



Your Dreams, Our Challenge

Introduction of New Generation Membrane FLEMION™ F-9010

March, 2019
Membrane Business Division
AGC Chemicals

CREATION THROUGH SEPARATION



Key Technologies of New Generation Membrane F-9010 **AGC**

Key Words

◆ High CD Operation

- Increment of Cell Voltage
- Increment of Mass Flow
- Fluctuation of Anolyte / Catholyte Concentration

◆ Zero-Gap Electrolyzer

- Increment of NaOH Concentration at Membrane Surface
- High Membrane Temperature
- Direct Touch to Cathode

Concept

Low Voltage

Wider Operational Range

Higher Robustness

Higher Durability against Brine Impurities

Suitability for Zero-Gap

Key Technologies

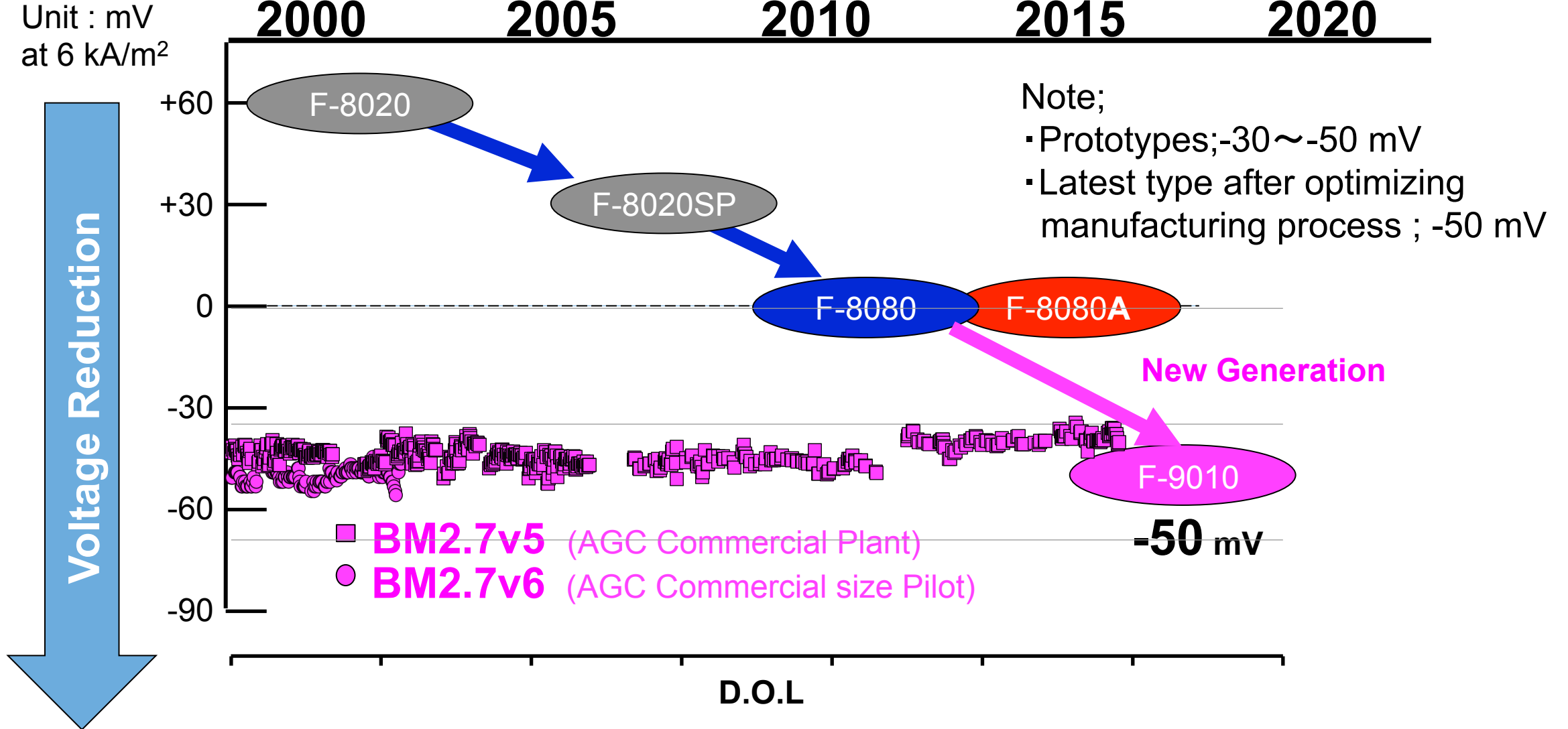
New Cloth

New Sulfonic Polymer Layer

New Ion Channel

Others

Voltage of F-9010 in Commercial Electrolyzer (AGC)

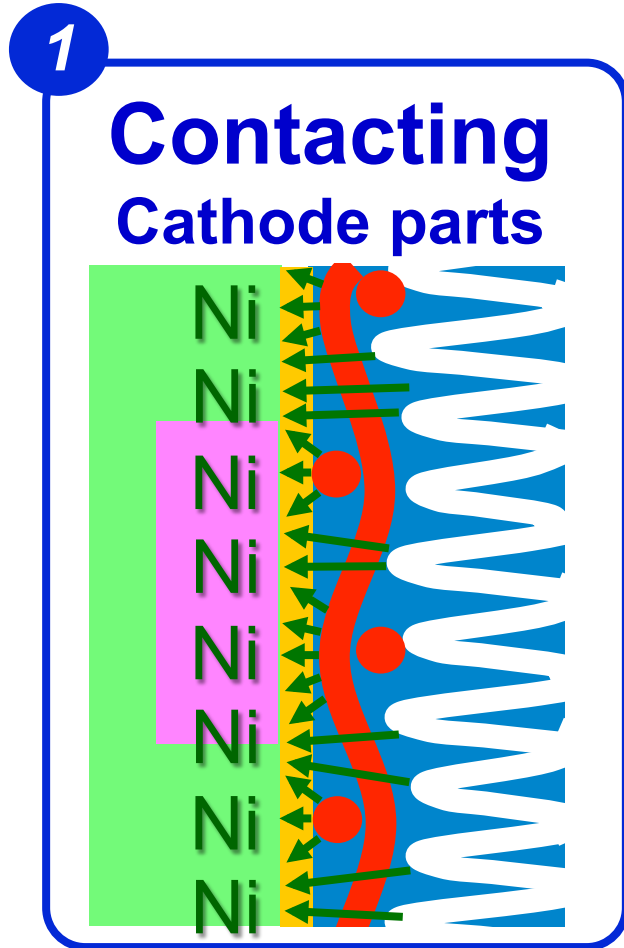


Prototypes of new generation membrane keep stable low voltage in AGC commercial electrolyzer more than 3 years.

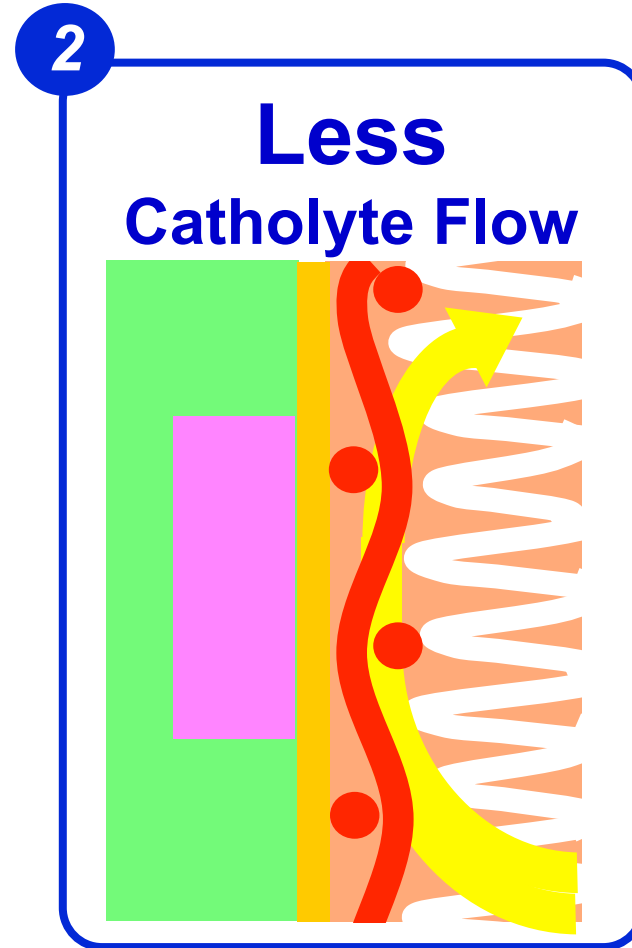
Voltage of F-9010 in Commercial Electrolyzers

	Area	Electrolyzer Type	MOL		Comparison	Current Density (kA/m ²)
A	SEA	CEC n-BiTAC	20	3 sheets	-80 mV vs. F-8080A	5.3 kA/m ²
B	China	AK NCZ	10	4 sheets	-20 mV vs. Comp.-1	4 kA/m ²
C	China	CEC n-BiTAC	13	2 sheets	-60 mV vs. F-8080A	5.5 kA/m ²
D	China	CEC n-BiTAC	10	4 sheets	-40 mV vs. Comp.-2	5.5 kA/m ²
E	Europe	UHDE Gen5	12	10 sheets	-60 mV vs. F-8080A	6 kA/m ²
F	SEA	UHDE Gen5	11	6 sheets	-40 mV vs. F-8080A	6 kA/m ²
G	North America	UHDE Gen5	12	4 sheets	-50 mV vs. F-8080	6 kA/m ²
H	Japan	UHDE Gen5+	13	186 sheets	-70 mV vs. F-8080A	6 kA/m ²
I	Japan	CEC n-BiTAC	11	70 sheets	-50 mV vs. F-8080A	6 kA/m ²
J	Japan	CEC BiTAC	12	25 sheets	-30 mV vs. Comp-2	5 kA/m ²
K	North America	CEC BiTAC	8	4 sheets	-30~40 mV vs. Comp-2	5 kA/m ²
L	North America	CEC BiTAC	6	4 sheets	-100 mV vs. Comp-3	5 kA/m ²

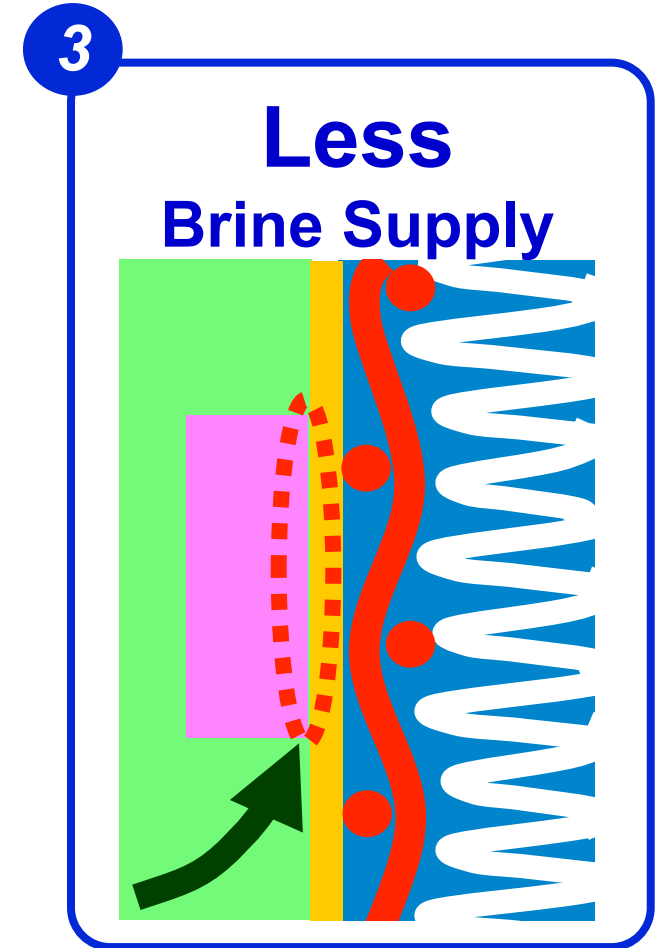
“Zero gap” has **Three** Key Points



1 Ni stain



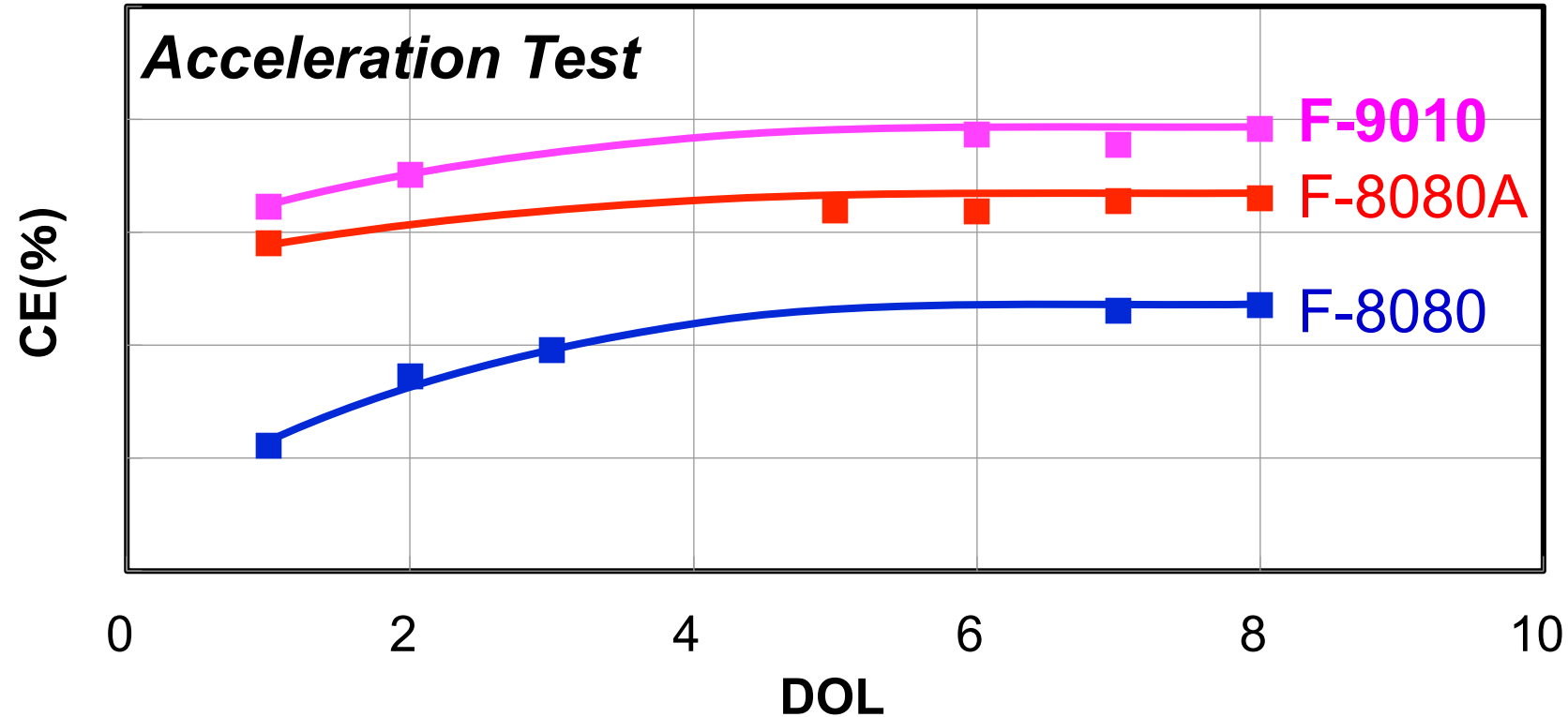
2 High Temperature



3 Weak brine

Durability against Ni Stain(for Zero Gap)

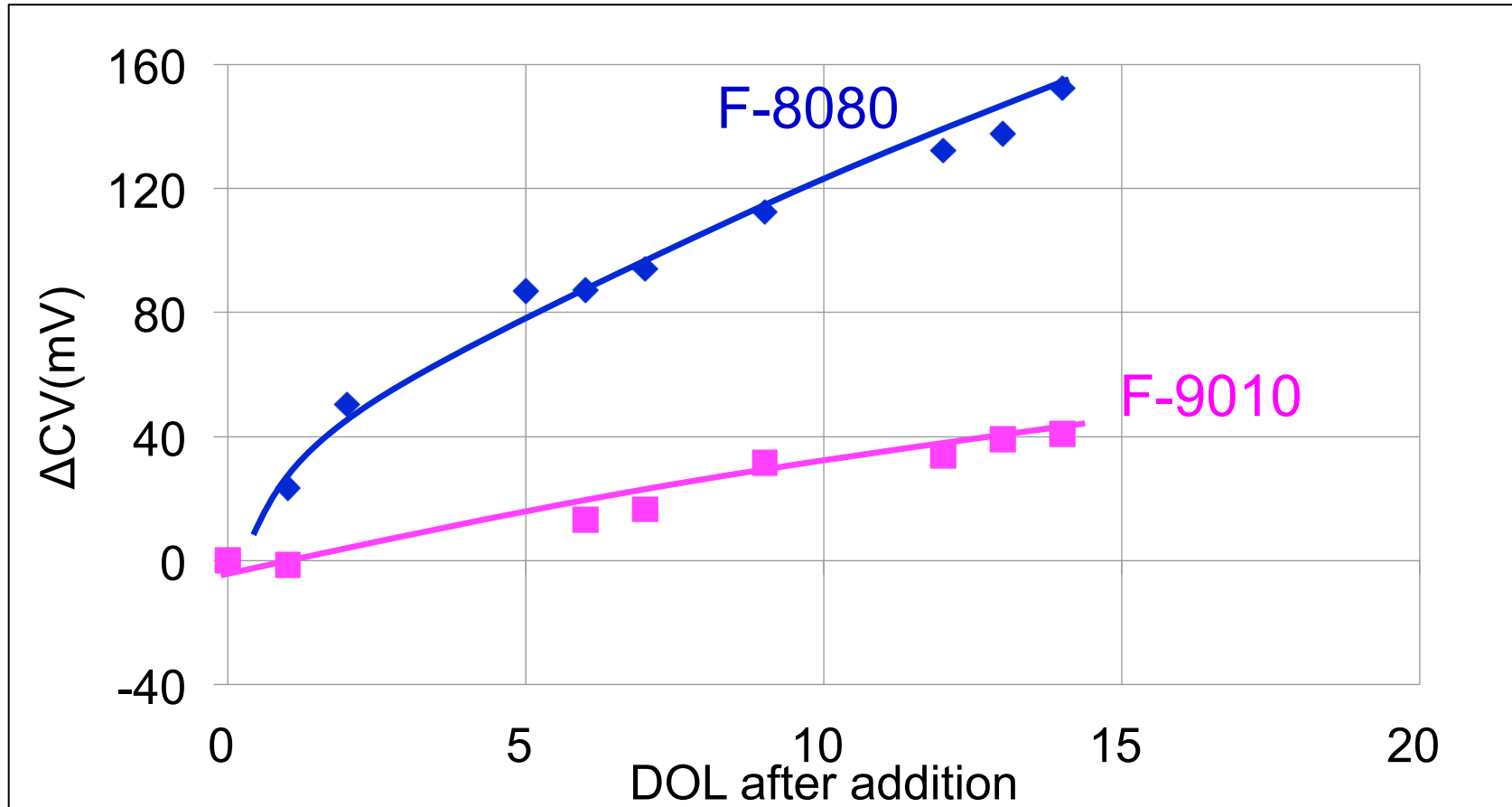
6 kA/m², 90 °C, 32 wt% NaOH,



F-9010 shows higher stability of CE against Ni stain.

“New Ion Channel” is applied!

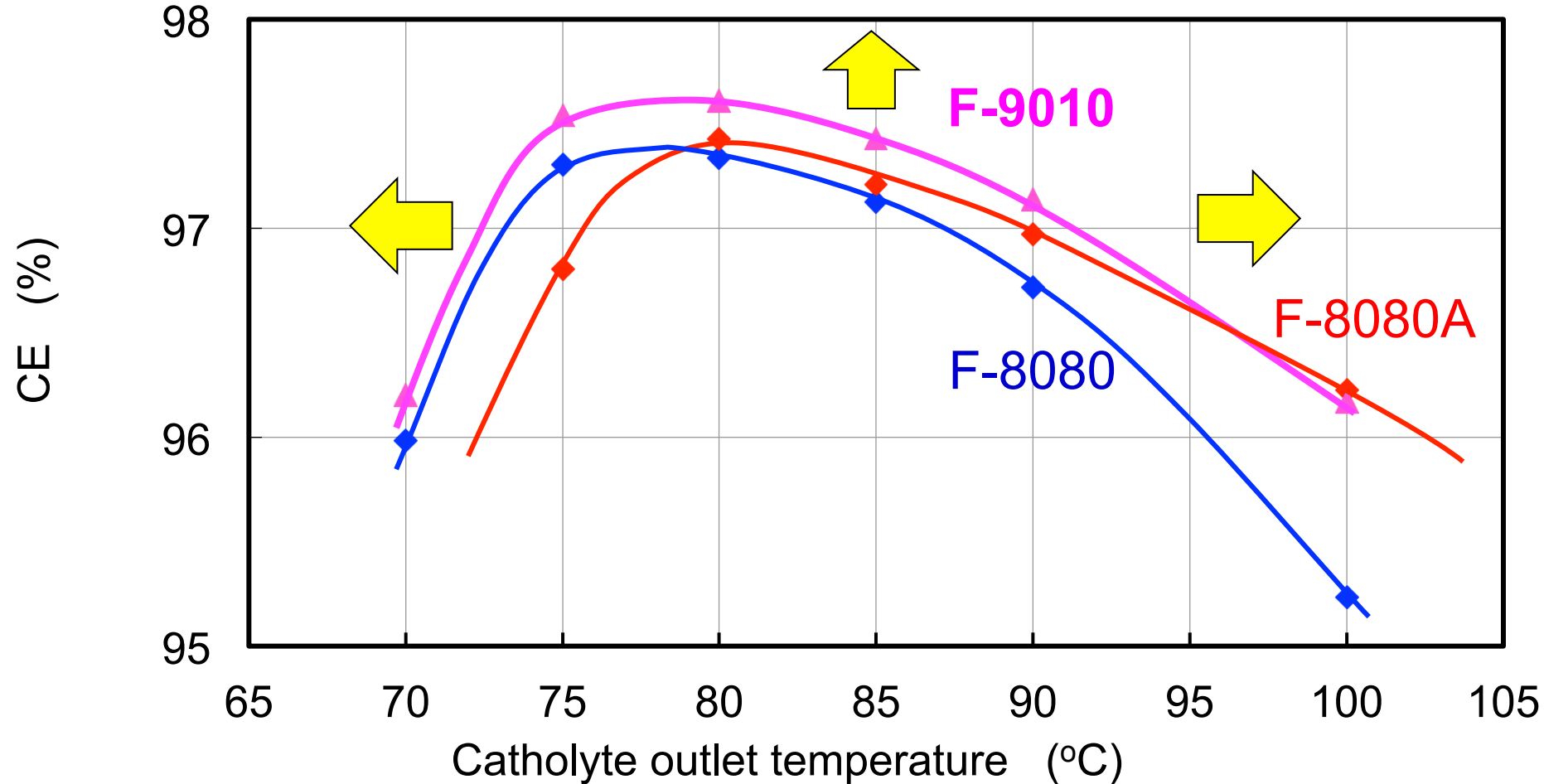
8 kA/m², 90 °C, 32 wt% NaOH, Ni=0.1 ppm



F-9010 has higher stability of CV against Ni.

Higher CE in Wider Temperature Range

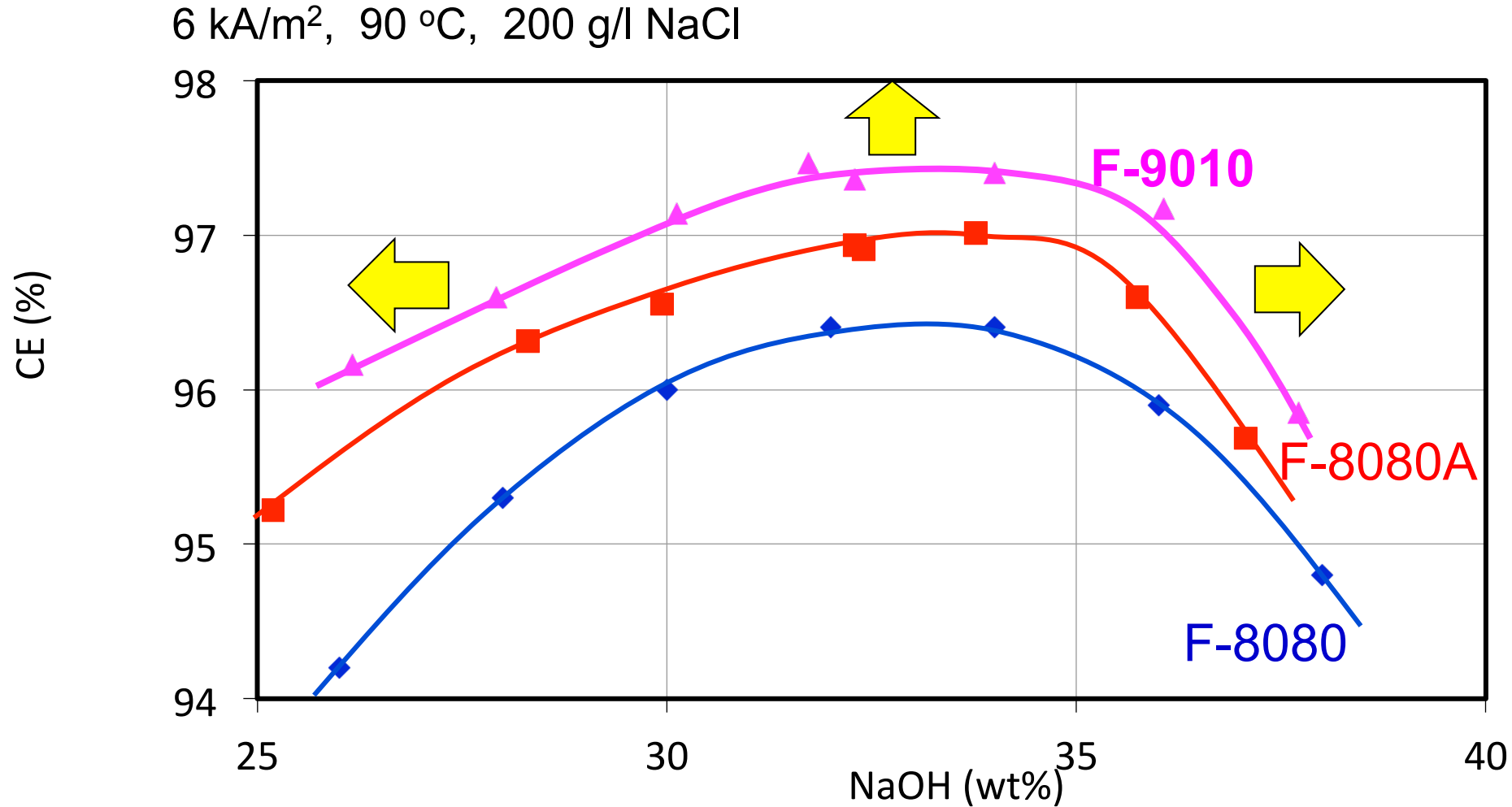
6 kA/m², 32 wt% NaOH, 200 g/l NaCl



F-9010 shows higher CE

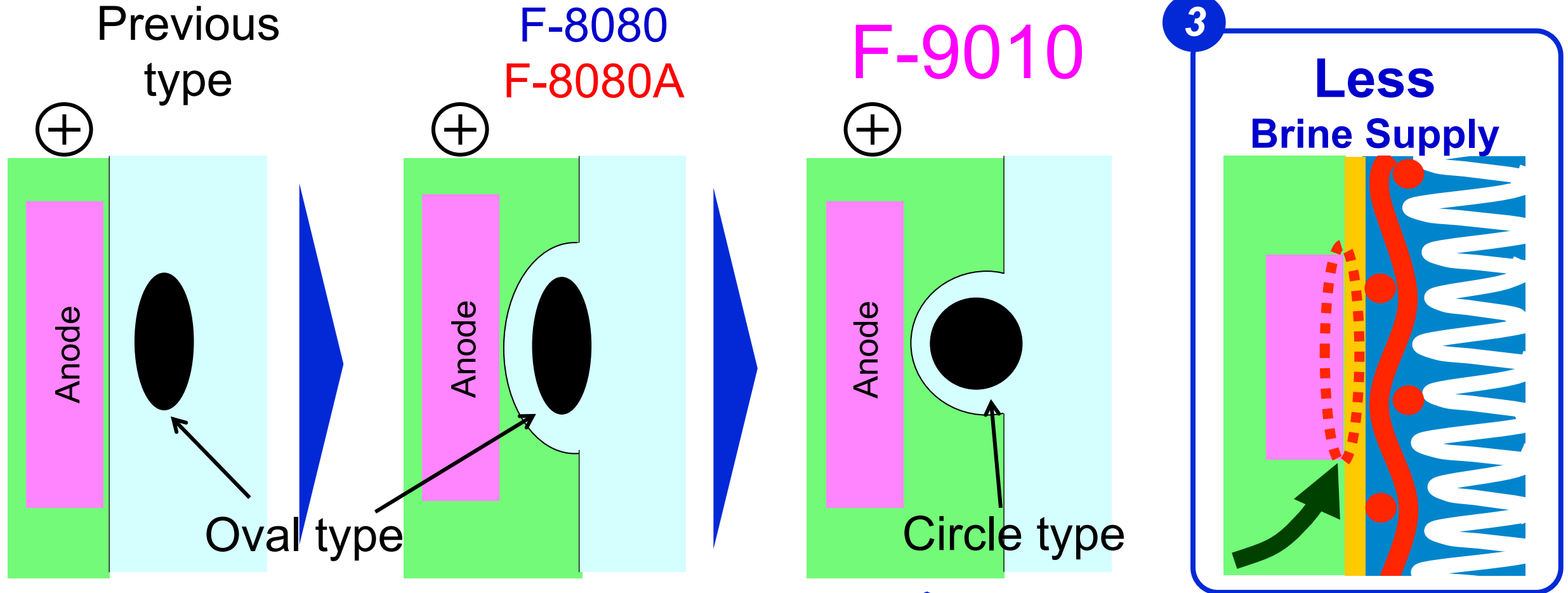
not only at high temperature but also at low temperature.

Higher CE in Wider Range of Caustic Strength



F-9010 shows higher CE in weak and strong caustic.

Proper Surface Shape Cause Good Brine Supply



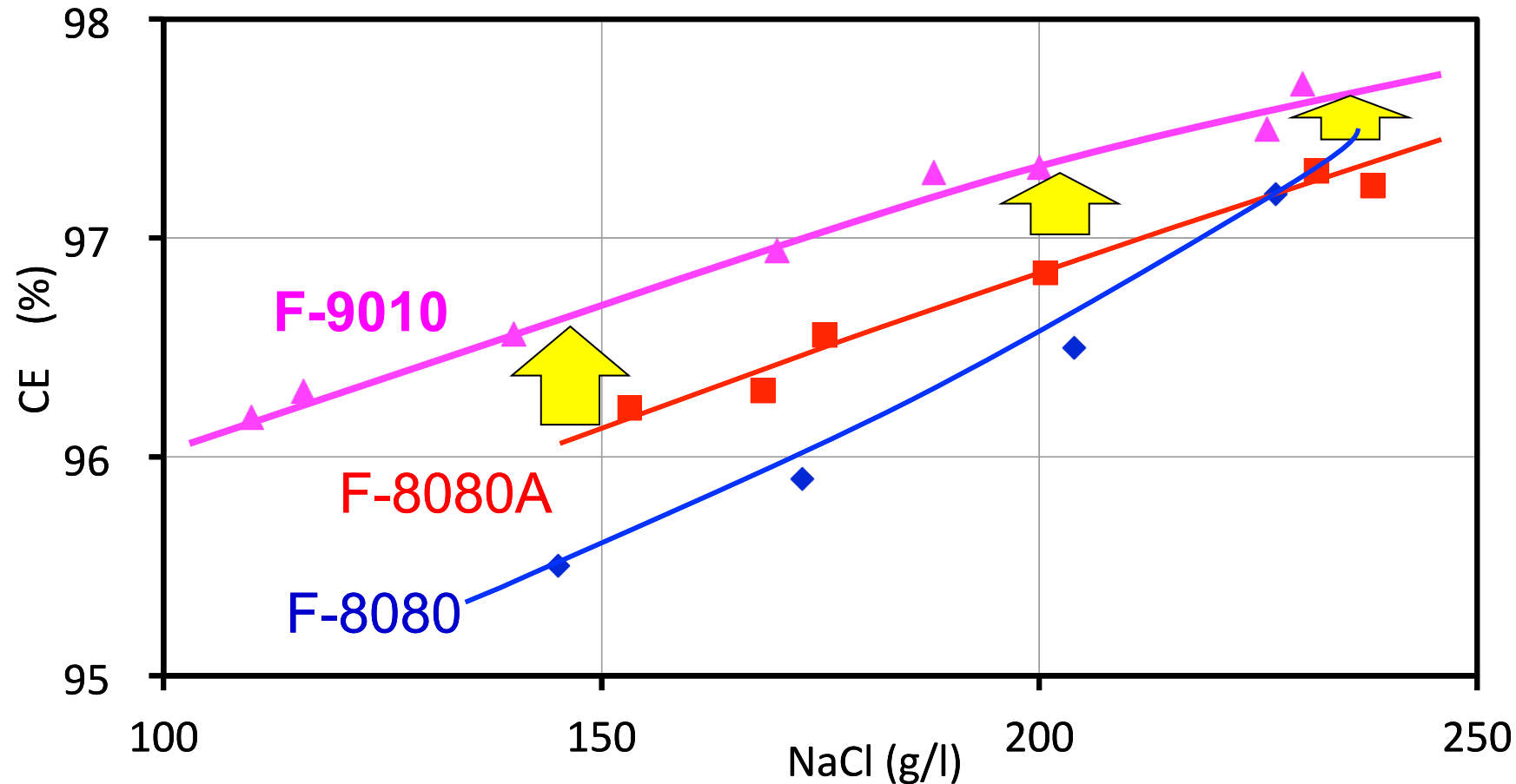
Good Brine Supply

Note) It also shows good supply of added HCl !

3 Weak brine

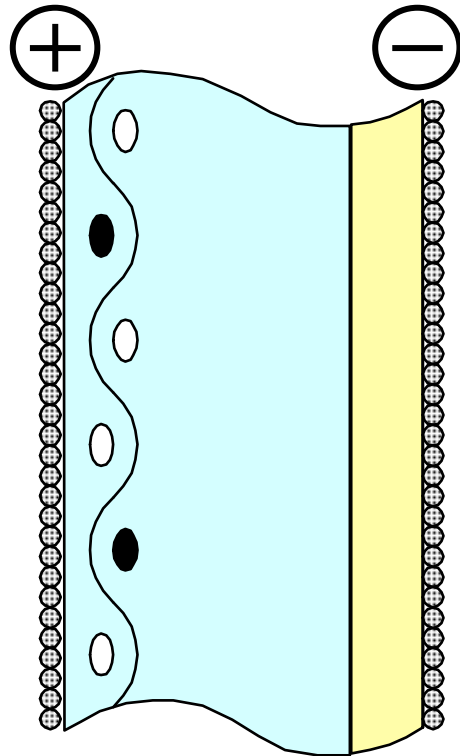
Higher CE in Weak Brine

6 kA/m², 90 °C, 32 wt% NaOH



F-9010 shows higher CE in weak brine.

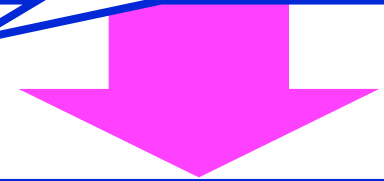
It is suitable for electrolyzers which have less inner circulation of brine.



- Reduction of Membrane Thickness
- Improvement of Reinforcement
- Optimization of Polymer
- Improvement of Surface Coating

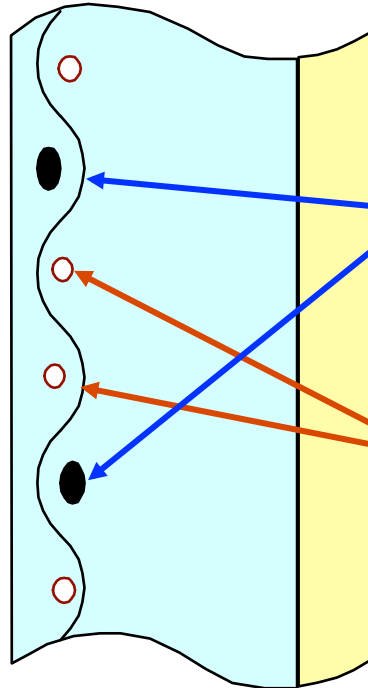
Key point

“Shadow influence”



How to reduce
“Shadow influence”
with
“New Cloth”?

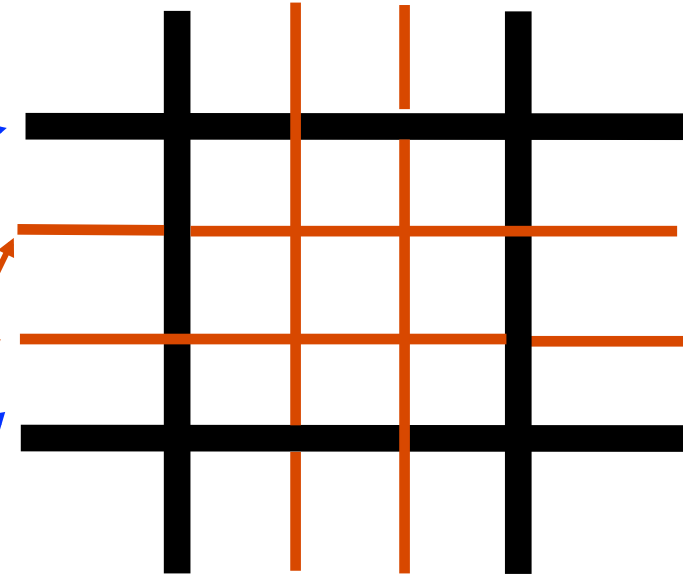
Cross Section



Permanent Fiber
(PTFE fiber)

Sacrificial Fiber
(PET fiber)

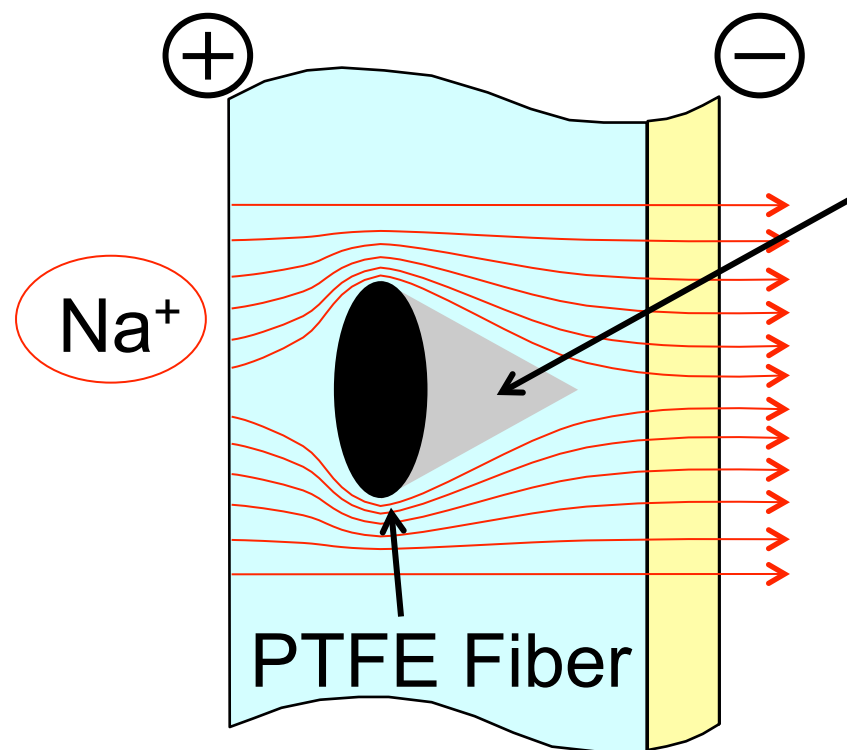
Plane Figure



Note;

- F-8080 and F-8080A have standard reinforcing cloth
- PET fiber dissolves under the electrolysis

Standard Cloth : 1) Plain-woven fabric 2) PTFE and PET fiber.



“Shadow”

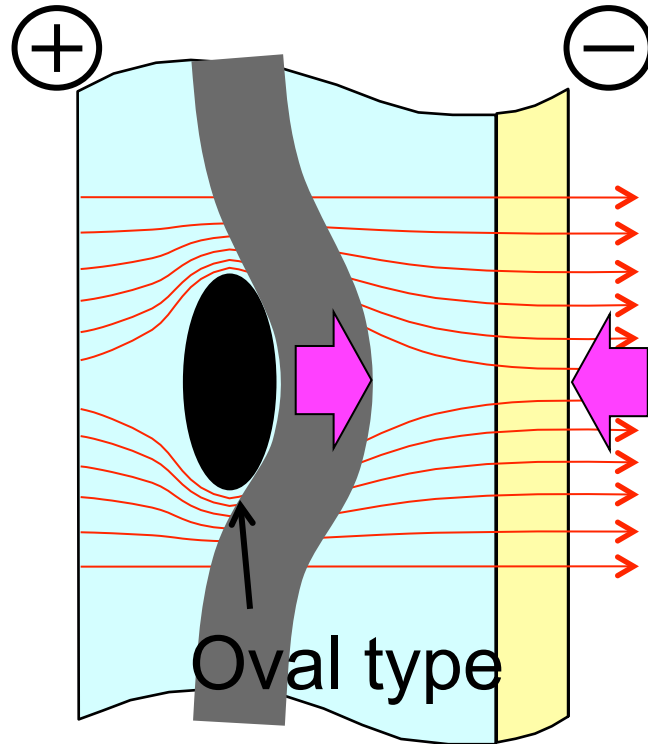
PTFE fiber interferes the Na^+ migration which causes the increase of the cell voltage.

How to reduce the shadow influence?

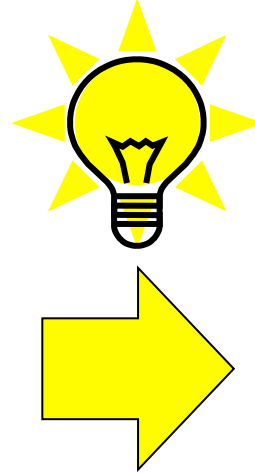
Two kinds of tech. !!

How to Reduce the Shadow Influence (1)

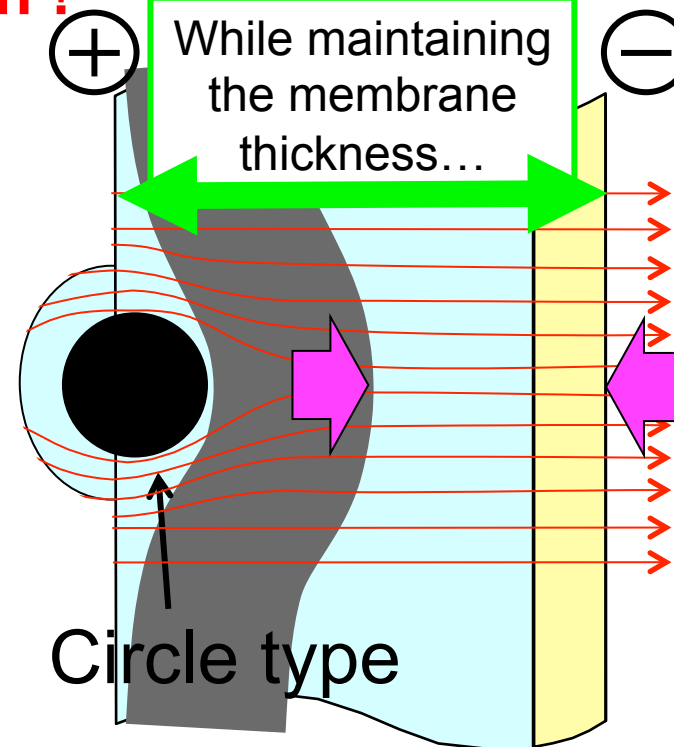
Conventional Cloth



Breakthrough !

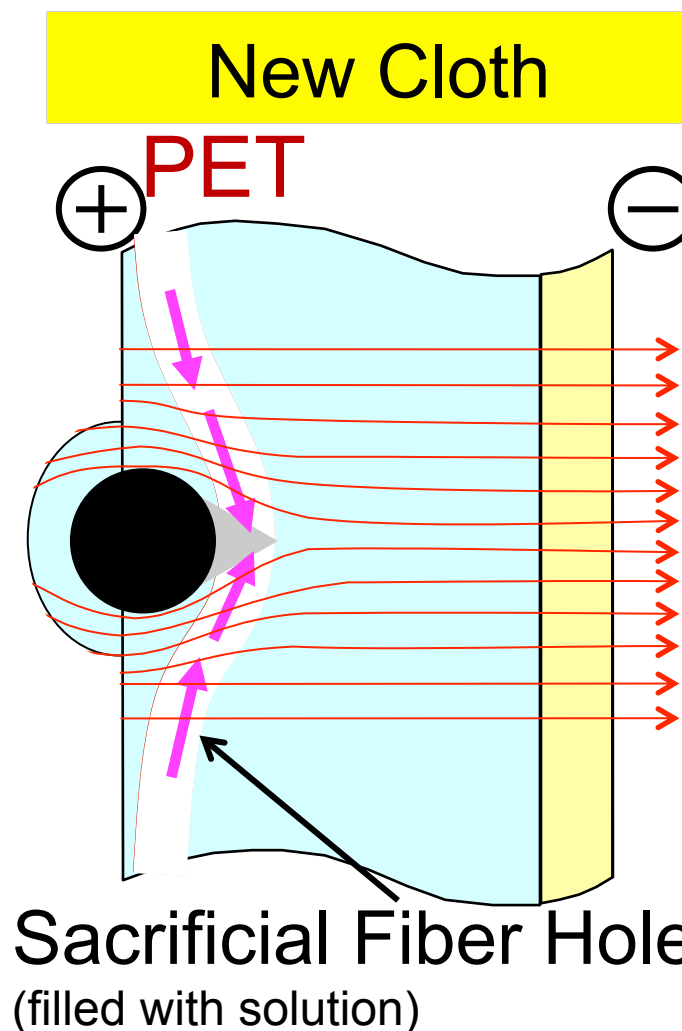
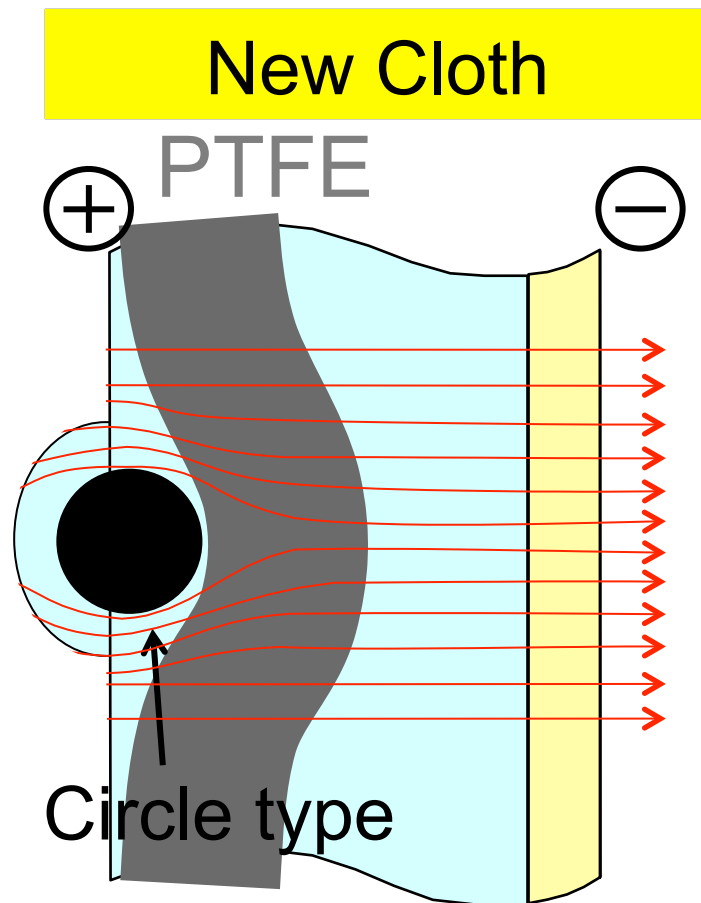


New Cloth



Proper surface shape reduces cell voltage !

How to Reduce the Shadow Influence (2)

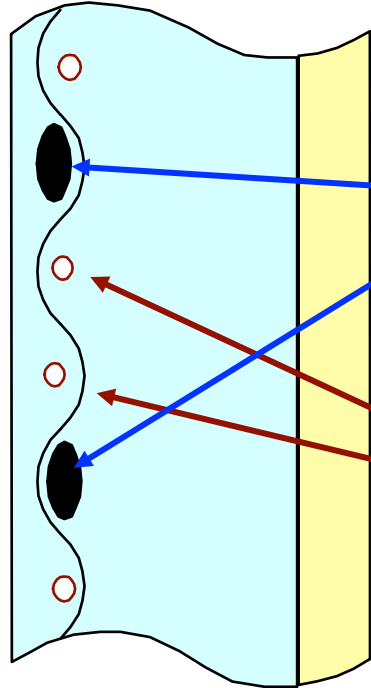


PET fiber dissolves under the electrolysis and makes sacrificial fiber holes, which reduce the shadow influence.

How to Reduce the Shadow Influence (2)

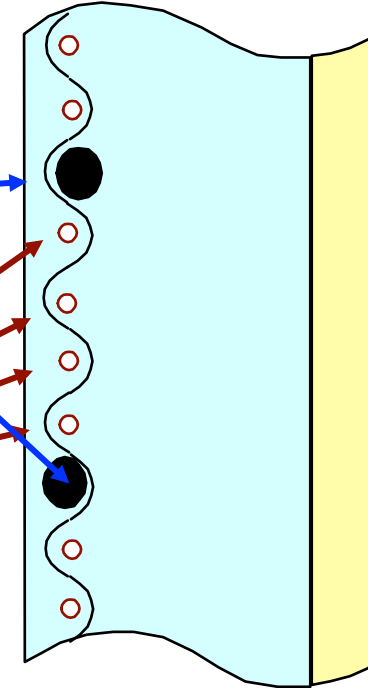
Conventional Cloth

F-8080/F-8080A



New Cloth

F-9010



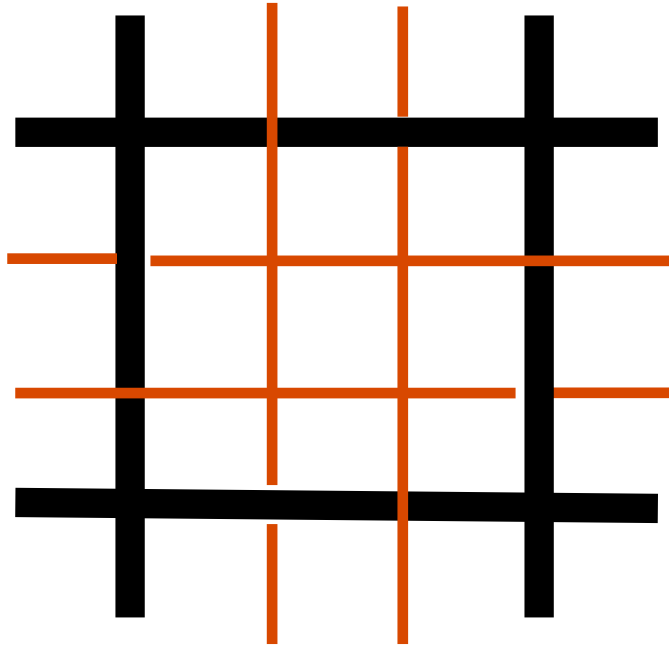
PTFE Fiber

PET Fiber

New cloth has 4 PET fibers between PTFE fibers, which reduce the shadow influence more.

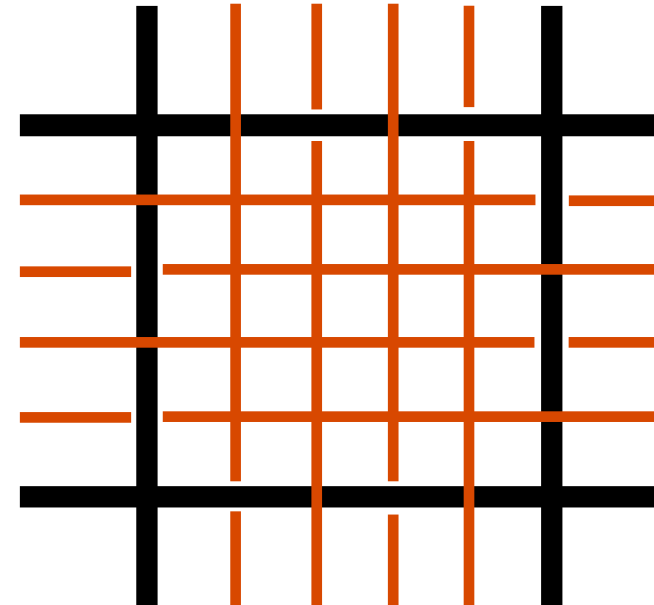
Conventional Cloth

F-8080/F-8080A



New Cloth

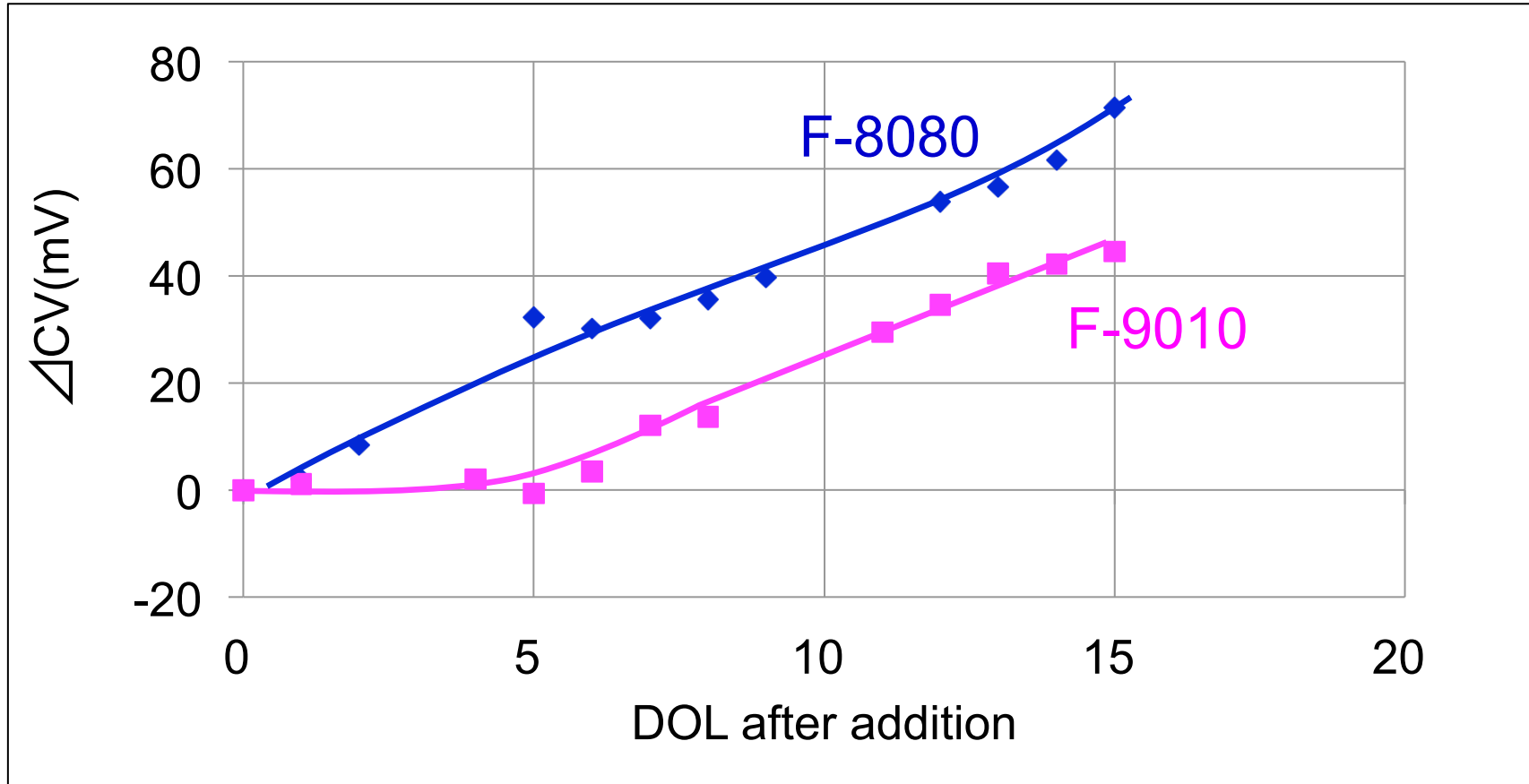
F-9010



New cloth reduces the shadow influence more and makes F-9010 show lower voltage.

Note; New cloth is a part of voltage reduction technologies.

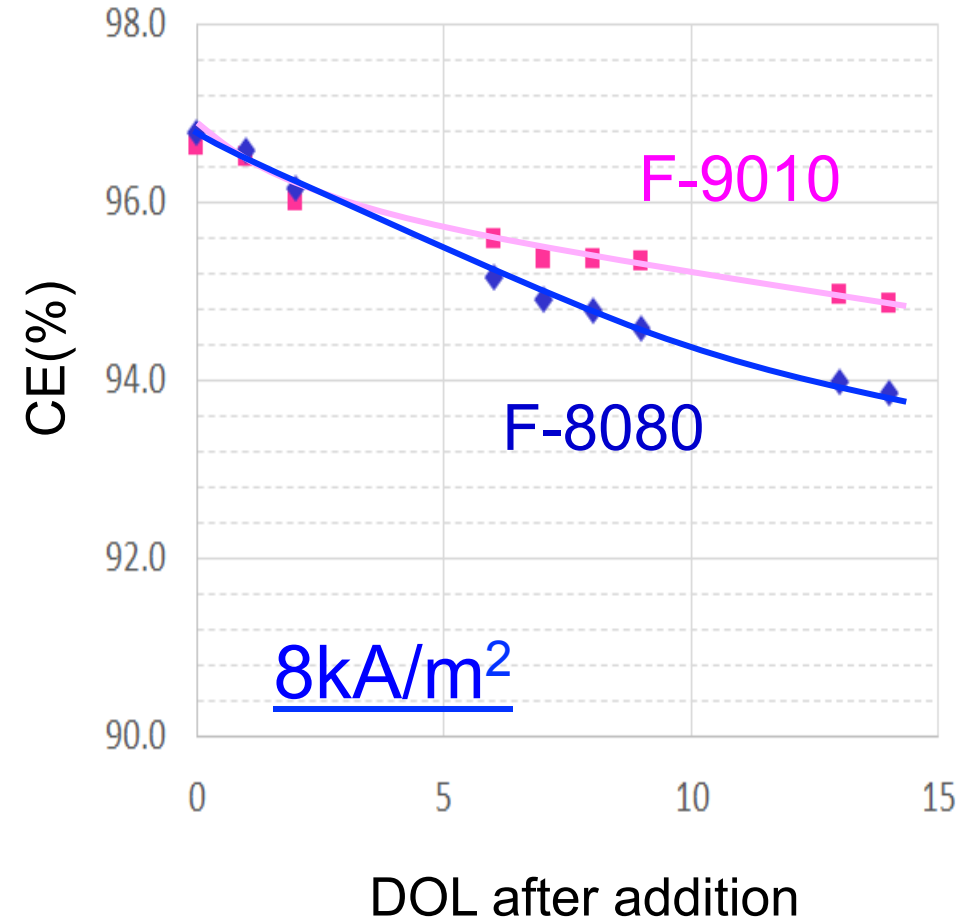
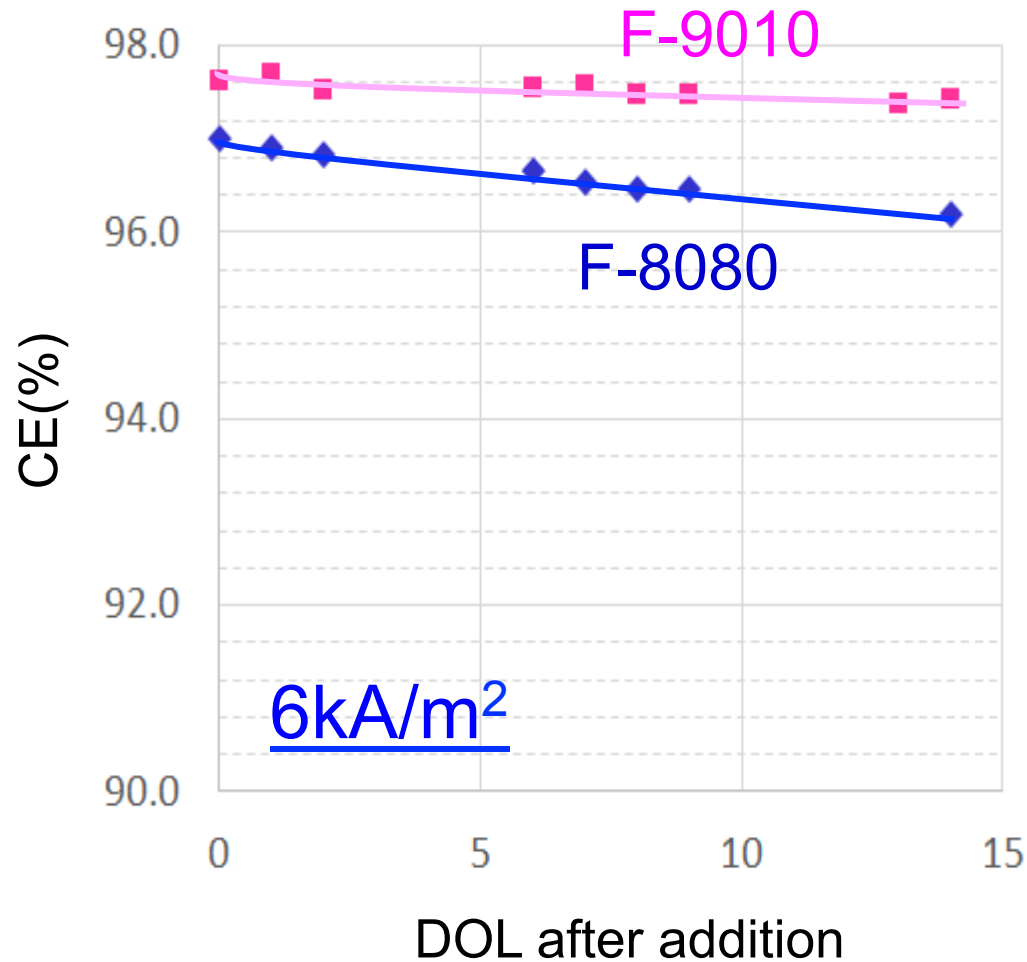
8 kA/m², 90 °C, 32 wt% NaOH, Mg=0.1 ppm



F-9010 has higher stability of CV against Mg.

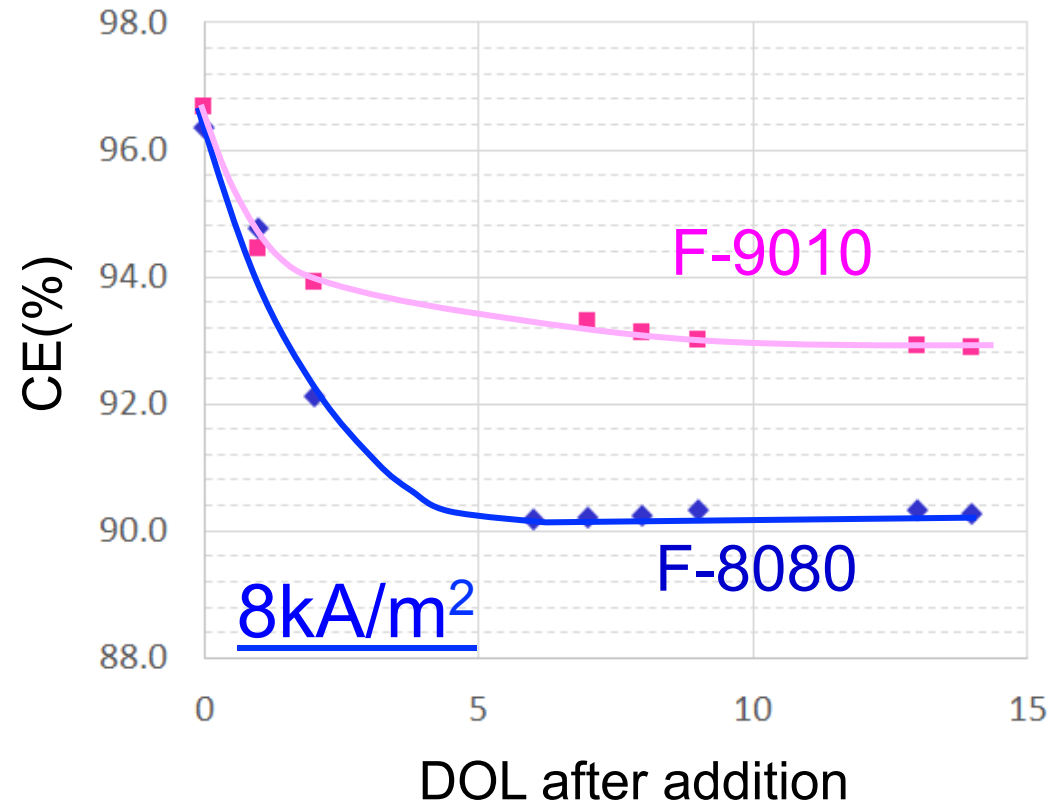
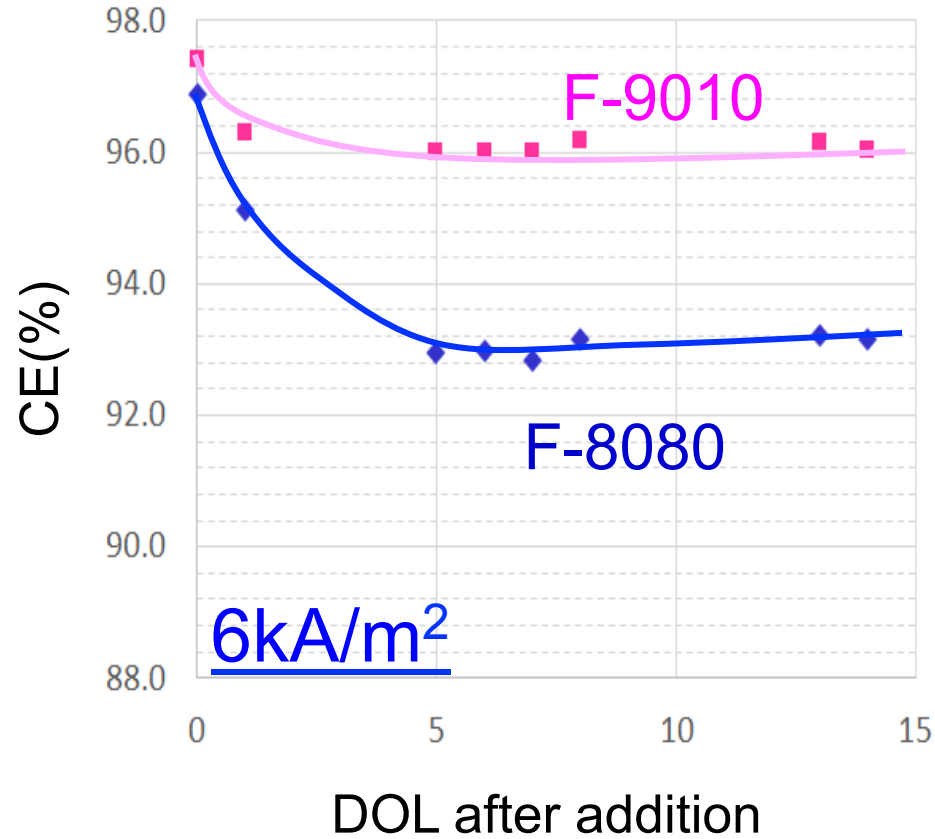
Durability against Al/SiO₂

85 °C, 32wt% NaOH, Al/SiO₂=1/30ppm



Durability against Ca/SiO₂

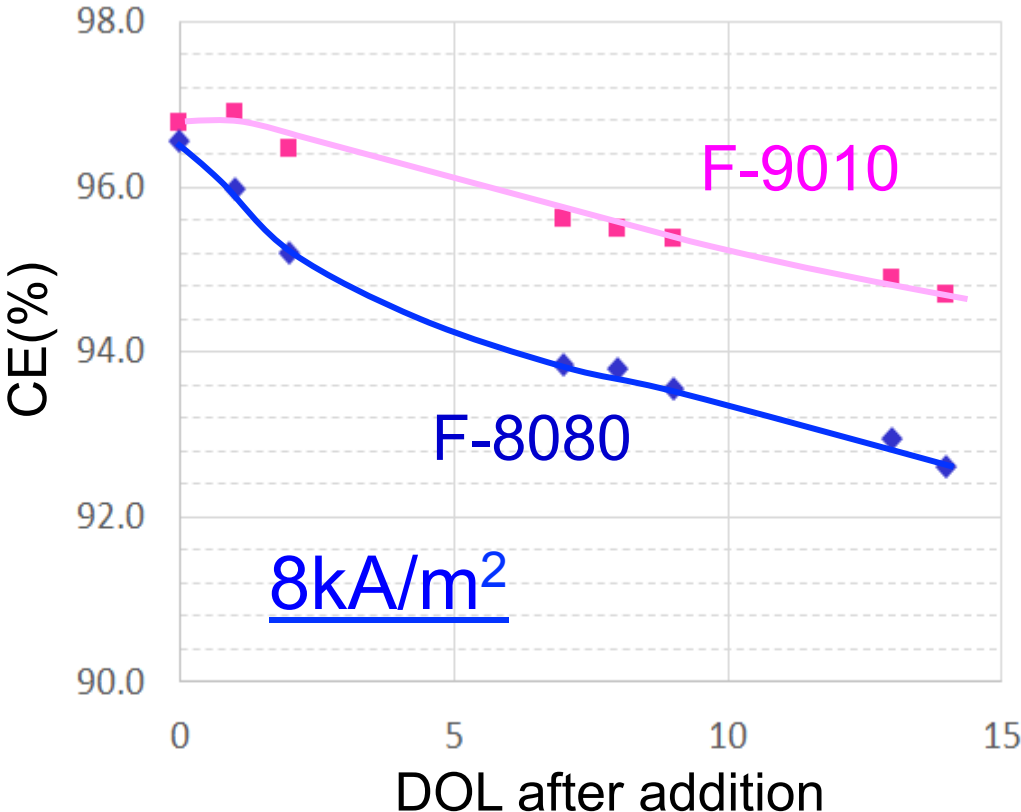
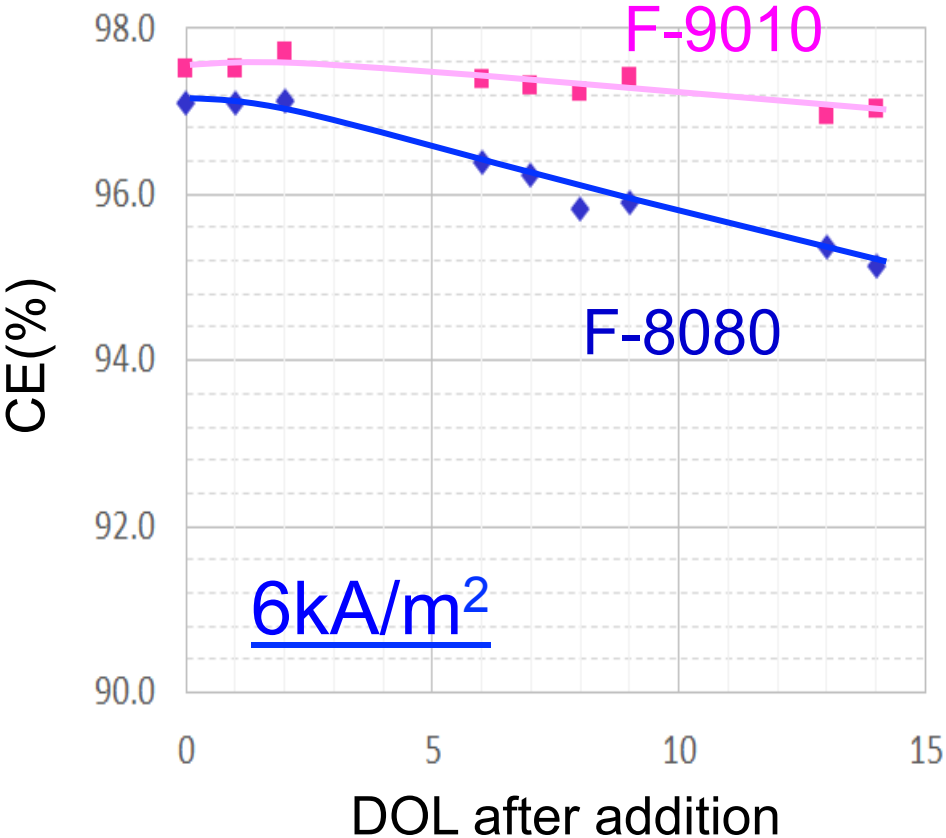
85 °C, 32wt% NaOH, Ca/SiO₂=0.05/15ppm



Durability against I/Ba

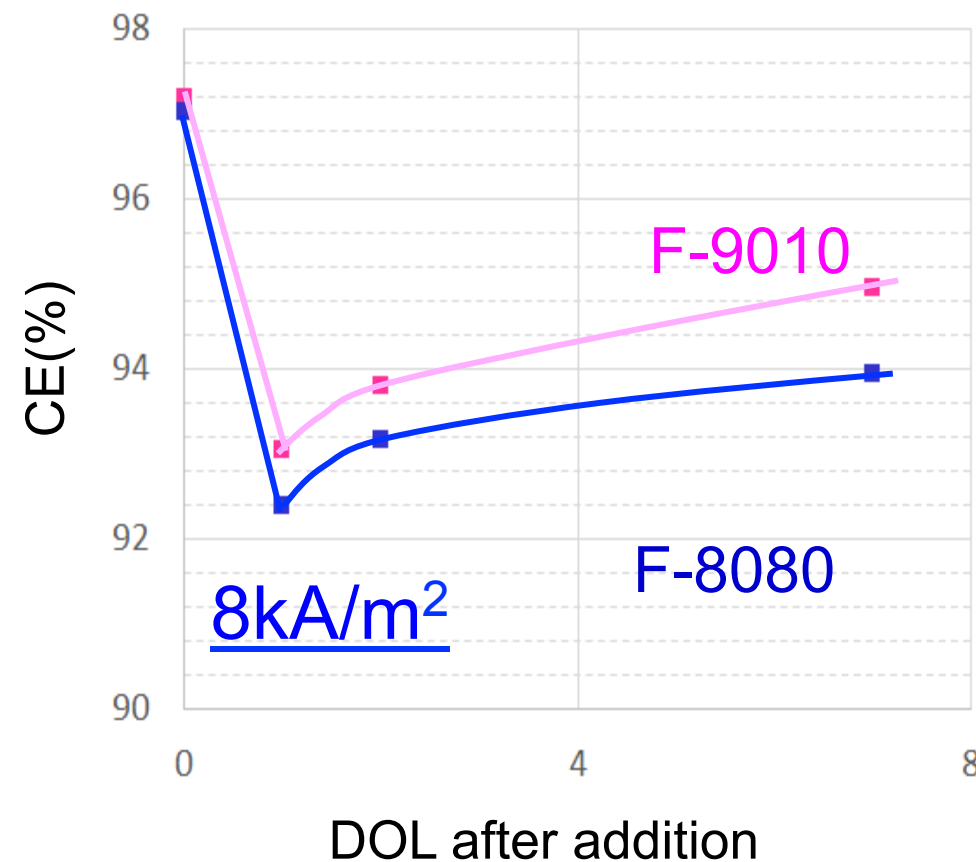
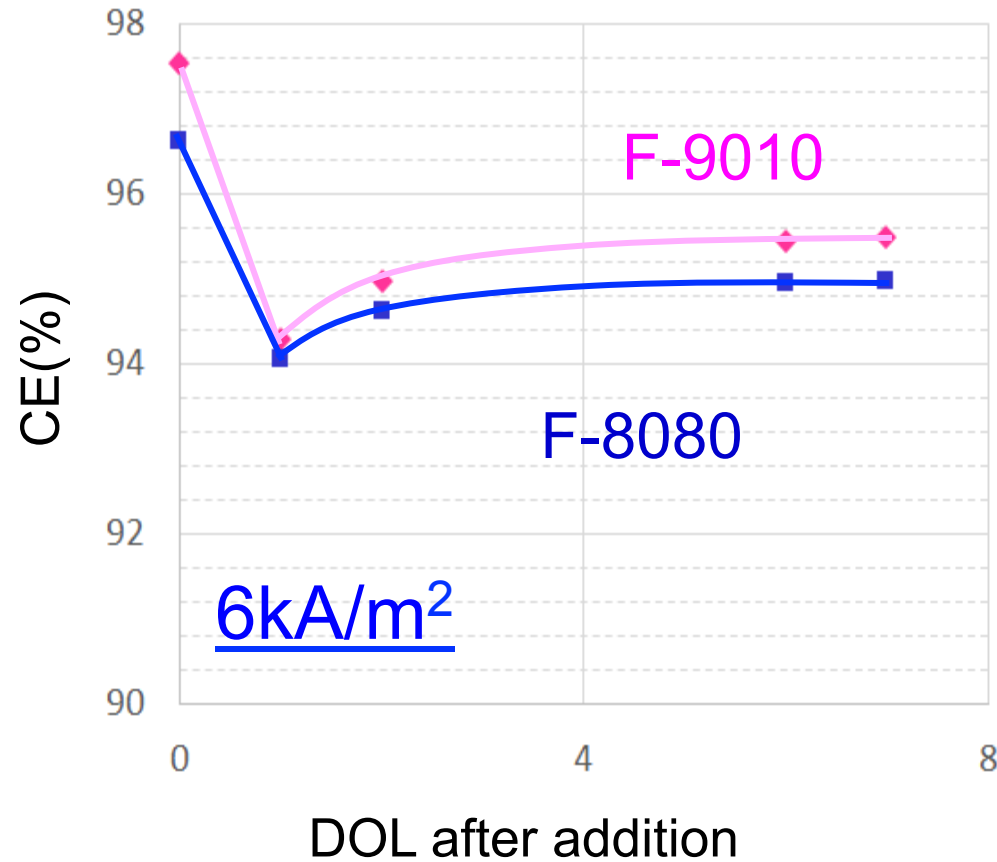


85 °C, 32wt% NaOH, I/Ba=20/1ppm

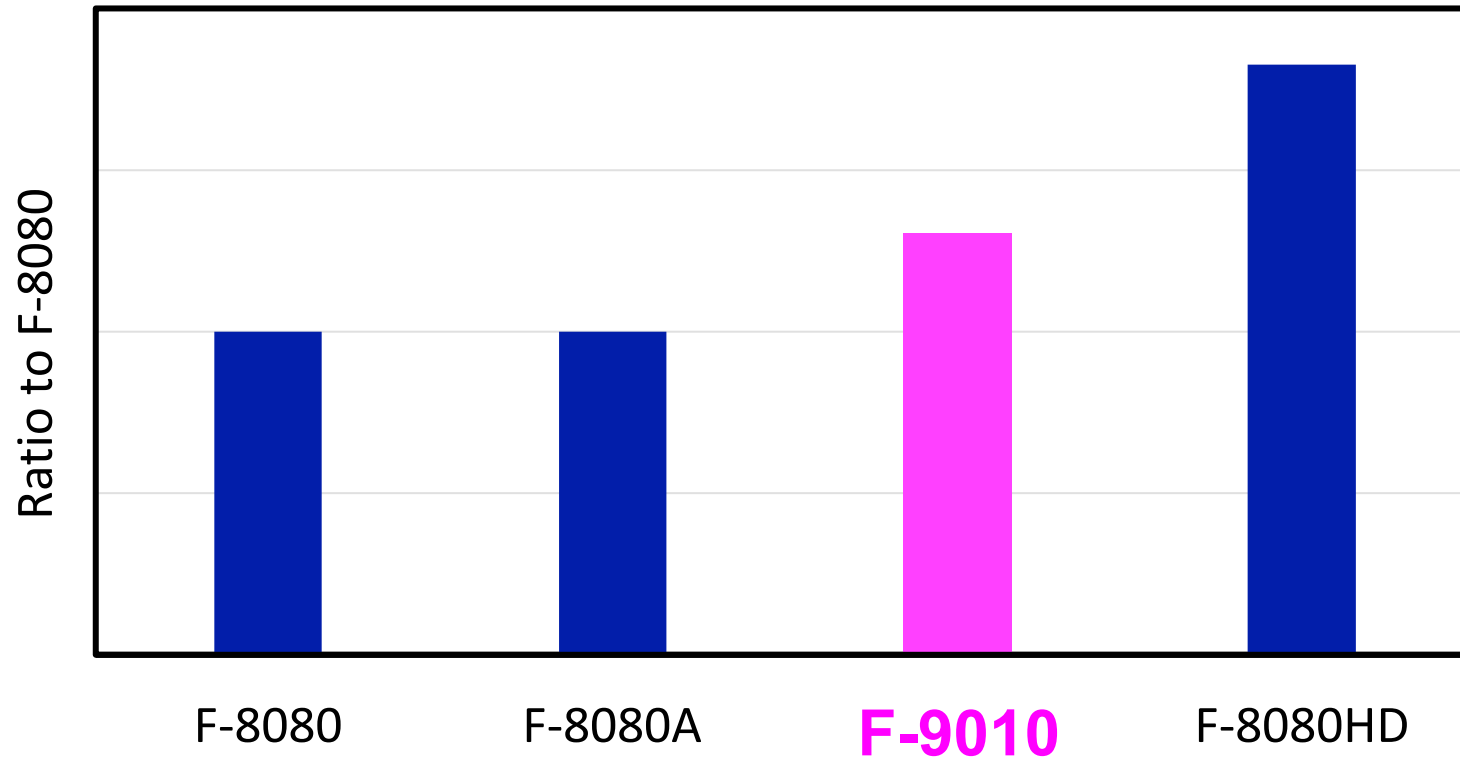


Durability against Ca Upset

85 °C, 32wt% NaOH, Ca=1.5ppm, 4hr



Total number of frequent load tensile test until membrane breaking
(Sum of the value to various direction. Load : 60 % of tensile strength)



F-9010 is more robust than F-8080 and F-8080A.