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# Research on Bipolar Plates for PEM Technology at SINTEF

Anders Ødegård SINTEF Materials and Chemistry



## About SINTEF

- Non-profit research foundation
- Fourth largest in Europe, about 2100 employees
- Covers most technological aspects of modern society





Smart survival suits



Tracking of foodstuffs



Sub-sea technology



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A multidisciplinary research organisation with international top level expertise in specific fields

SINTEF Building and Infrastructure SINTEF ICT SINTEF Materials and Chemistry SINTEF Technology and Society SINTEF Energy Research SINTEF Fisheries and Aquaculture SINTEF Petroleum Research MARINTEK





## PEM fuel cell activities in SINTEF

#### Activities

- > Performance characterisation and evaluation
- > Assessment of membrane / electrode degradation
- > Dynamic behaviour of fuel cells
- > Thermal effects / calorimetric measurements
- > Modelling (electrodes, single cells)
- > Fuel and fuel quality, effect of fuel impurities
- > Catalyst/support development
- > BPP/coating development



Instrumentation and software for efficient 4-cell parallel testing (materials screening)



Single cell and electrode characterisation by Electrochemical Impedance spectroscopy, Cyclic Voltammetry etc.



lon Chromatograph for accurate determination of trace amounts of degradation products in effluents



SINTALYZER, equipment developed at SINTEF for monitoring of the fluorine emission rate



PEM fuel cell preparation





## Corrosion protection of steel at SINTEF

- The Corrosion group at SINTEF has a long experience in:
  - Corrosion testing and evaluation
  - Corrosion protection and protective coatings
  - Material selection





















### Thin film deposition and structuring



PLD, CVD, sputtering, evaporation,... Functional oxides, semiconductors, metals...

From atomically flat to engineered roughness

Lithography (photo-, e-beam, imprint-) Wet- and dry-etch processes

#### From millimeters to nanometers





### Surface and interface studies

Characterisation by Auger spectroscopy, XPS, TEM







### Post mortem SEM/EDS, XRD analysis of coatings





### In-situ testing of coated BPPs





12.5x131.3x0.8 mm



### In-situ measurement of ICR





### Stainless steel and gold at alternating voltage (OCV/0.4V) and $75^{\circ}$ C

Bare SS316

Gold coated







### Fluoride release – membrane degr. with different BPPs

- Analysis of effluent water from anode and cathode with a Liquid Chromatograph.
  - Membrane degradation depends on coating material (left)
  - Fluoride release also depends on the test protocol (right)





### Ex-situ and in-situ evaluation of coatings

- Show the same behaviour, ex-situ requiring much less efforts.
  - ICR before and after 1 h polarization at 0.69 V, **ex-situ** (left figure)
  - ICR before and after test protocol, in-situ (cycling voltage, right figure)





# Carbon based coating developed at SINTEF and NTNU

- Spraying of a carbon -and binder mixture with subsequent treatment
  - Low cost materials
  - Fast and low-cost process
  - Low contact resistance, initial and after 1 h ex-situ polarization
  - Low corrosion current measured ex-situ
  - Long term stability and in-situ testing to be performed







## STAMP'EM – new project for development of coatings for BPP

- FCH JU funded project starting Summer 2012
- Partners
  - ElringKlinger (DE)
  - Fraunhofer ISE (DE)
  - Fronius (AU)
  - MIBA/Teer Coatings (UK)
  - SINTEF (Coordinator, NO)
  - University of Birmingham (UK)





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NTNU

IMPACT COATINGS

