Characterization of Electrolyte Membrane for Polymer Electrolyte Fuel Cell by Humidity Control Thermal Analysis

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Introduction

The perfluorocarbon ion-exchange membrane is used for the electrode membrane of Polymer Electrolyte Fuel Cell, PEFC, for improving the heat resistance property, dimensional stability, and mechanical strength of the operating environment. The electrolyte membrane in PEFC is in humidified environment for obtaining H+ ion conductivity. The thermal analysis measurements under the humidity control as well as temperature in the property evaluation test are also required.

The dimension change, the moisture adsorption characteristics, and the viscoelastic properties of the electrolyte membrane of humidity dependence are observed using TMA, TGA, and DMA which enables the humidity control. As a result, under the simulated temperature and humidity environment, the dependency of the humidity of dimensional stability, moisture adsorption characteristics, and viscoelastic property etc. were observed.

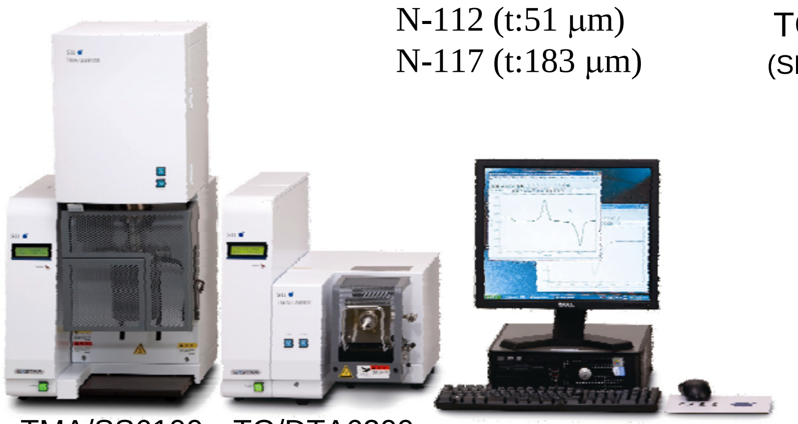
Experiment

Materials:

Nafion® (DuPont™)
N-112 (t:51 μm)
N-117 (t:183 μm)

Instruments:

TMA/SS6100
TG/DTA6200
(SII NanoTechnology Inc.)



TMA/SS6100 TG/DTA6200

An example of humidity generator
(InstruQuest Inc.)

Measurement Condition: :

RH control **TMA** measurements
Humidity dependence which influences expansion and shrinkage behavior
Temperature; 30 °C constant and 90 °C constant
Humidity; 1hr hold at 20, 30, 40, 50, 60, 70, 80, and 90 %RH

RH control **TG** measurements
Mass change by water absorption and release
Temperature; 30 °C constant
Humidity; 1hr hold at 20, 30, 40, 50, 60, 70, 80, and 90 %RH

RH control **DMA** measurements
Humidity dependence of modulus
Temperature; 30 °C constant, 60 °C constant, and 90 °C constant
Humidity scan rate; 0.5 %RH/min

Results

RH Control TMA

Humidity dependence which influences expansion and shrinkage behavior

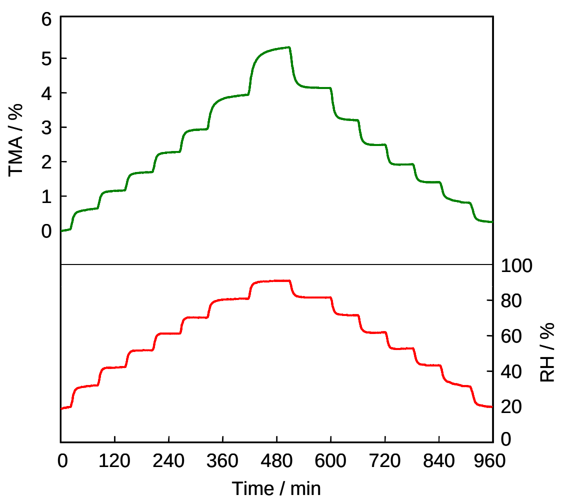


Figure 1 Humidity dependence for Expansion and Shrinkage

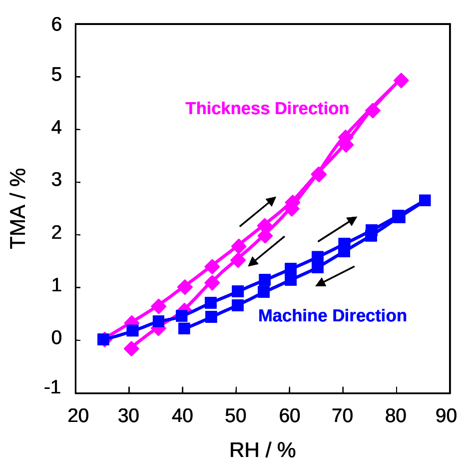


Figure 2 Humidity dependence for Machine and Thickness Direction

RH Control TG

Mass change by water absorption and release

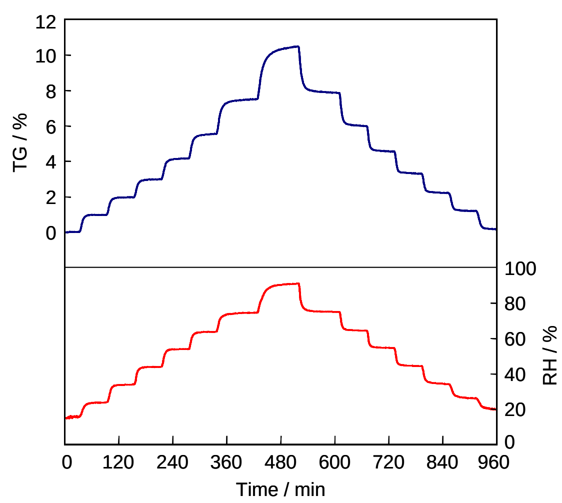


Figure 3 Humidity dependence for Mass change

RH Control DMA

Humidity dependence of modulus

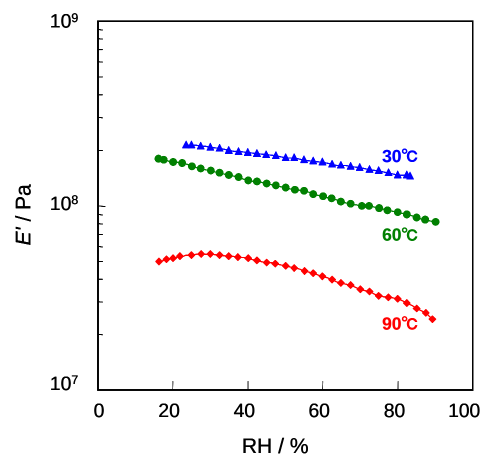


Figure 4 Humidity dependence for Storage modulus

Specimen dimensions during relative humidity changing process increased and increase rate rose as the humidity is raised. During humidity changing process, expansion of Nafion® to thickness direction was observed more than twice that of machine direction.
Sample mass during relative humidity changing process increased and increase rate rose as the humidity was raised.
storage modulus *E'* during relative humidity changing process was detected lower when the temperature increases.
E' of each temperatures decreased when the humidity increased.

Conclusions

- Under the simulated temperature and humidity environment, the dependency of the humidity of dimension stability, moisture adsorption characteristics, and viscoelastic property etc were observed.
- During humidity changing process, expansion of Nafion® to thickness direction was observed more than twice that of machine direction.