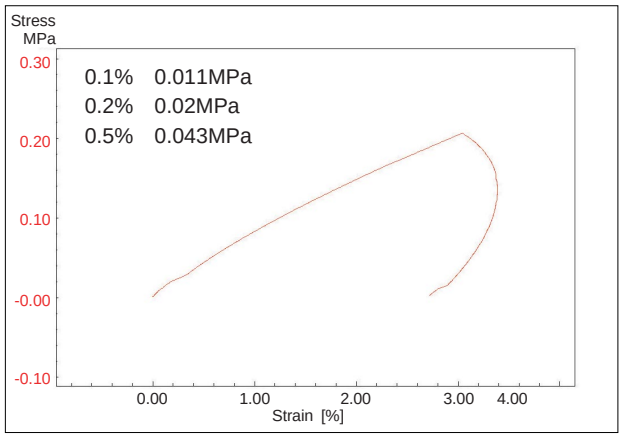


Fig.6 Stress - Strain at 80˚C

NOTES:
✻This Application News has been produced and edited using information that was available when the data was acquired for each article. This Application News is subject to revision without prior notice.

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