MoreH2

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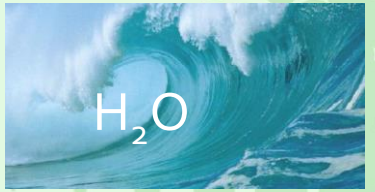
Nordic Energy Research

Jan Froitzheim
Chalmers University of Technology
Gothenburg, Sweden

Hydrogen



The most abundant element in the universe…

3rd most abundant on Earth

”No” natural hydrogen

H_2 needs to be produced, currently almost exclusivly from fossil fuels.

-> Electrolysis

$$H_2O \xrightarrow{\text{electricity}} H_2 + \tfrac{1}{2}O_2$$

Green hydrogen

Targets Elektrolysis:

EU: 100 GW (2030)

Sweden: 5 GW (2030) 15 GW(2045)

Finland: 12 GW (2030)

Denmark: ~5 GW (2030)

2030:

4 years, 11 month, 8 days, 9 hours

Forsmark Nuclear Plant:

(3 reactors) ~3.2 GW

Olkiluoto Nuclear Plant:

(3 reactors) ~3 GW

Vattenfall/TVO

Sweden: 5500 Windturbines

Installed Power 16.2 GW

Avg. Power 3.9 GW

Energimyndigheten 2023

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Electrolysis techniques

	Alkaline Water Electrolysis (AWE)	Proton Exchange Membrane Water Electrolysis (PEMWE)	Solid Oxide Electrolysis (SOEC)
Maturity			
Efficiency			
Responsiveness			

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Based on C. Bernuy Lopez (H2 Green Steel)

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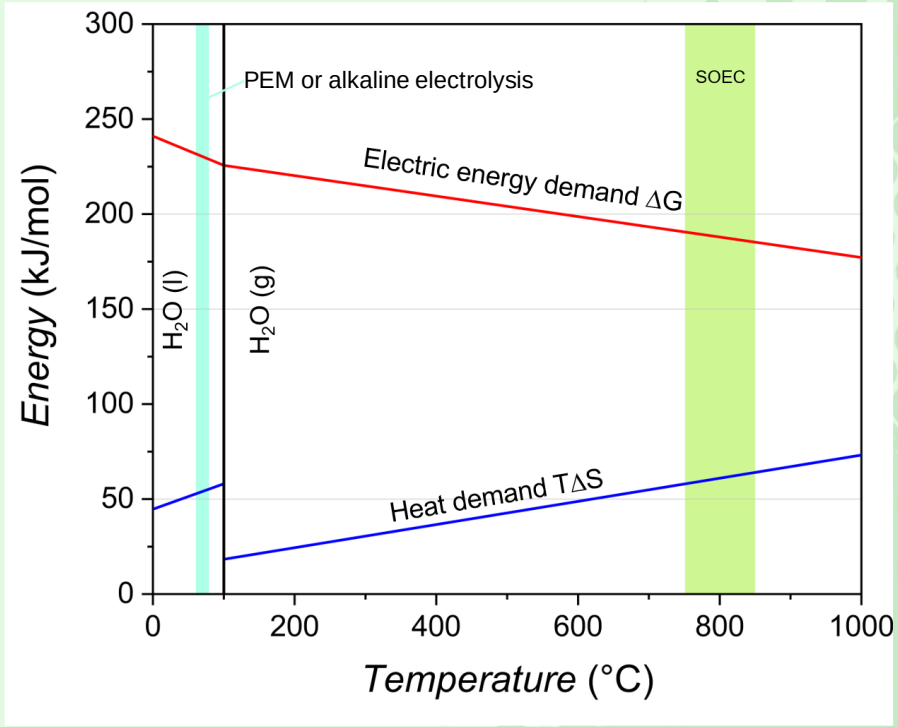
Proton exchange membrane Electrolysis (PEMWE) has unmatched flexbility and thus most suitable at accomodate load balancing.

Solid Oxide Electrolysis (SOEC) needs ~20% less electricty*.

*when heat/steam is available



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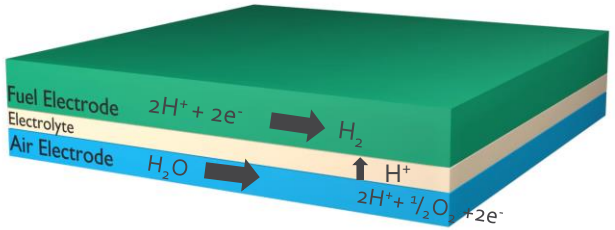
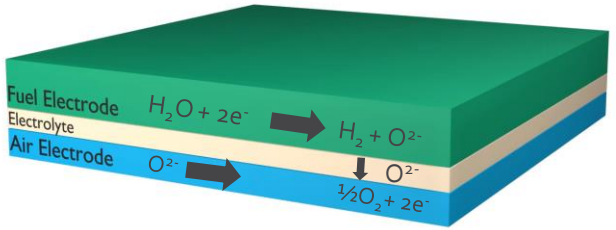
Interconnects/Bipolar plates



PEMWE

T ~ 80°C



SOEC

T = 600-900°C

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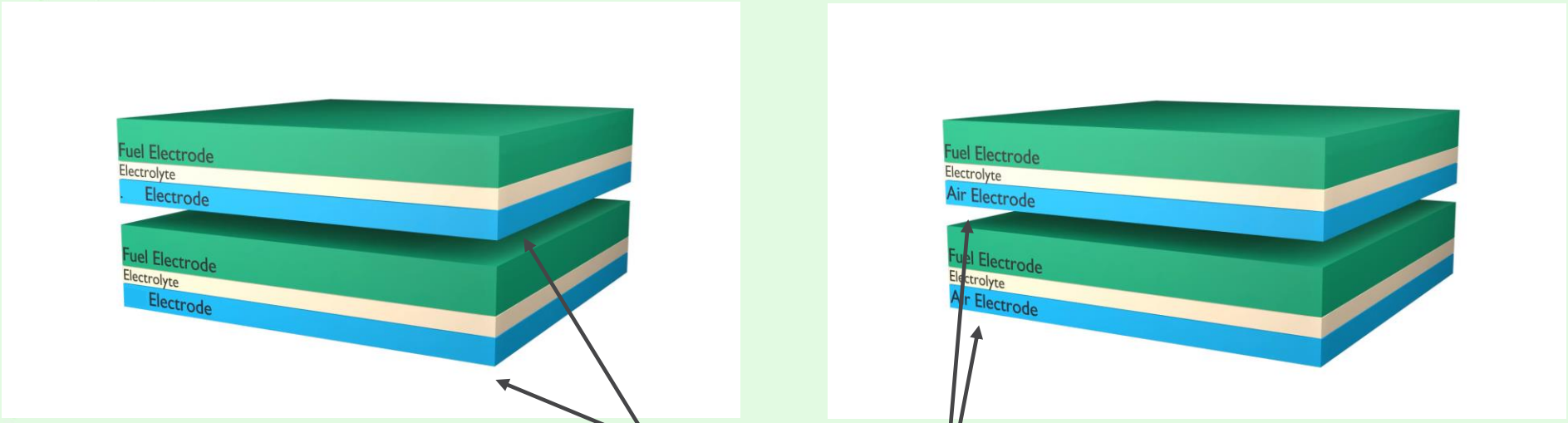
Interconnects/Bipolar plates



PEMWE

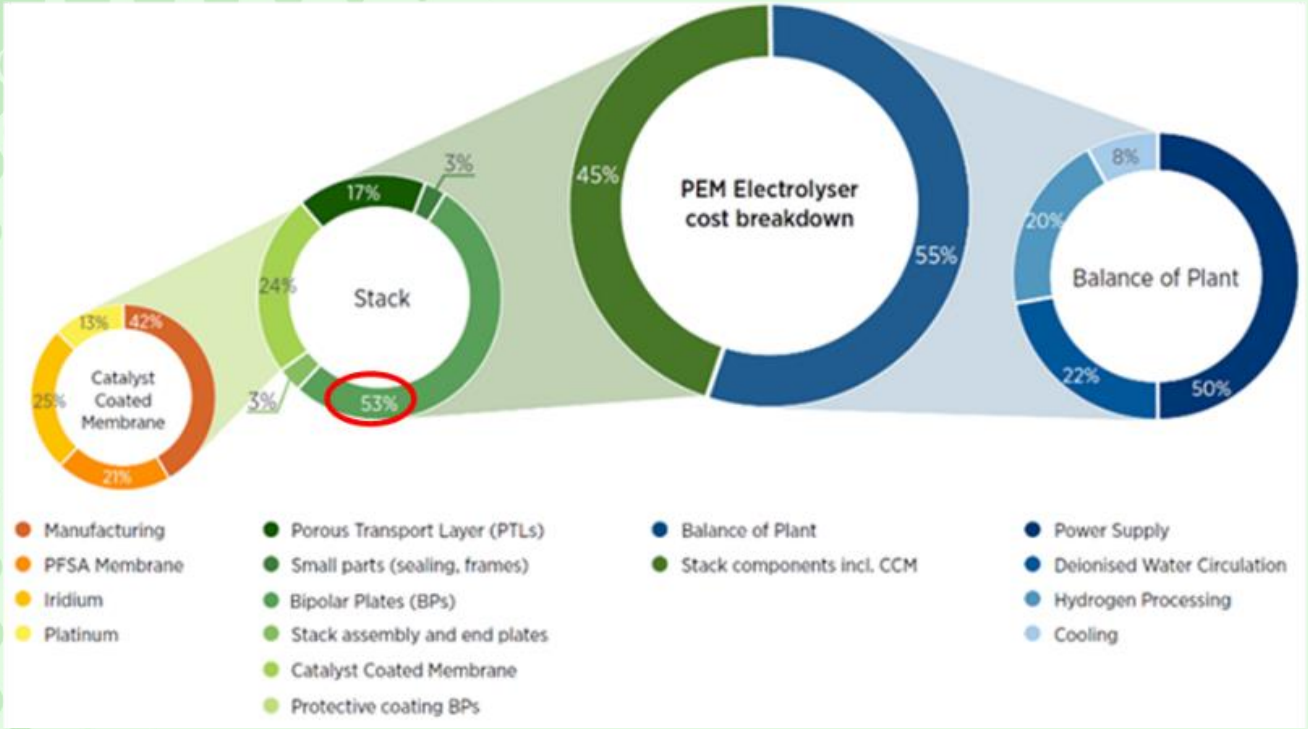
T ~ 80°C

Bipolar plate

Interconnect

SOEC

T = 600-900°C



Cost breakdown of a 1 MW PEM electrolyser system based on IRENA analysis.

Replace Pt coated Ti with stainless steel bipolar plates

Develop protective coatings for SOEC interconnects

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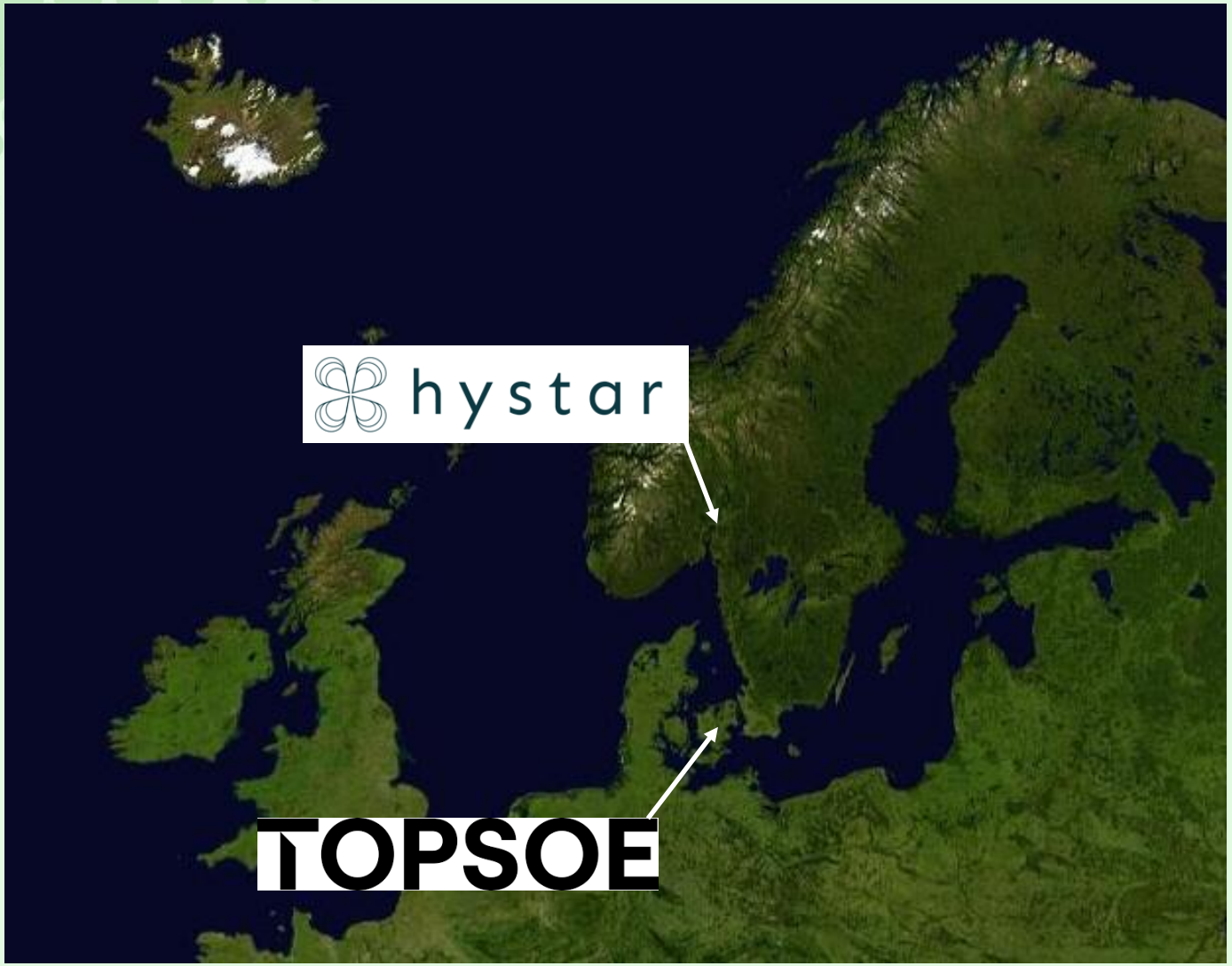

Largest SOEC factory in the world, Herning DK

-> Tobias Holt, tomorrow ~9:10

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Jan Froitzheim
Dept. of Chemistry and Chemical Engineering
Chalmers University of Technology
jan.froitzheim@chalmers.se

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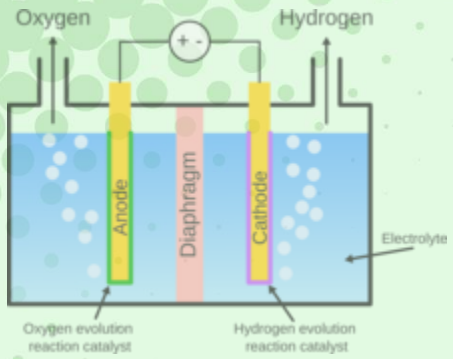
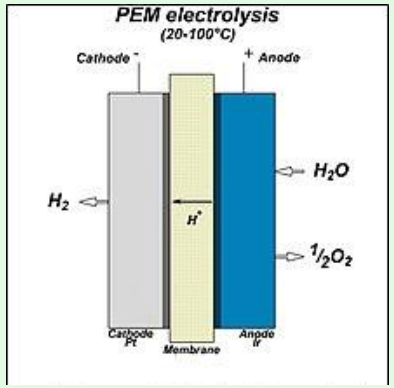


Alkaline Water Electrolysis (AWE)

+ Well established

+ Cheap

- Low current density



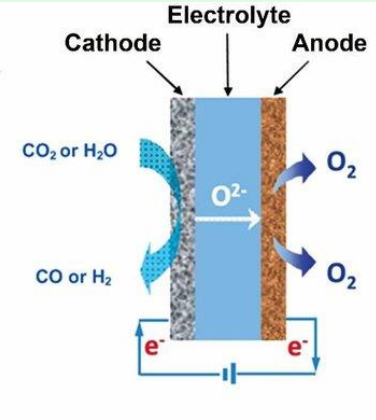
Proton exchange membrane Electrolysis (PEMWE)

+ Fast response

+ High current density

- Pt/Ir needed

- Expensive



Solid Oxide Electrolysis (SOEC)

+ Requires ~20% less electricity

+ Requires no expensive materials

- Maturity

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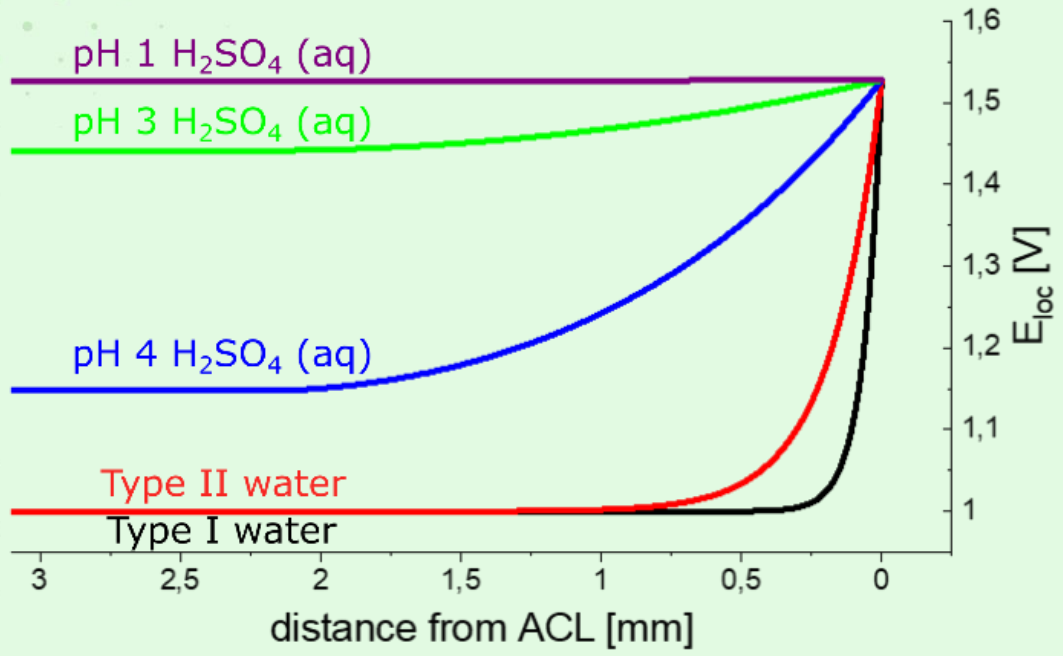
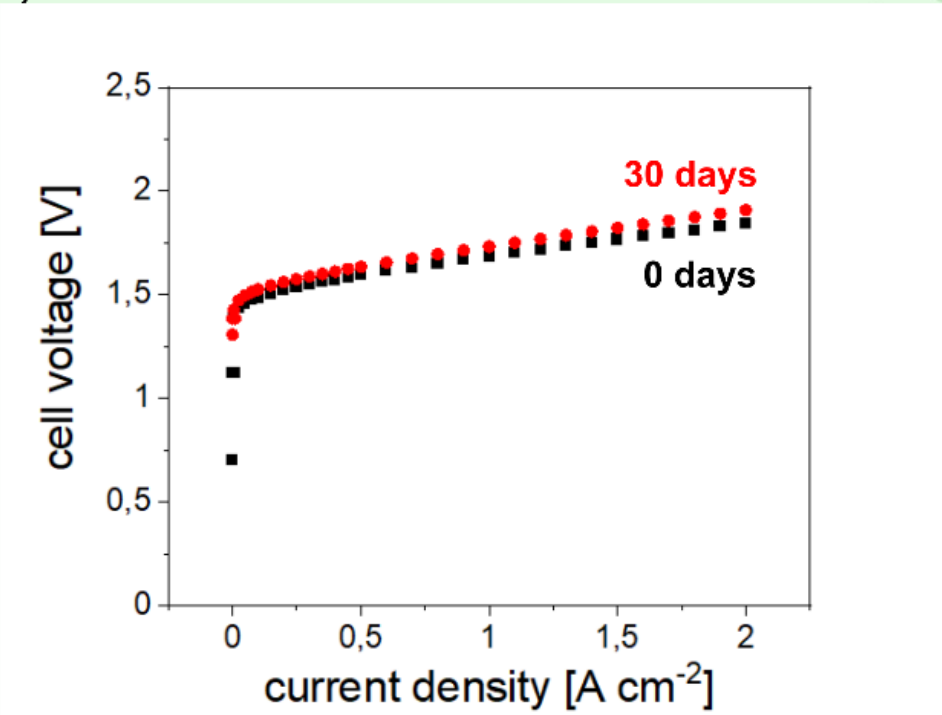
a)



b)



Assessing potential profiles in water electrolysers to minimise titanium use†

Hans Becker,[a] Edmund J. F. Dickinson,[a] Xuekun Lu,[ab] Ulf Bexell,[c] Sebastian Proch,[c] Claire Moffatt,[c] Mikael Stenström,[c] Graham Smith[a] and Gareth Hinds*[a]

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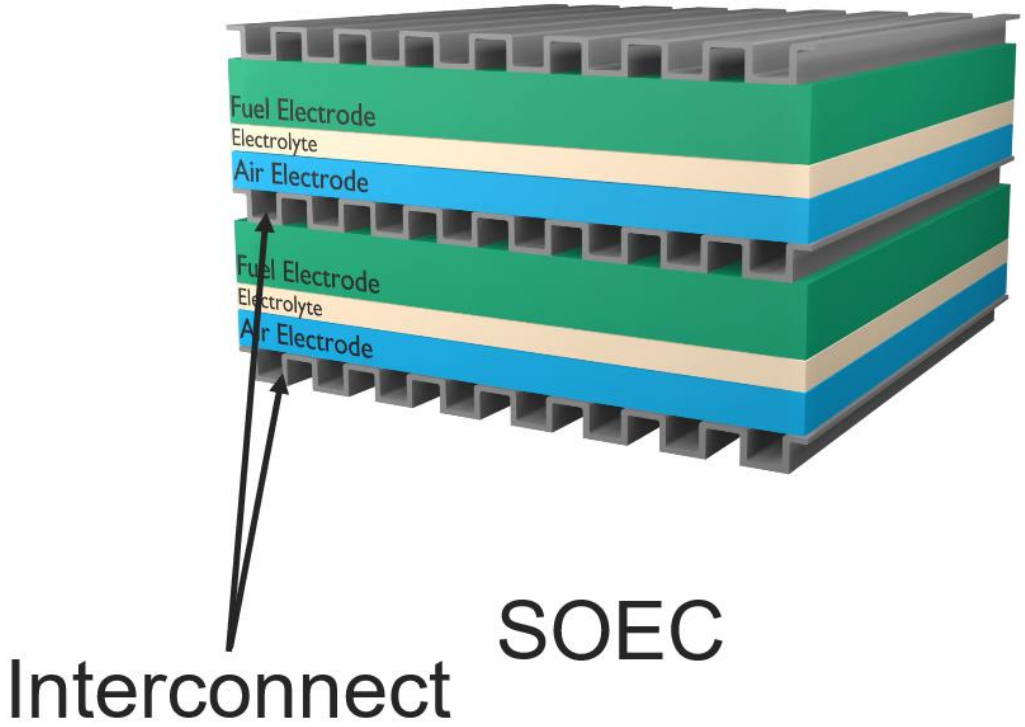


State of the art:

Ferritic stainless steel (low volume special grades)

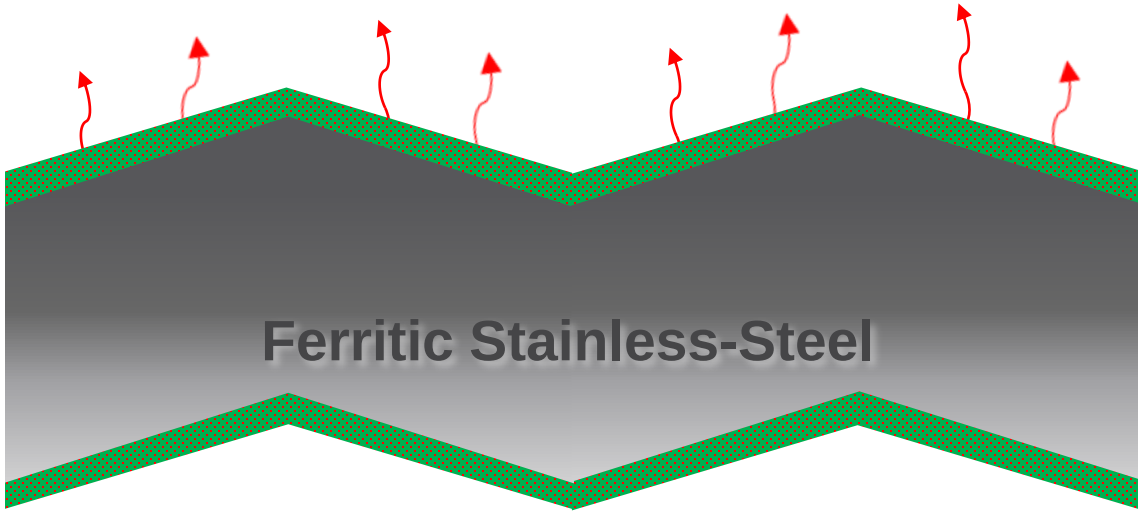
Coatings developed for SOFC

Goal of the project:

Identify/Develop alternative steels

Develop SOEC specific coatings

Ferritic stainless-steel interconnect



Cr_2O_3

\+ Protective oxide

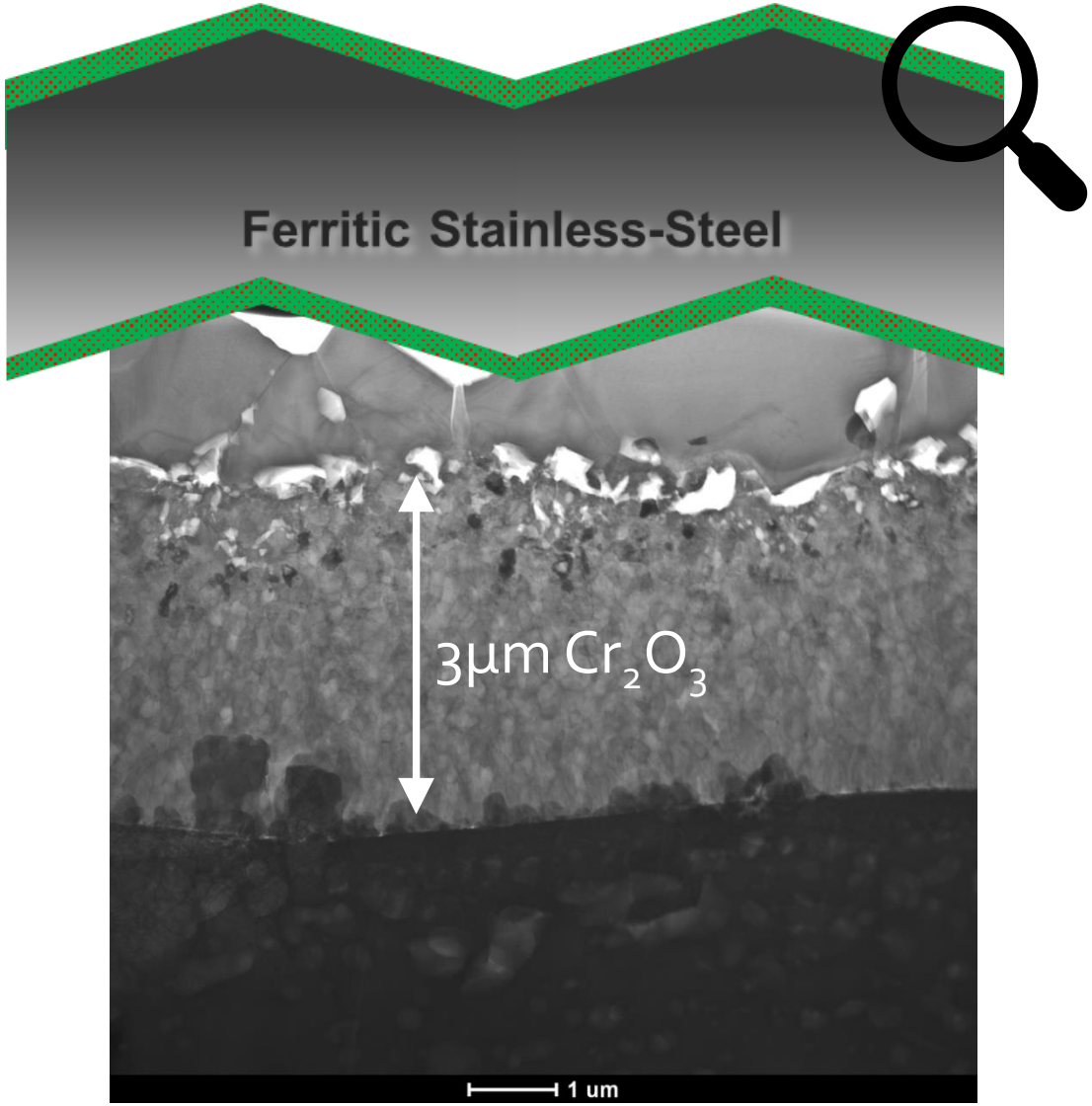
\- Growing Cr_2O_3 layer

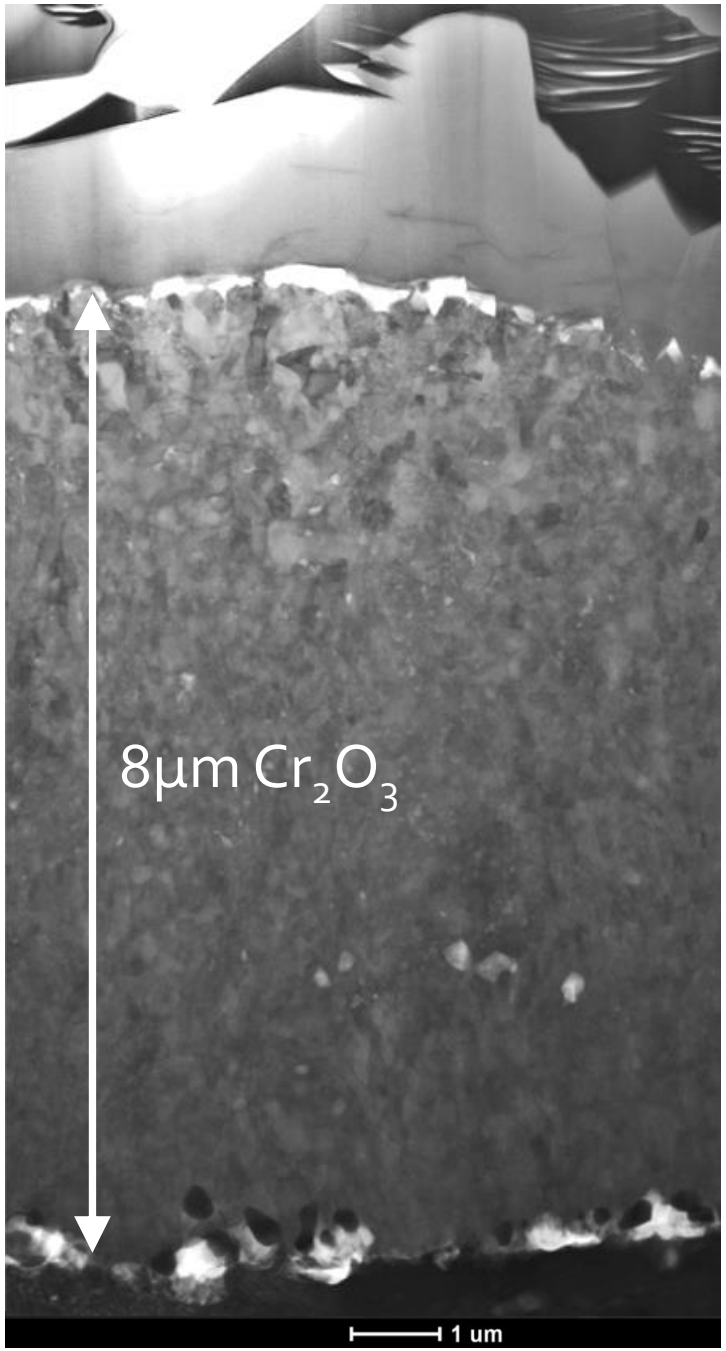
→ Requires continuous Cr supply

→ Increase in electrical resistance

\- Cr(VI) formation- poisons the electrode

Coatings!

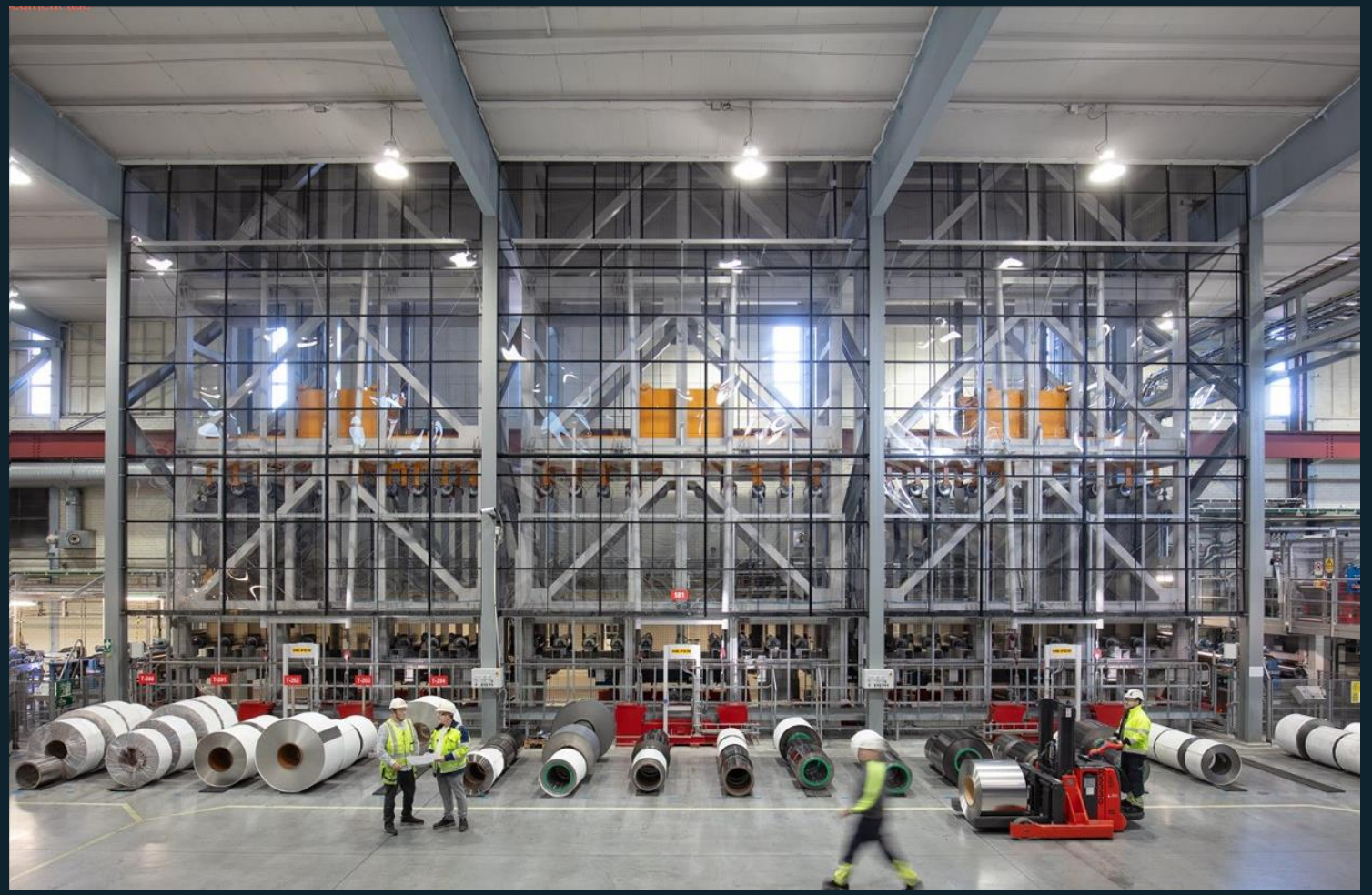

Ferritic Stainless-Steel
3µm Cr_2O_3
1 um


8µm Cr_2O_3
1 um

Alleima
Surface Technology

Continuous PVD coating technology:

- Gigawatt coating capacity
- Integrated product – substrate and coating
- Single or double-sided coating
- Products designed for long term durability in fuel cell environment
- Supplied in coils slit to width for subsequent processing



Alleima
Surface Technology

Product offerings

—Sanergy™ LT

Pre-Coated Solution for PEMFC Metallic bipolar plates

—Sanergy™ HT

Enabling sustainable stationary power

Hystar scaling-up to full commercial operations

- Based on 15 years of research on PEM electrolysers
- Founded in September 2020 as a spin-off from SINTEF
- Three co-founders:
  - Fredrik Mowill
  - Magnus Thomassen
  - Alejandro Barnett
- Raised MNOK 384 since 2020
- Key investors:
  - AP Ventures, SINTEF Ventures, Firda, Mitsubishi Corporation, Finindus, Nippon Steel Trading, Hillhouse Investment, Trustbridge Partners

Hystar is headquartered at Høvik, by the beautiful Oslo fjord.

1. HQ and offices
2. R&D/test/pre-production
3. GW automated production facility

Hystar specializes in ultra-efficient **PEM electrolysers** for the production of **green hydrogen** from water electrolysis.