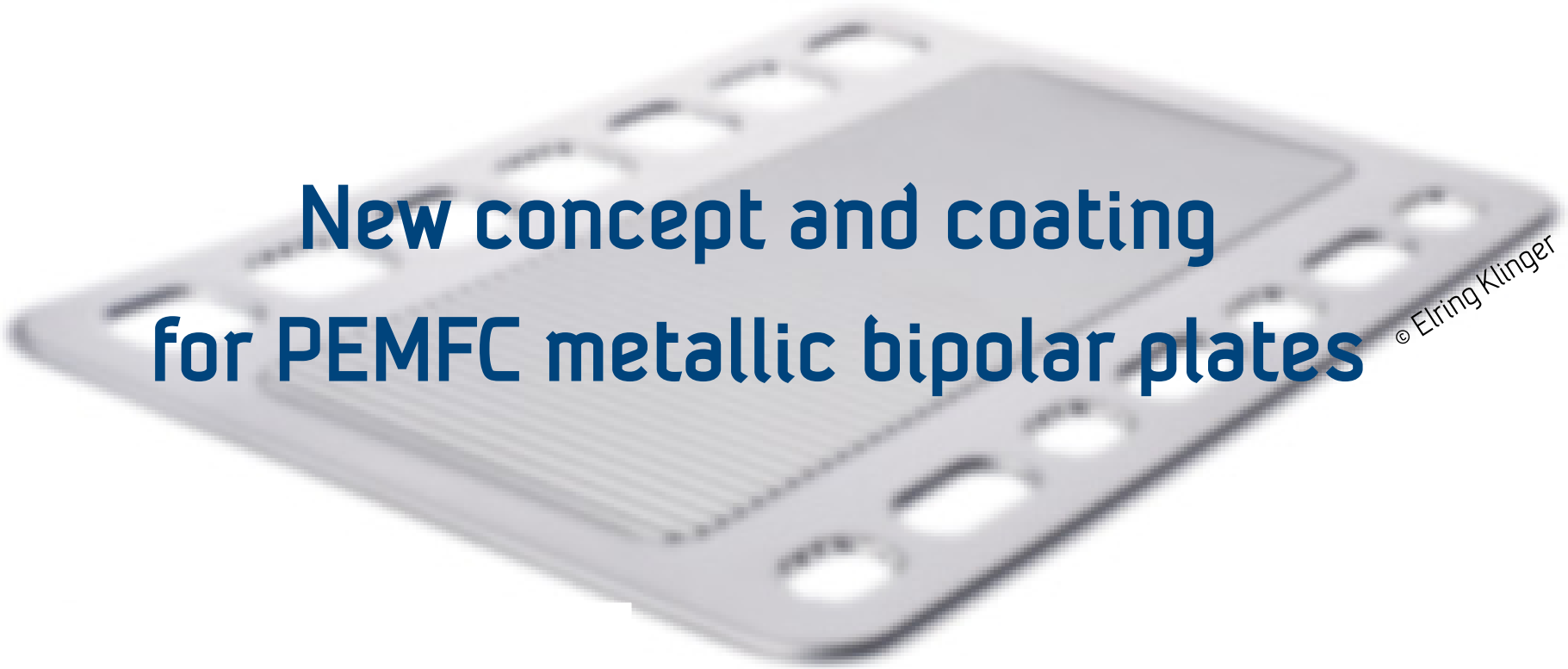


New concept and coating for PEMFC metallic bipolar plates

© Elring Klinger

Anders Ødegård, SINTEF
Nordic Hydrogen Conference 2013, Oslo

Outline

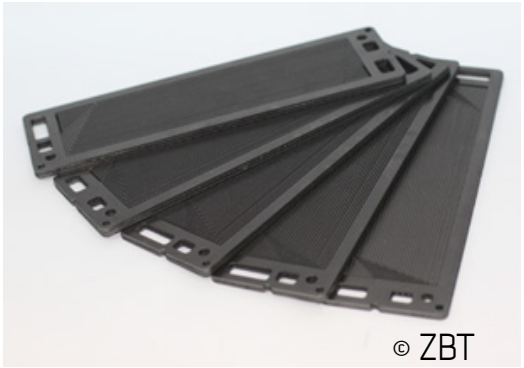
- Bipolar plates for PEMFC- background
- Ex-situ and in-situ procedures
- Carbon-based coating
- Combined GDL/BPP concept
- Further work

Bipolar plates for PEM technology

- Requirements from automobile industry for fuel cell vehicles

- Main performance requirements:
  - Corrosion stability in acidic environment (<1 µA / cm^2)
  - High electric conductivity (surface contact) (<10 mOhm cm^2)
  - Withstand manufacturing process (deforming up to 40%)

- Applied materials and solutions
  - Carbon based plates – expensive manufacturing
  - Metal coated plates – coating properties challenges
    - Nitrided metals
    - Carbon-based
    - Noble metals (ultra-low amounts, nanometres thickness)
    - Polymers
    - ….



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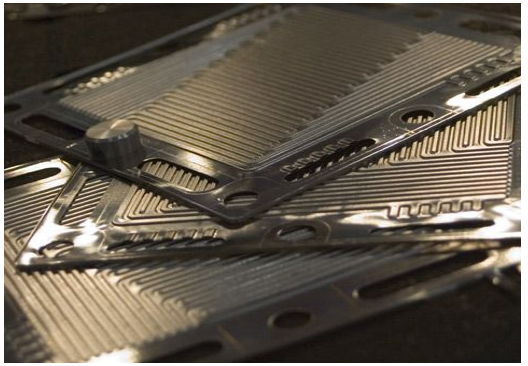

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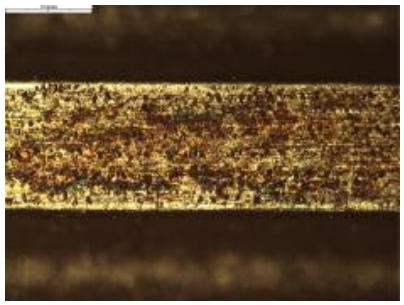
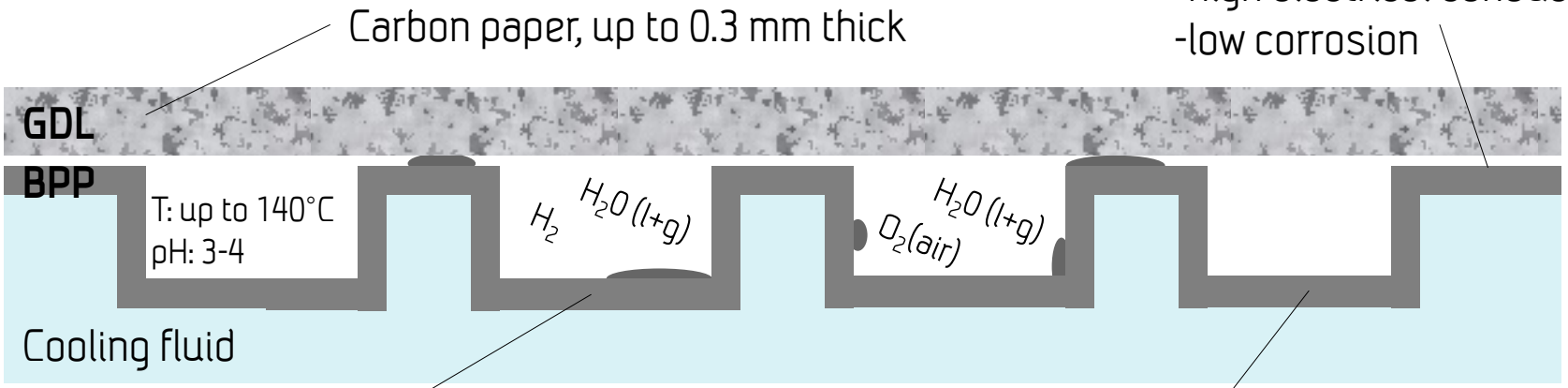
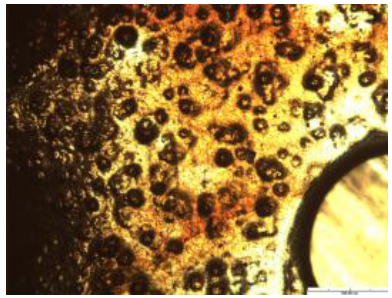
Bipolar plate conditions



Requirement land area
-high electrical conductivity
-low corrosion



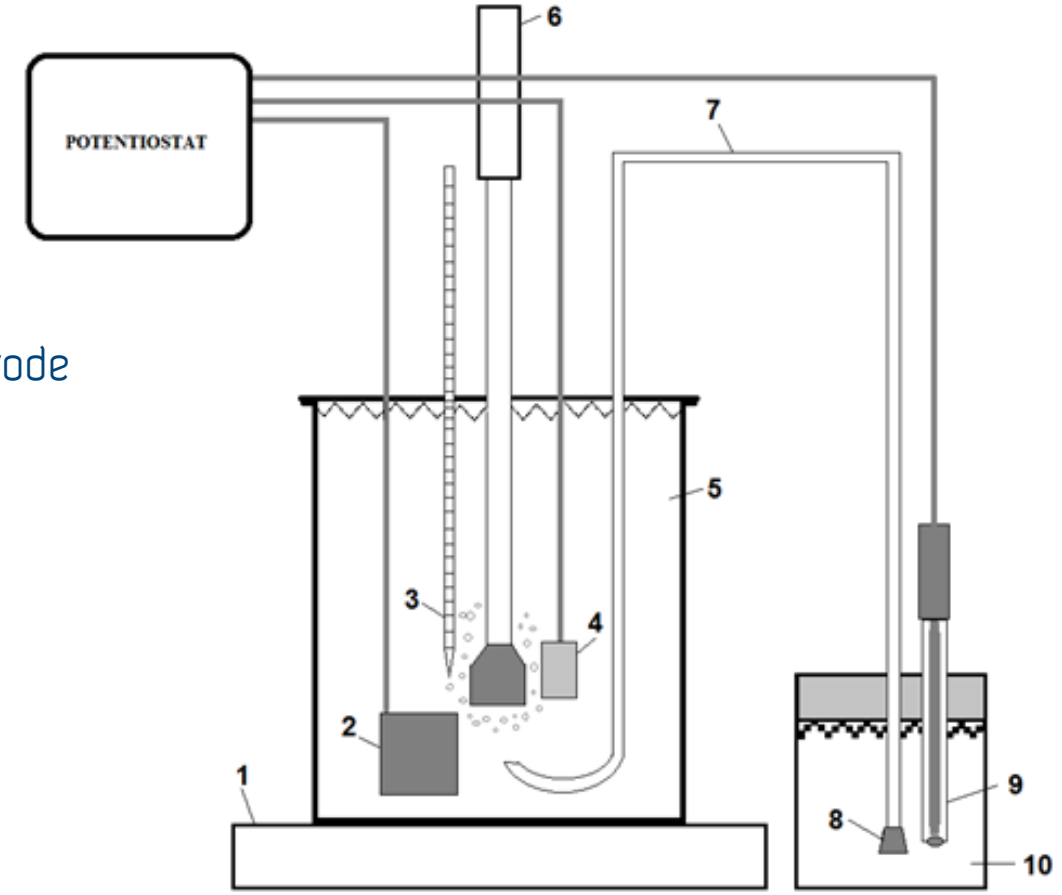
Requirement channel
-low corrosion
-min change in hydrophobicity



Ex-situ BPP testing

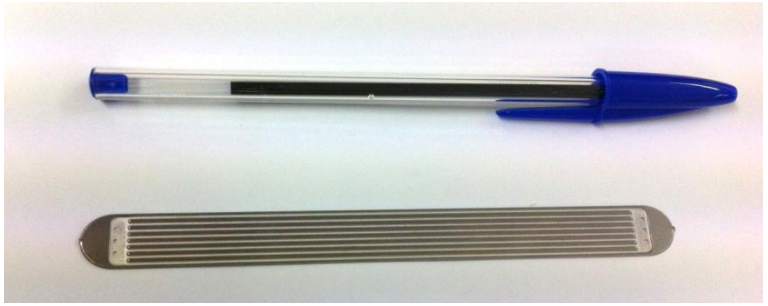
- 1 mM H_2SO_4
- 80 °C
- De-aerated
- $Hg/Hg_2SO_4/K_2SO_{4Sat}$ (0.64 V vs SHE)
  Mercury-mercurous reference electrode

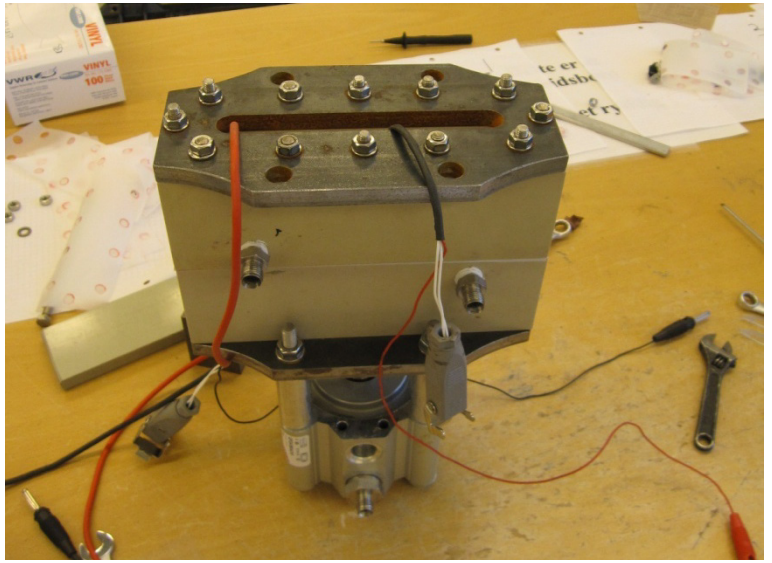
- Linear sweeps
- Potentostatic experiments



In-situ BPP testing

- AST procedure
  - Conditioning of MEA 0.7V – 0.4 V cycling
  - Cycling 0.4V – OCV, 20 min each for 100 hours
  - ICR before and after
  - Water and MEA/GDL analysis

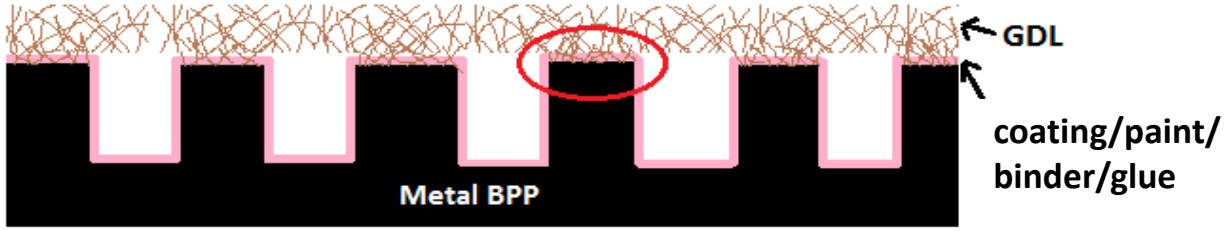




Two approaches

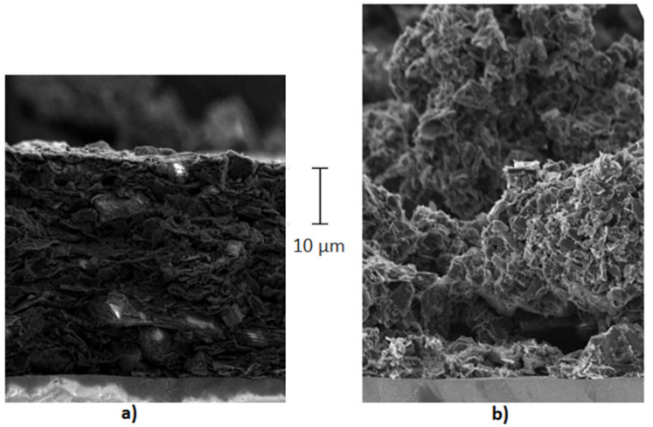
- Carbon-based coating with compression during hardening
  - Simple process, low cost materials

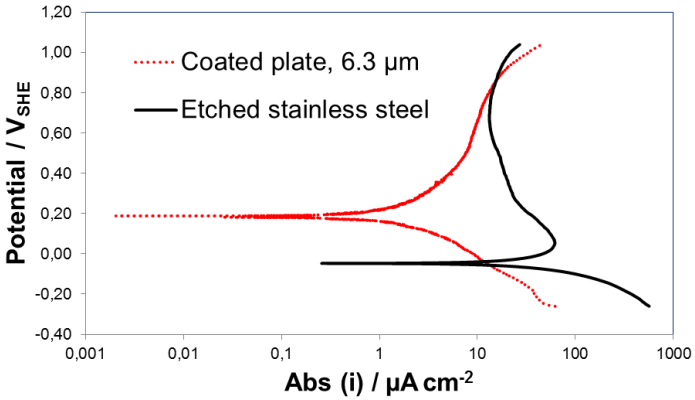
- Combine the GDL and BPP
  - direct contact GDL/BPP, non-conducting coating/paint/binder/glue

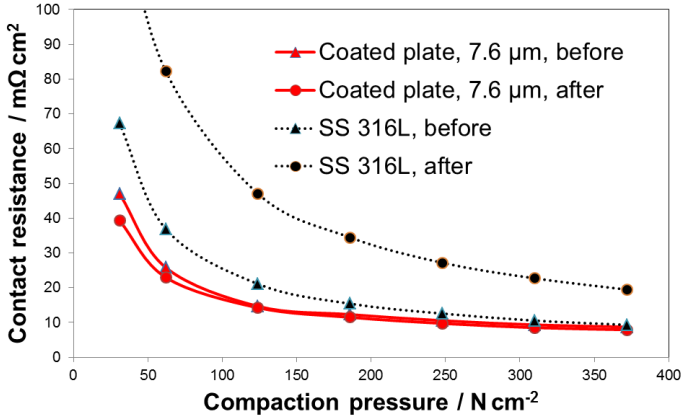


Carbon-based coating

- Cross sectional SEM images of coating in **left compressed** and **right not compressed state**
- Corrosion currents, linear sweep polarization 1 mM H_2SO_4 solution without oxygen at 80 °C.
- ICR values for coated and bare SS 316L plates, before and after linear sweep



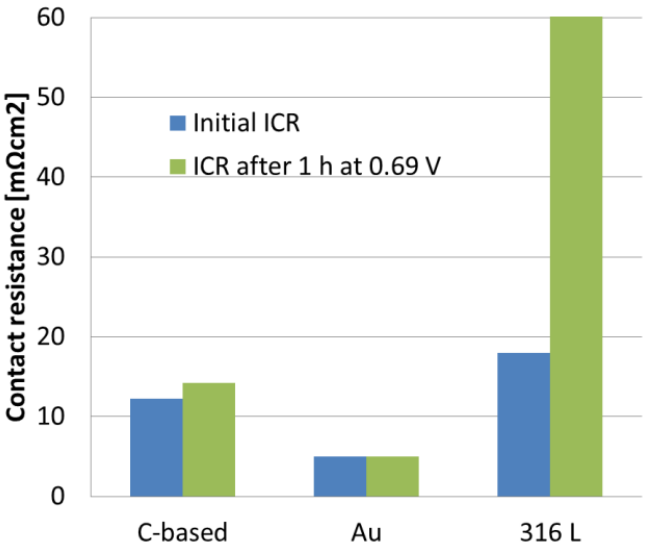


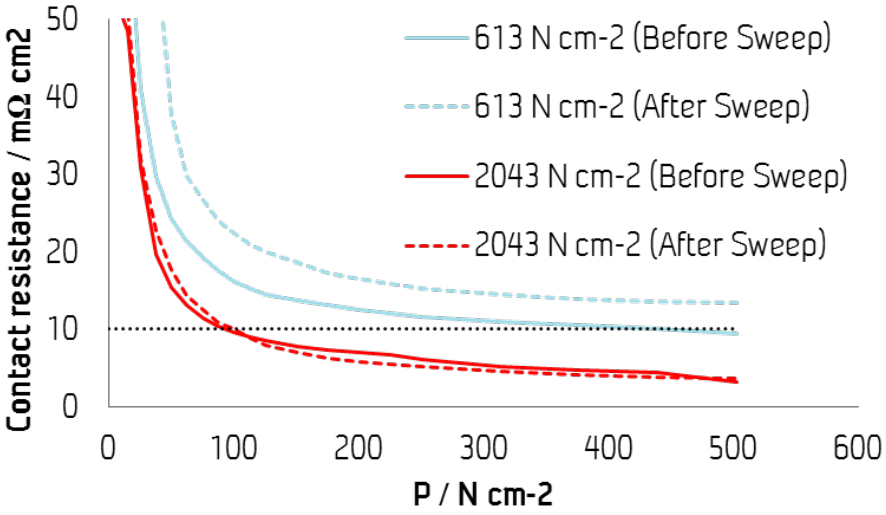


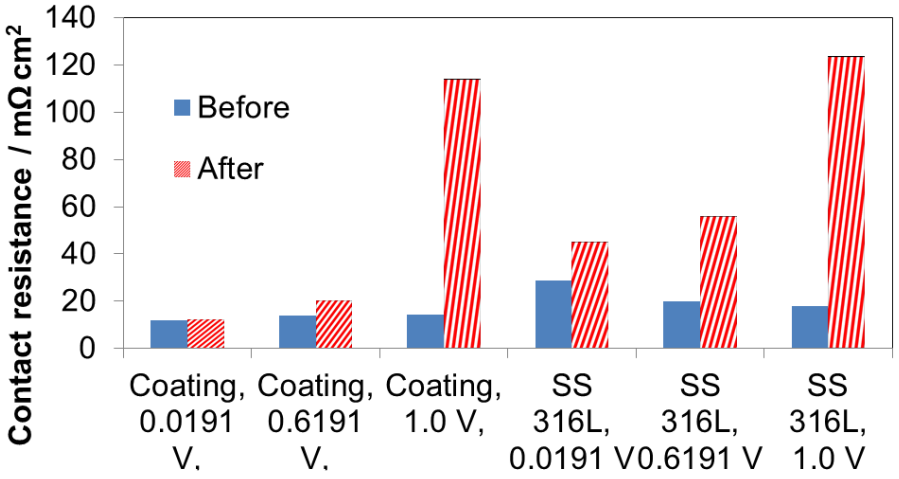
Carbon-based coating II

- Compared with no and gold coating
- OK initial ICR
- High ICR after exposure to high voltages

  ->Oxidation of substrate

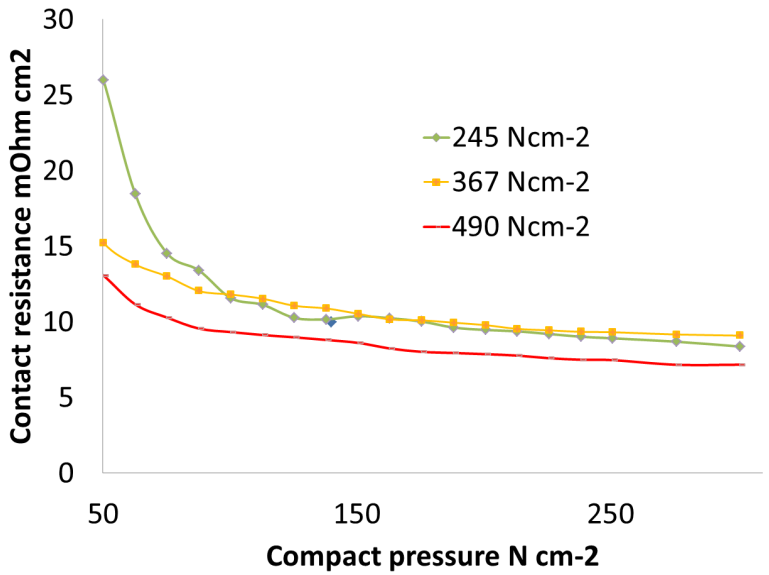


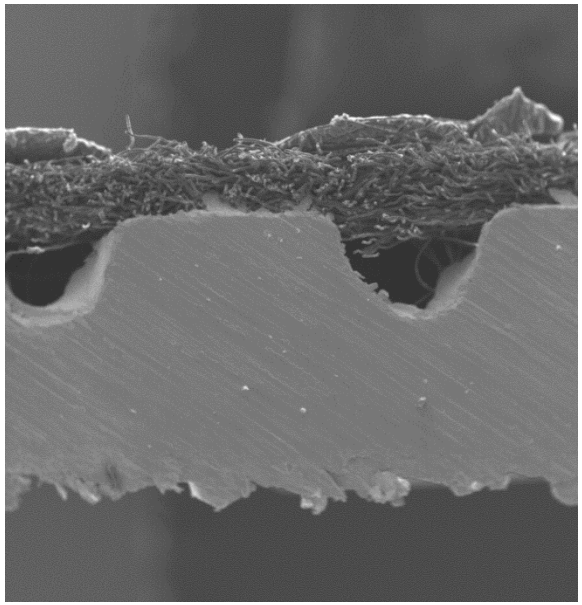




Combined GDL/BPP concept

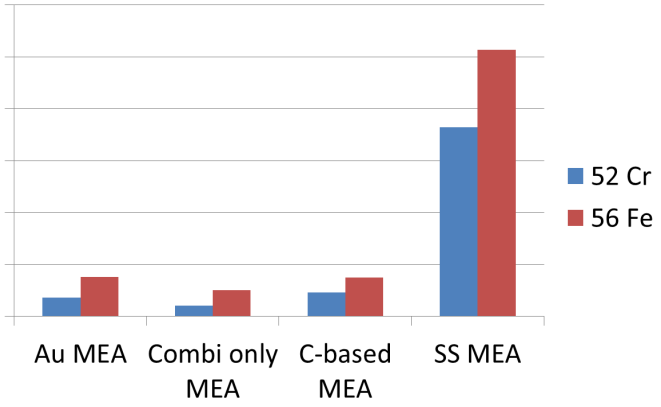
- Applying a commercial corrosion protective lacquer/paints
- Variation in clamping pressure

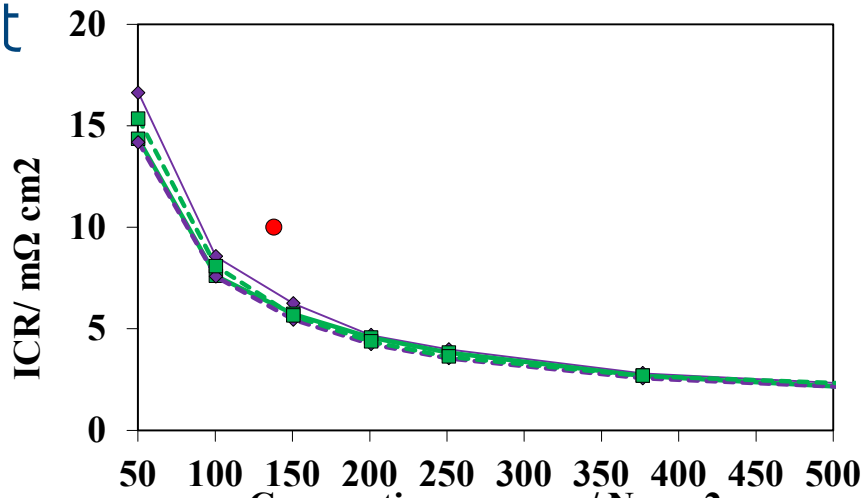


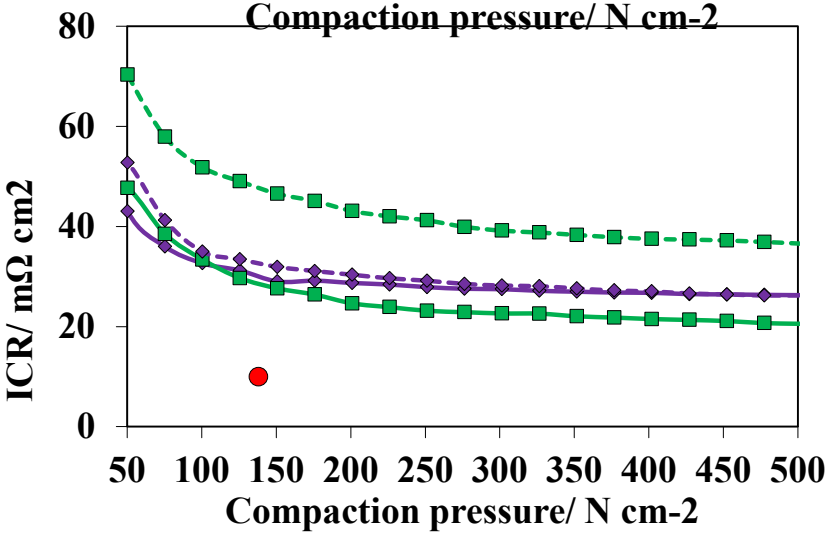


Combined GDL/BPP in-situ test

- Comparison gold coated BPPs and "normal" GDL vs combined concept
- Little (or improved) change in ICR
- Reduction on Fe/Cr ions in MEA/GDL

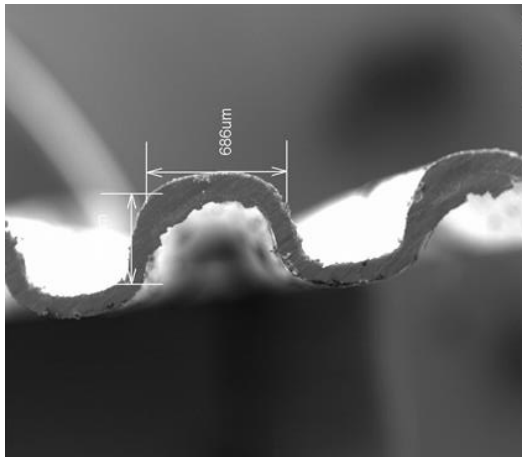


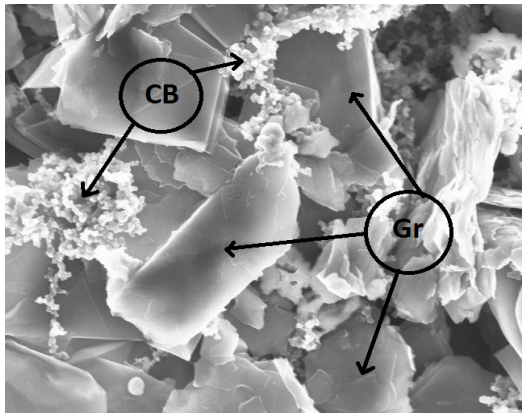


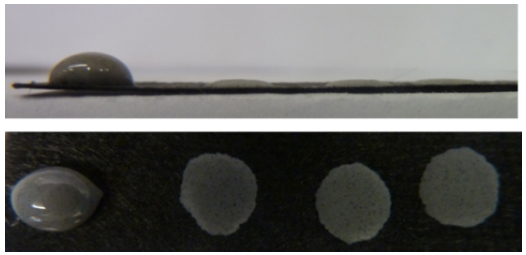


Further work

- Apply coating/GDL-BPP concept on new stamped BPP
- Optimize carbon/epoxy mix ratios/materials
- Optimize wettability of coating/glue
- …







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- Sidsel Meli Hanetho (SINTEF)
- Sigrid Lædre (Sør-Trøndelag University College)
- Others?
- STAMPEM partners

- NFR
- FCH JU

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