We use a two-color headline system to highlight our rational and emotional side alike. The first line appears in blue (the rational side), the second line in orange (the emotional side) and the duality principle is reflected in the wording of the headline.

This system refers to the first page title only, all other headlines are blue. Learn more about our verbal identity in the Sandvik Brand Identity Directives, which you can download at the Intranet > home.sandvik.com/brand.
AGENDA

• Sandvik pre-coated solution
• Sandvik Sanergy LT for PEM fuel cells
• Forming of plates
• Short stack test
SANDVIKS PRE-COATED SOLUTION
NANOTECHNOLOGY READY FOR MASSPRODUCTION

1. Cleaning/inspection
2. Coating
   Coating of layers by Sandvik’s continuous evaporation process.
3. Inspection
   Automatic X-ray inspection devices measure the thickness and quality of the coating.
4. Testing, slitting and packaging
High capacity PVD coating line

Coil
- Width: < 800 mm
- Thickness: 0.07-0.8 mm

Coating
- Homogeneous or heterogeneous
- Multiple layers in one coating run
COIL COATING CONCEPT

SHORTENING THE VALUE CHAIN
SANDVIK SANERGY LT FOR PEMFC

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

- **Sandvik Sanergy LT**
  - Graphite-like carbon (GLC) coating
  - Metallic interlayer
MEASURING INTERFACIAL CONTACT RESISTANCE (ICR)

Method according to D.P. Davies et al and modified by H. Wang et al.

I = 1 A/cm²
R = 20 mm
Sample size variable
IN-HOUSE ICR MEASUREMENT

• Importance of ICR measurement
  - Key parameter for coating development
  - Process optimisation
  - Product quality control

• Setup
  - Dedicated for ICR
  - Stable
  - Method error ± 0,2 mΩ·cm²
  - CE-certified
FORMING OF COIL-COATED MATERIAL

• Forming operation produces cracks in the coating
• Impact on ICR?
  1. Biaxial strain, 12%
  2. ICR
  3. Potentiostatic test
     • 100h @ 0.7V (vs Ag/AgCl)
     • pH3, H₂SO₄
     • 80°C, N₂
  4. ICR
FORMING OF COIL-COATED MATERIAL

\[ \Delta \text{ICR} = -1 \pm 0,2 \, \text{m}\Omega \cdot \text{cm}^2 \]

<table>
<thead>
<tr>
<th></th>
<th>Unstrained</th>
<th>12% biaxial strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>As produced</td>
<td>3,1</td>
<td>3,5</td>
</tr>
<tr>
<td>Corr. test (100h)</td>
<td>4,9</td>
<td>3,9</td>
</tr>
</tbody>
</table>
FORMING OF COIL-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 indication of stable performance

\[ \Delta \text{ICR} = -1 \pm 0.2 \, \text{m}\Omega \cdot \text{cm}^2 \]
DEGRADATION TESTING OF ELRING KLINGER - PEMFC NM 5 STACK

RESULTS LOAD CYCLE TESTING (NUMERICAL STATISTICAL ANALYSIS)

- 10 cell short stack
- Load cycle testing
- Low pressure operation
- Degradation rate: ~ 4-9 μV/h at different load levels (220/120/40 A)
- Test ongoing
ELRING KLINGER STACK TEST - COMMENTS

- A load-cycle for fork-lifts is employed
- Plates experience up to 40% elongation during the forming operation
- Polarization curve showed similar behavior to Au-coated reference plates – Good performance!
THANK YOU!

Anna Jansson
Coated Strip Products, R&D
Sandvik Materials Technology
Phone +4626269508
anna.jansson@sandvik.com