



Your Dreams, Our Challenge

The Latest Development of **FLEMION™** Membrane

June 2023

AGC Inc.

Chemicals Company

CREATION THROUGH SEPARATION



Table of Initial Performance in Laboratory Cell



AGC lab cell, 6 kA/m², 90 °C, NaOH 32 wt%, NaCl 200 g/l

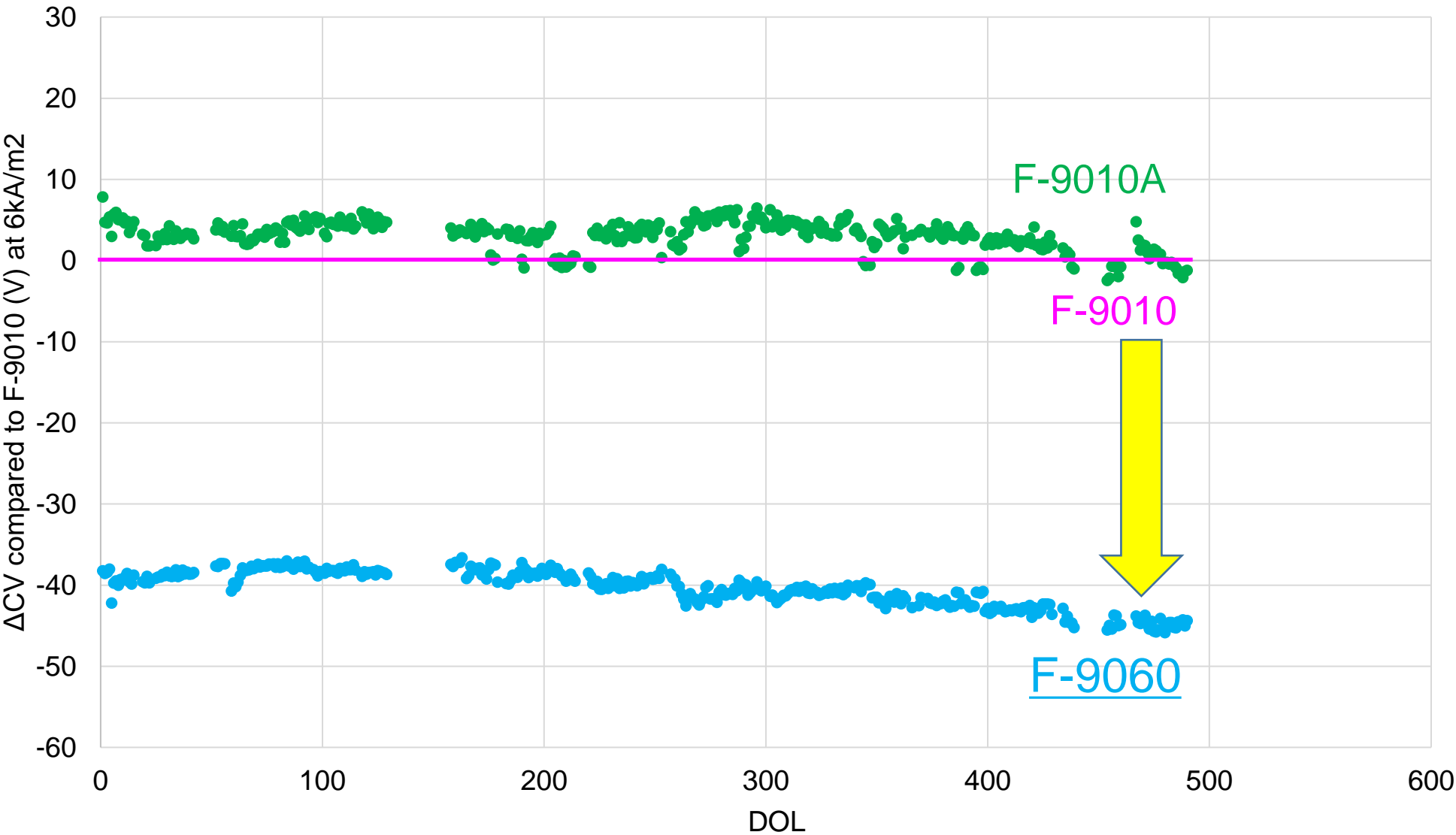
	CE	ΔCV	Features
F-8080	≥ 96.0	+50mV	Previous standard membrane
F-8080A	≥ 96.5	+50mV	Higher CE than F-8080 suitable for zero gap technology.
F-9010	≥ 96.8	0mV	Standard Membrane suitable for zero gap technology
F-9010A	≥ 97.0	+20mV	Higher CE than F-9010 with CV increase suitable for zero gap technology
F-9060	≥ 97.0	-40mV	<u>the lowest voltage & the highest CE</u> suitable for zero gap technology

New Generation Membrane F-9060 has both the lowest voltage and the highest CE

New Generation Performance in AGC plant



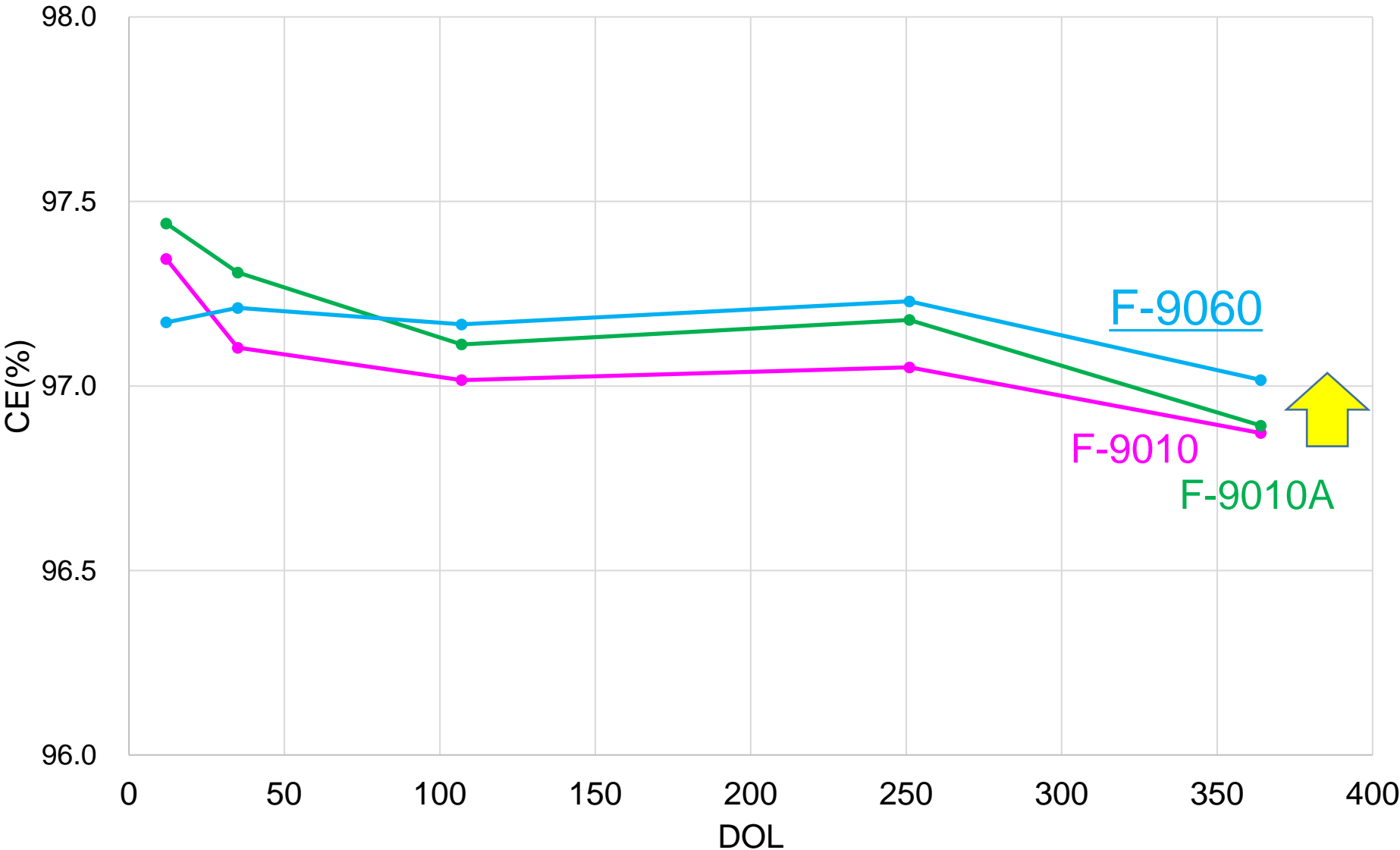
Condition : 5.5-5.8kA/m², 85°C, 32%, 210g/l , UhdeBM2.7v5



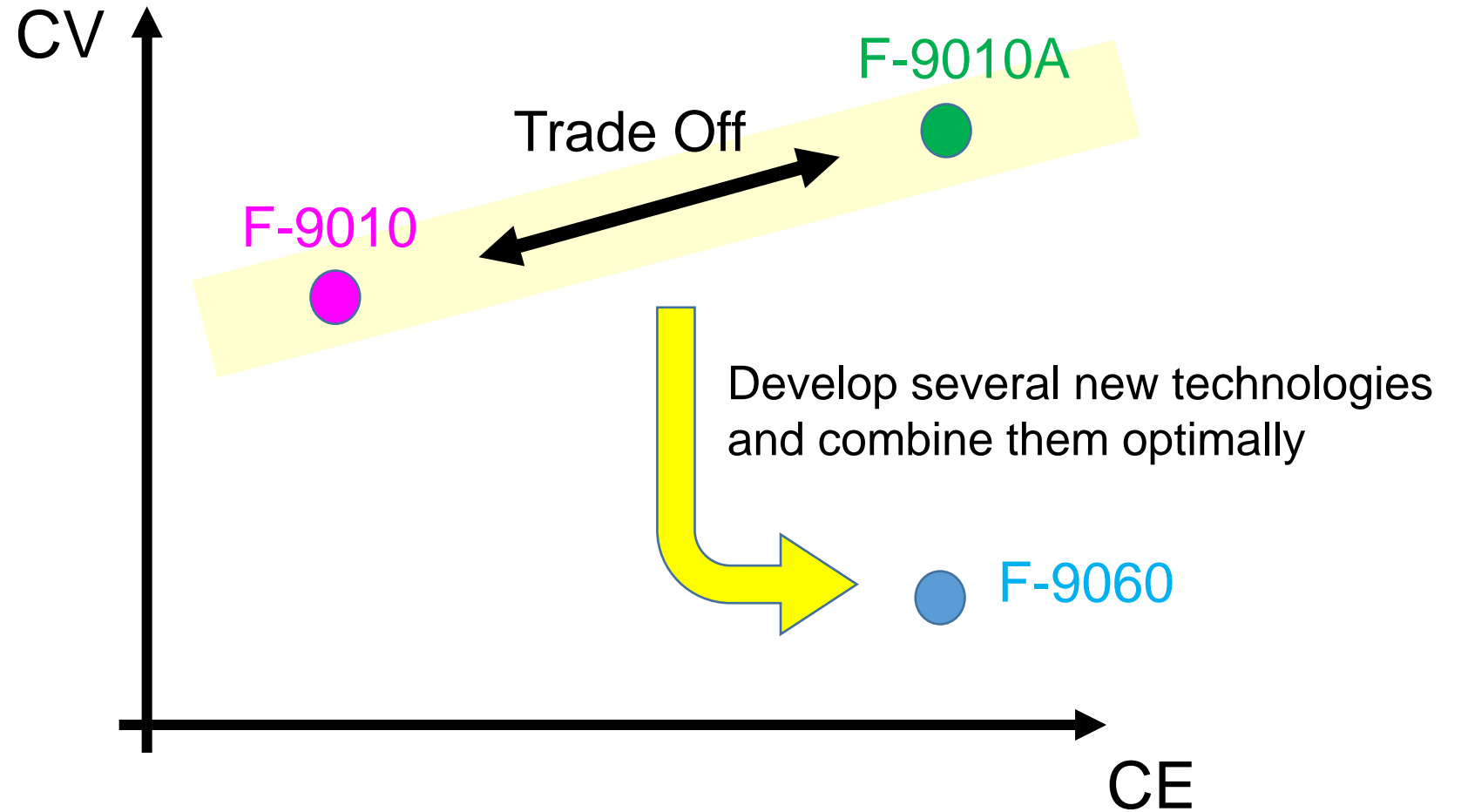
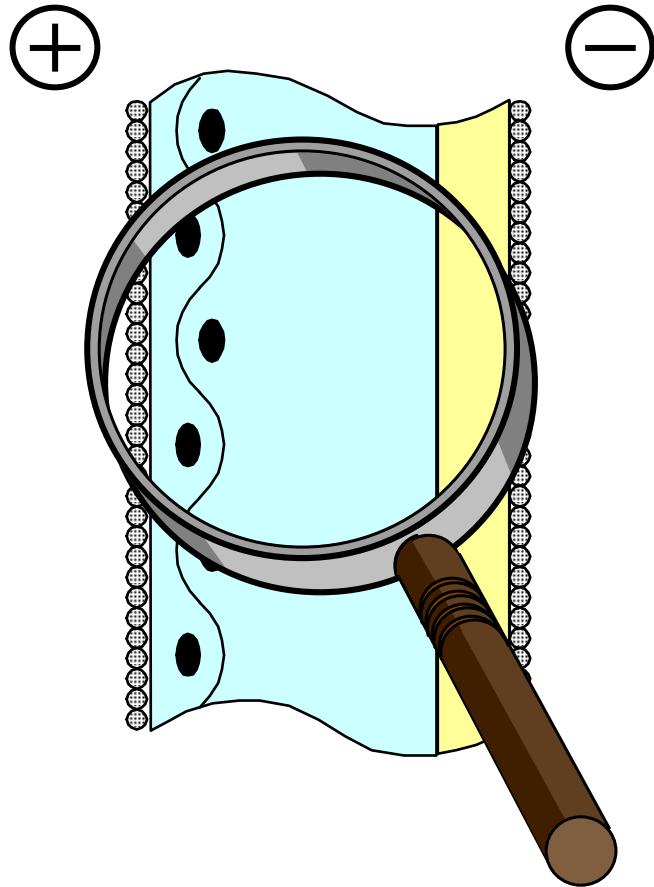
New Generation Performance in AGC plant

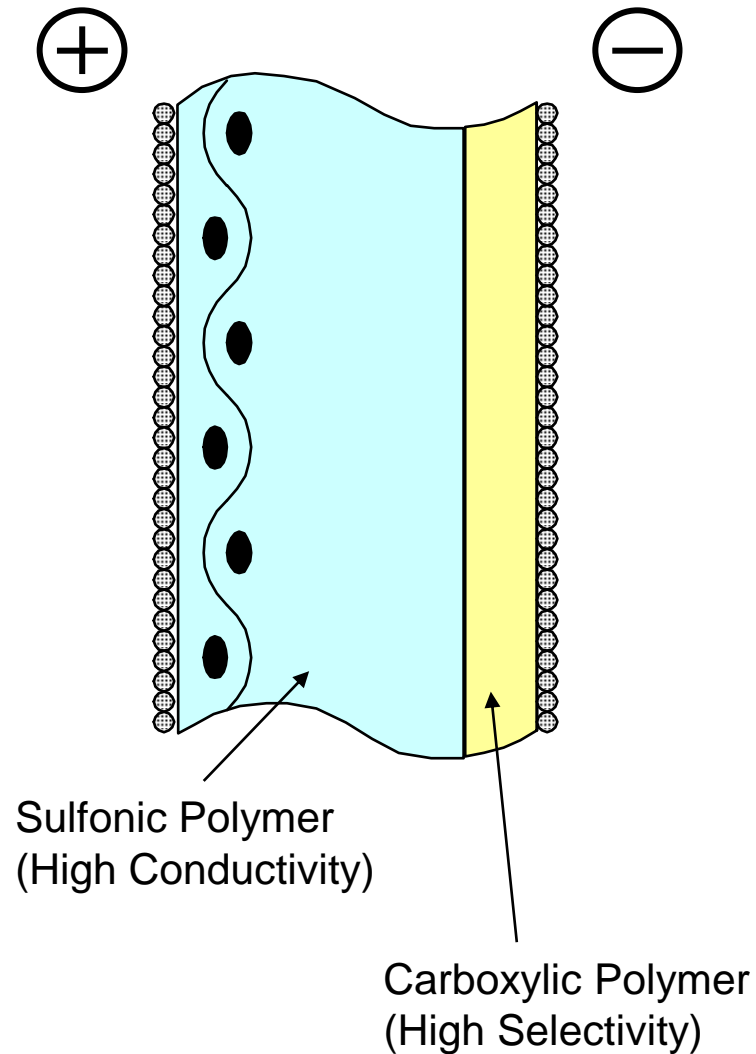


Condition : 5.5-5.8kA/m², 85°C, 32%, 210g/l , UhdeBM2.7v5



What's new ?





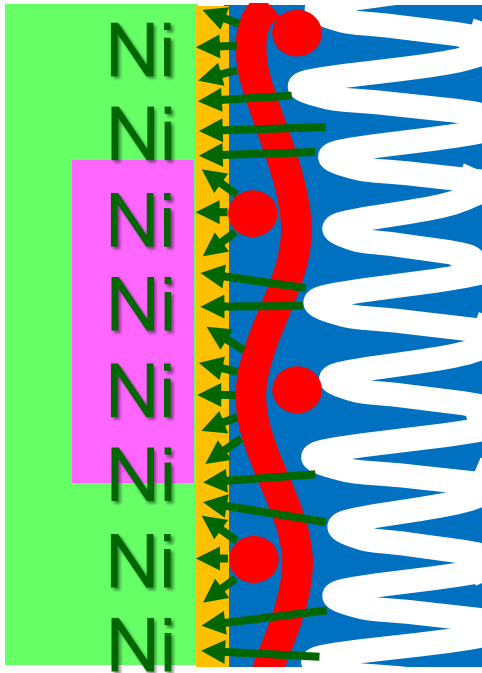
Merit	Key Technology
Lower Voltage	New S Polymer
Higher CE in Zero Gap	New Ion Channel
Stable Performance	Optimized Polymer Layer Configuration

Note) They are some parts of applied new technologies

“Zero gap” has **Three** Key Points

1

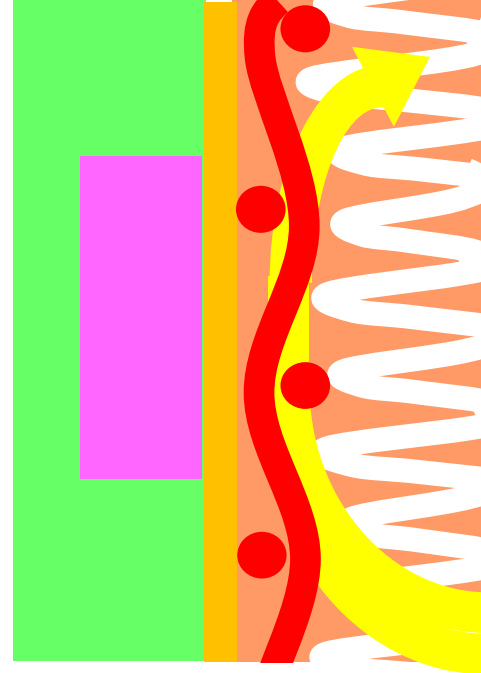
**Contacting
Cathode parts**



1 Ni stain

2

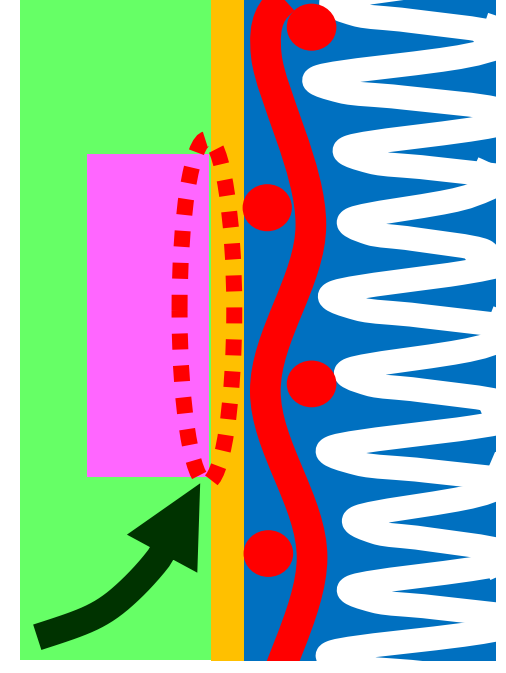
**Less
Catholyte Flow**



**2 High
Temperature**

3

**Less
Brine Supply**

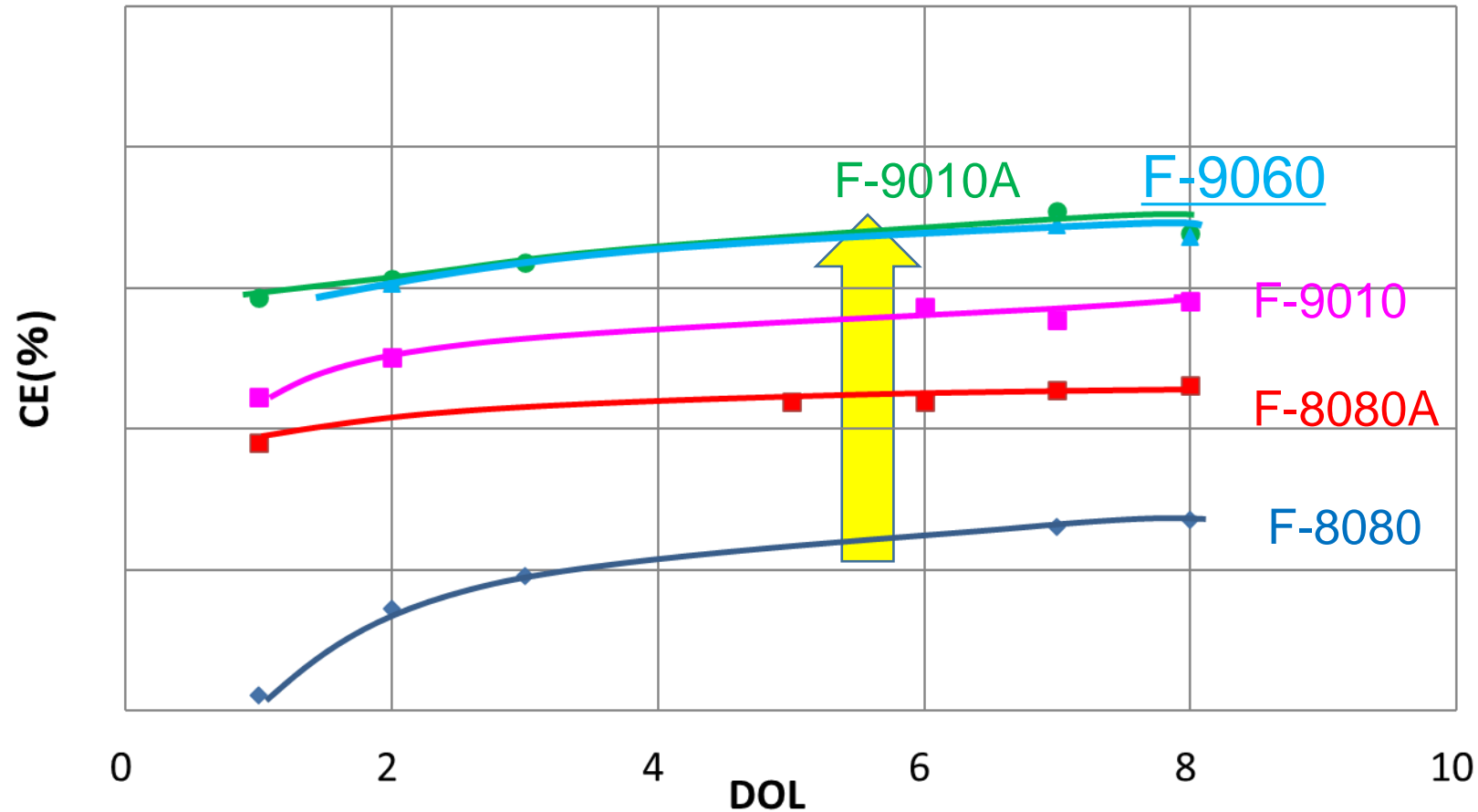


3 Weak brine

New Generation : Resistance to Ni stain

Precondition ; soaked in a Ni solution

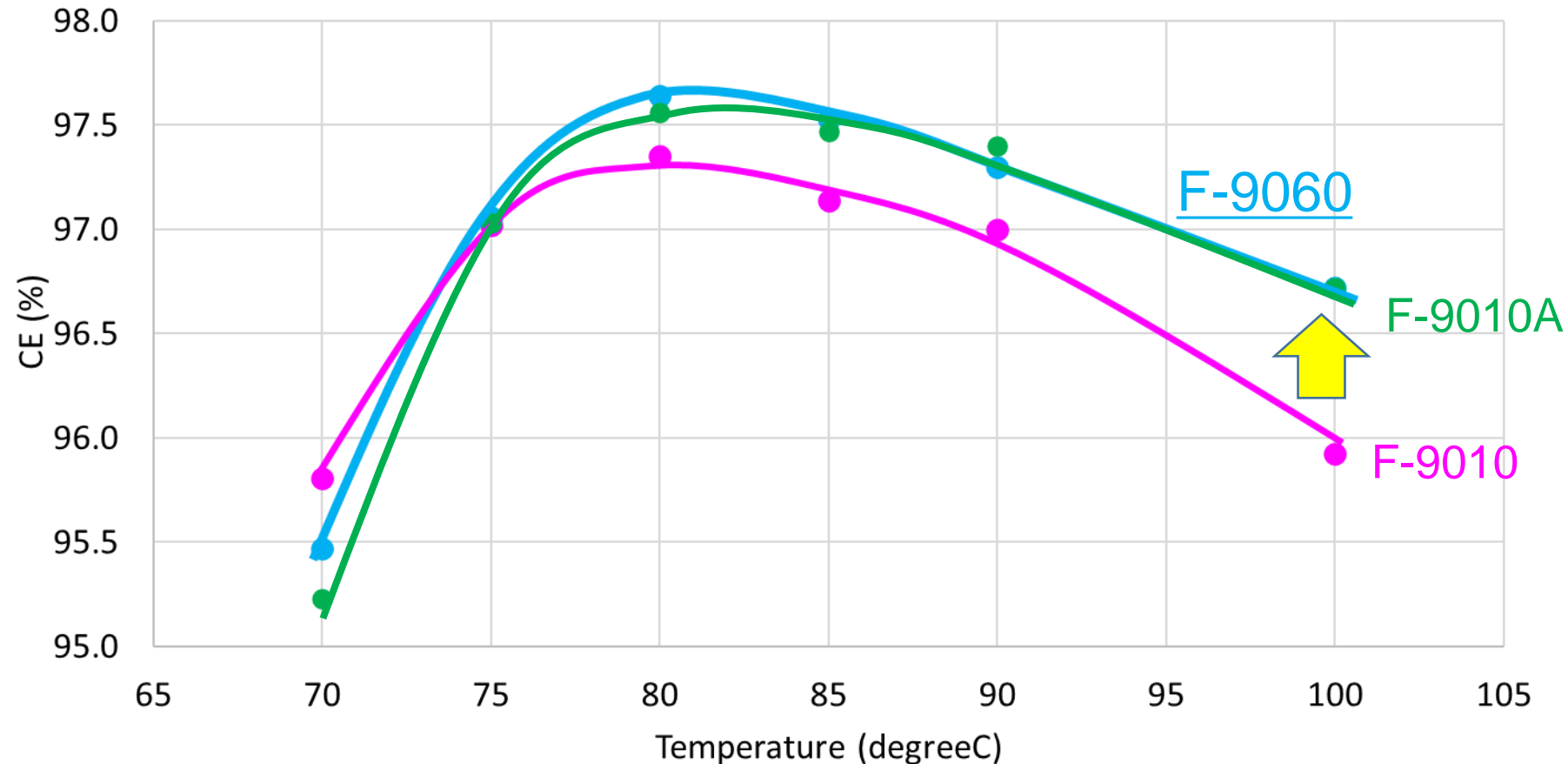
AGC Laboratory cell, 6 kA/m², 90 °C, NaOH 32 wt%, NaCl 200 g/l



F-9060 shows the highest resistance to Ni stain

New Generation : Temperature Characteristic

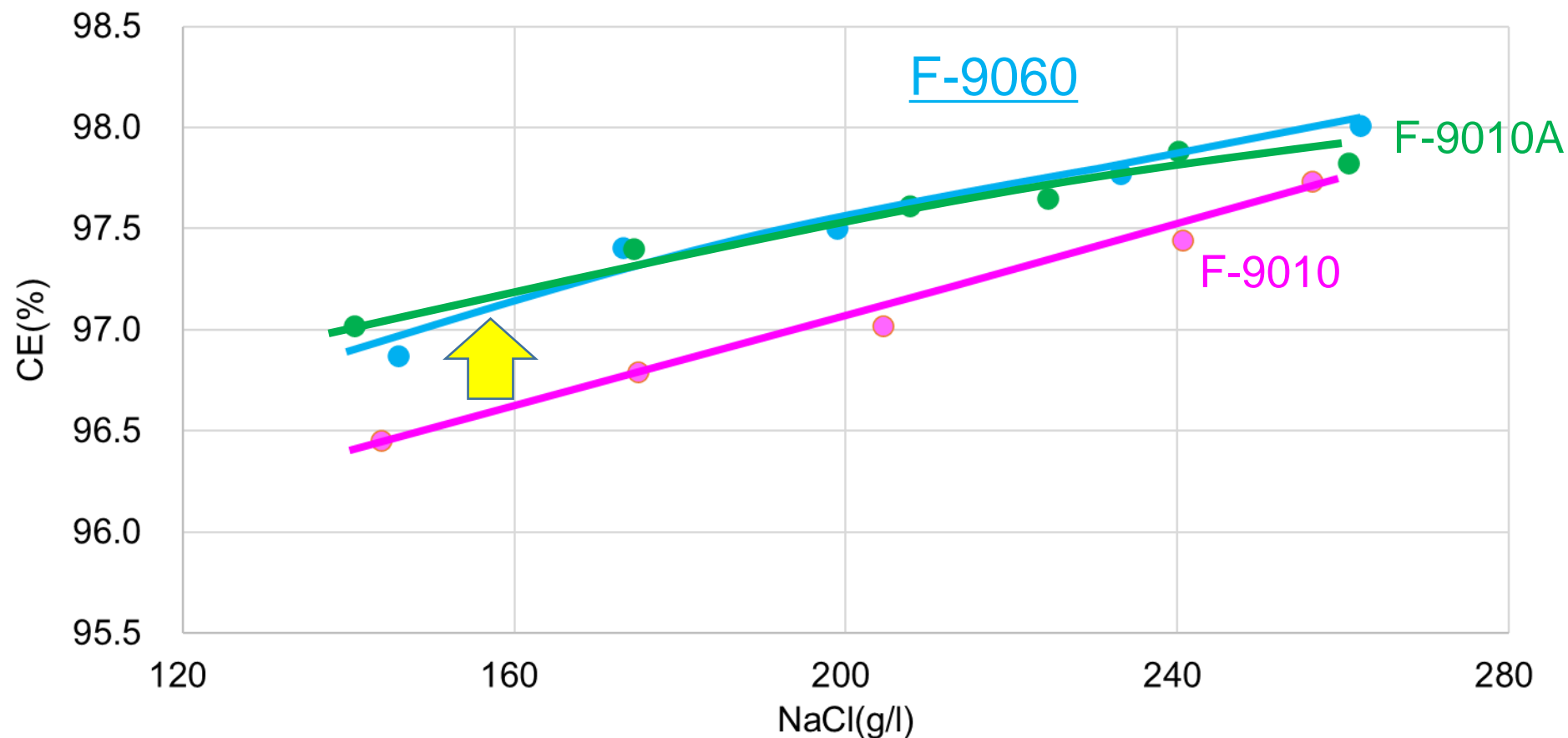
AGC LabCell, 6 kA/m², NaOH 32 wt%, NaCl 200g/l



F-9060 shows higher CE at higher temperature

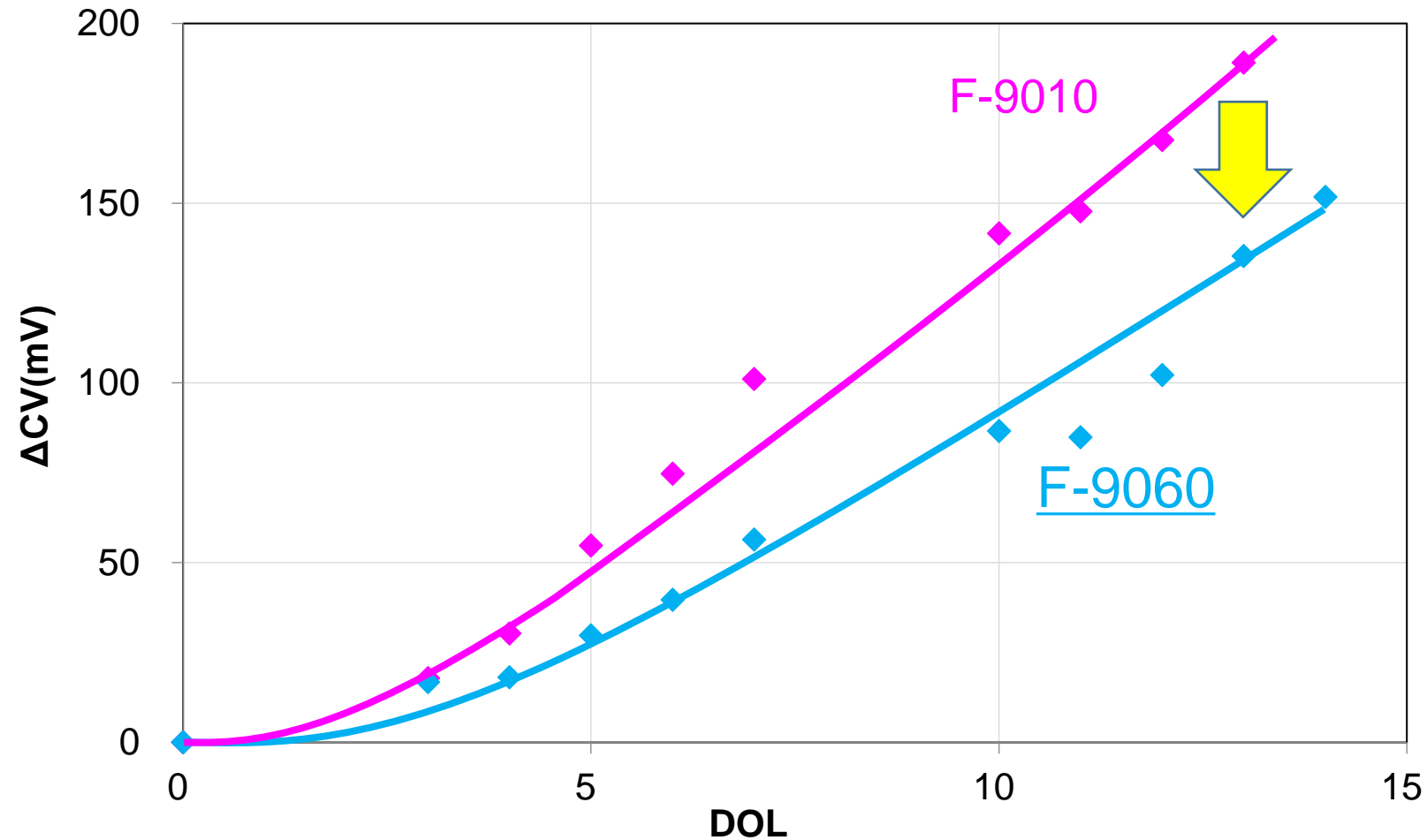
New Generation : NaCl Concentration Characteristic

AGC LabCell, 6 kA/m², 90 °C, NaOH 32 wt%



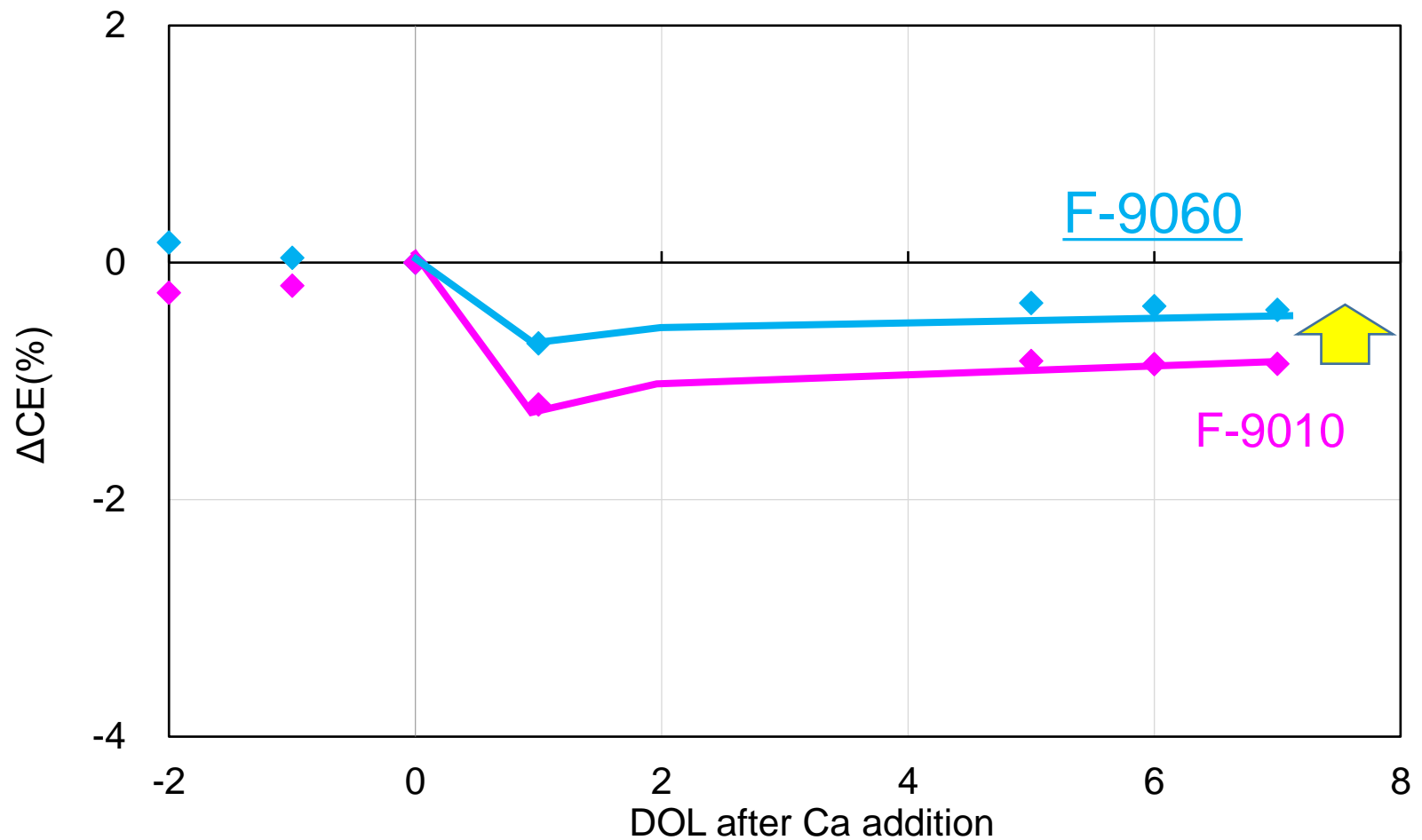
F-9060 shows higher CE in weak brine

Fe = 5 ppm, 8 kA/m², 85°C, NaOH 32wt%



F-9060 shows higher durability against Fe

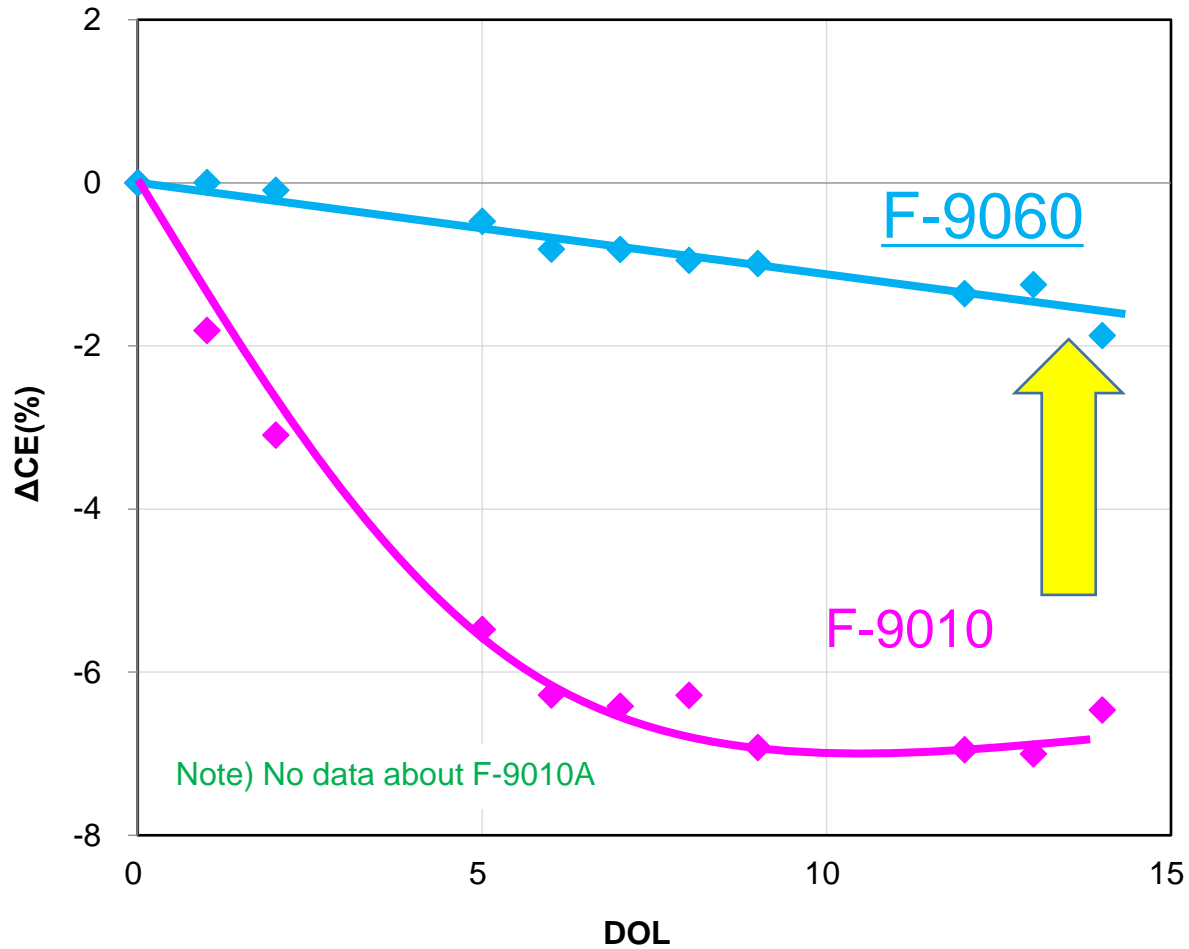
Ca = 0.5 ppm * 4 hr, 8 kA/m², 85°C, NaOH 32wt%



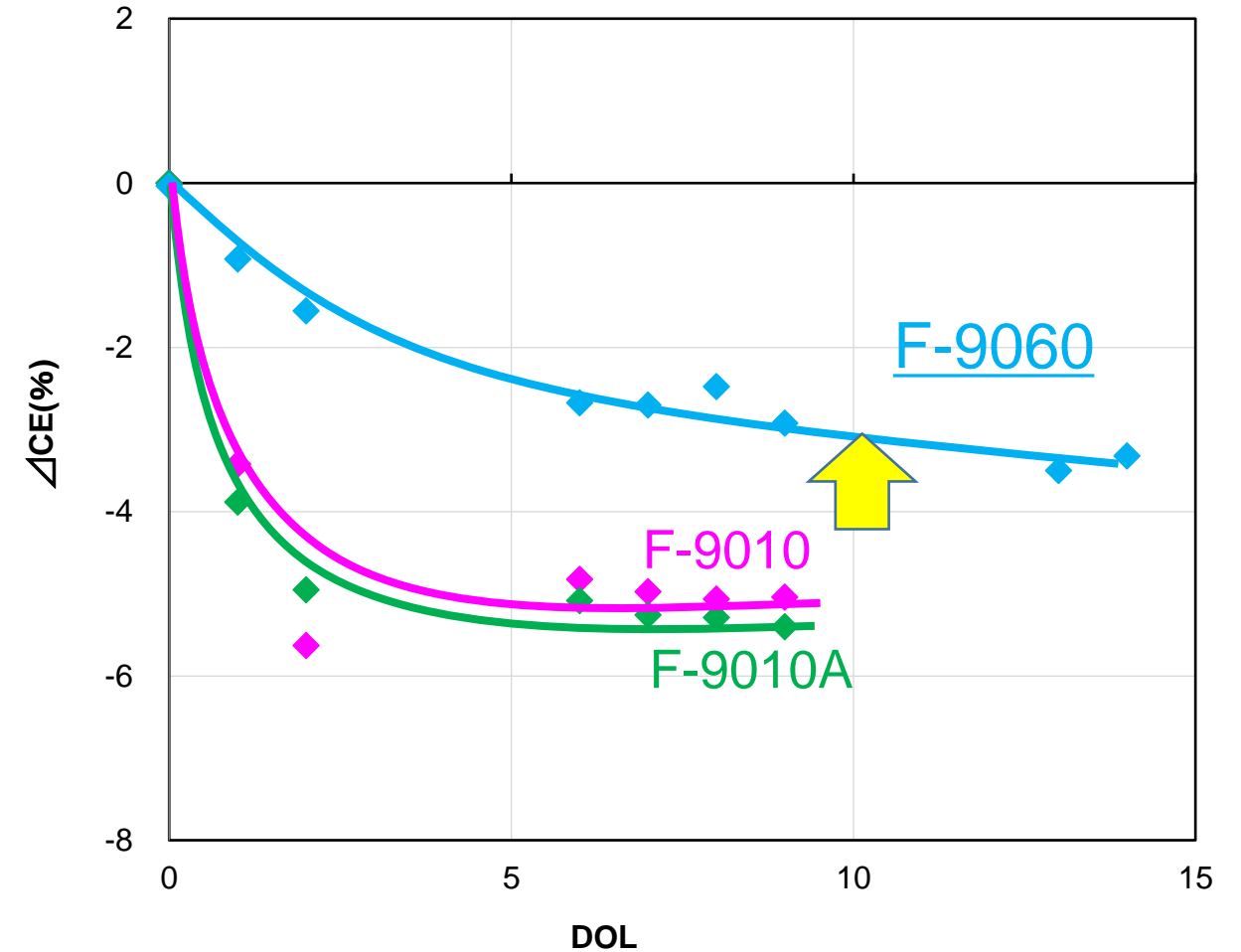
F-9060 shows higher durability against Ca

Durability against Sr/SiO_2 and Ca/SiO_2

$\text{Sr/SiO}_2 = 1/30$ ppm, 8 kA/m², 85°C, NaOH 32wt%

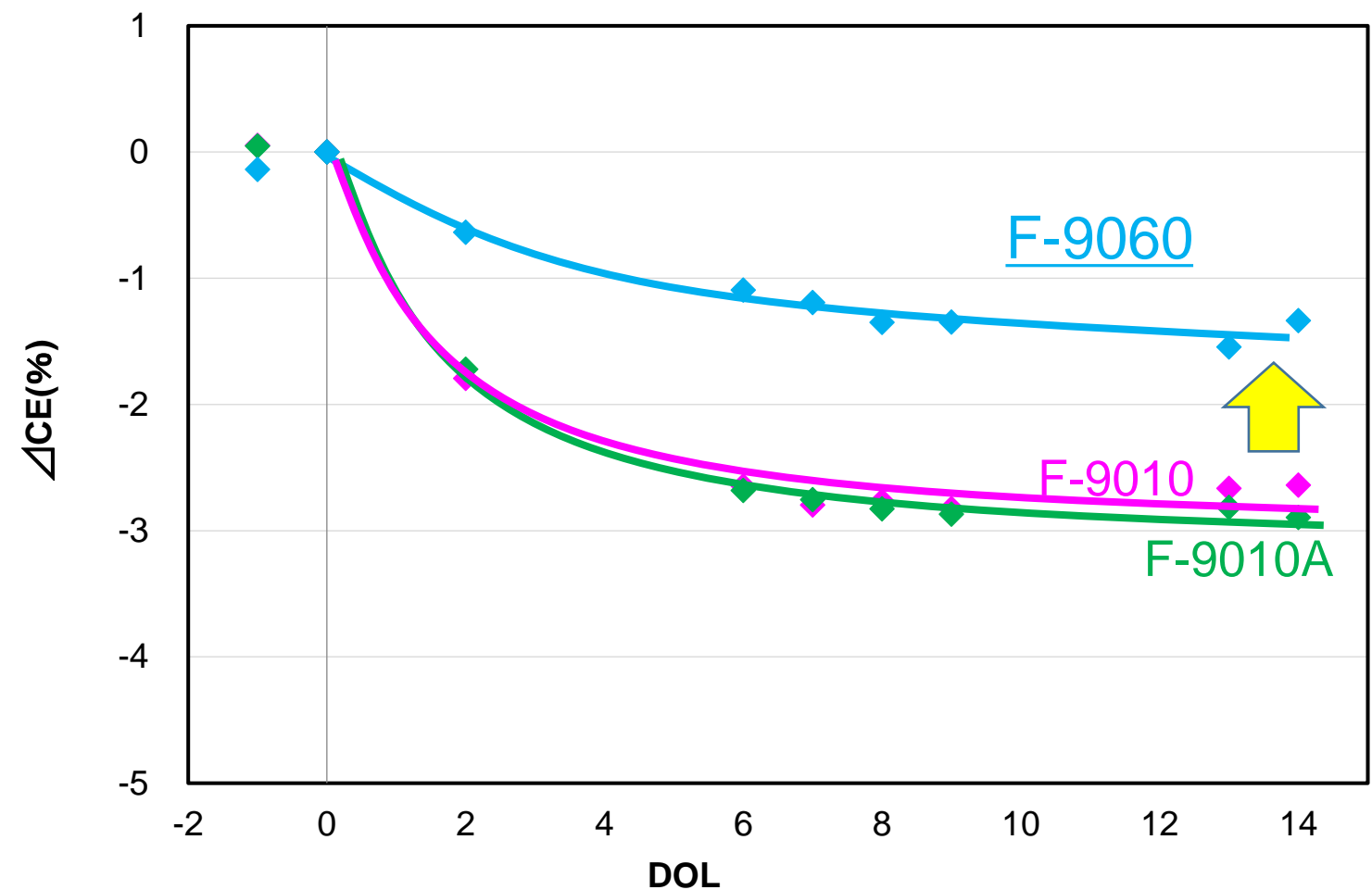


$\text{Ca/SiO}_2 = 0.05/15$ ppm, 8 kA/m², 85°C, NaOH 32wt%

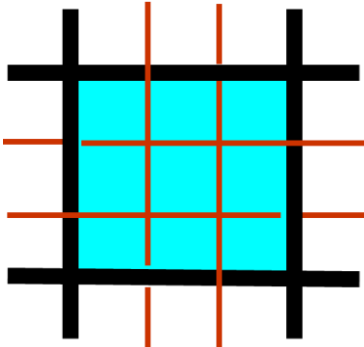
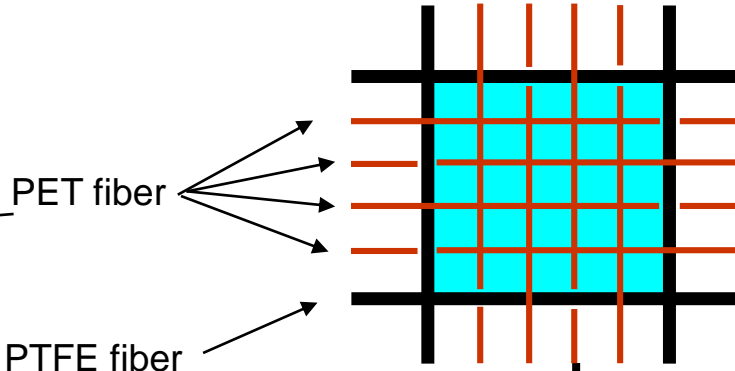
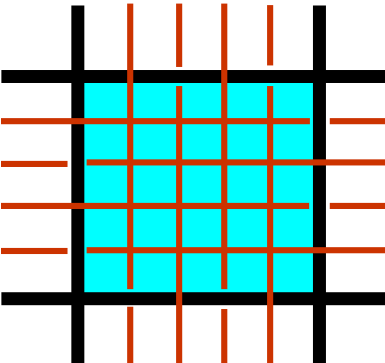


F-9060 shows higher durability against Sr/SiO_2 and Ca/SiO_2

I/Ca =10/0.3 ppm, 8 kA/m², 85°C, NaOH 32 wt%



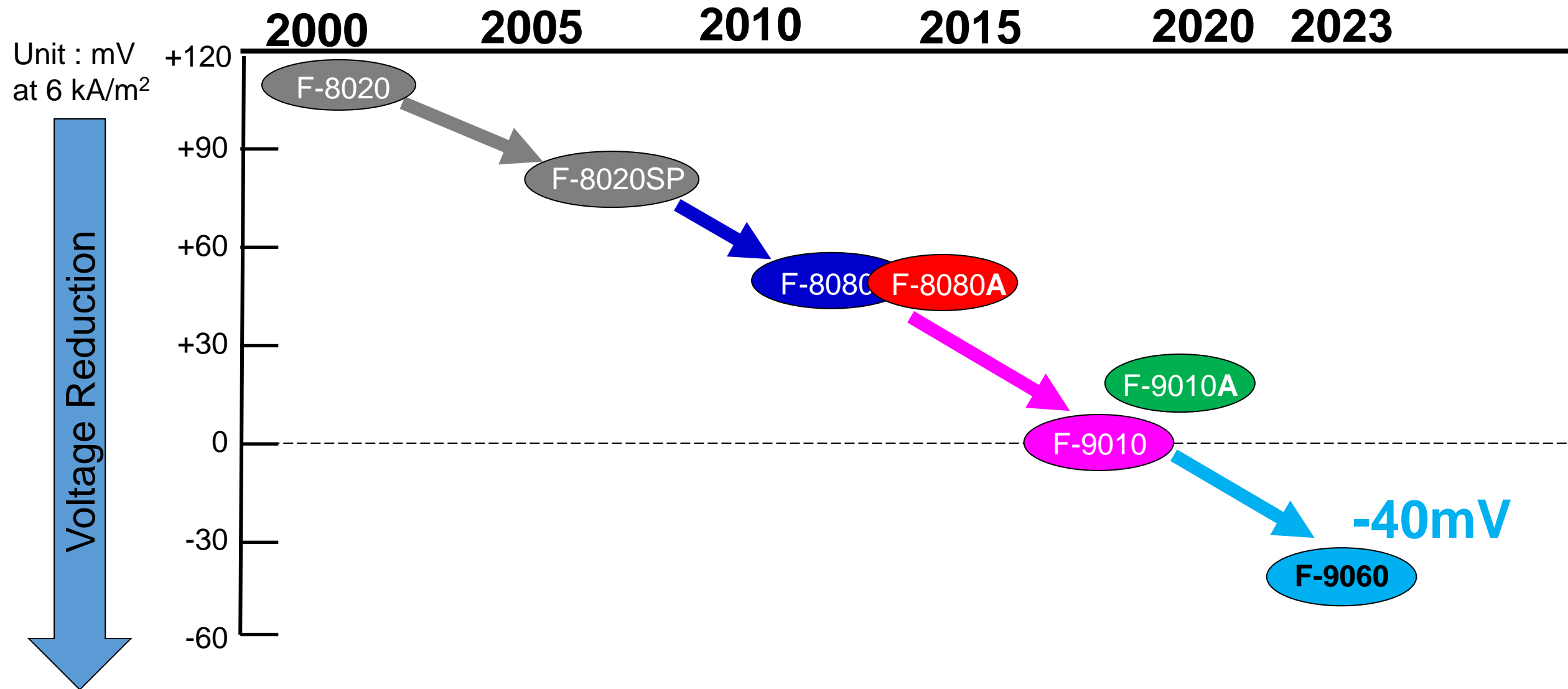
F-9060 shows higher durability against I/Ca

	F-8080/F-8080A	F-9010/F-9010A	F-9060
Reinforcement Cloth Type			
Tensile Strength	Approx. 45 N/cm	←	←
Elongation (Fiber direction)	Approx. 40 %	←	←
Frequent Load Tensile Test (AGC Original Overload Test)	Standard	Better	Standard

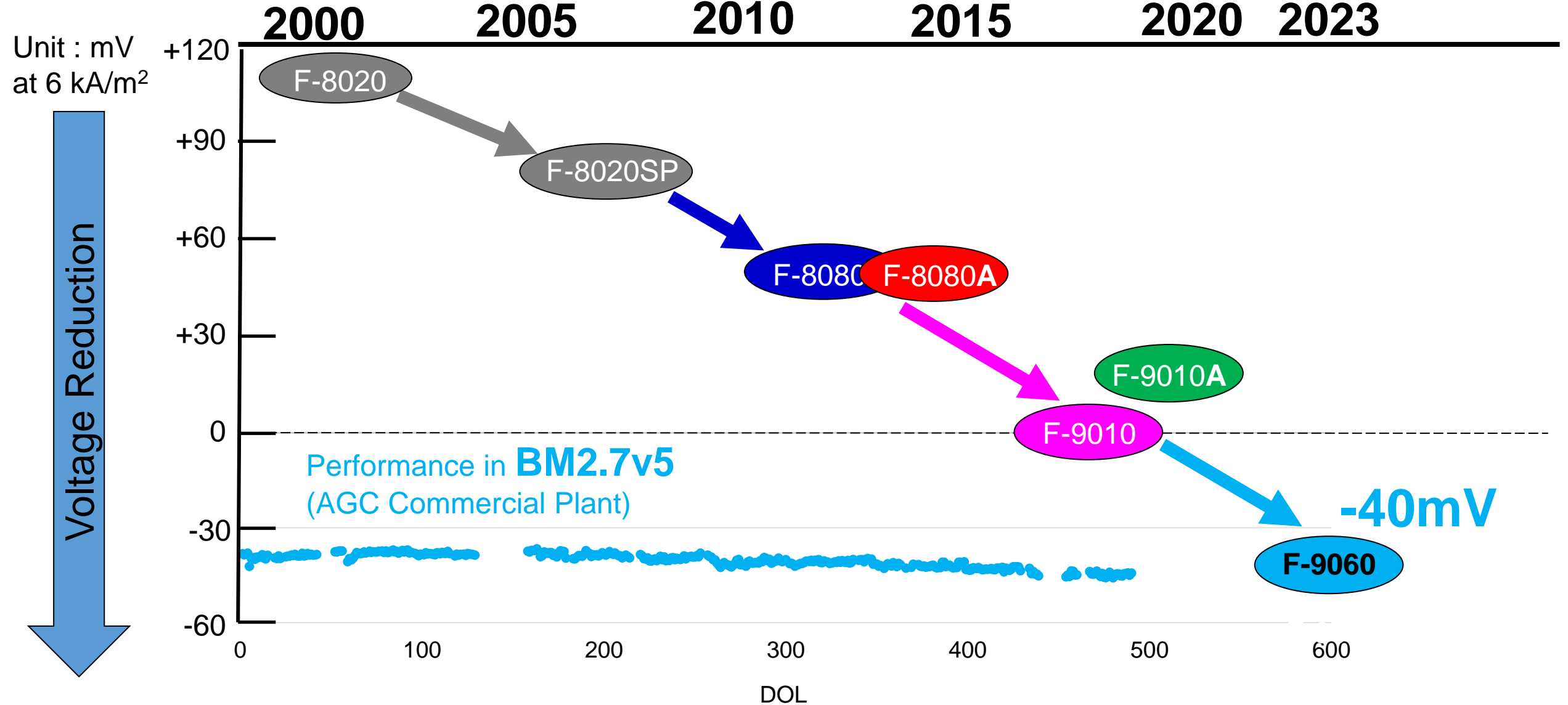
Note) Total number of frequent load tensile test until membrane breaking including fiber direction and 45 degree direction for fiber.
Frequent Load Tensile Test is an indicator for handling, and “Standard” indicates New Generation has sufficient mechanical strength as F-8080/A have.

One More Thing

FLEMION™ Voltage Reduction

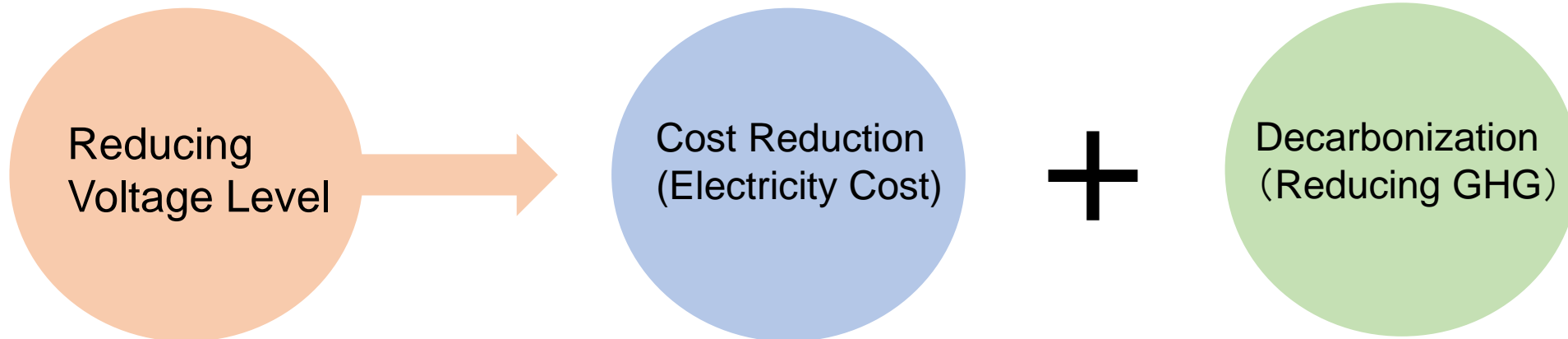


FLEMION™ Voltage Reduction



F-9060 keeps stable & low voltage in BM2.7v5 for around 16 months.

Reducing voltage level further would increase not only economical value but also environmental contribution:



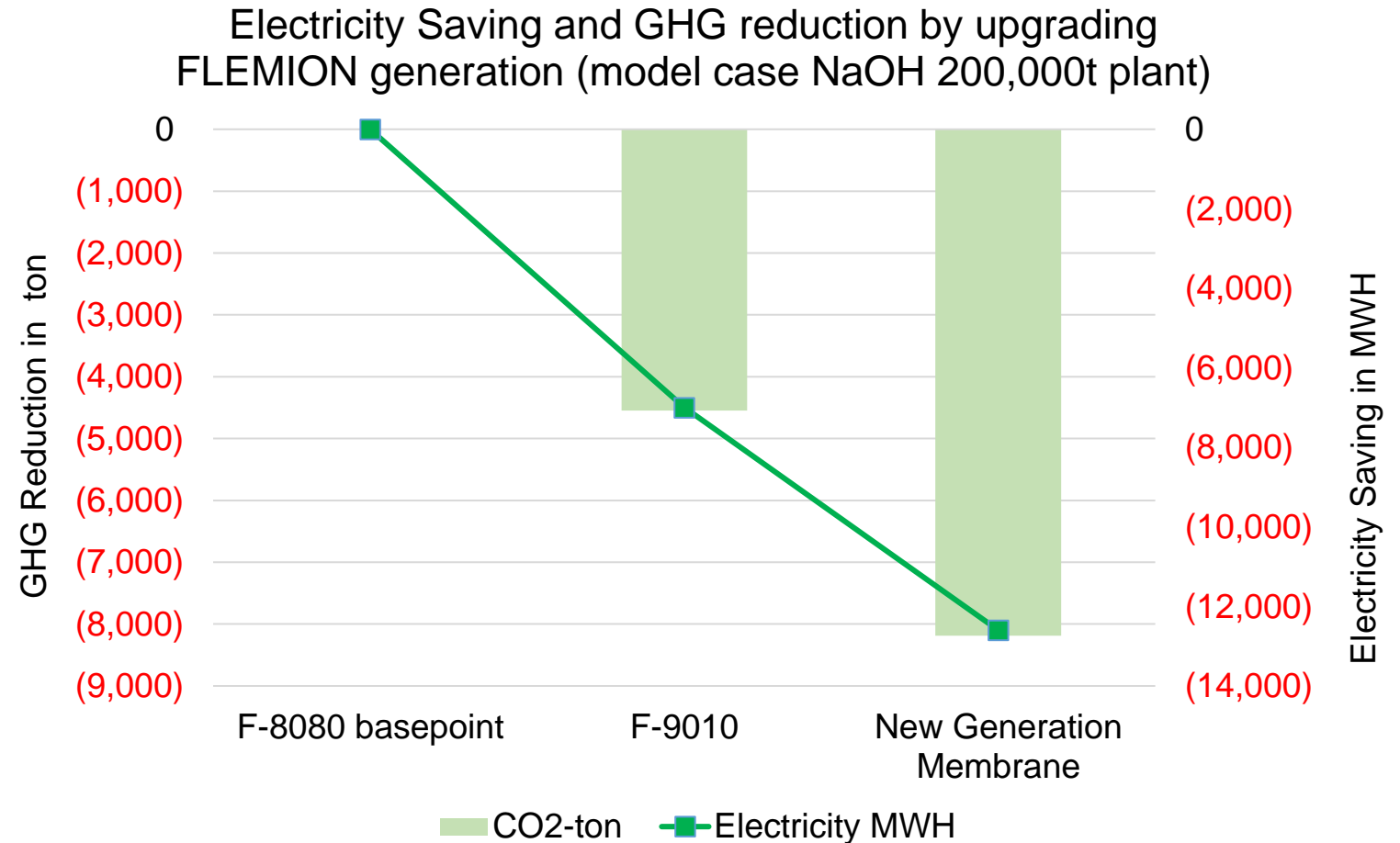
FLEMION™ Membrane: Value of reducing voltage level



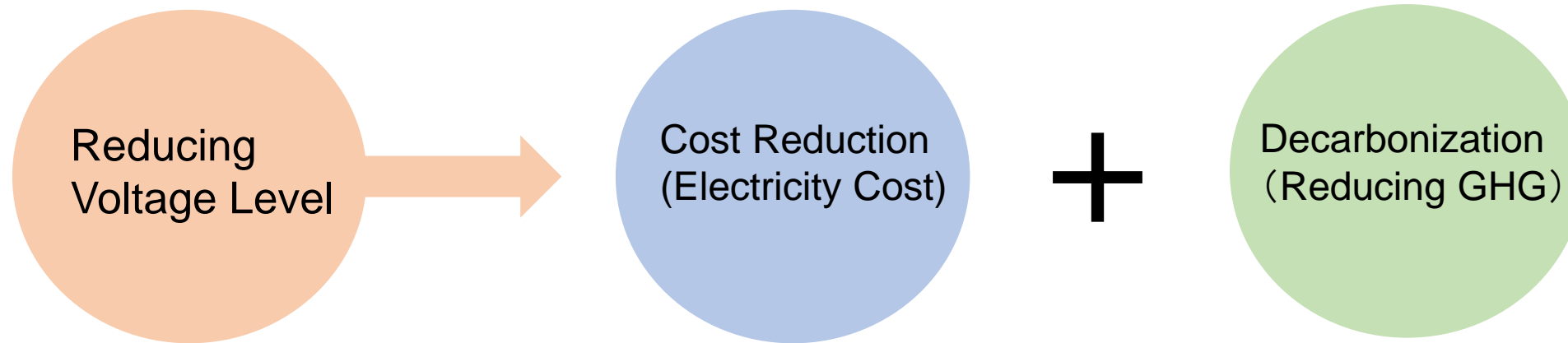
By utilizing FLEMION™ F-9060 membrane and reducing voltage level, chlor-alkali plant can save energy cost and also reduce CO₂ emission.

Premises:

- 1.. Consider FLEMION™ F-8080 as base point, calculating the impact of reducing 50mV by using F-9010 and further reducing 40mV by using New Generation Membrane.
- 2.. Consider Chlor-alkali plant with 200,000 ton/Y capacity as a model case
- 3.. Adopting US EPA's average CO₂ emission factor (in electricity, Non-baseload, 2020)



FLEMION™ Membrane: Value of reducing voltage level



▲40mV voltage reduction:

equivalent to approx. 28kWh/t-NaOH Power Consumption reduction

Economical impact on chlor-alkali plant with 200,000t /Y capacity:

assume electricity cost at 20 yen/kwh, cost reduction impact is roughly ¥ 110 million/year

▲40mV voltage reduction:

equivalent to approx. 12.5 kg/t-NaOH※¹ CO₂ reduction

※¹: adopting JP CO₂ basic emission factor: 0.000445 t-CO₂/kwh

Economical impact on chlor-alkali plant with 200,000t /Y capacity:

assume CO₂ ETS price is 102 euro/CO₂-ton※²
impact is roughly ¥ 37 million/year (exchange rate: 145 yen/euro)

※²: ETS = Emission Trading Scheme

- New Generation Membrane F-9060
 - 1. Lowest voltage**
40mV lower voltage than F-9010 at 6kA/m²
 - 2. Higher CE stability in zero gap**
Higher resistance to Ni stain and high temperature operation
 - 3. Higher durability against and Fe, Ca, Sr/SiO₂, Ca/SiO₂ and I/Ca**

Thank you for your attention