

Evaluation of the aggregate state and the molecular mobility of the ionomer in the solution for PEFC

When fabricating a fuel cell catalyst layer, the power generation performance is varied by changing the solvent used for the ionomer solution. It is possible to analyze the molecular size/mobility in ionomer solutions with different solvent compositions, which is useful in studying the relationship between the ionomer solution conditions and power generation performance.

Purpose of analysis and samples

➤ Purpose of analysis

To analyze how solvent compositions affect the dispersion level and molecular mobility of a fluorinated ionomer (Nafion®) in solvents.

➤ Samples

- Sample1 5% Nafion® / 15% H₂O / 80wt% ROH
- Sample2 5% Nafion® / 45% H₂O / 50wt% ROH
- Sample3 10% Nafion® / 90% H₂O

*ROH: Lower alcohol

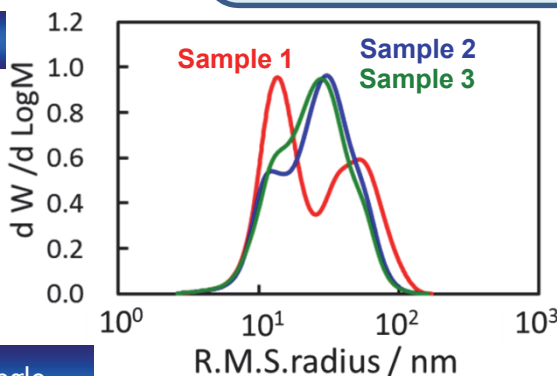
Molecular size analysis by GPC-MALS

➤ What is GPC-MALS

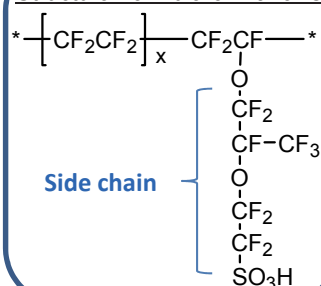
Molecular sizes (R.M.S. Radius, mean square radius) can be obtained by multi-angle light scattering (MALS).

➤ Comparison between samples

In Sample1 with a high alcohol content, the number of large-size molecules of aggregated Nafion® is small.



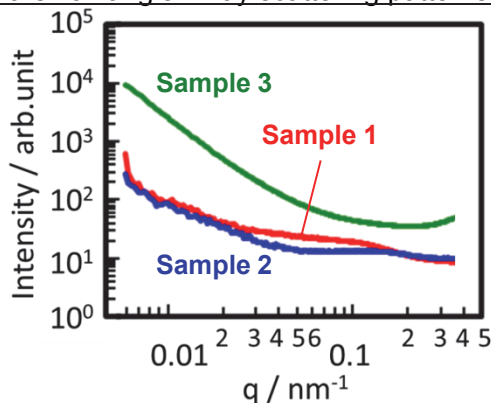
Structural formula of Nafion®



Domain size analysis by ultra-small angle X-ray scattering (USAXS)

The aggregation level is higher in Sample3 where the solvent contains only water.

Ultra-small angle X-ray scattering patterns (USAXS)



Molecular mobility analysis by ¹⁹F NMR relaxation time T₂

➤ What is relaxation time

The NMR relaxation time T₂ is a parameter that reflects molecular mobility. In similar samples, a longer T₂ is considered to indicate a higher molecular mobility.

➤ Comparison between samples

Components with different mobilities are present; the mobilities are low in some components due to aggregation, etc. The molecular mobilities are high in both the main and side chains in Sample1 with a high alcohol content.

Sample	Particle diameter	Interparticle distance
Sample 1	27 nm	92 nm
Sample 2	27 nm	81 nm
Sample 3	Large aggregated particles of several hundred nm or larger which exceed the USAXS measurement limit are present.	

Solid-state ¹⁹F NMR relaxation time (T₂) measurements

