

SANDVIK SURFACE TECHNOLOGY



COMMERCIALIZING FUEL CELL TECHNOLOGY



# AGENDA

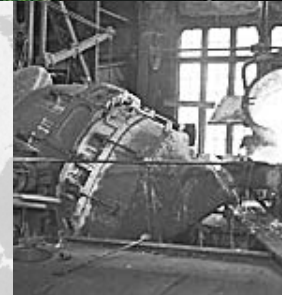
1. Introduction to Sandvik
2. Sanergy LT: pre-coated stainless steel for PEMFC bipolar plates
3. Characteristics of Sandvik Sanergy LT
  - Corrosion resistance & ICR
  - Measuring ICR
  - Forming of pre-coated SS
4. Cost target
5. Summary and questions

## HERITAGE

*Founded 1862 in  
Sandviken, Sweden*

*A breakthrough and an  
innovation started the company.*

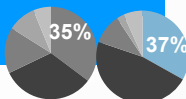
*Göran Fredrik Göransson  
redesigned the Bessemer  
furnace to mass-produce steel*



# BUSINESS AREAS



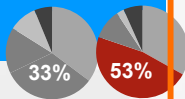
Sandvik Mining



Equipment, tools, service and technical solutions for exploration, excavation and processing of rock and minerals in the mining industry.



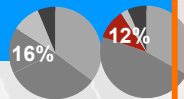
Sandvik Machining Solutions



Holds a clear global leadership by offering productivity enhancing products and solutions for advanced industrial metal cutting.



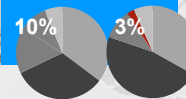
Sandvik Materials Technology



Industry-leading provider of high value-added products in advanced metallic materials for selected niches in the most demanding industries.



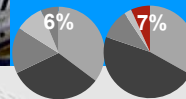
Sandvik Construction



The world's widest range of rock drilling, rock excavation, rock processing, demolition and bulk-materials handling equipment, tools, services and technical solutions for the construction industry.



Sandvik Venture



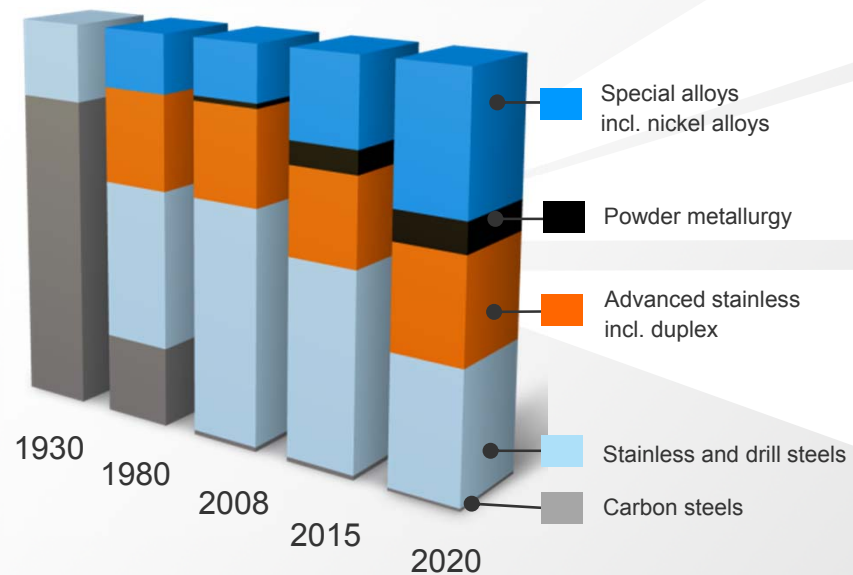
Unique customer offering within selected areas.

■ Share of Sandvik Group's total invoicing 2013.  
■ Share of Sandvik Group's operating profit 2013 adjusted for nonrecurring charges.  
Group activities account for -12%



# SMT MATERIALS EVOLUTION

SETTING THE INDUSTRY STANDARD IN ENERGY AND ENERGY EFFICIENCY



**NICKEL ALLOYS** to accelerate growth in high corrosion applications in oil and gas and chemical.



**POWDER METALLURGY** offers **complex shapes** and **unique material properties** to segments like energy, aerospace, as well as 3D-printing.



**ADVANCED STAINLESS AND DUPLEX** – **next generation of duplex materials** setting the industry standard in segments like oil and gas – and chemical.



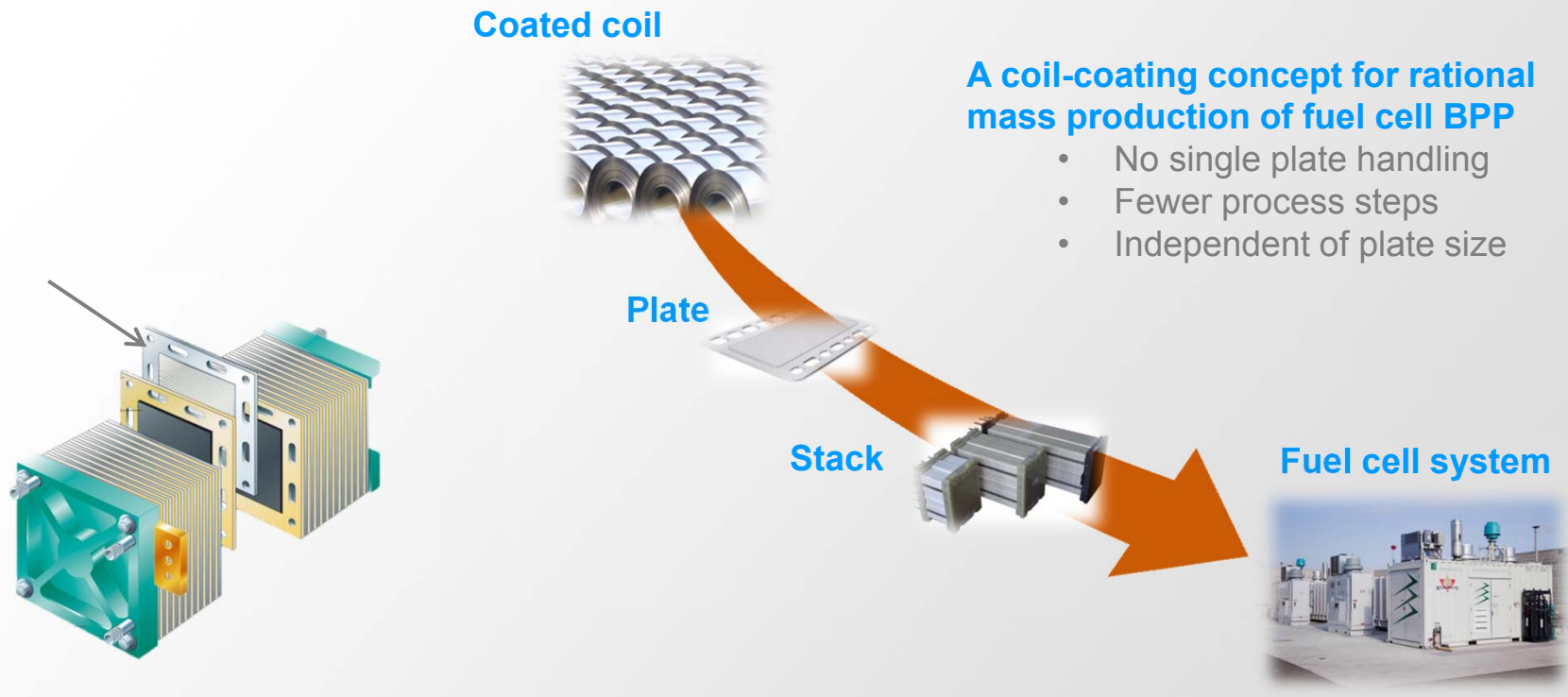
# SMT Product Offering



# SANERGY LT

## PRE-COATED METAL FOR PEMFC BPP

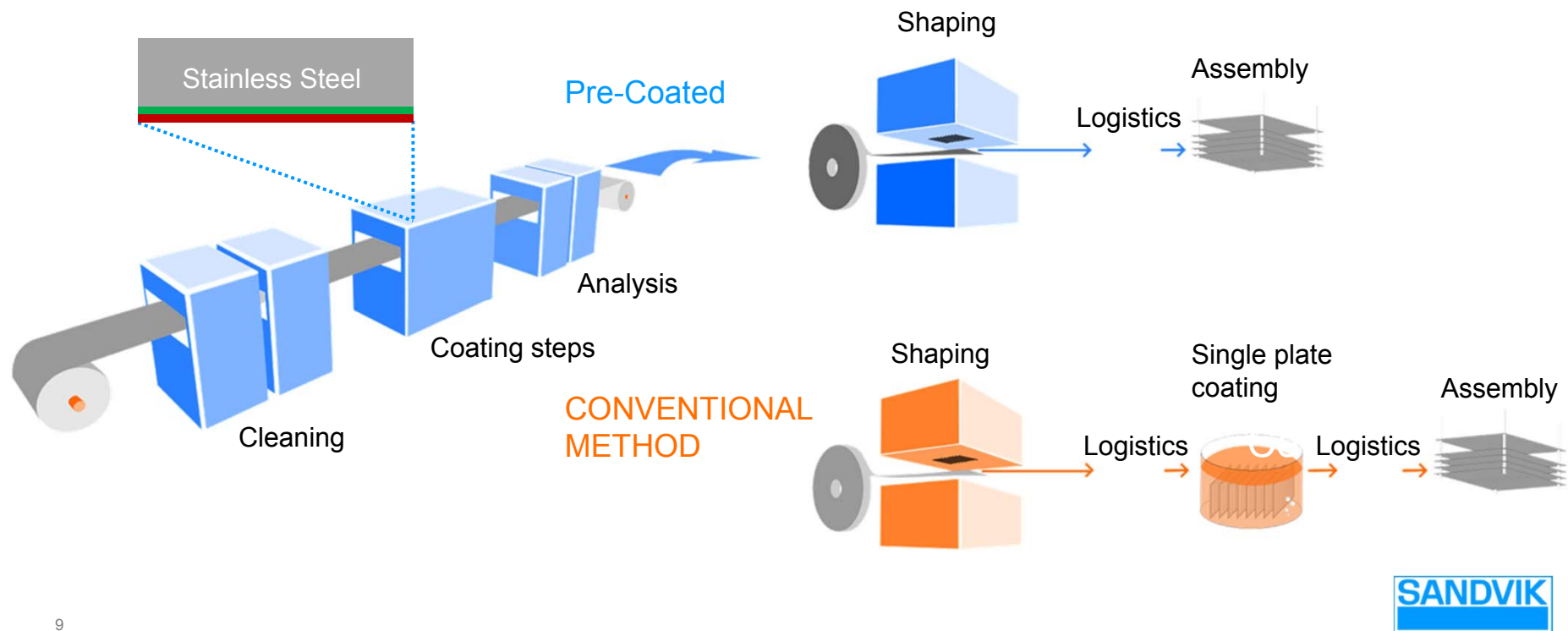
# SANDVIK PRE-COATED METAL FOR PEMFC BPP





# SANDVIKS PRE-COATED METAL FOR PEMFC BPP

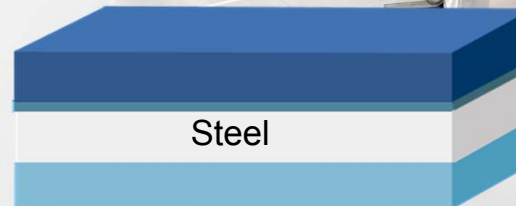
## NANOTECHNOLOGY READY FOR MASSPRODUCTION



# SANERGY LT PRODUCTION LINE

- High capacity PVD coating line
- Coil max. width: 800 mm
- Coil thickness: 0,07-0,8mm
- Coating
  - Homogeneous or heterogeneous
  - Multiple layers in one coating run
  - In-line thickness measurements
- Environmental advantages:
  - Clean process
  - No wet chemistry or solvents

A  
B  
C



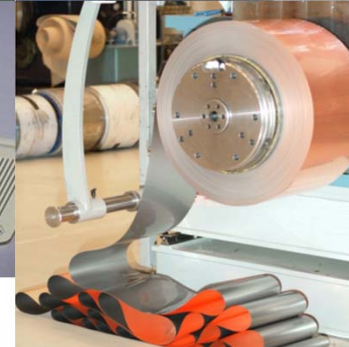
# COATING REQUIREMENTS

- **PEMFC Coating**

- Graphite-like carbon (GLC) coating
- Metallic interlayer layer

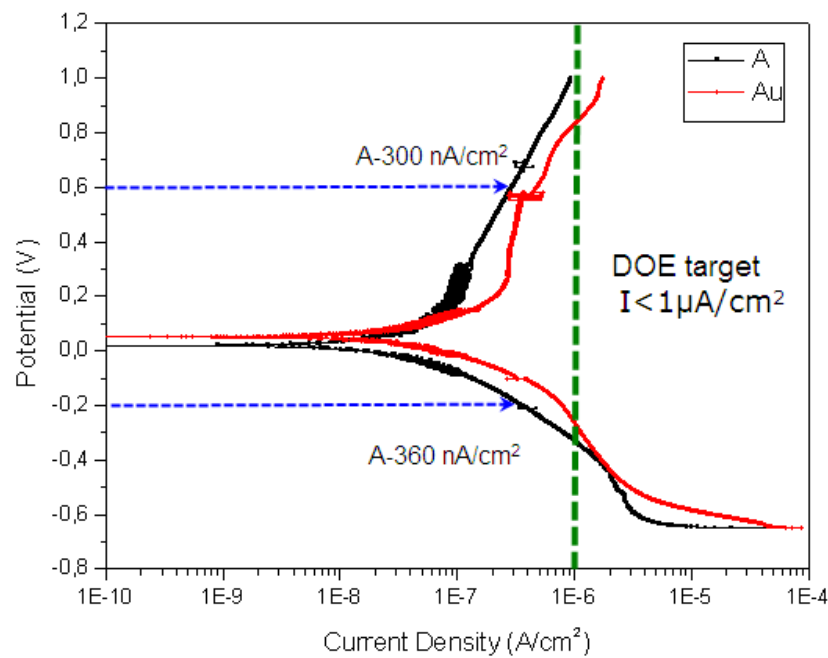
- **Properties**

- Prevent formation of oxide scale on SS
- Low contact resistance (ICR/ASR)
- Good corrosion resistance
- Good formability / coating adhesion



# PROPERTIES OF SANERGY LT

## Corrosion resistance



GLC-coated AISI 304L

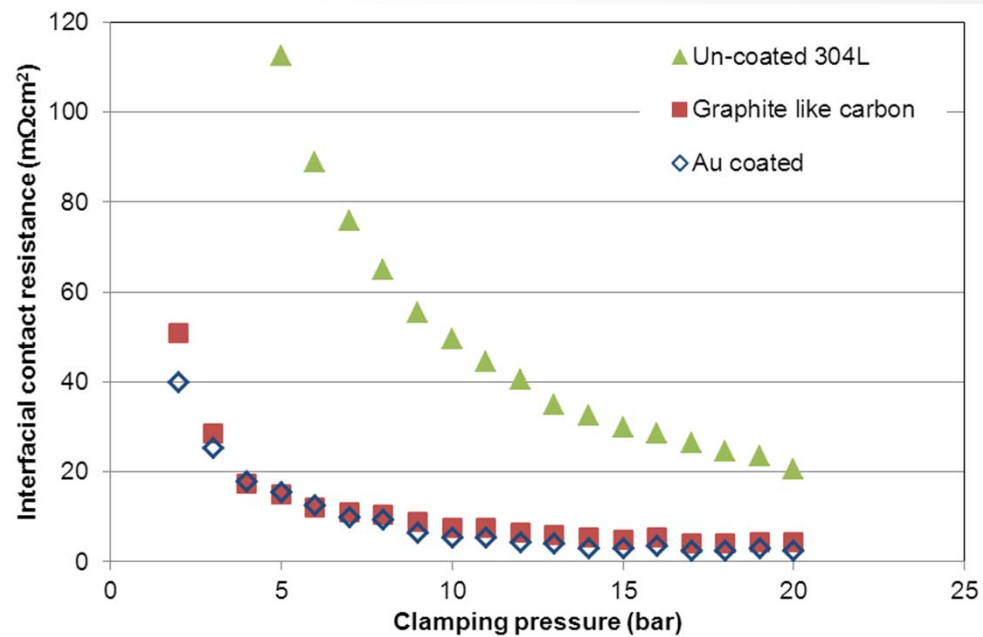
Currents are in the **passive region** between 0.6 V and -0.2 V, well **below the DOE target** for 2015;  $I < 1 \mu\text{A}/\text{cm}^2$

Testing conditions:

- $\text{H}_2\text{SO}_4$  (1M)
- $\text{N}_2$  purge
- pH 3
- $80^\circ\text{C}$

# PROPERTIES OF SANERGY LT

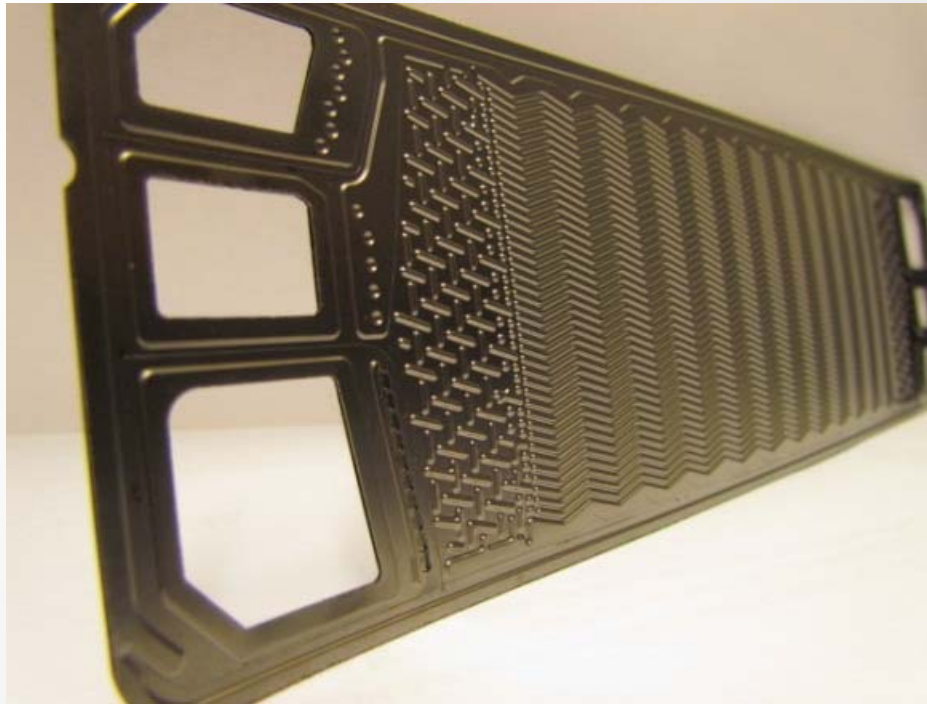
## Contact resistance



- GLC coating comparable to Au-coating
- $ICR_{GLC} = 3-6m\Omega \cdot cm^2 @ 14 \text{ bar}$

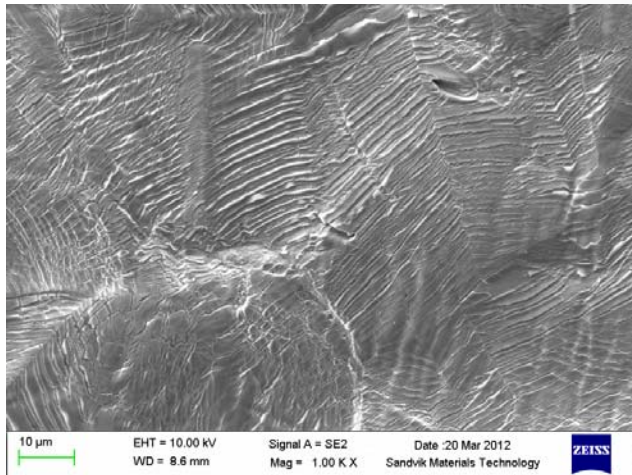


# FORMING OF PRE-COATED MATERIAL



*Sandvik / ZSW / Borit*

# FORMING OF PRE-COATED MATERIAL

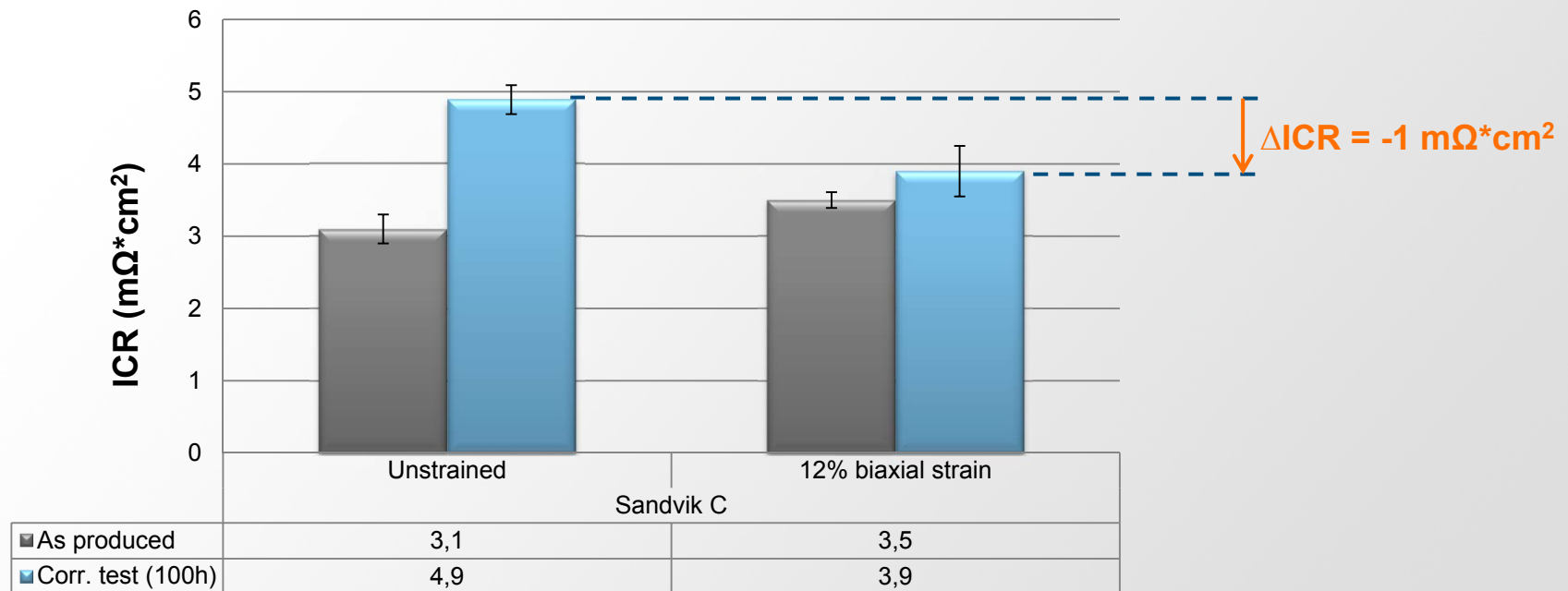


Forming operation produces cracks in the coating  
→ Impact on ICR?

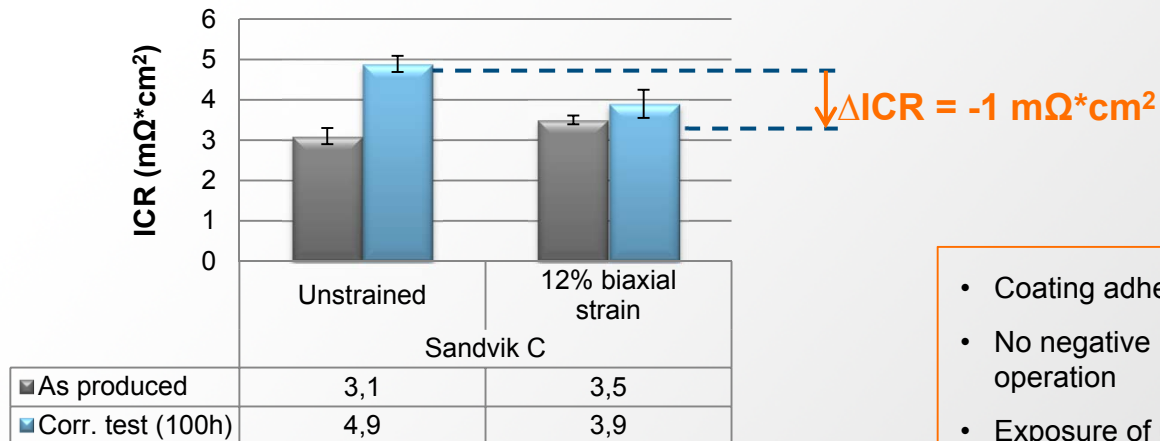
1. Biaxial straining, 12%
2. Potentiostatic test, 100h @ 0,7V (vs Ag/AgCl) in PEM environment
3. ICR



# FORMING OF PRE-COATED MATERIAL

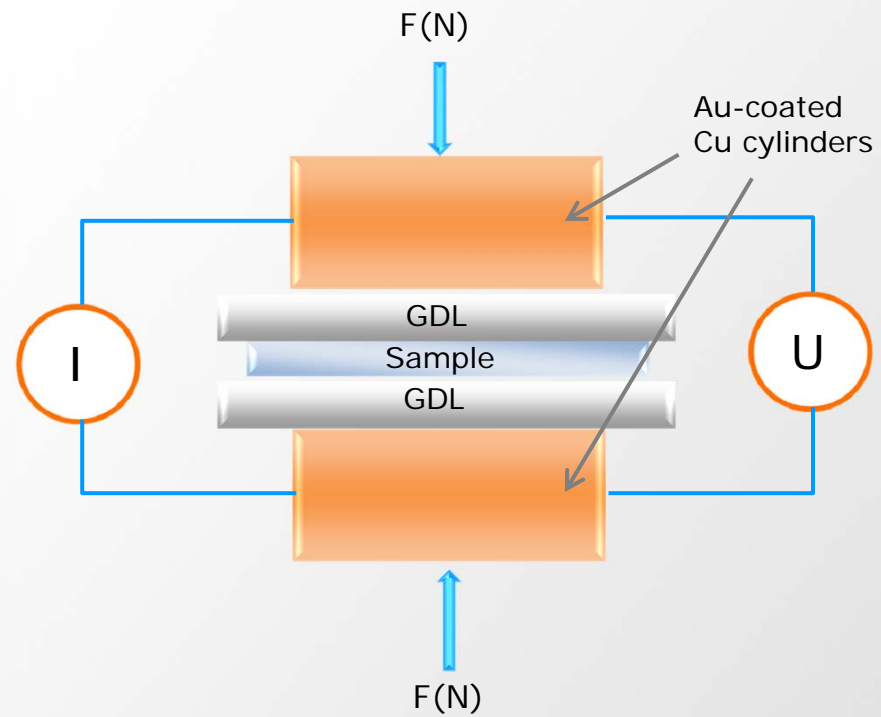


# FORMING OF PRE-COATED MATERIAL



- Coating adhesion is key
- No negative impact on ICR as a result of forming operation
- Exposure of underlying substrate
  - Choice of substrate important
  - Publishable data of Me ion release not available
  - Long-standing relationships with OEMs indicator of stable performance

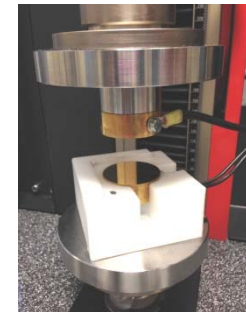
## MEASURING ICR





# MEASURING ICR

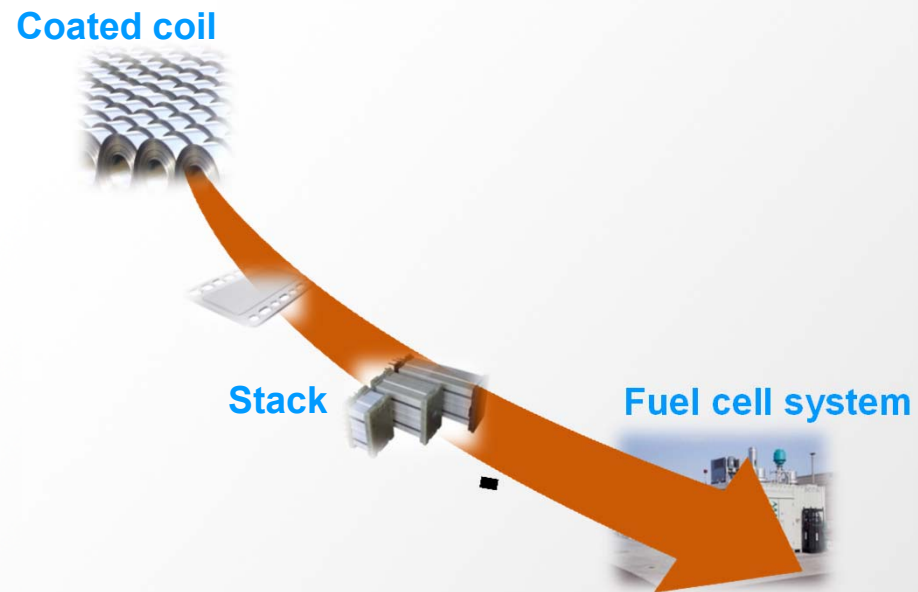
- Importance of ICR measurement
  - Key parameter for coating development
  - Process optimisation
  - Product quality control
- Setup No. 3
  - Dedicated for ICR
  - $I = 1 \text{ A/cm}^2$
  - $R = 20\text{mm}$ , sample size variable
  - Stable
  - Method error better than  $\pm 0,2 \text{ m}\Omega\cdot\text{cm}^2$
  - CE marked



OK, THAT'S GREAT, BUT...  
HOW MUCH IS IT?!



# COST TARGET



## Cost target Sanergy LT

- 10€ / m<sup>2</sup>
- 316L , 0.1mm
- At volume production



# SUMMARY – SANERGY LT

1. High capacity production line
2. Good corrosion resistance and consistent, low ICR
3. Forming of pre-coated material
  - Coating adhesion is key!
  - No negative impact on ICR in simulated PEMFC environment
4. Material costs 10 €/m<sup>2</sup>
  - Improved logistics



# THANK YOU!



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