PRECOATED INTERCONNECTS MASS-PRODUCED IN PVD ROLL TO ROLL PRODUCTION LINE

Robert Berger
Jörgen Westlinder
SANDVIK GROUP: WORLD-LEADING POSITIONS
IN THE FOLLOWING POSITIONS

TOOLS AND TOOLING SYSTEMS

as well as components in cemented carbide and other hard materials

EQUIPMENT AND TOOLS FOR THE MINING AND CONSTRUCTION INDUSTRIES

as well as various types of processing systems

HIGH VALUE-ADDED PRODUCTS IN ADVANCED STAINLESS STEELS

and special alloys and titanium as well as metallic and ceramic resistance materials
46,000
EMPLOYEES

91
BILLION SEK
INVOICED SALES

60
R&D CENTERS
GLOBALLY

150
COUNTRIES
AROUND THE GLOBE

3
BILLION SEK
INTO R&D
EACH YEAR

8,000
ACTIVE PATENTS
GAME-CHANGING MATERIALS
MEETING THE ENERGY CHALLENGE

CUSTOMER REALITY:
Find smarter ways to use energy resources and new ways to become more energy efficient.

OUR SOLUTION:
Materials expertise to make industrial processes safer and more energy efficient, yielding greater output while consuming fewer resources.
Sandvik Sanergy™ pre-coated strip steel for fuel cells
1. **Cleaning/inspection**
   Wet chemical de-greasing off-line followed by plasma cleaning/etching in-line)

2. **Coating**
   Coating of metal layers by Sandvik's continuous evaporation coating process.

3. **Inspection**
   Automatic X-ray inspection devices measure the thickness and quality of the coating.

4. **Testing, slitting and packaging**
SHORTENING THE VALUE CHAIN

SANDVIK COIL-COATING CONCEPT FOR INDUSTRIAL BIPOLAR PLATE PRODUCTION

ADDITIONAL PROCESS STEPS FOR BATCH COATING OF BIPOLAR PLATES
Coil

- width: < 800 mm
- thickness: 0.07-0.8 mm
COATING REQUIREMENTS PEMFC

- **PEMFC Coating**
  - Graphite-like carbon (GLC) coating
  - Metallic interlayer layer

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

- Measure film properties
  - In-line thicknesses measurements
  - Residual stress measurements
  - Measure properties of the GLC
- Interfacial studies before and after stack testing – TEM analysis, ESCA, AES
- Accessibility to electrochemical measurements, i.e. single cell / stack tests
Improve SOFC life time by keeping Cr in the steel:
Reduce Cr evaporation
Improve corrosion resistance
- Cobalt coating to create \((\text{Co,Mn})_3\text{O}_4\) spinel to reduce outward diffusion of chromium
- Cerium coating to reduce oxidation rate
CHROMIUM EVAPORATION MEASURED AT 850 °C

Accumulated Cr [mg/cm²] vs. Exposure time [h]

- Red squares: uncoated
- Blue circles: Co
COMPARISON AFTER 3000 HOURS

EFFECT OF THIN CERIUM LAYER

~8µm Cr$_2$O$_3$  
(inner oxide)  

Co-coated

~3µm Cr$_2$O$_3$  
(inner oxide)  

Ce/Co-coated
SHAPING THE PRECOATED STEEL?

Crack formation?
10% biaxially deformed sample exposed at 800 °C
“...after only 168 h of exposure, the surface of the pre-coated material was homogenously covered by an oxide rich in Co and Mn. As an effect of this rapid healing, no increase in Cr vaporization was measured for the pre-coated material.”
SELF HEALING – FIB EXPERIMENT

As coated

Ce/Cr coating
Ce 30nm Co 600nm

Uncoated
AISI 441

FIB trench 1

13 µm

Uncoated

Coated

504 hours oxidation at 800°C

FIB trench 1

(short end)

oxide

steel

13 µm

26 µm

SEM view

qSOFC
SANDVIK GAINING FUEL CELLS MARKET SHARE

SURFTECH SALES (SEK)

GLOBALLY SHIPPED (MW)

HYDROGEN REFUELING STATION IN SANDVIKEN
OPENED DEC 6TH 2016

TRILATERAL COOPERATION
• Sandviken Municipality
• Sandvik
• AGA Linde

FIRST STEP TOWARDS A FOSSIL-FREE REGION
• 6 hydrogen cars
• 1 HRS (6 cars/hr)
This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under Grant Agreement No 735160. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and Hydrogen Europe.

www.qsofc.eu