

Composition analysis of the catalyst layer for PEFC

Compositional analyses of catalyst layers was conducted for the sample before and after OCV (Open Circuit Voltage) test. Structural analyses of supported carbon and electrolyte was also conducted for the same sample. The membrane electrode assembly (MEA) used for the test is composed from Nafion®112 as the electrolyte membrane, Pt/Ru as the anode catalyst, and Pt as the cathode catalyst.

1. Compositional analysis of catalyst layers

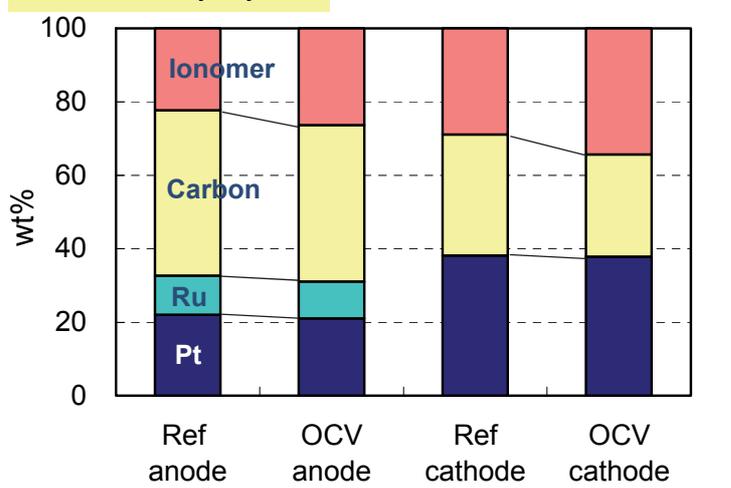
The table shows the results composition analysis. The catalyst amounts was determined by ICP-AES, and the carbon/ionomer ratio determined by elemental analysis and solid state ¹⁹F MAS NMR spectroscopy. The water content was also measured using TPD-MS.

Taking into account that the oxygen in the electrolyte is difficult to determine, the total is near 100wt%, revealing that quantitative analysis is possible.

The chart on the right shows the relative ratio of the catalyst, carbon, and electrolyte. The decrease in supported carbon after the OCV test suggests that carbon corrosion (gasification) occurred. The change was more pronounced in the cathode than in the anode.

Sample	Pt	Ru	Carbon	Ionomer	H ₂ O	Total
Ref anode	20.4	9.83	41.6	20.6	2.7	95.2
Ref cathode	33.0	—	28.5	25.0	6.0	92.5

Change in the composition ratio in the catalyst layers



◆ The degradation factors can be identified by compositional analysis.

Decrease in carbon -> Corrosion/gasification

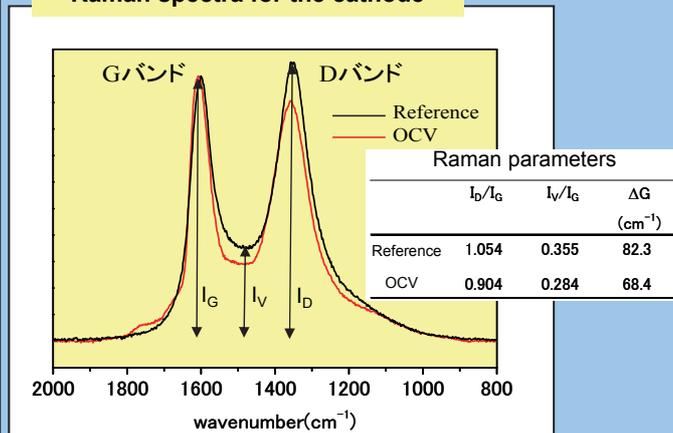
Decrease in catalyst -> Elution

Decrease in ionomer -> Decomposition/elution

2. Structural analysis of supported carbon

Raman spectra for the carbon in the cathode layer are shown below. After the OCV test, a decrease in the intensity ratios of the Raman (I_D/I_G , I_V/I_G) and G band width (ΔG) was observed. The changes may be caused by disordering of the carbon structure in the cathode.

Raman spectra for the cathode



3. Structural analysis of electrolyte

The sulfonate unit ratios and equivalent weights (EW) of the electrolyte membrane and the ionomer were obtained by solid state ¹⁹F MAS NMR. After the OCV test, an increase in the unit ratios on the main chain and decrease in the side chain were observed in the cathode and electrolyte membrane. The trend was more pronounced in the cathode.

Unit ratio analysis for the electrolyte by solid state NMR spectroscopy

