

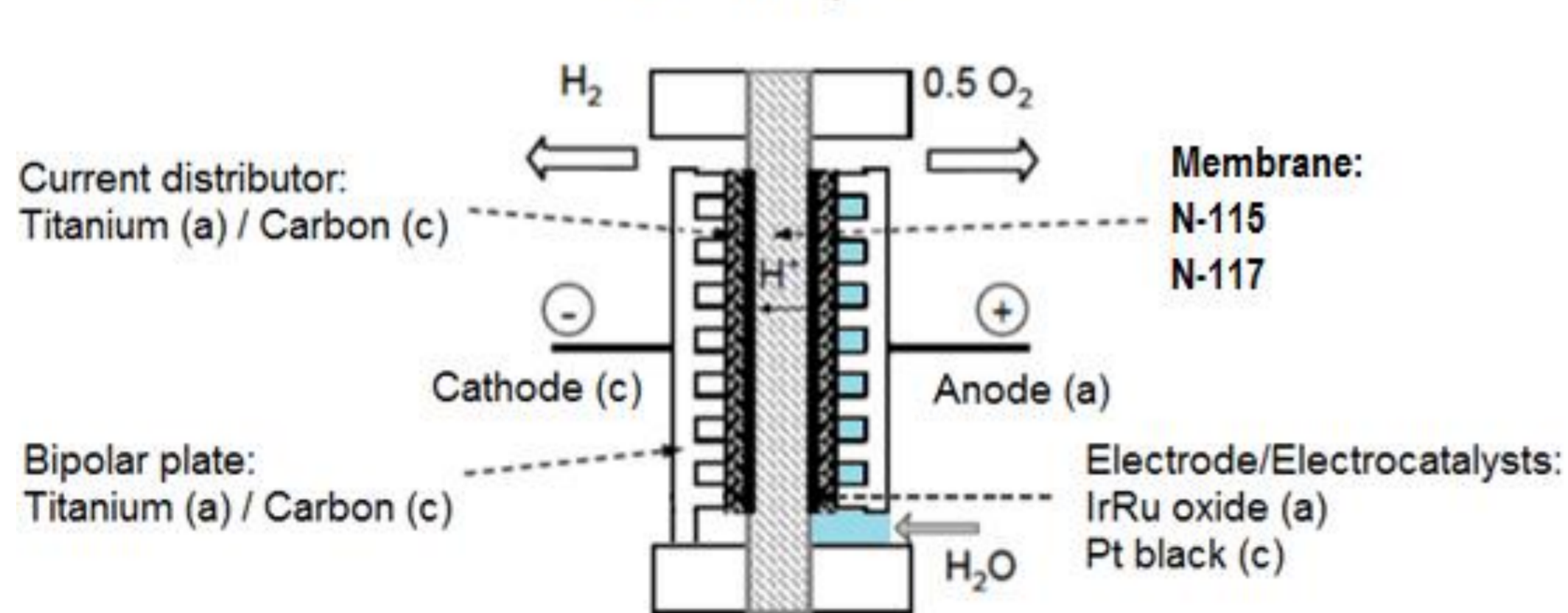
Radiation grafted polymer electrolyte membranes for water electrolysis cells Characterization of key membrane properties

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Motivation

Electrolyzer



Key membrane properties

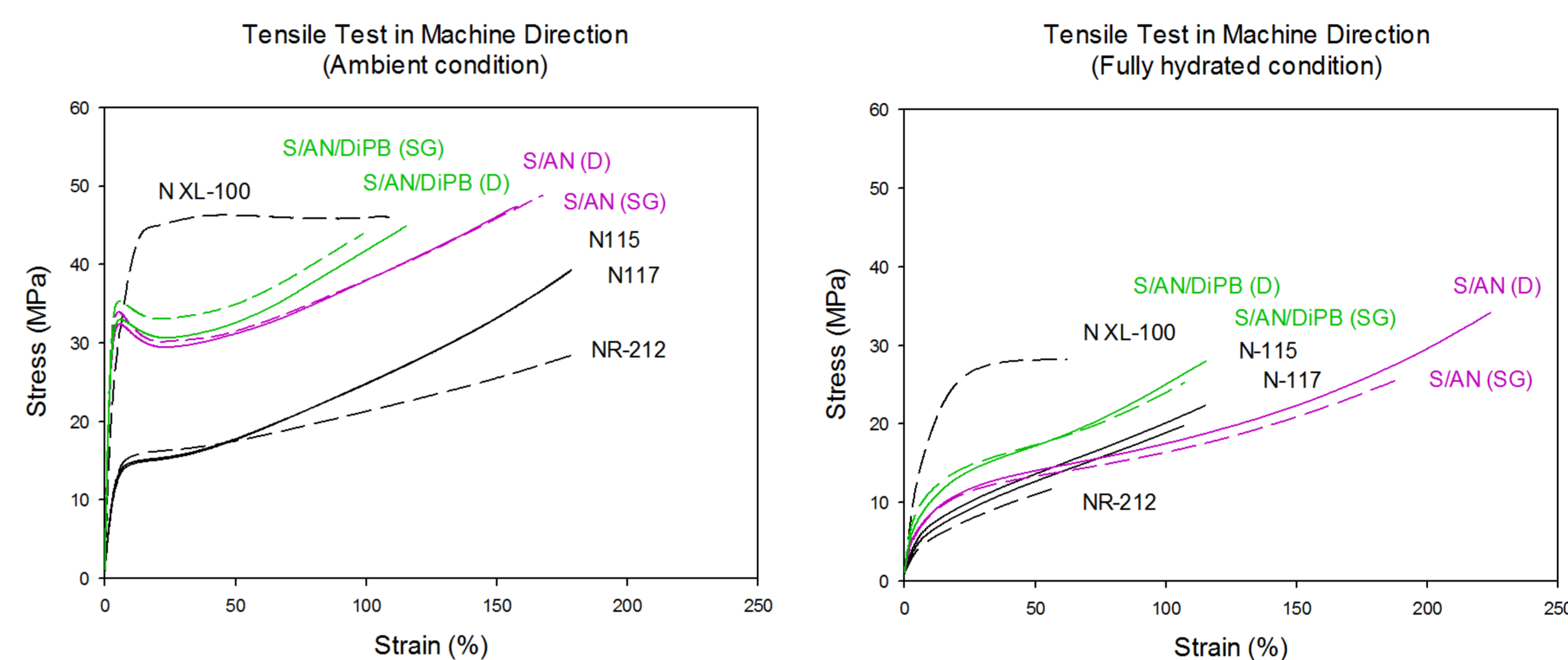
- **Gas crossover¹**
(gas purity, safety, current efficiency, high pressure application)
- **Resistance¹**
(voltage efficiency)
- **Mechanical properties¹**
(durability, high pressure application)
- **Cost**
(production)

Radiation grafted membranes as alternatives for Nafion

- ❖ ETFE-*g*-P(Styrene-*co*-Acrylonitrile) (**S/AN**)
- ❖ ETFE-*g*-P(Styrene-*co*-Acrylonitrile(-1,3-Diisopropenylbenzene)) (**S/AN/DiPB**)

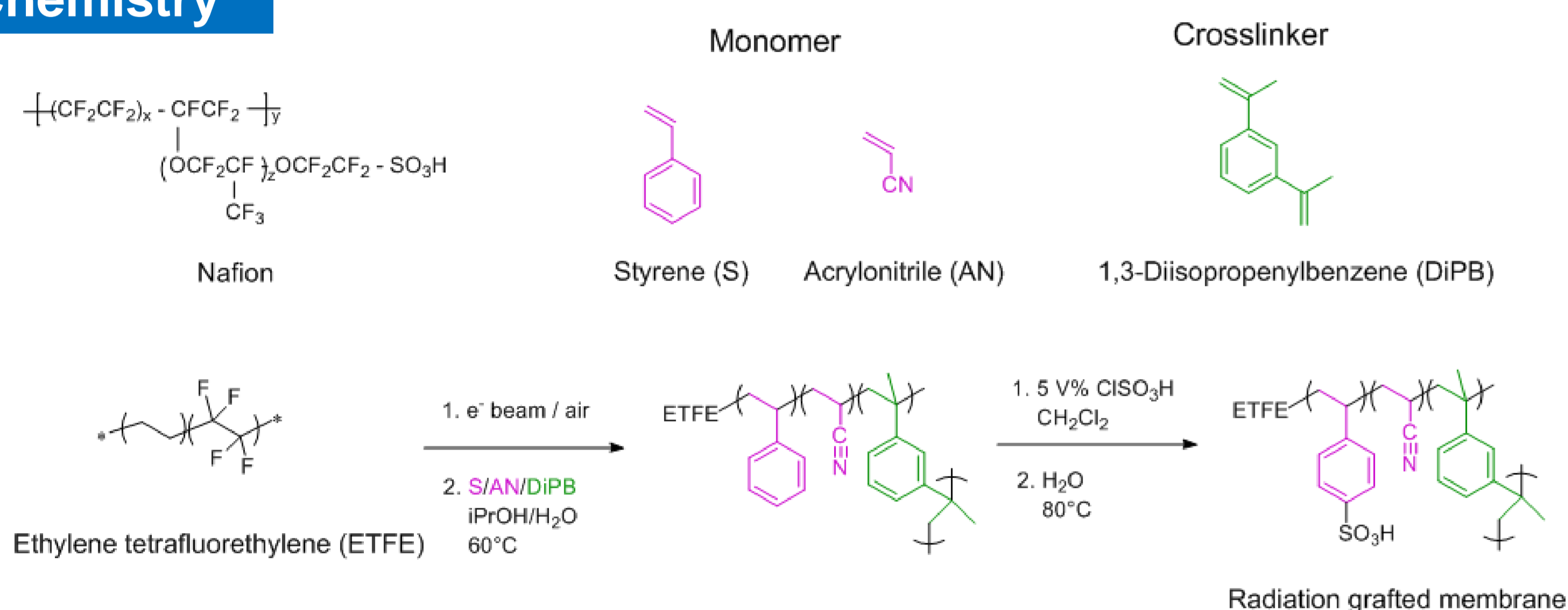
Mechanical Properties

Mechanical testing according to ASTM D 882 (tensile properties of thin plastic sheeting)



➤ Better mechanical properties, especially under fully hydrated condition

Chemistry

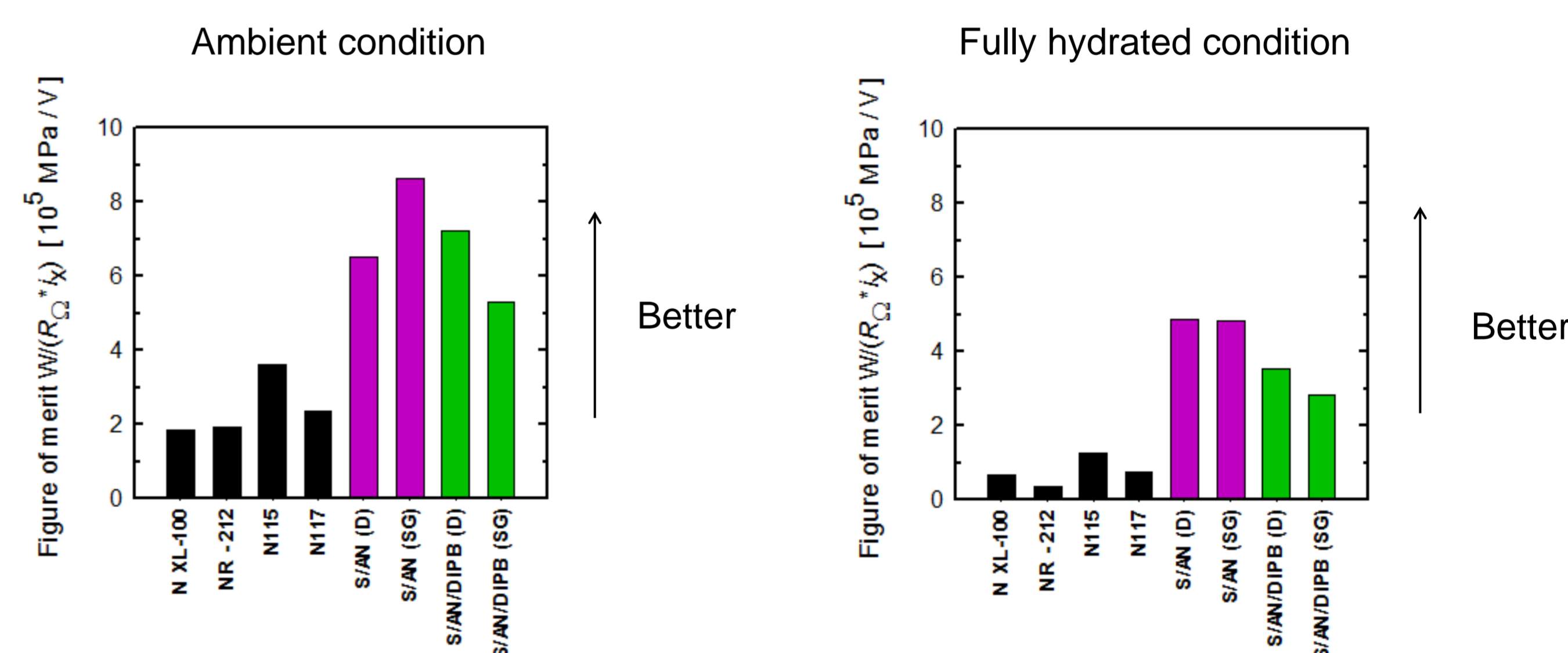


❖ ETFE 50 μm from DuPont (D) or Saint-Gobain (SG)

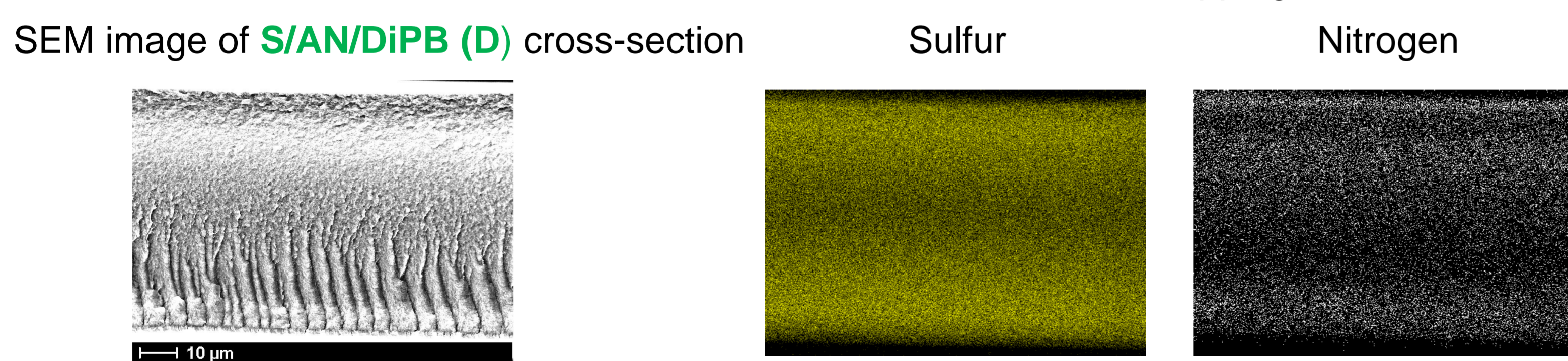
Figure of Merit

$$M = \frac{W}{R_{\Omega} \cdot i_x}$$

M : Figure of merit (MPa/V)
 W : Toughness (area under the stress-strain curve) (MPa)
 R_{Ω} : Area resistance (mΩ·cm²)
 i_x : H₂ crossover current density (mA/cm²)

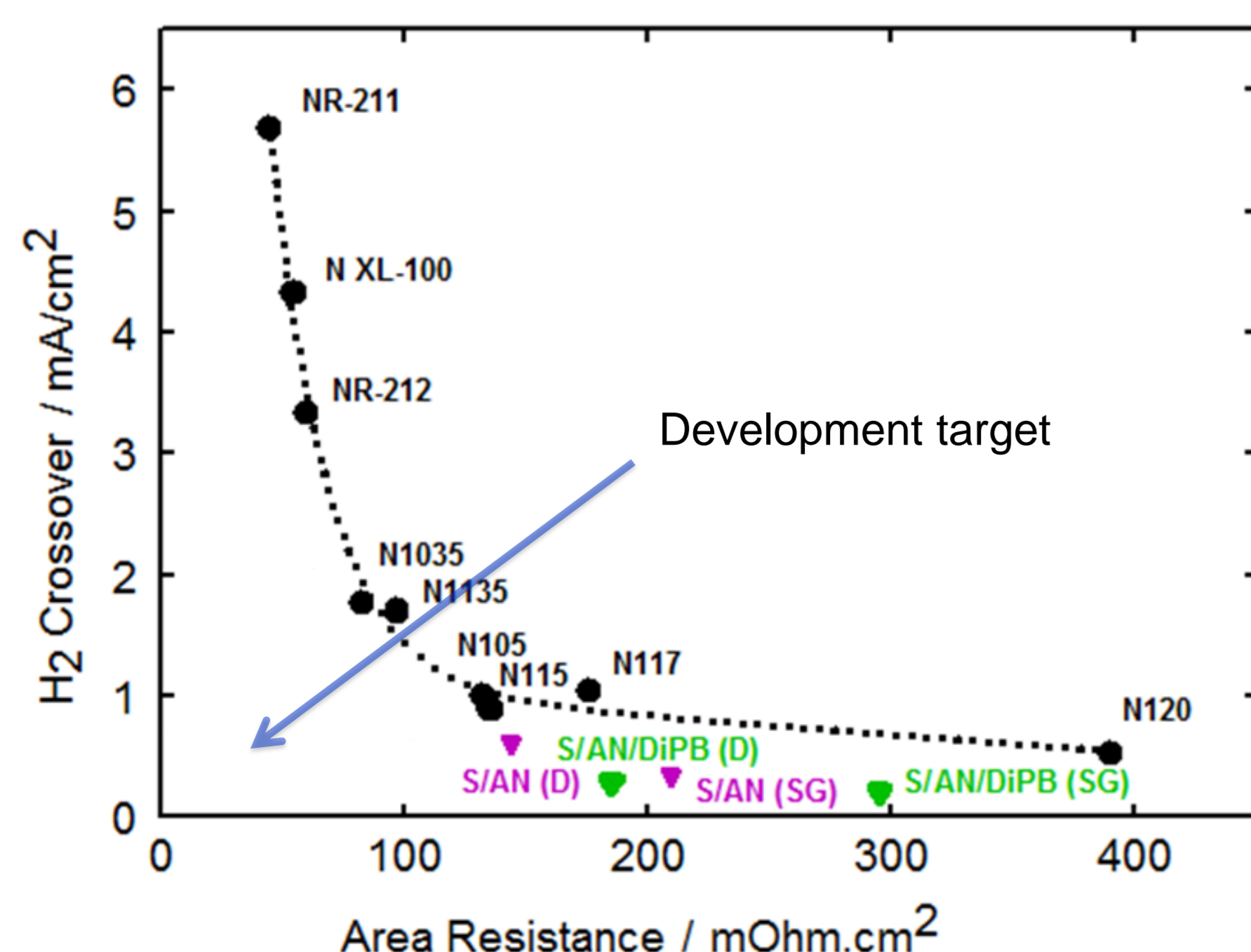


Distribution of Grafts



Property Map

Gas crossover (H₂ crossover experiments; fuel cell; H₂/N₂; 80 °C; 2.5/2.5 bar_a; RH 100%)
Area resistance (high frequency resistance @ 0.2 A/cm²; fuel cell; H₂/O₂; 80 °C; 2.5/2.5 bar_a; RH 100%)

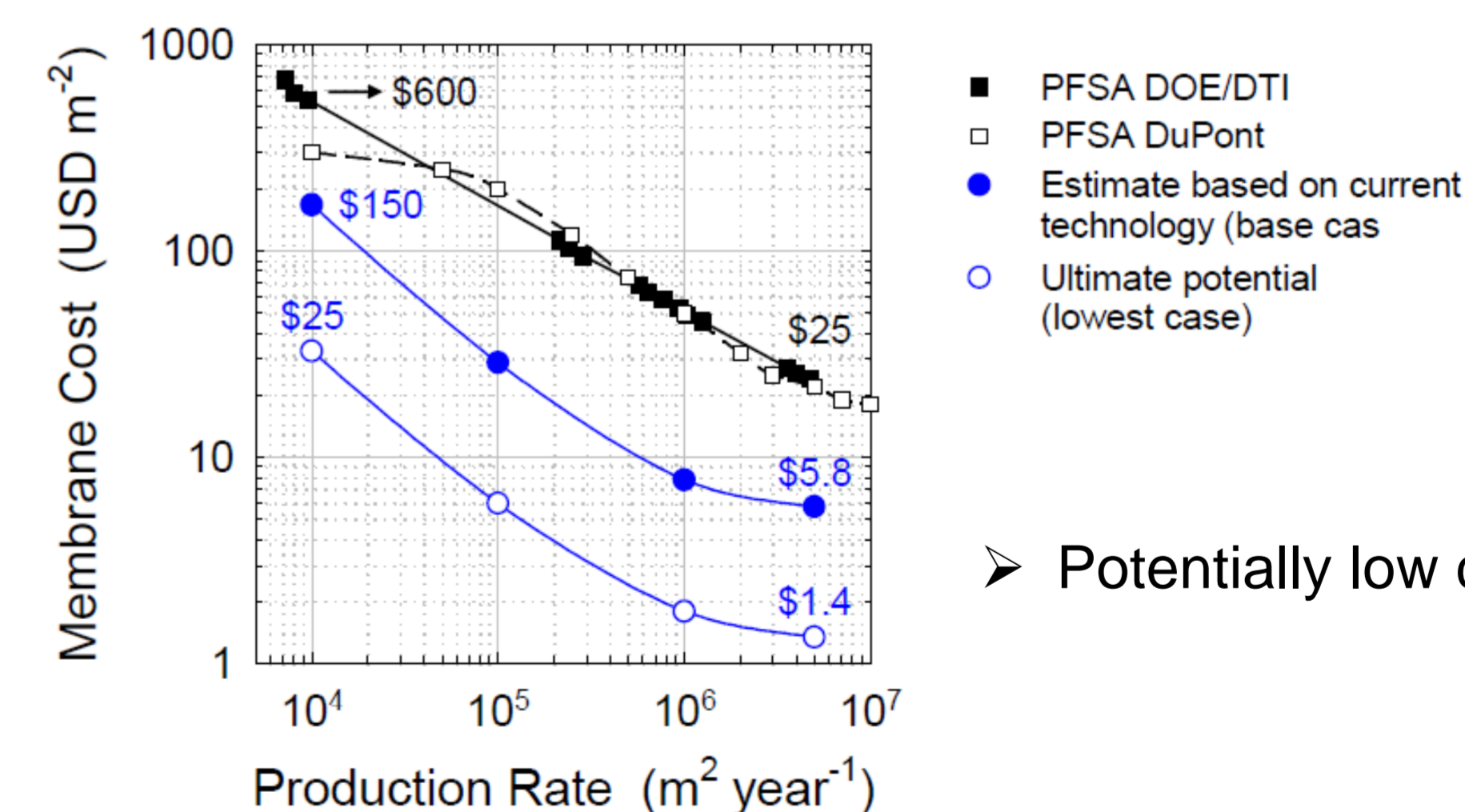


Radiation grafted membrane vs N115 / N117

- Lower gas crossover
- Similar resistance

Cost

Estimated production cost of radiation grafted membranes²



➤ Potentially low cost

Conclusion

- Lower gas crossover
 - Similar resistance
 - Better mechanical properties
 - Potentially low cost
- The radiation grafted membranes are promising alternatives to Nafion for water electrolyzer applications.

Acknowledgement

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative under grant agreement n°303484 (**NOVEL project**).

¹ M. Schalenbach, M. Carmo, D.L. Fritz, J. Mergel, D. Stolten, Int J Hydrog Energy 38, 14921 (2013).

² L. Gubler, L. Bonorand, ECS Trans. 58, 149 (2013).