



Your Dreams, Our Challenge

Introduction of New Generation Membrane FLEMION™ F-9010

March, 2019

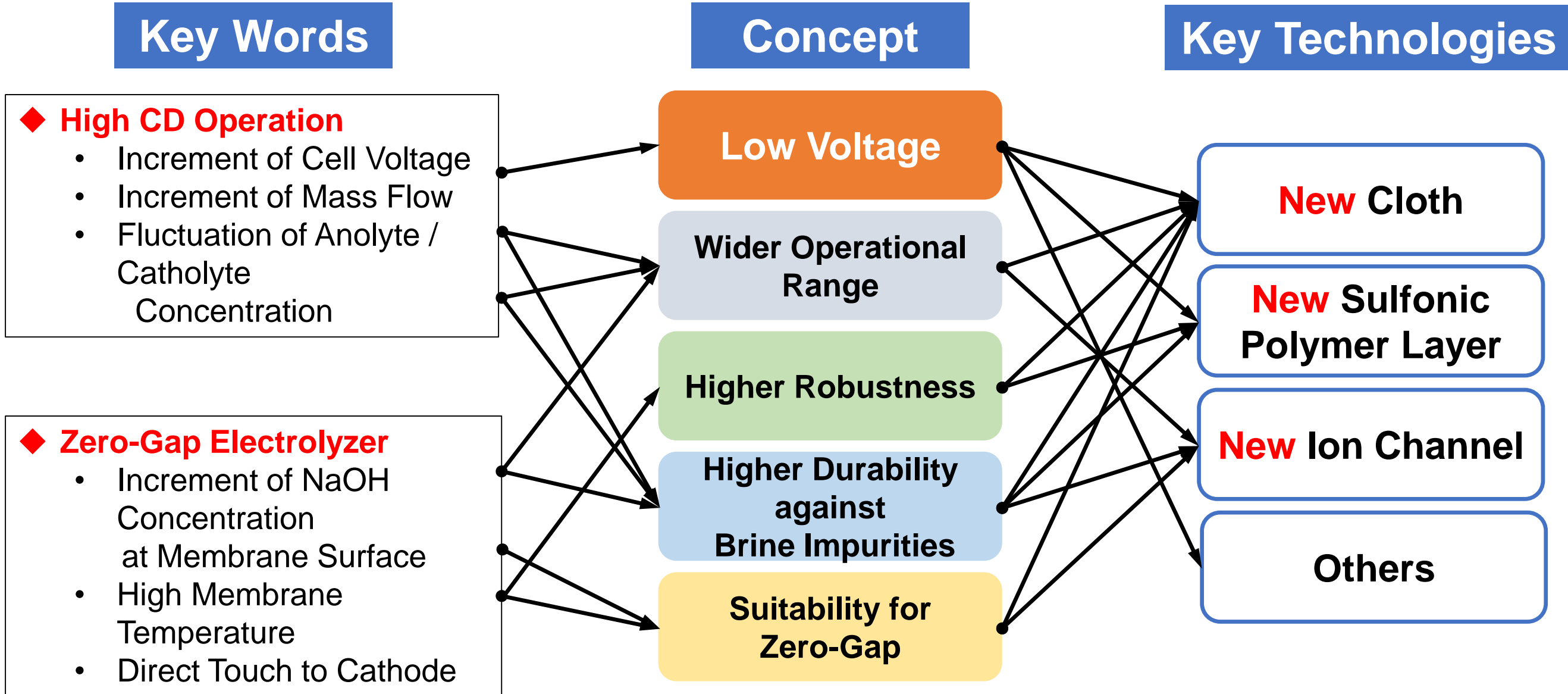
Membrane Business Division

AGC Chemicals

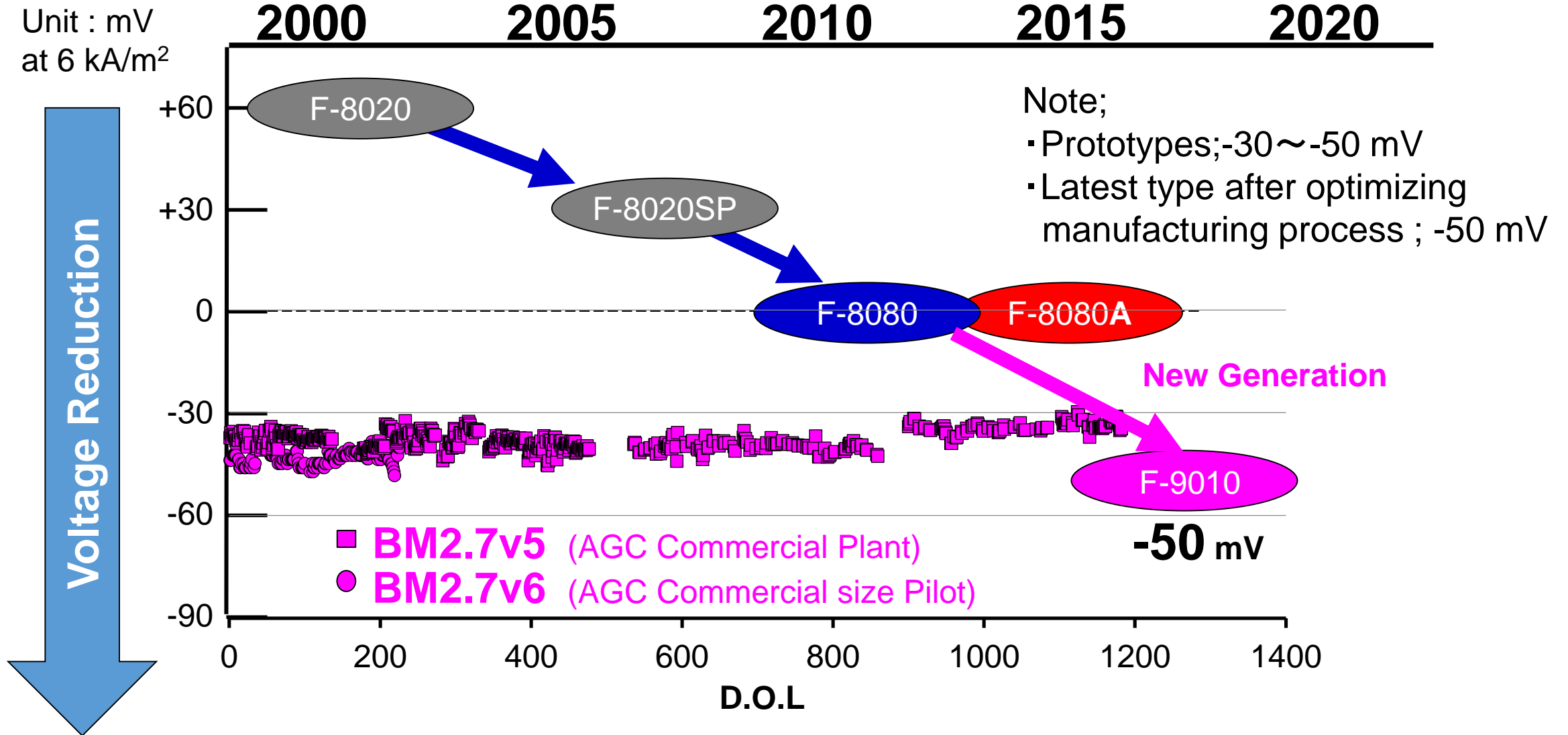
CREATION THROUGH SEPARATION



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



Voltage of F-9010 in Commercial Electrolyzer (AGC)

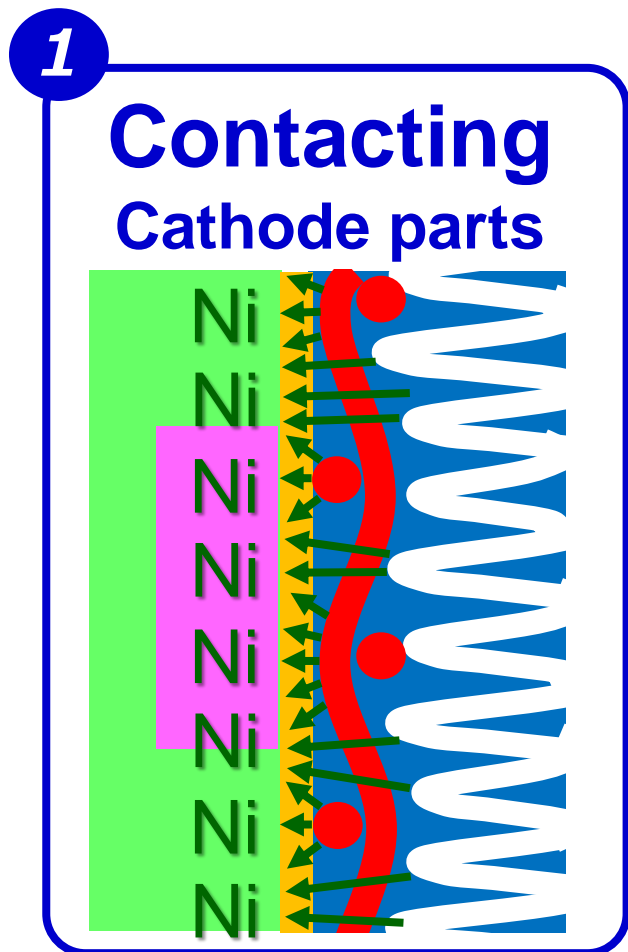


Prototypes of new generation membrane keep stable low voltage in AGC commercial electrolyzer more than 3 years.

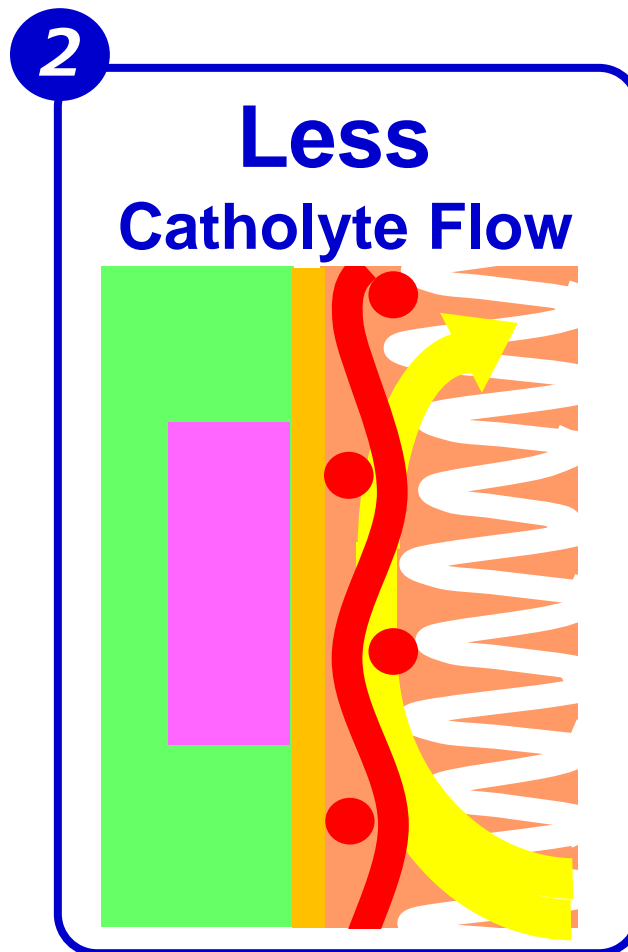
Voltage of F-9010 in Commercial Electrolyzers

	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

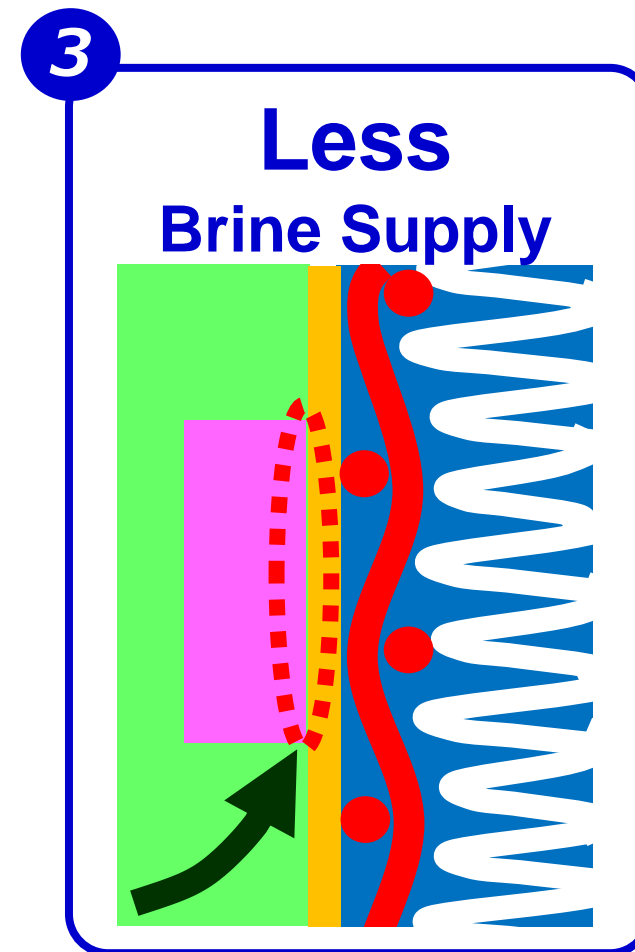
“Zero gap” has **Three** Key Points



1 Ni stain



2 High
Temperature



3 Weak brine

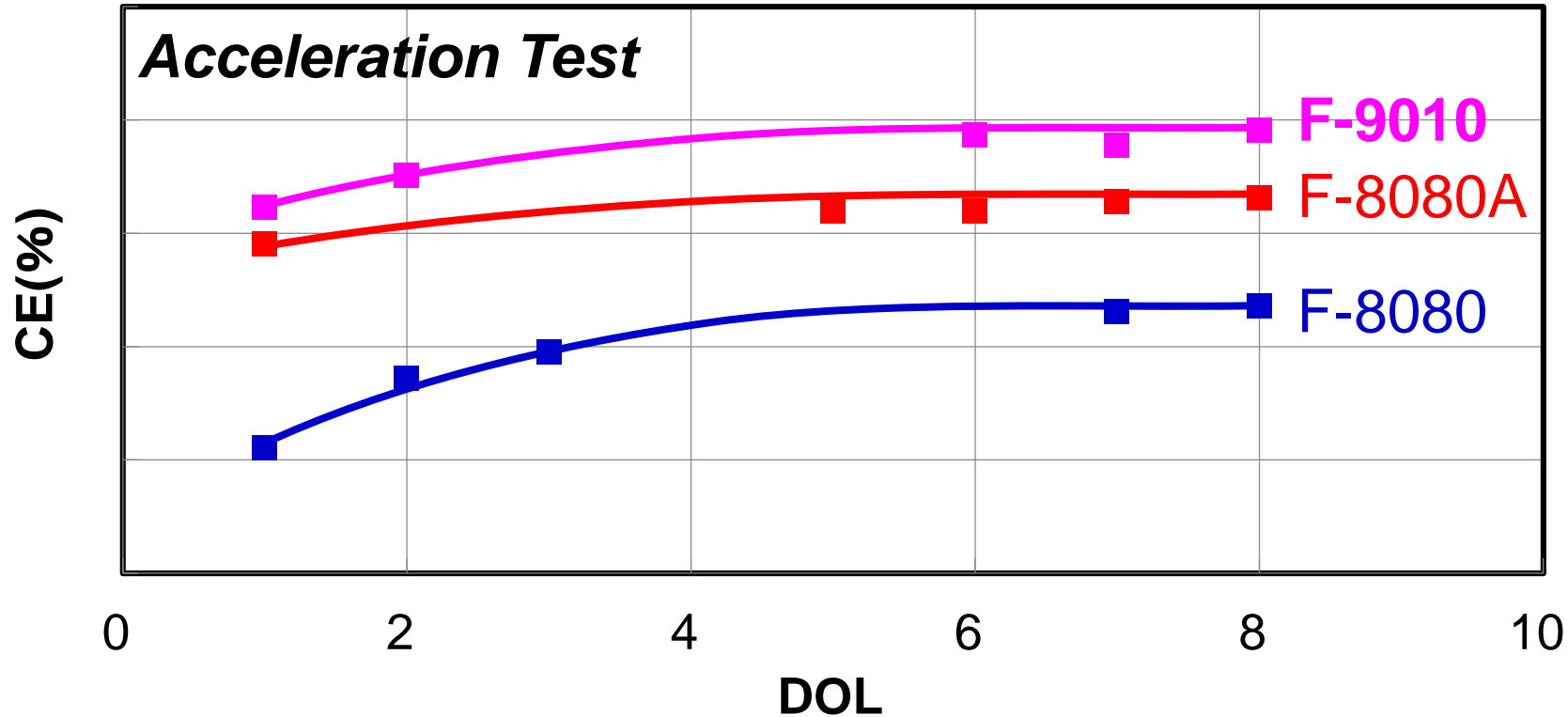
Durability against Ni Stain(for Zero Gap)

Soaked in Ni Solution before installation.

6 kA/m², 90 °C, 32 wt% NaOH,



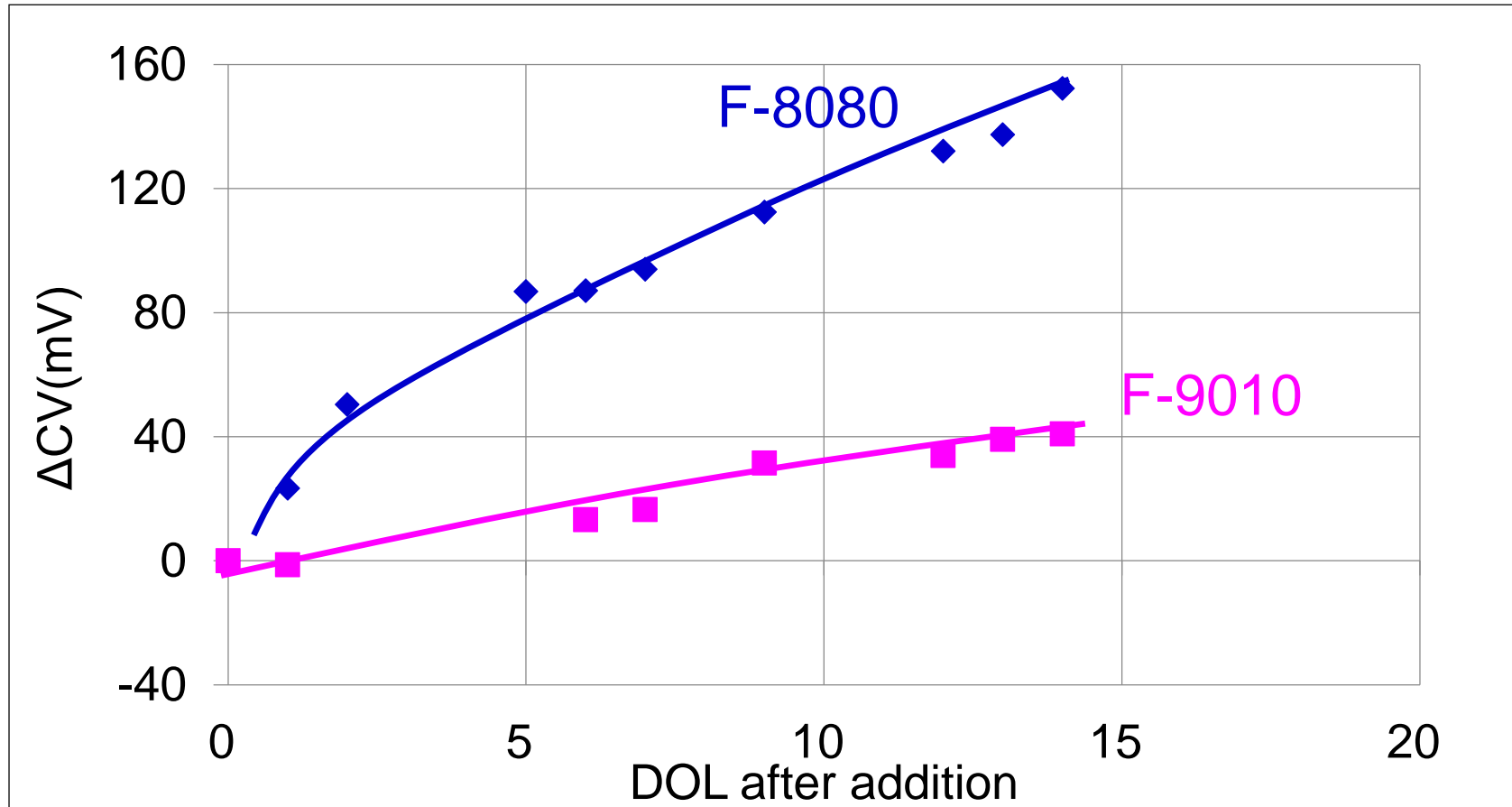
Note)
Test conditions are confidential



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

“New Ion Channel” is applied!

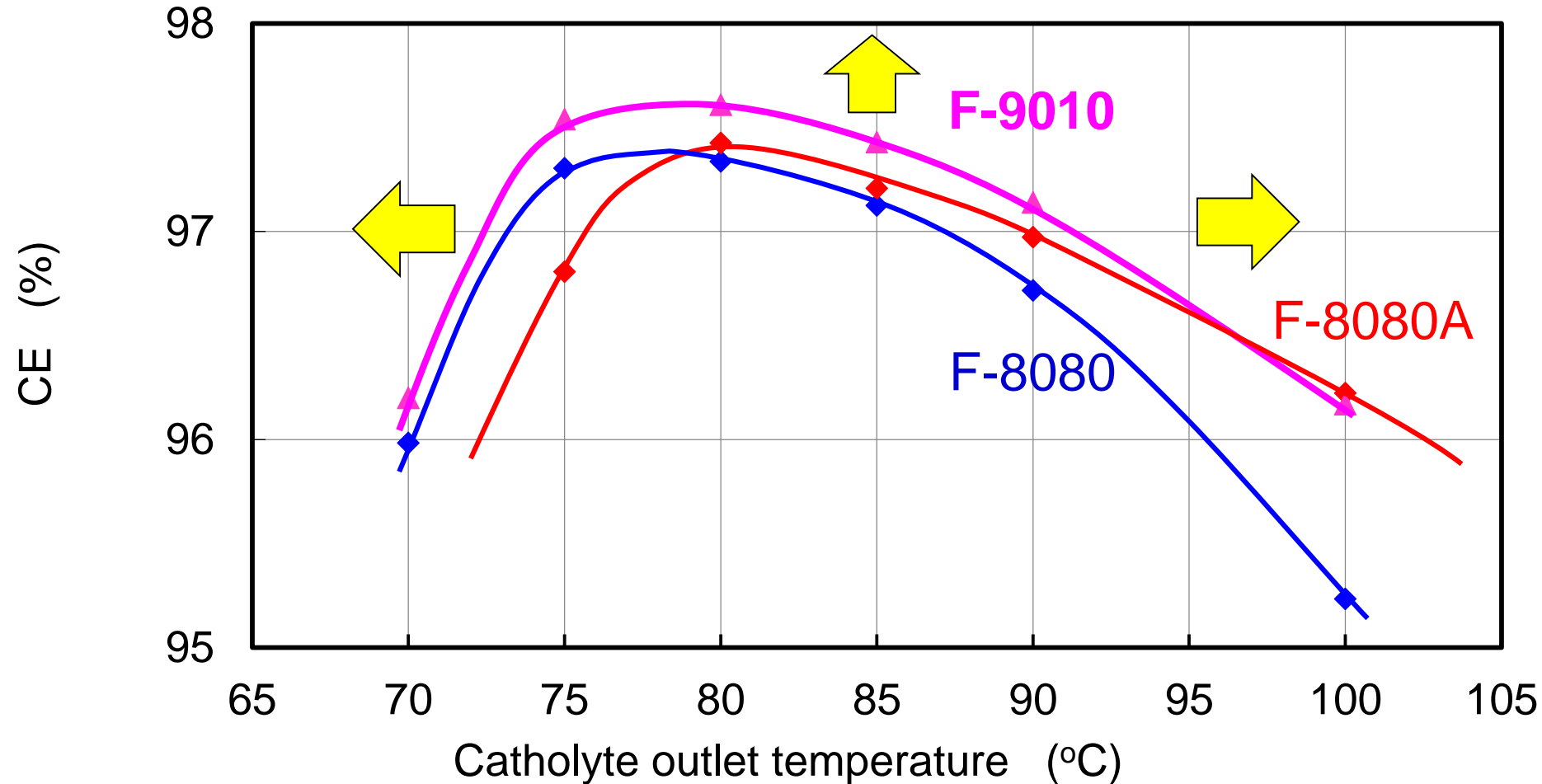
8 kA/m², 90 °C, 32 wt% NaOH, Ni=0.1 ppm



F-9010 has higher stability of CV against Ni.

Higher CE in Wider Temperature Range

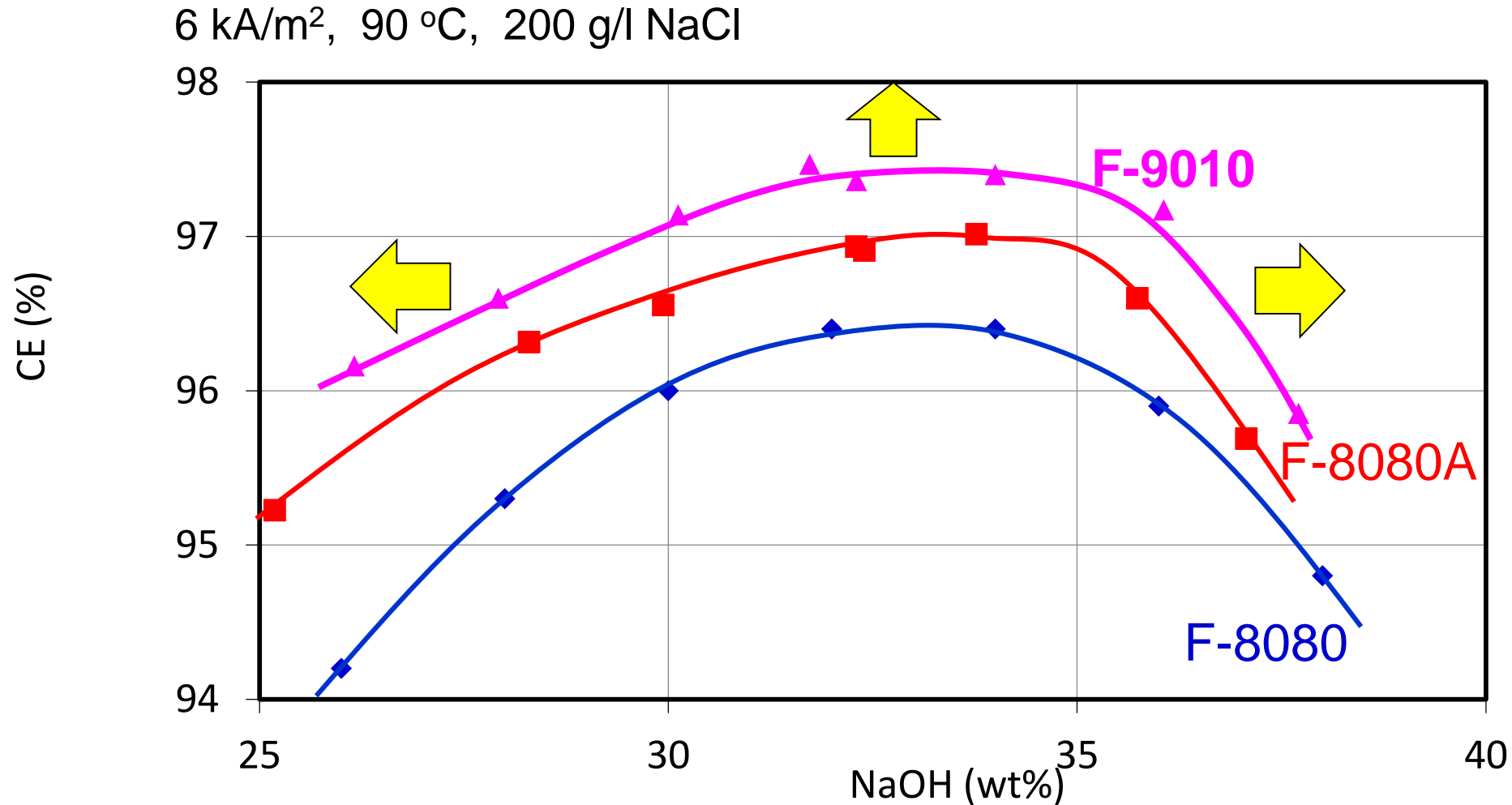
6 kA/m², 32 wt% NaOH, 200 g/l NaCl



F-9010 shows higher CE

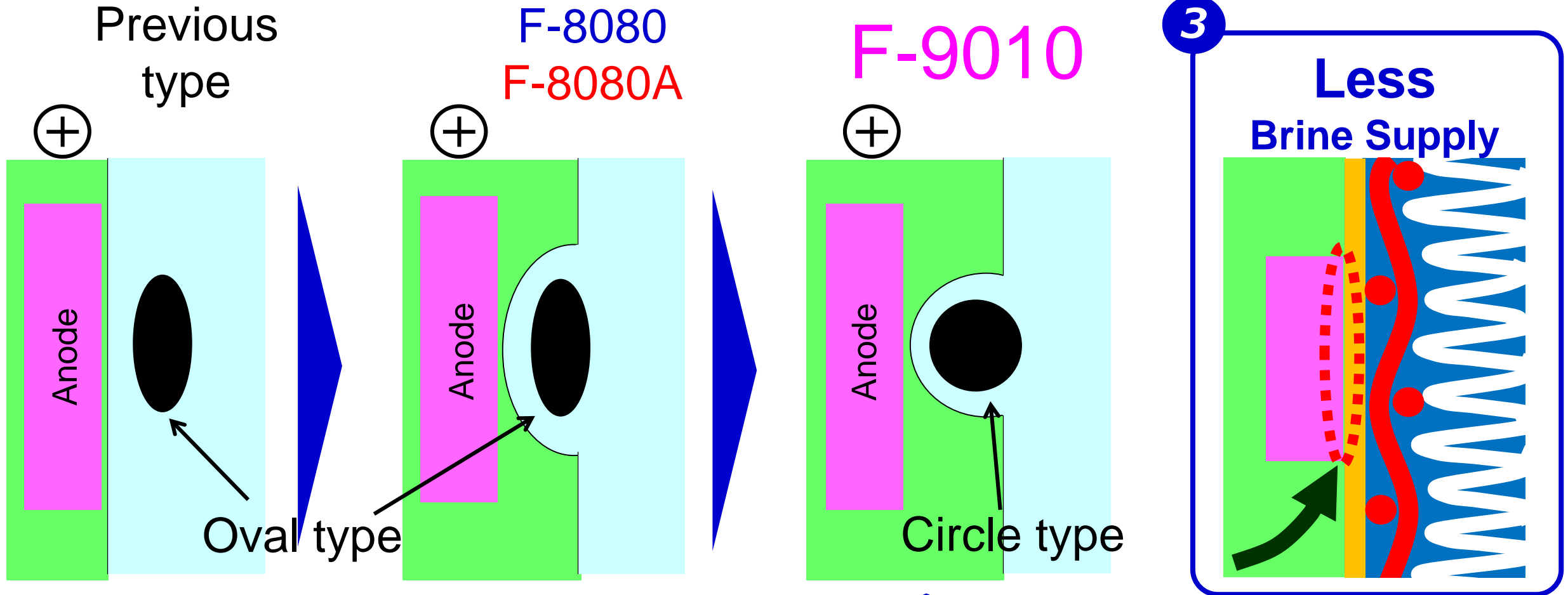
not only at high temperature but also at low temperature.

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



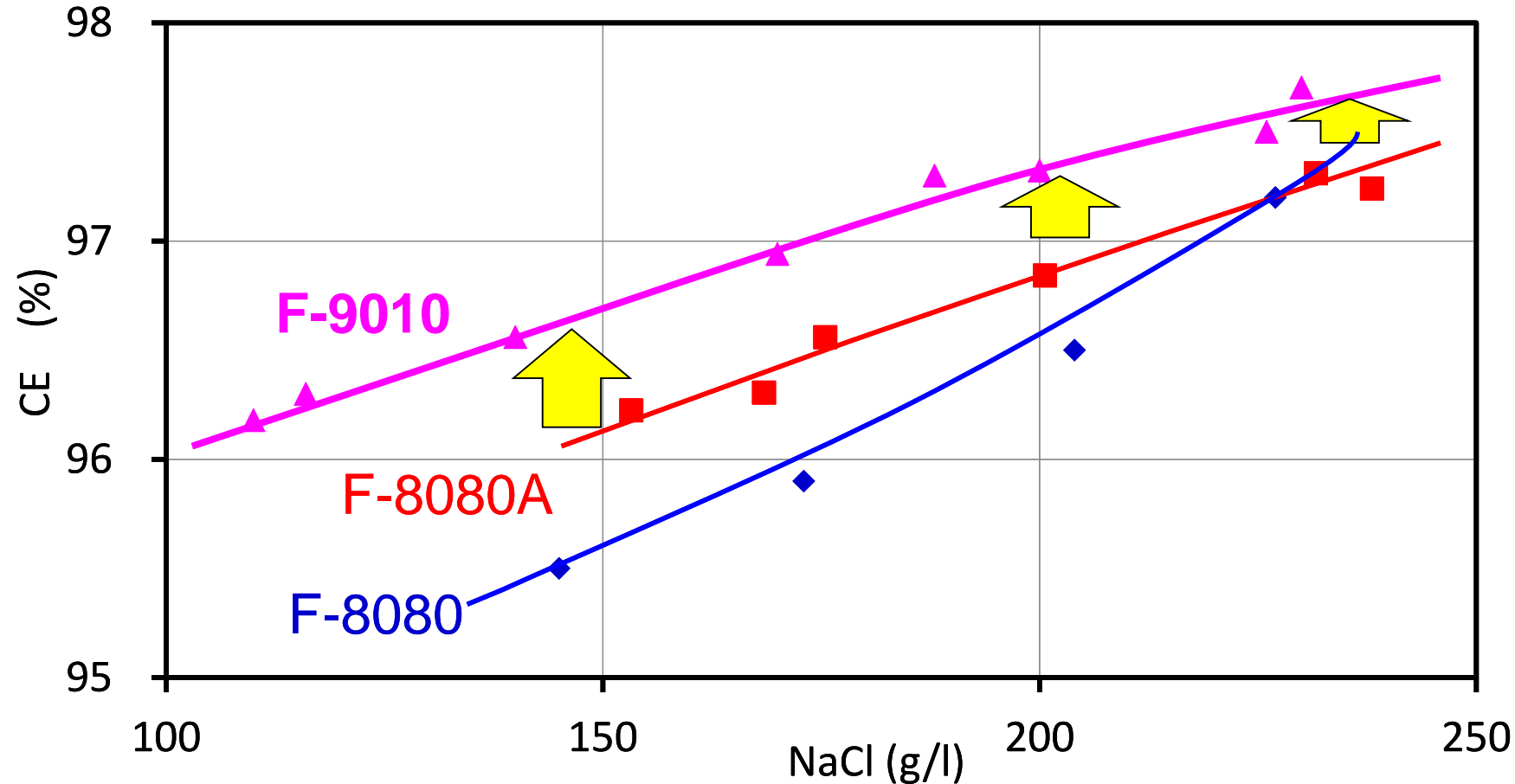
Good Brine Supply

Note) It also shows good supply of added HCl !

3 Weak brine

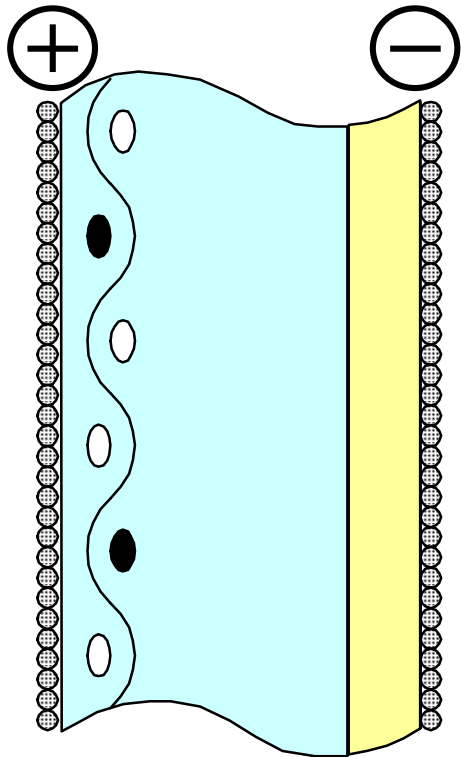
Higher CE in Weak Brine

6 kA/m², 90 °C, 32 wt% NaOH



F-9010 shows higher CE in weak brine.

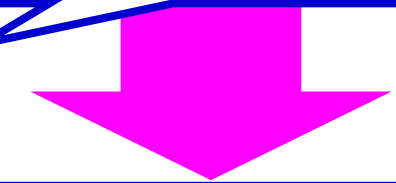
It is suitable for electrolyzers which have less inner circulation of brine.



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

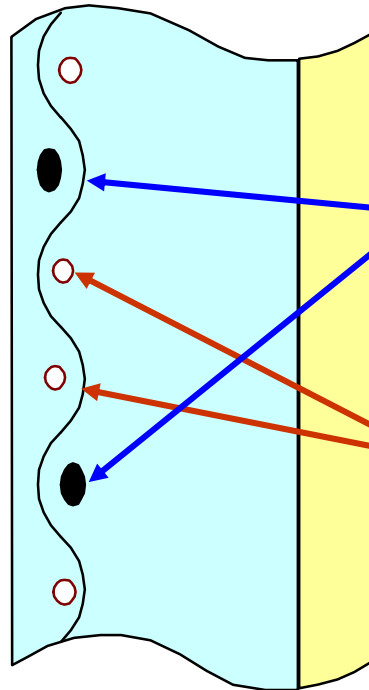
Key point

“Shadow influence”



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

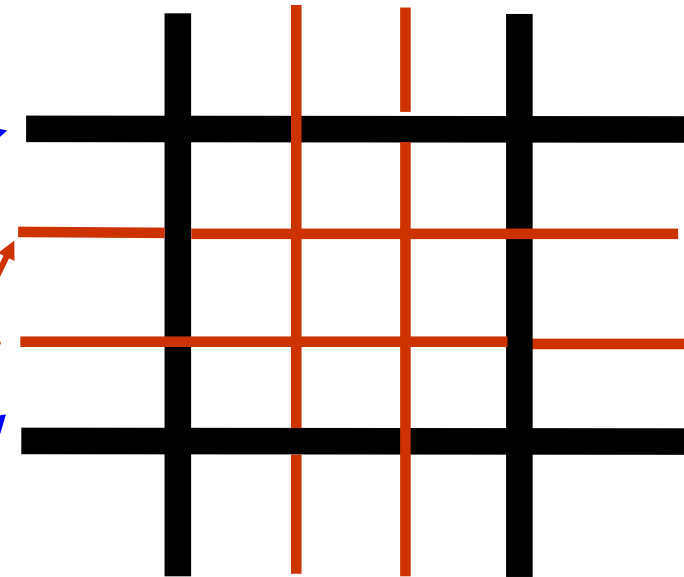
Cross Section



Permanent Fiber
(PTFE fiber)

Sacrificial Fiber
(PET fiber)

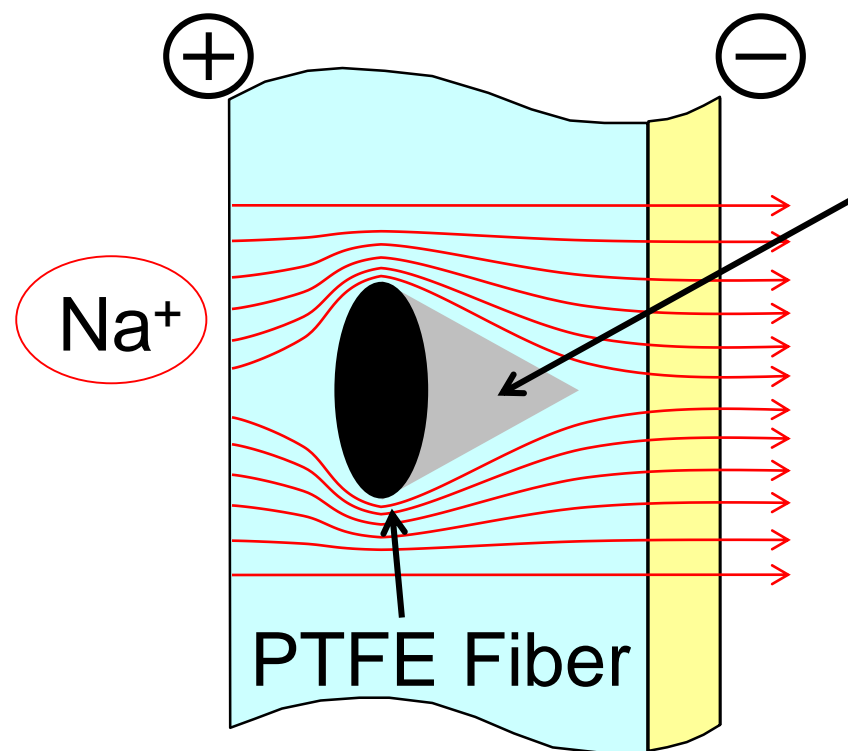
Plane Figure



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”

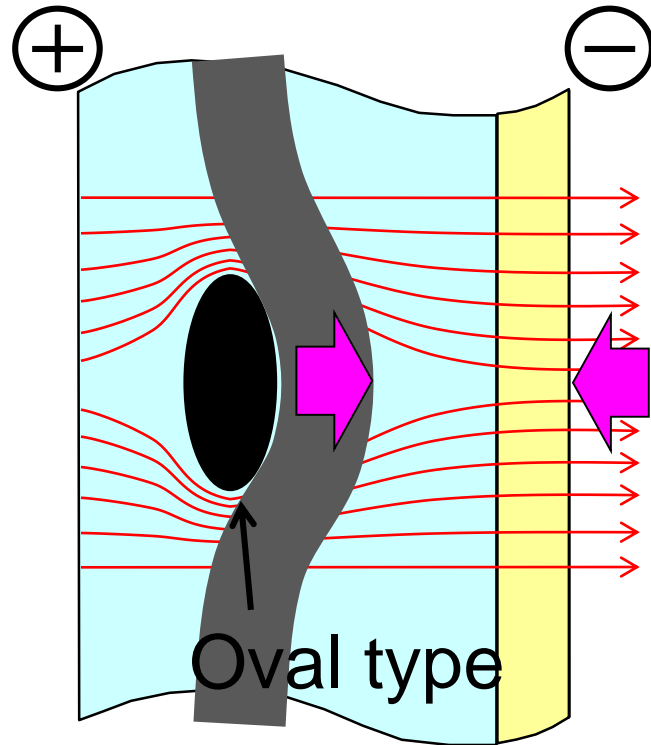
PTFE fiber interferes the Na^+ migration which causes the increase of the cell voltage.

How to reduce the shadow influence?

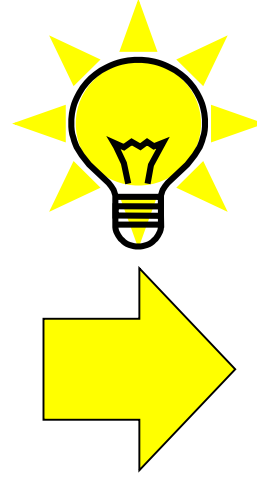
Two kinds of tech. !!

How to Reduce the Shadow Influence (1)

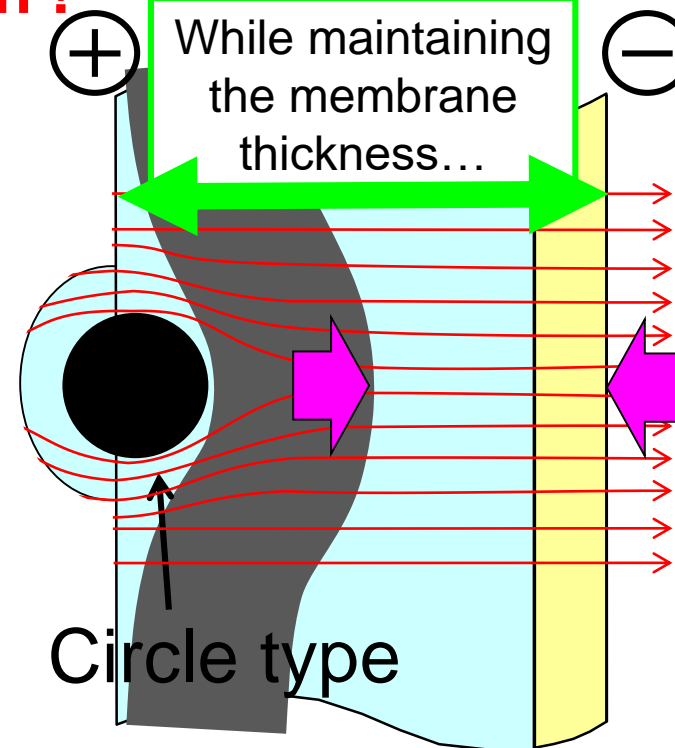
Conventional Cloth



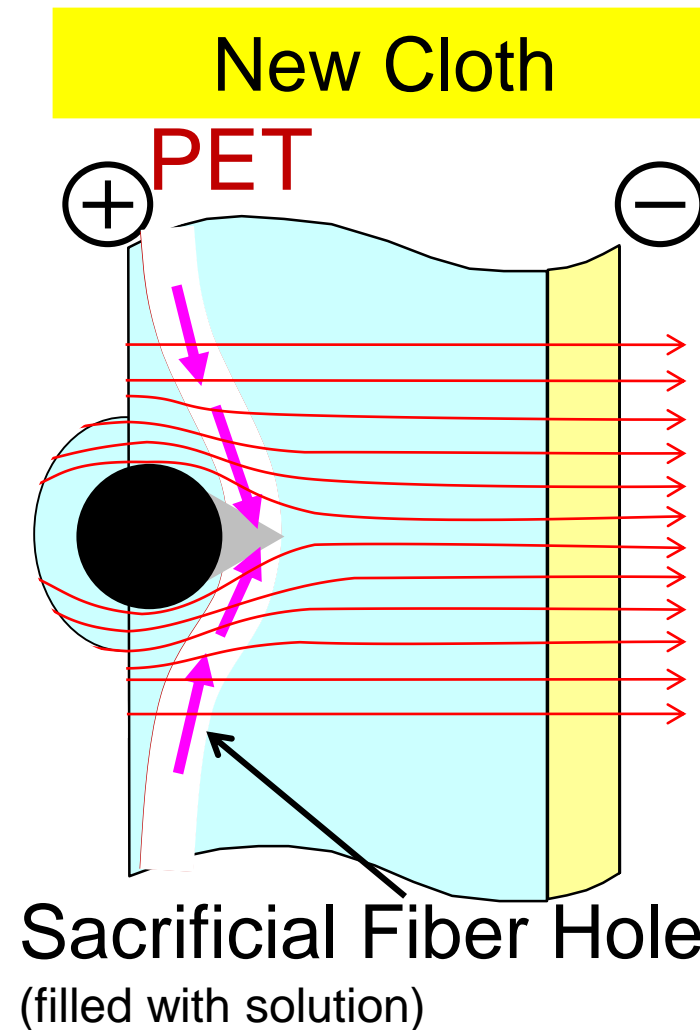
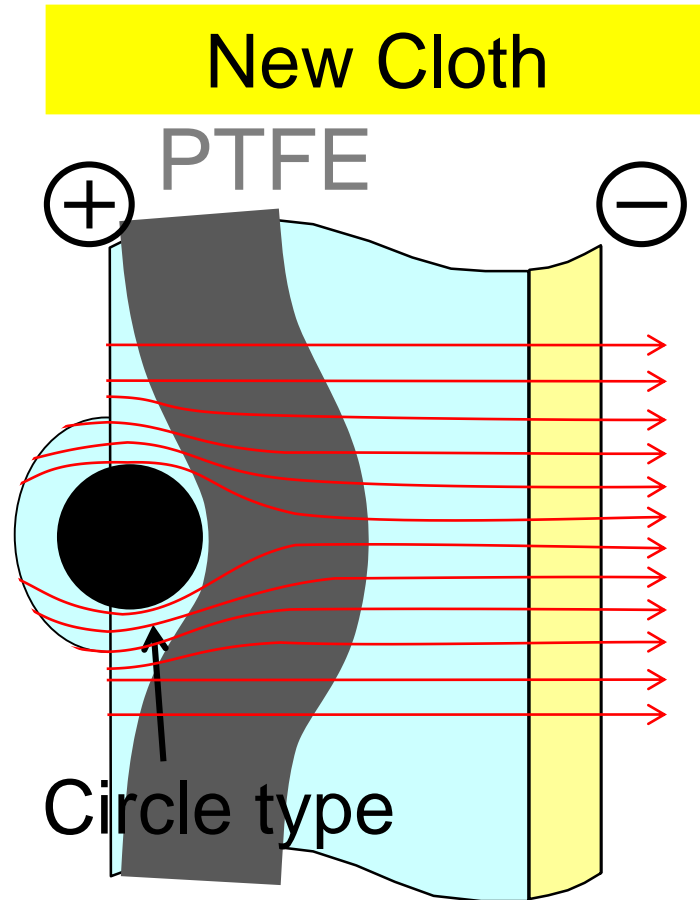
Breakthrough !



New Cloth



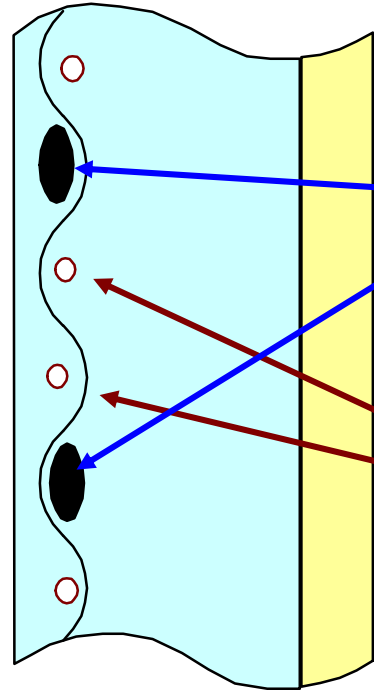
Proper surface shape reduces cell voltage !



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

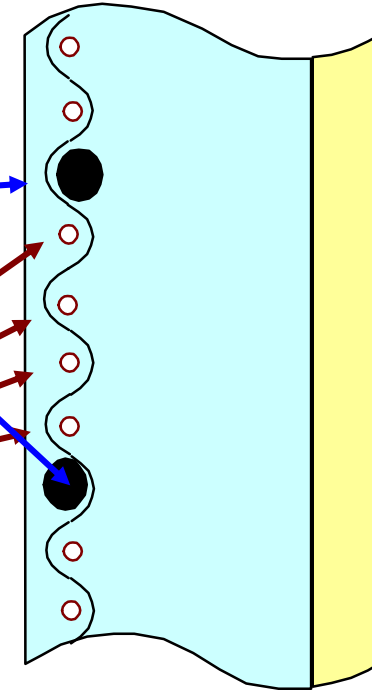
Conventional Cloth

F-8080/F-8080A



New Cloth

F-9010



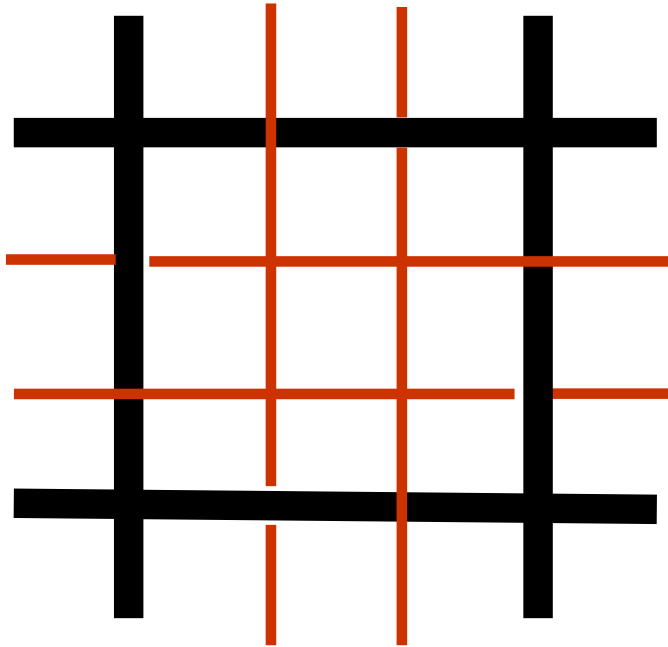
PTFE Fiber

PET Fiber

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

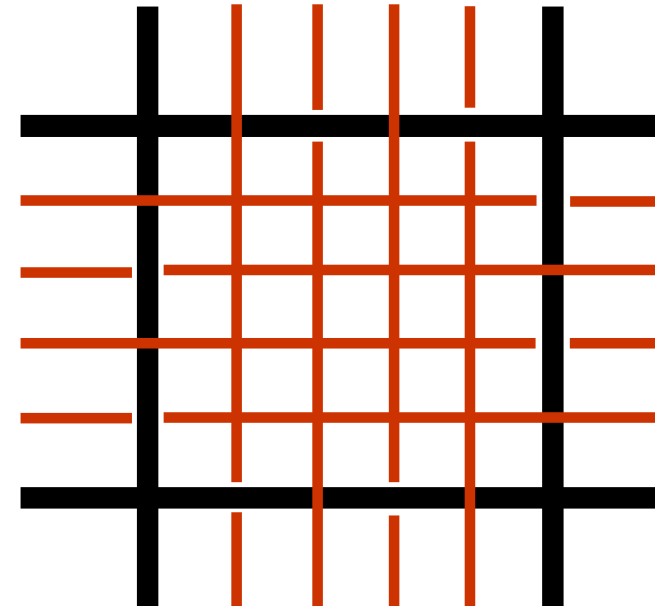
Conventional Cloth

F-8080/F-8080A



New Cloth

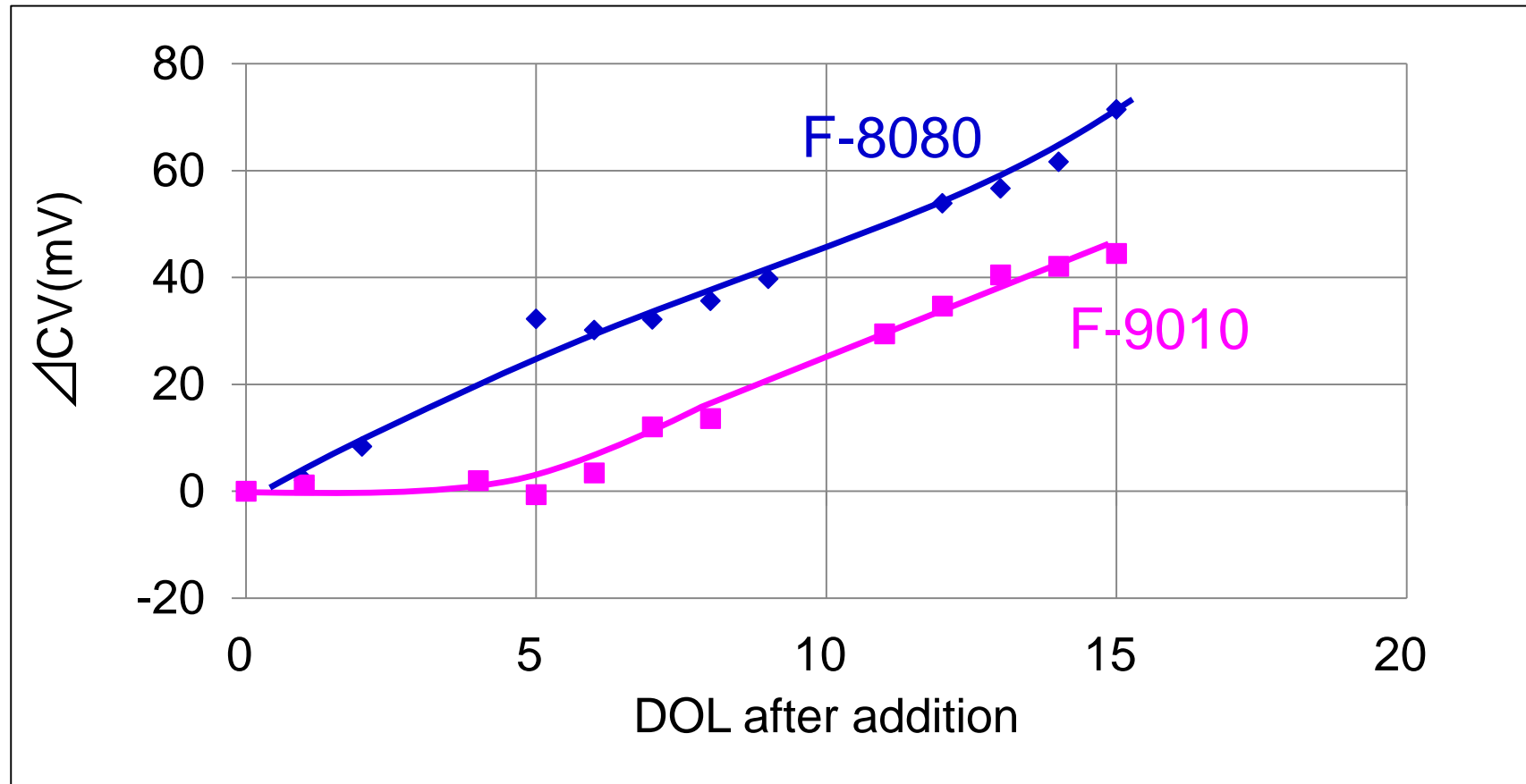
F-9010



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

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

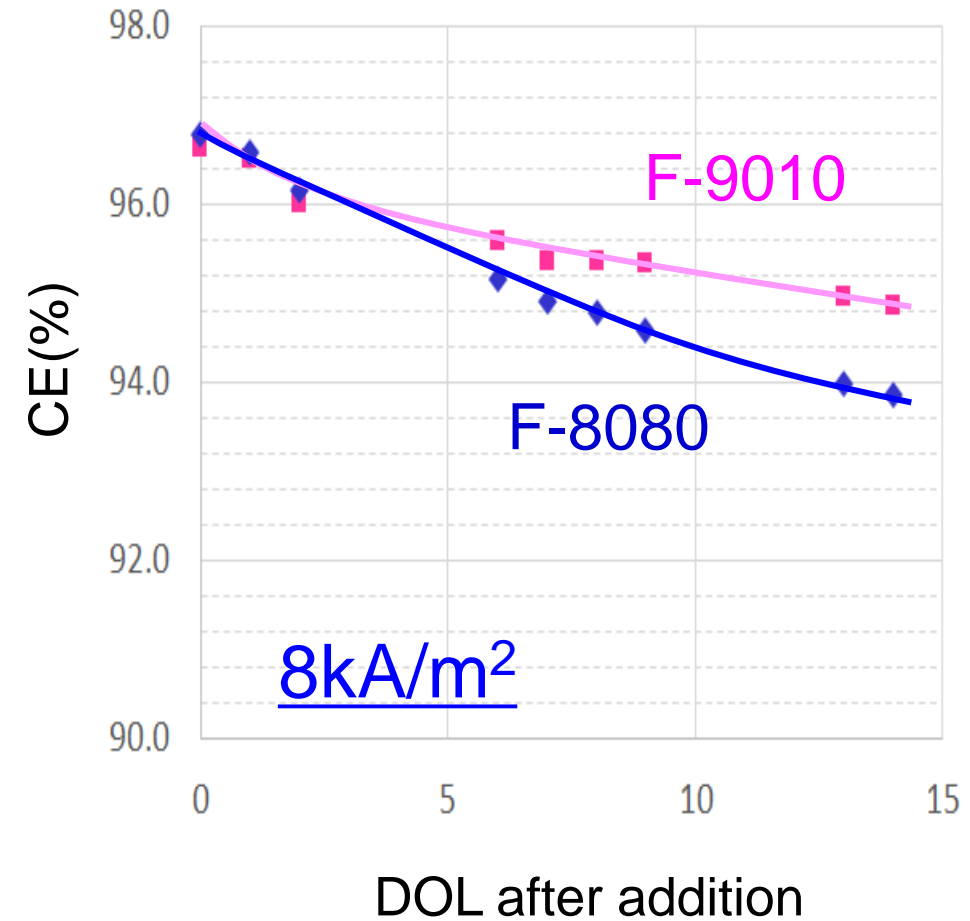
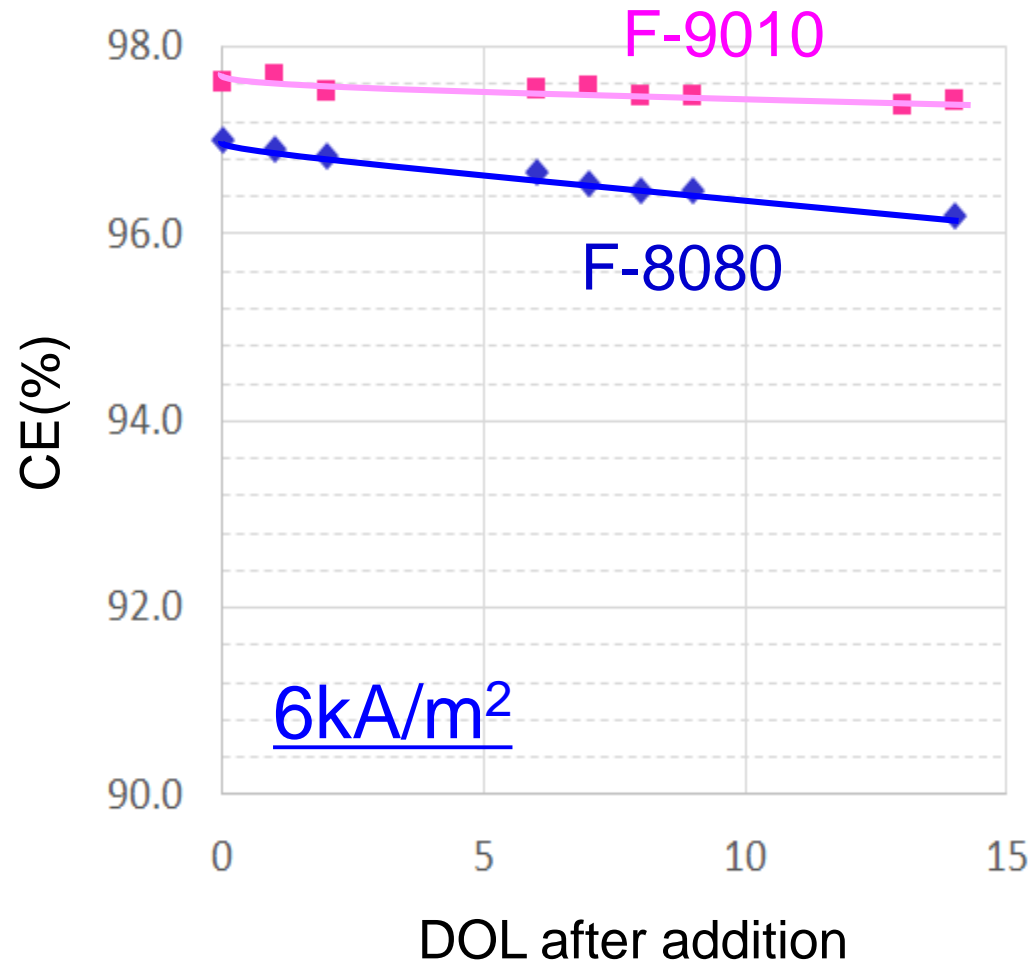
8 kA/m², 90 °C, 32 wt% NaOH, Mg=0.1 ppm



F-9010 has higher stability of CV against Mg.

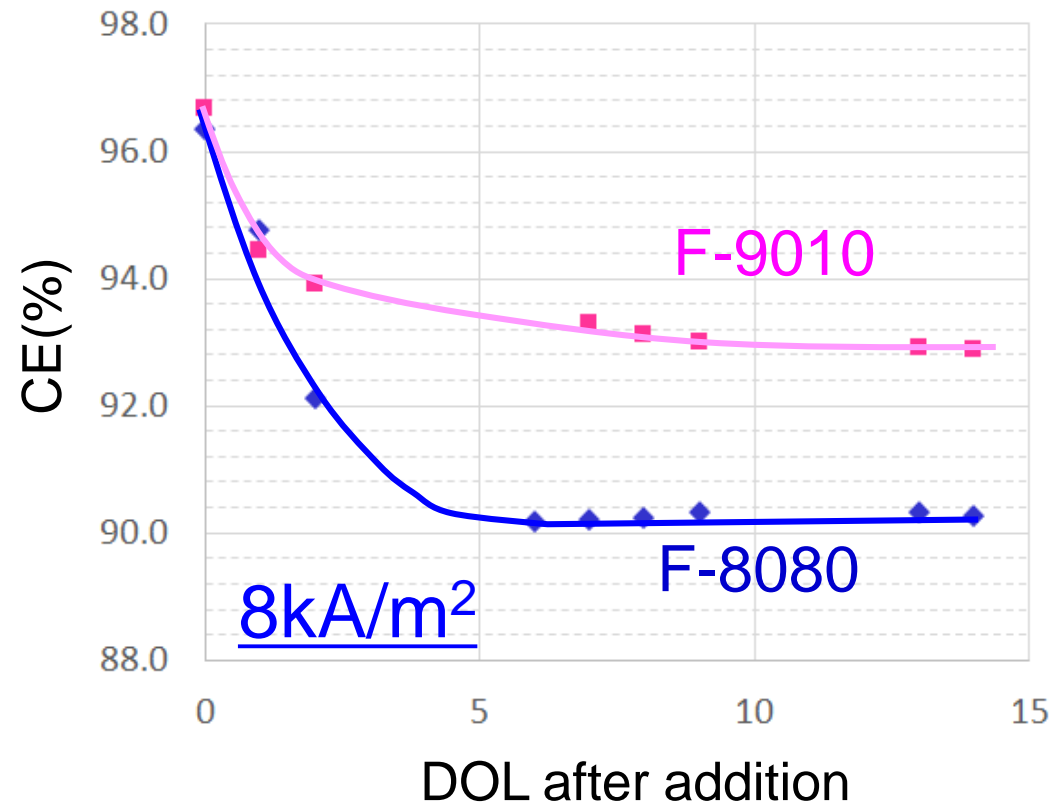
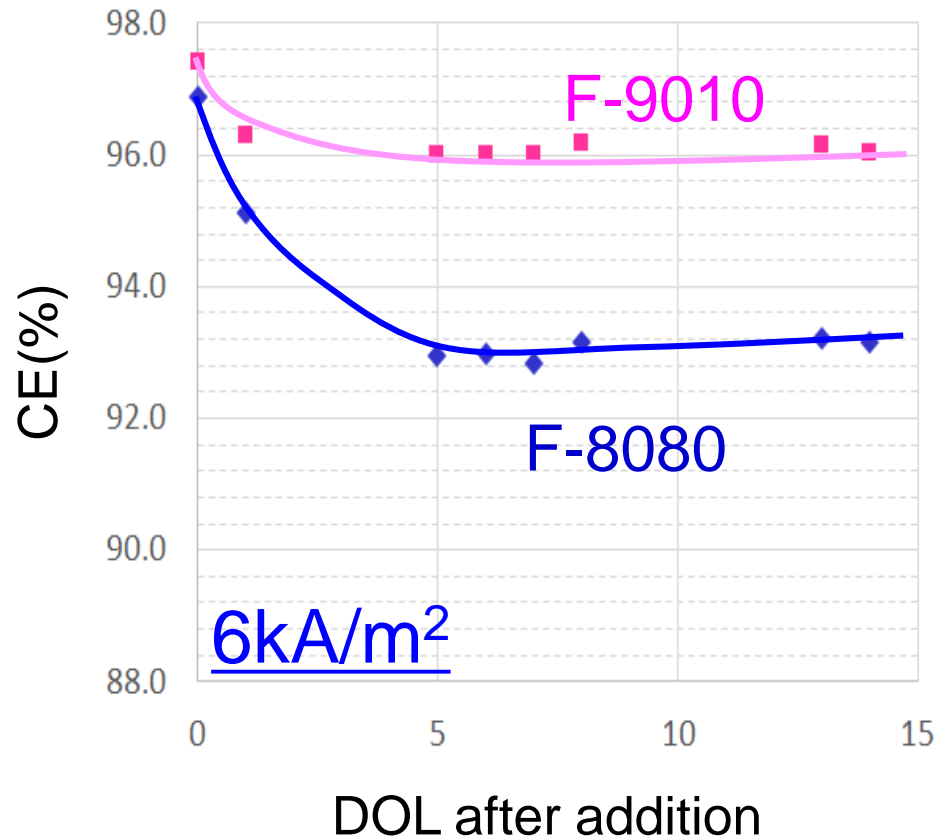
Durability against Al/SiO₂

85 °C, 32wt% NaOH, Al/SiO₂=1/30ppm



Durability against Ca/SiO₂

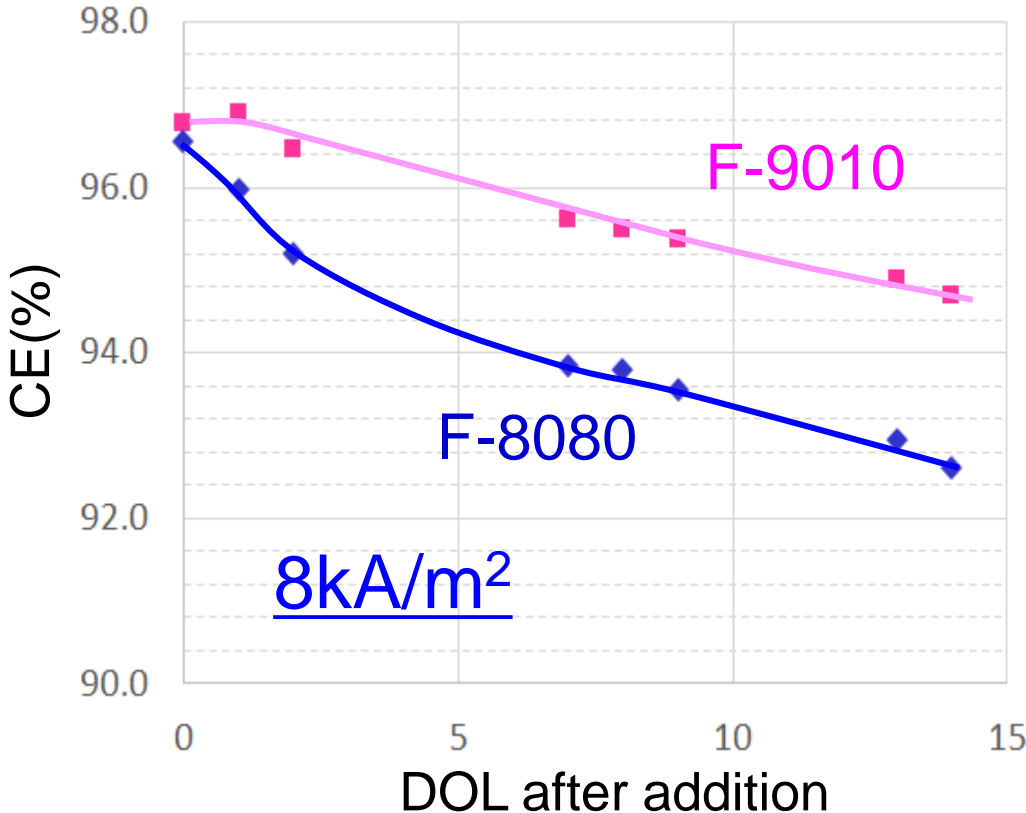
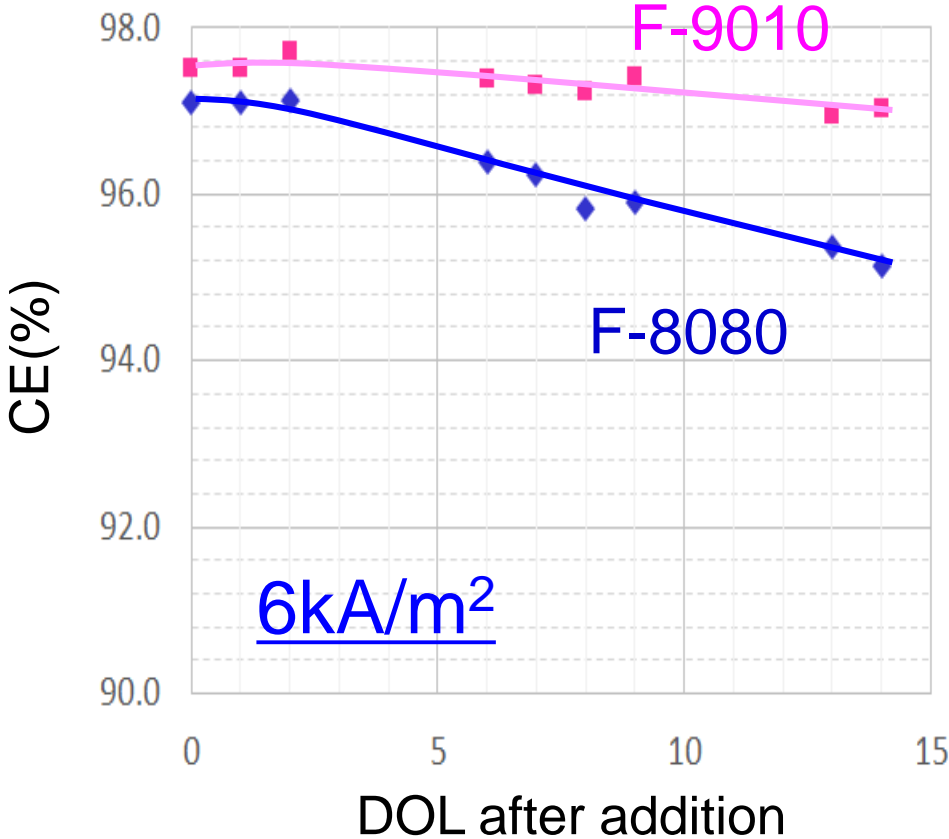
85 °C, 32wt% NaOH, Ca/SiO₂=0.05/15ppm



Durability against I/Ba

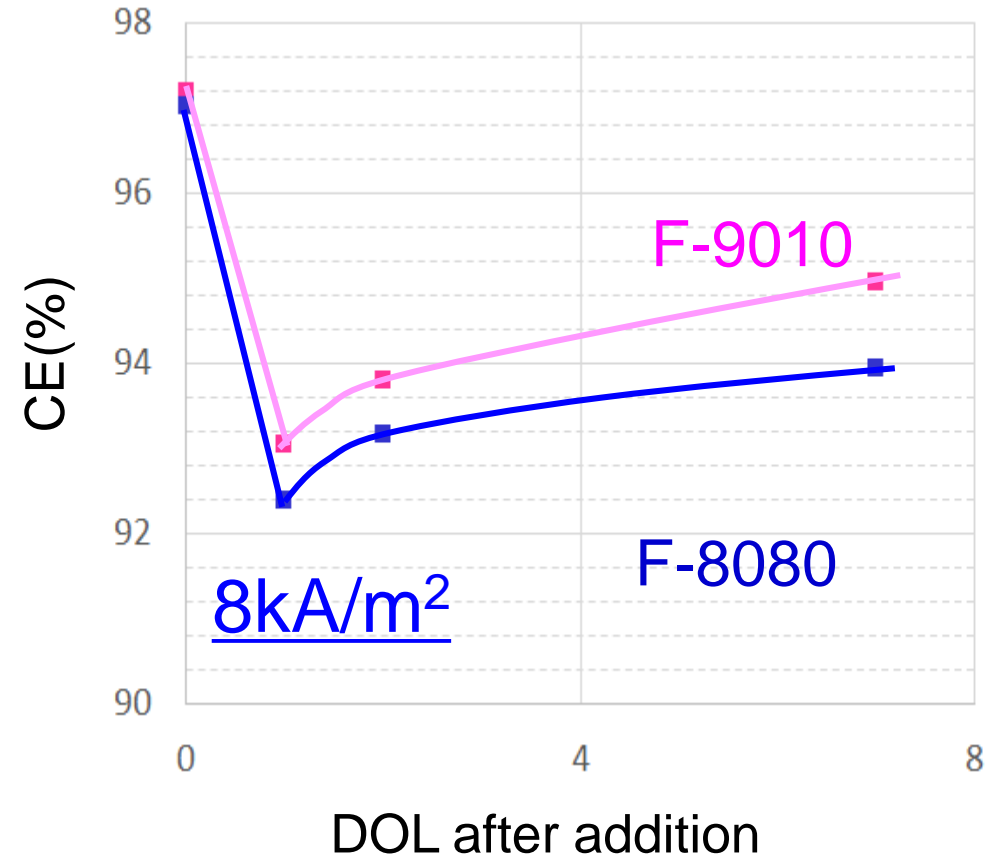
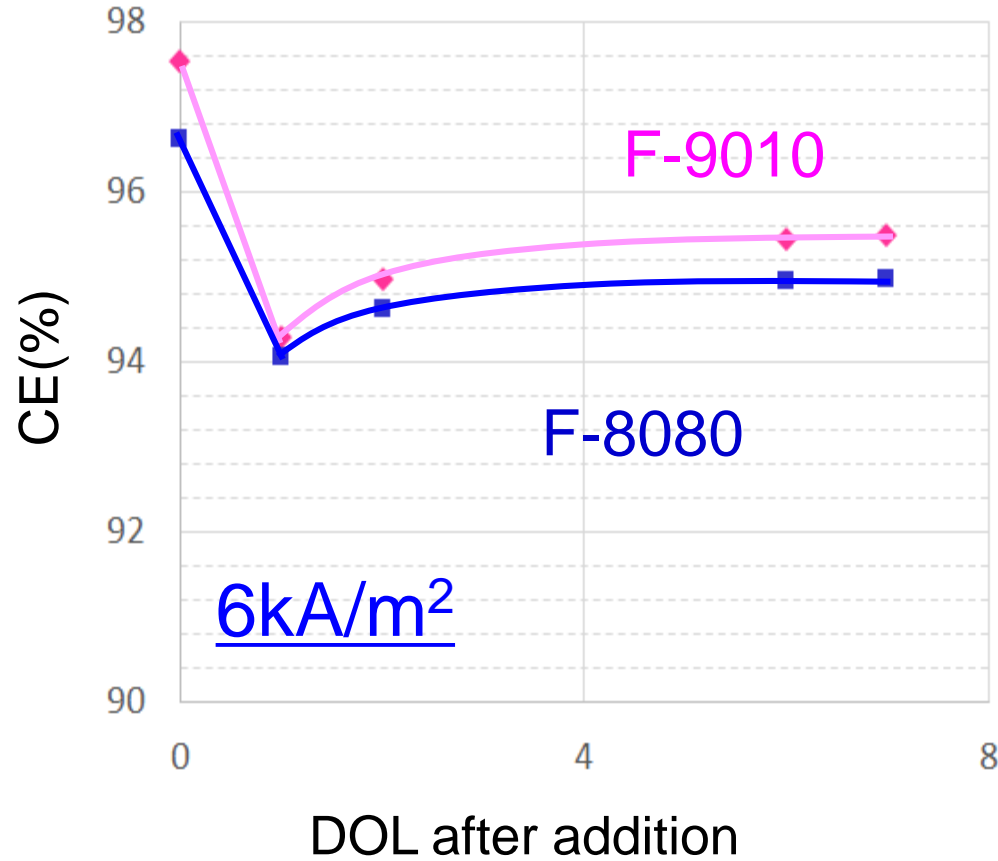


85 °C, 32wt% NaOH, I/Ba=20/1ppm

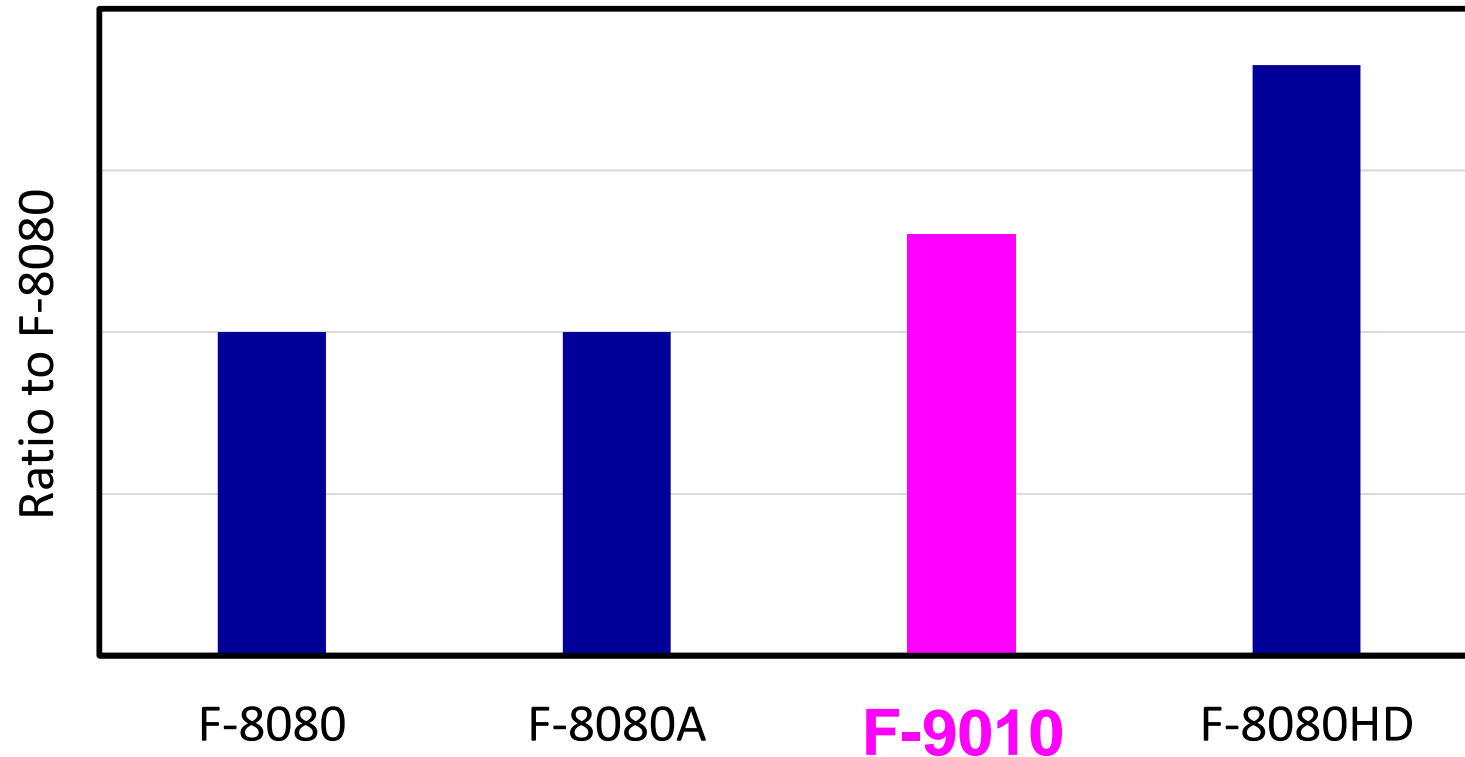


Durability against Ca Upset

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.