Ex-situ testing of Bipolar Plates with and without CrN coatings for PEM fuel cells

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Sharing possibilities

Outline

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  * Background and motivation
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  * CrN coatings
* Conclusions / Further work

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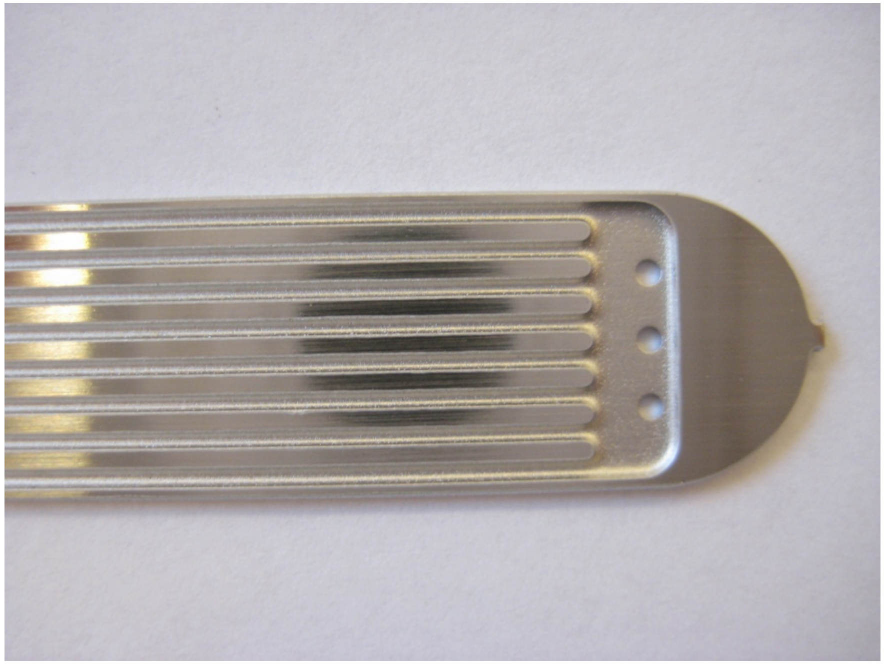
Introduction

Stainless steel

* SS 316L
  * Attractive as bipolar plate material.
  * High interfacial contact resistance with the carbon backing.
  * Due to the chromium oxide formed on the surface.
  * Coating of the steel.



Uncoated SS 316L bipolar plate

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Introduction

Background

* In-situ characterization of bipolar plates is often time consuming and complicated.
* Develop reliable and easy ex-situ measurements for bipolar plates.
  * Corrosion measurements.
  * Interfacial contact resistance (ICR) measurements.
* Use these methods to investigate properties of new coatings for SS 316 L bipolar plates

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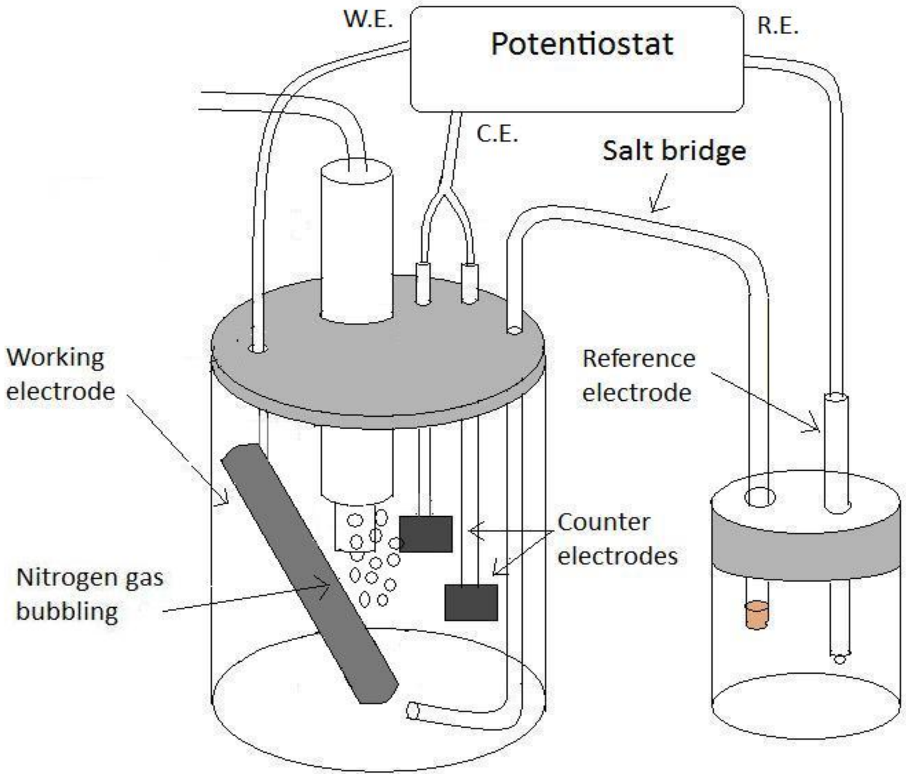
Introduction

Ex-situ measurements

* Objective:
    * Faster and easier than similar in-situ measurements.
    * Provides an opportunity to study the bipolar plate while its being polarized.
    * Wish to investigate the possibility of accelerating the processes taking place in an operating fuel cell.
* Experiments performed ex-situ:
    * Corrosion measurements
        * Potentiostatic and potentiodynamic polarizations of the bipolar plates.
    * Contact resistance measurements
        * In order to study the change of the stainless steel surface before and after polarization.

Experimental setups

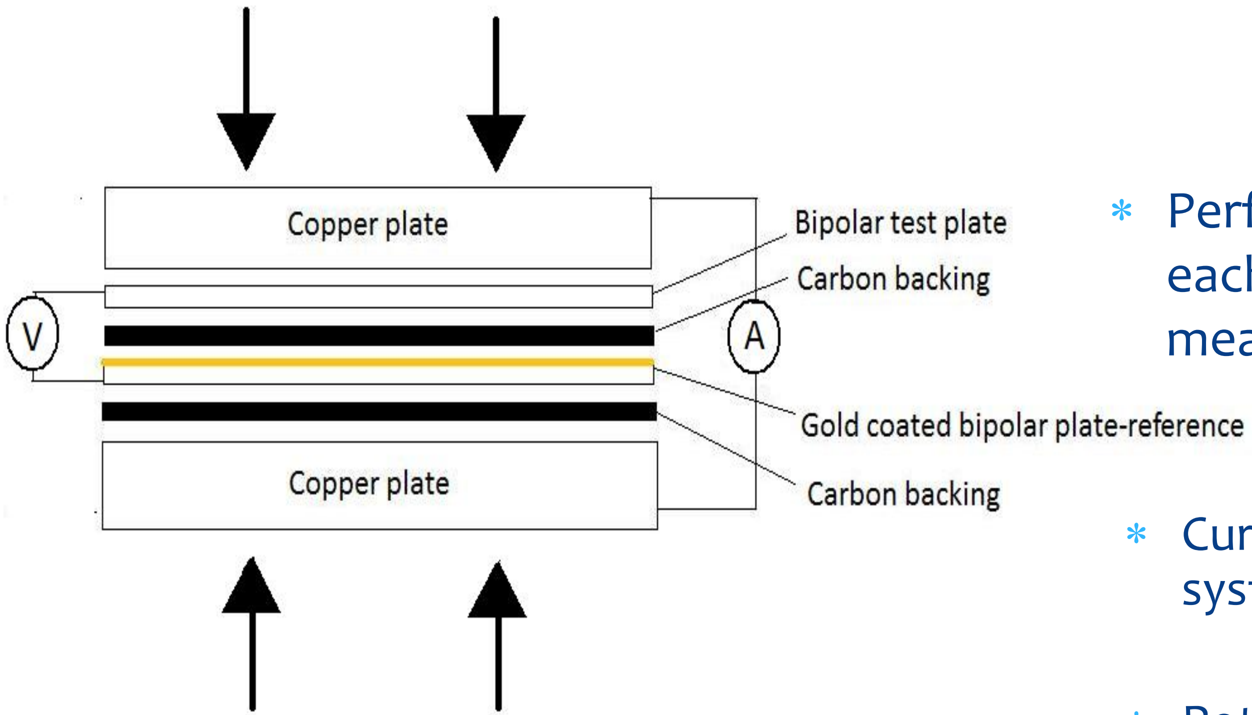
Corrosion measurements



- Electrolyte: H_2SO_4 solution
- Temperature: 75°C
- Reference electrode: Hg/Hg_2SO_4

Experimental setups

Interfacial Contact Resistance

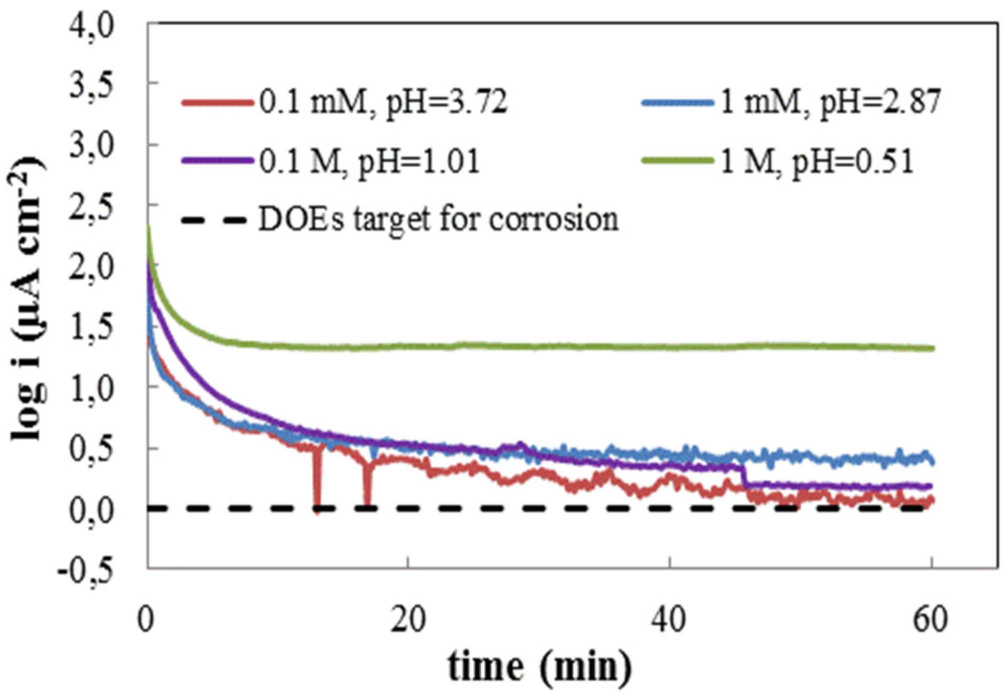


* Performed before and after each polarization measurement.
* Current is sent through the system.
* Potential is measured.

Initial Results

pH variation: polarization

* pH measured in water from fuel cell outlets: around 3,5.
* From the figure:
  * High pH results in high corrosion currents.
  * Close to no corrosion current when the pH is 3,72.
* 1 M electrolyte
  * Could alter the oxide layer on stainless steel in a way that might never happened in an operating fuel cell.



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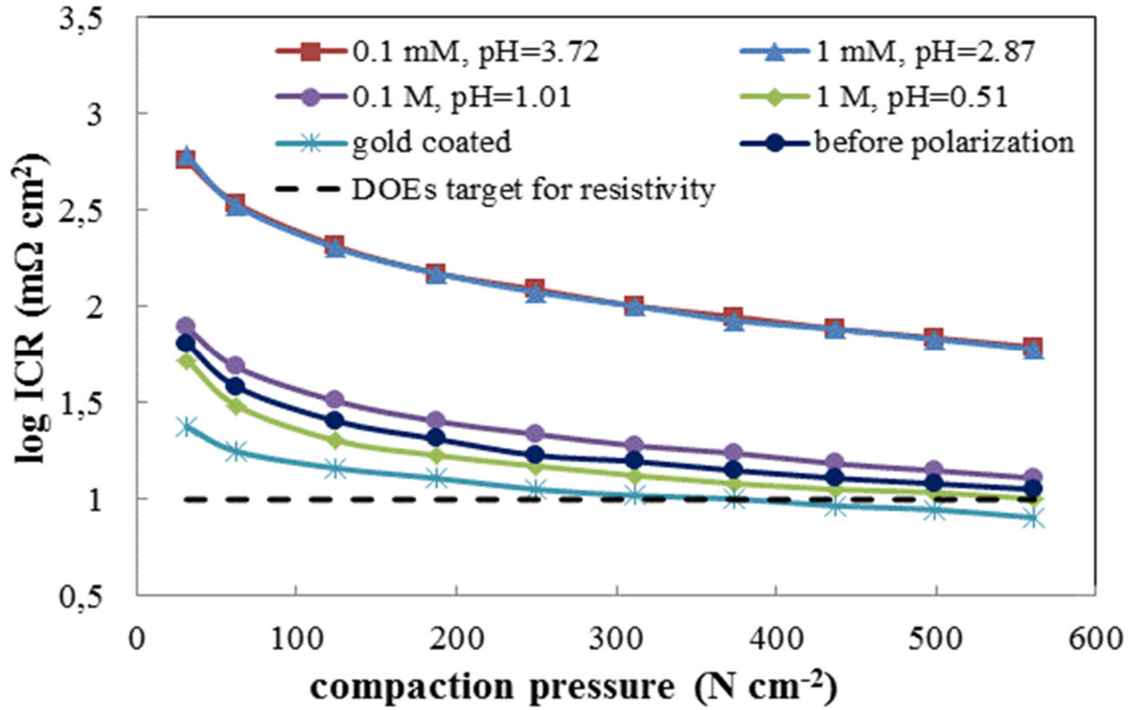
Initial Results

pH variation: ICR

* Low pH= low contact resistance
* Probably due to a reduction of oxide layer thickness.
  * Possible exposure of steel surface.
  * Corrosion of the steel.



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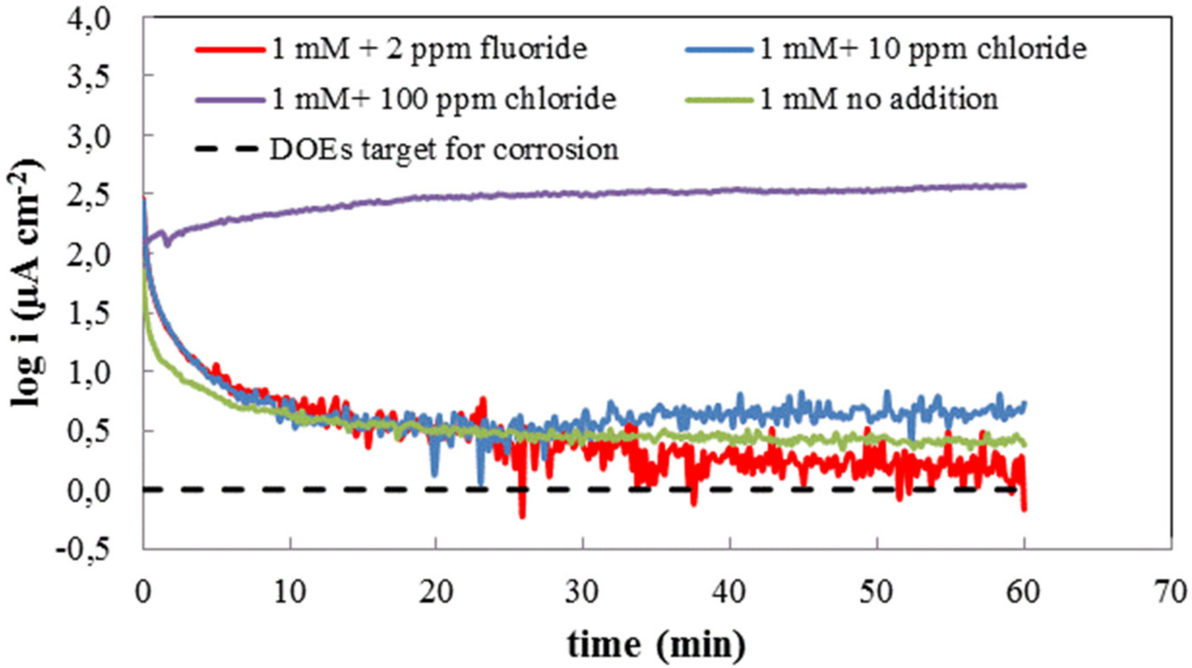
Initial Results

F^- and Cl^- additions: polarization

* 1 mM (pH= 2,87) sulfuric acid solution with either:
  * 2 ppm fluoride
  * 10 ppm chloride
  * or 100 ppm chloride

* The corrosion current does not seem to be increased by either 2 ppm fluoride or 10 ppm chloride.



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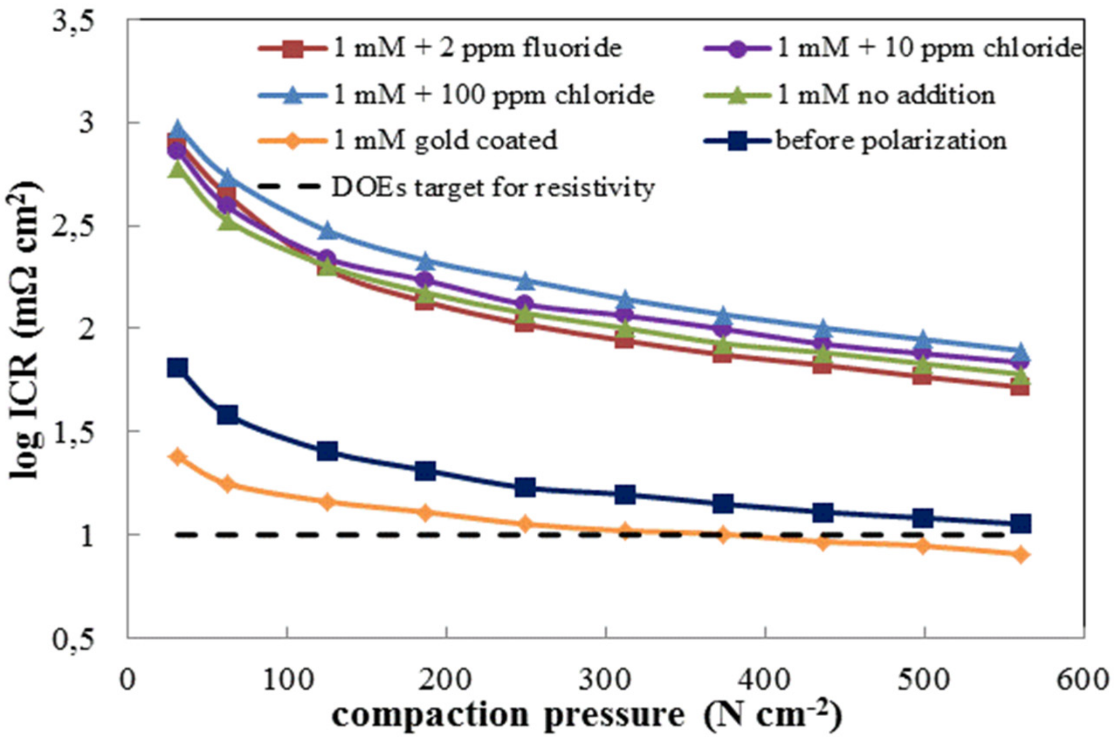
Initial Results

F^- and Cl^- additions: ICR

- Little or no difference with the additions of either fluoride and chloride.
- Confirms the corrosion test results.



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CrN coatings

* Coated plates were supplied by VTT.
* CrN
    * Hexavalent Cr.
    * Trivalent Cr.
    * Applied by Electrodeposition.
    * Plasma nitrided to obtain CrN.

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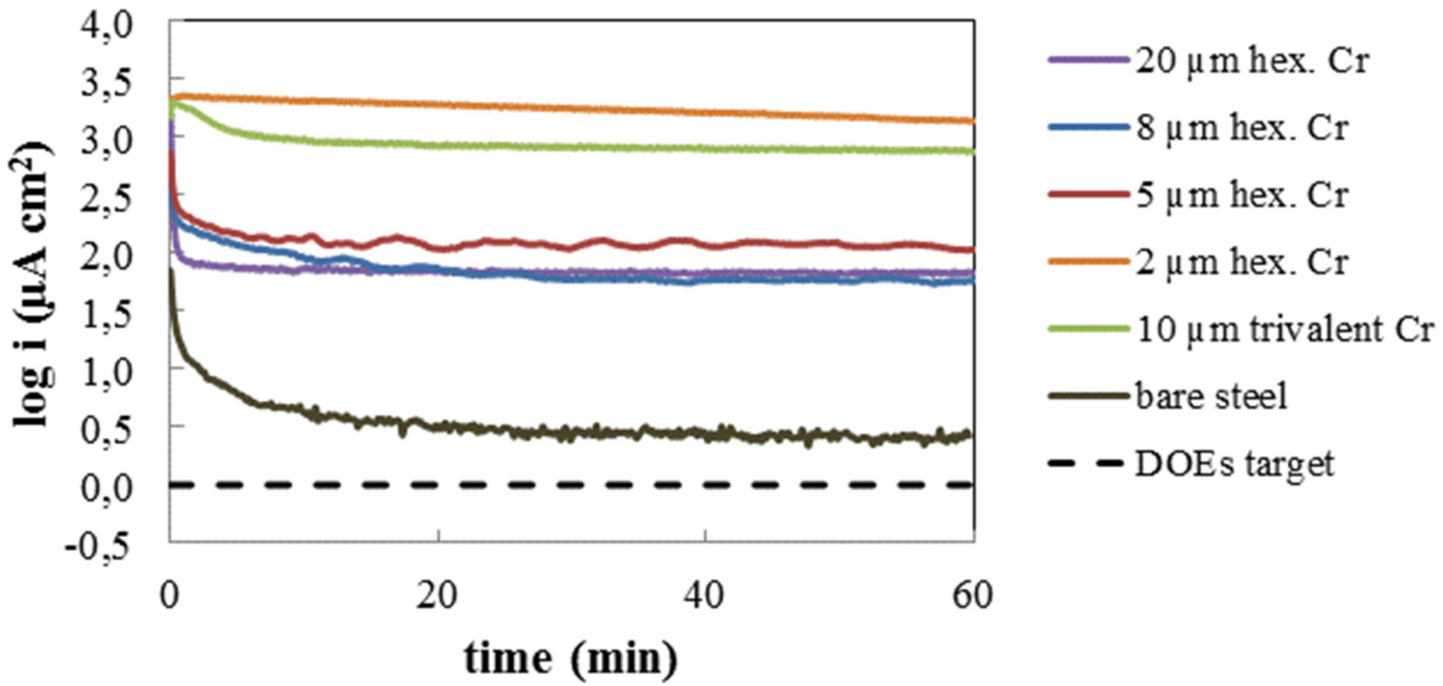
CrN coatings

Polarization



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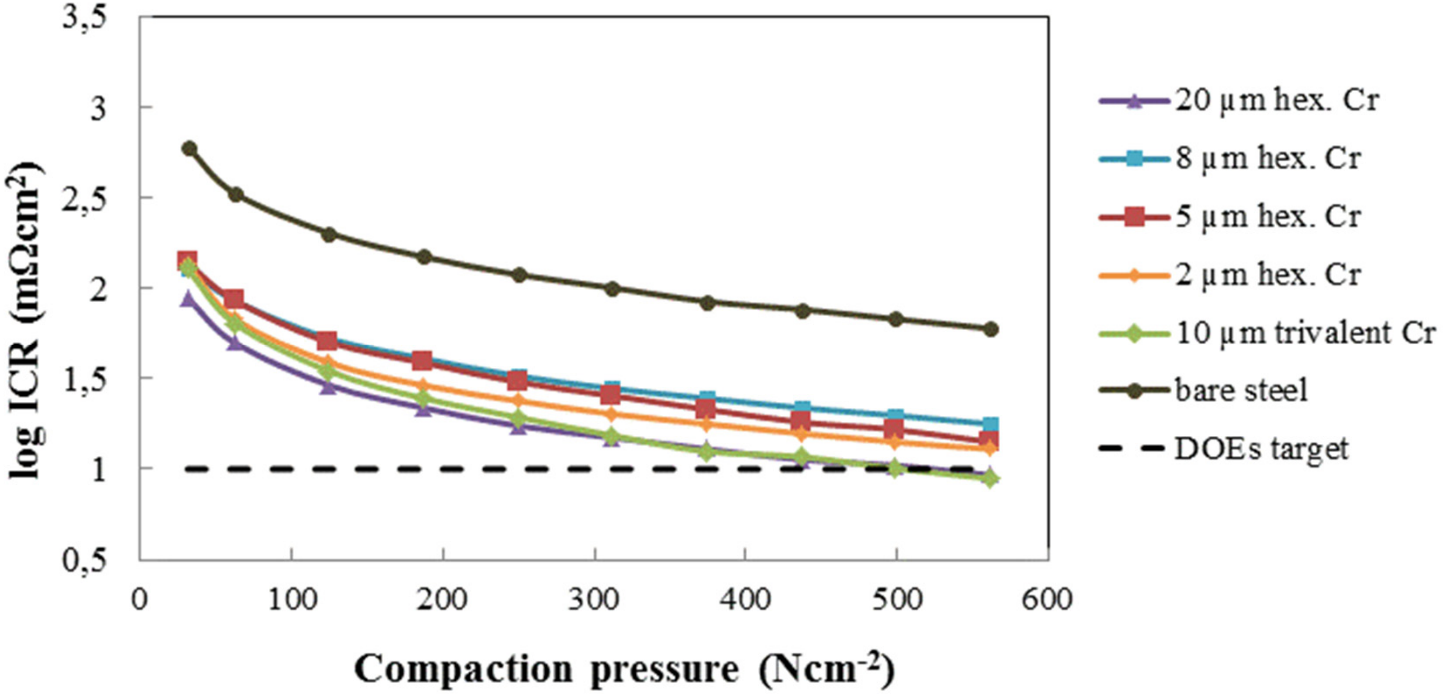
CrN coatings

ICR measurements



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Conclusions and further work

* Both the corrosion test setup and the ICR test setup makes it possible to do ex-situ testing easier and faster than when the PEM fuel cell is in operation.
* Low pH might not be the best way to accelerate the corrosion process of the stainless steel.
* The CrN coated bipolar plates showed very promising ICR.
* Further work will focus on development and testing of self produced coatings.

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Thank you for your attention

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