THE CONCENTRATION OF THE CARBON-PTFE DISPERSION FOR GAS DIFFUSION ELECTRODES

Nagakazu Furuya

University of Yamanashi – Department of Applied Chemistry, Faculty of Engineering, Kofu, Japan

Introduction

Proton Exchange Membrane (PEM) fuel cells operate at relatively low temperatures, have high power density, can vary their output quickly to meet shifts in power demand, and are suited for applications such as in automobiles. Gas diffusion layer (GDL) of PEM fuel cell electrodes were prepared by dispersion of carbon black and PTFE in water with nonionic surfactant such as Triton X-100. The dispersion was then applied to the electrode backing (*e.g.* carbon fiber paper) by using either a brush or a spray gun. It is necessary to remove 90% water in order to choose the membrane by application and spraying method, because the solid concentration is about 10%. The much water must be removed in order to obtain the necessary film thickness. The water content wants to lower in order to improve the workability by simple method. Then, the cloud point of the surfactant property was noticed. It is well known to become hydrophobic property, when the surfactant is heated over the cloud point. The dispersion is separated to two phases of top and bottom. The upper part is thin, and the lower becomes thick. It is reported that the concentrated dispersion of the lower part does not cohere by this process.

Experimental

Triton X-100 (Octyl phenol ethoxylate) is used as a nonionic surfactant with 65.5 °C as the cloud point at 1wt%. The carbon black is AB-6 (Denka Black, DENKIKAGAKU KOGYO, INC.), and polytetrafluoroethylene (PTFE) dispersion (Fluon AD911, ASAHI GLASS CO., LTD). The dispersions were contained with 7.8wt% AB-6 and 5.2 wt% PTFE in water containing the 1-30 wt% nonionic surfactant.
The carbon black was mixed with pure water (miriQ) containing Triton X-100. The dispersing carbon black mixed solution was dispersed a jet mill (Genus PY) at 100MPa, and it is done 5 times. The particle size was measured in Fiber-Optics Particle Analyzer (FPAR 1000, Otsuka Electronics Co., Ltd). The average particle size of the carbon black in the dispersions was ca. 500 nm. The temperature of the heat treatment was 65-85 °C by 0.5 to 24hr in water bath with a temperature accuracy of +/- 0.1°C.
After heat treatment, the separated interface height of dispersion was measured. The concentration of the concentrated dispersion and the concentration of the surfactant were measured from the specific gravity.

Corresponding author:
Phone Number; +81-55-220-8559, Fax Number; +81-55-220-8559
E-mail: Furuya@ab11.yamanashi.ac.jp

Results and Discussion

The phase diagram for the Triton X-100 - H_2O system was measured. Figure 1 shows the phase diagram of Triton X-100 - H_2O system. The water containing a few percent of Triton X-100 takes place 2 phases at upper 66 °C. In the 2 liquids region, it is divided into upper layer with the less concentrated region of Triton X-100 and lower layer with the more concentrated region of Triton X-100.

The dispersion of carbon black and PTFE containing Triton X-100 was separated 2 liquids at upper temperature of the cloud point of Triton X-100 - H_2O system as shown Fig. 1. It is divided into upper layer with the less concentrated region of the total solid (carbon black and PTFE) and lower layer with the more concentrated region of the total solid. Many results were separated to dilute phase and thick phase. On certain conditions, the upper layer became a clear phase.

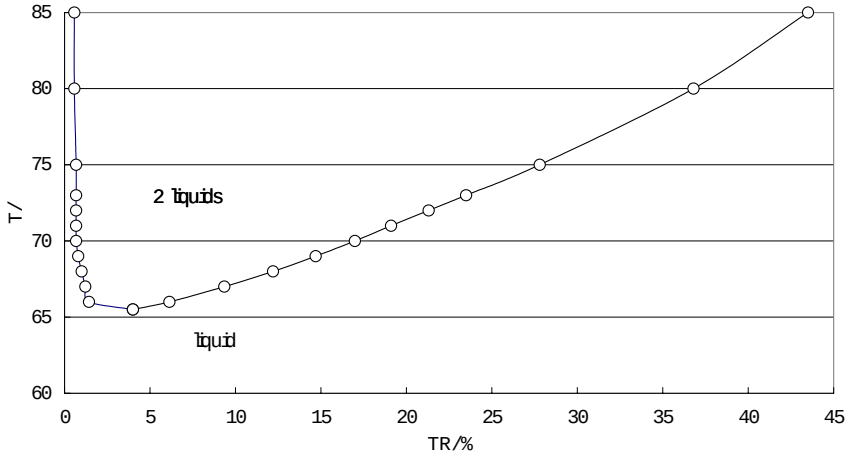

Fig. 1 *The phase diagram for the Triton X-100 - H_2O system*

Figure 2 shows separation rate of the dispersion containing various percent of Triton X-100 at 67.5 °C. The separation rate depends on heat treatment temperature and concentration of Triton X-100 in the dispersion. The separation rate is dependent on the concentration of Triton X-100. It was the most quickly separated at 7 % TR dispersion.

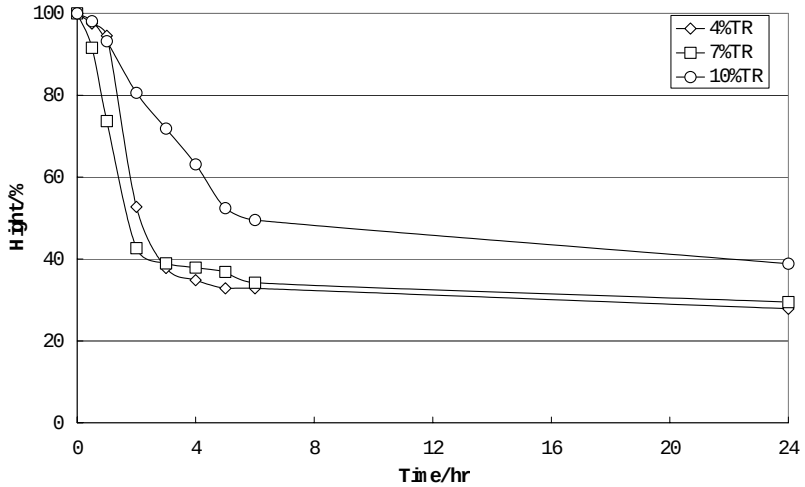

Fig. 2 *The separation rate of the dispersion at 67.5 °C.*

Figure 3 shows solid concentration of the under phase in the dispersion was treated with various temperatures for 15hr. It proves that concentration dispersion with the solid (carbon black and PTFE) over 40 wt% was possible.

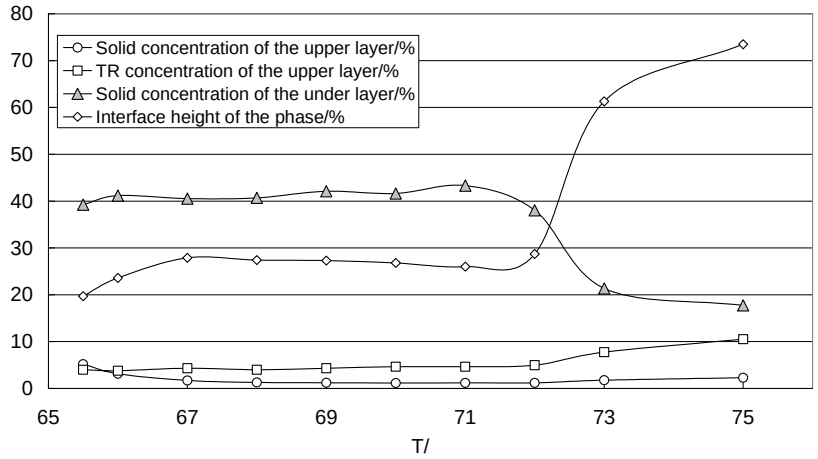

Fig. 3 *The solid concentration of the under phase of the dispersion for the heat treatment temperature for 15hr. The dispersion before the heat treatment is 4%TR.*

The concentrated dispersion was diluted at original concentration again, and then, the particle size was measured. It was almost equal to the particle size before and after heat treatment.

Conclusions

It was clarified that the ca. 10 wt% dispersion composed of carbon black and PTFE could be concentrated up to 40 wt% without flocculation by heating over its cloud point the dispersion including the Triton X-100.