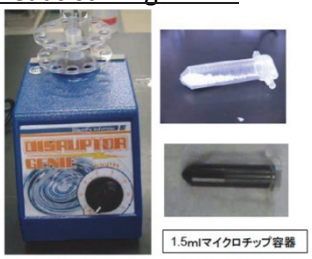
PEFC Dispersion state of catalyst ink

Dispersion state of catalyst ink affects the cell performance of PEFC, and it can be evaluated by particle size distribution, Synchrotron SAXS and NMR, which provide the information about the dispersion state of catalyst-supported carbon and ionomer, and the molecular mobility of ionomer

Catalyst ink sample

- Catalyst ink with same carbon-supported catalyst, ionomer and solvent but different stirring method
- Better performance with catalyst ink A than catalyst ink B（Sample and the PEFC performance data were provided by Prof. Hori, Daido university)

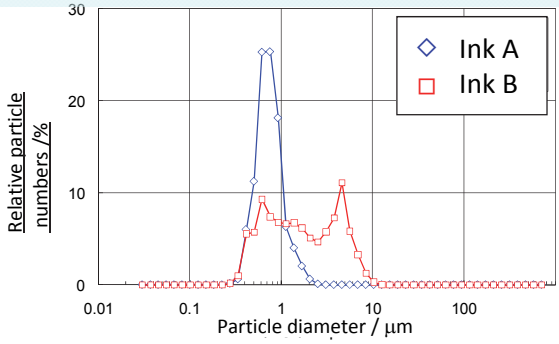
Beads stirring : Ink A



Mechanical stirring : Ink B

Particle size distribution (light diffraction)

- Ink A possesses narrow distribution around several hundred nm
- Ink B possesses 2 peaks, one is around several hundred mm, the other is around several hundred nm

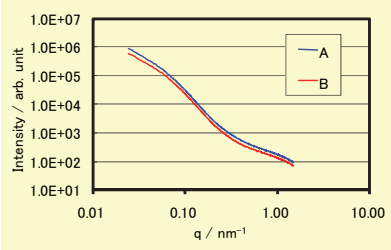


Synchrotron SAXS

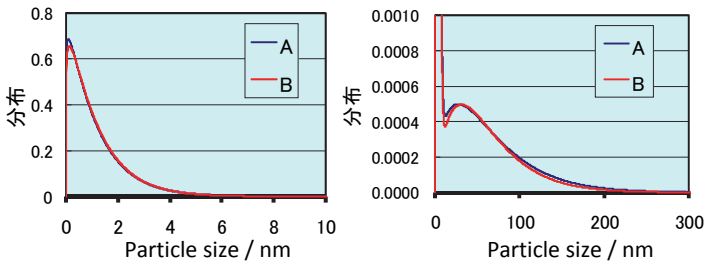
- Detectable size : several to several hundred nm domain size
- Domain size of 1-2 nm is assigned to catalyst particle and 60-70 nm is assigned to ionomer

SAX

- Almost same particle size distribution between samples
- Mixture of particles more than 2 sizes



Particle size distribution (Assumption of 2 particle with different size)



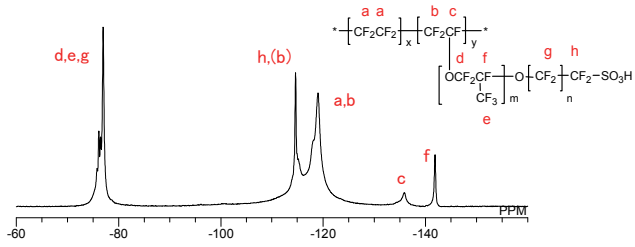
Ink		Particle size / nm		Volume fraction
		average	Most frequent	
A	Component 1	1.2	0.1	95.41
	Component 2	66.6	27.6	4.59
B	Component 1	1.2	0.1	95.75
	Component 2	62.8	31.1	4.25

Analysis of ionomer in the catalyst ink (NMR)

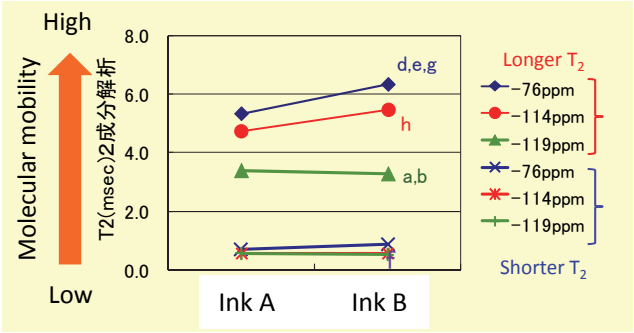
Two ionomer components with different molecular mobility

- 10 % in Ink A and 15 % in Ink B are ionomer with higher molecular mobility (-119 ppm : F in the main chain)
- Ink B has inhomogeneous dispersion including aggregate and isolated ionomer

^{19}F MAS NMR spectrum of Ink A



Relaxation time T2 of ^{19}F



This work was partially commissioned by the New Energy and Industrial Technology Development Organization (NEDO) of Japan.