

# AluChrom Cathode Air Pre Heaters



**senior**  
**Flexonics**



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## Cathode Air Pre Heater



As a result of many years of work Senior has developed a CAPH for use in fuel cell microCHP systems, using Aluchrom, which gives significantly reduced Cr evaporation compared to our competitor's alternatives.

At high temperatures Cr evaporates from traditional 300 series stainless steels and inconels causing contamination and reduced performance to the fuel cell.

Our CAPH has proven its robustness through millions of hours of in-field and laboratory testing.



# Cathode Air Pre Heater

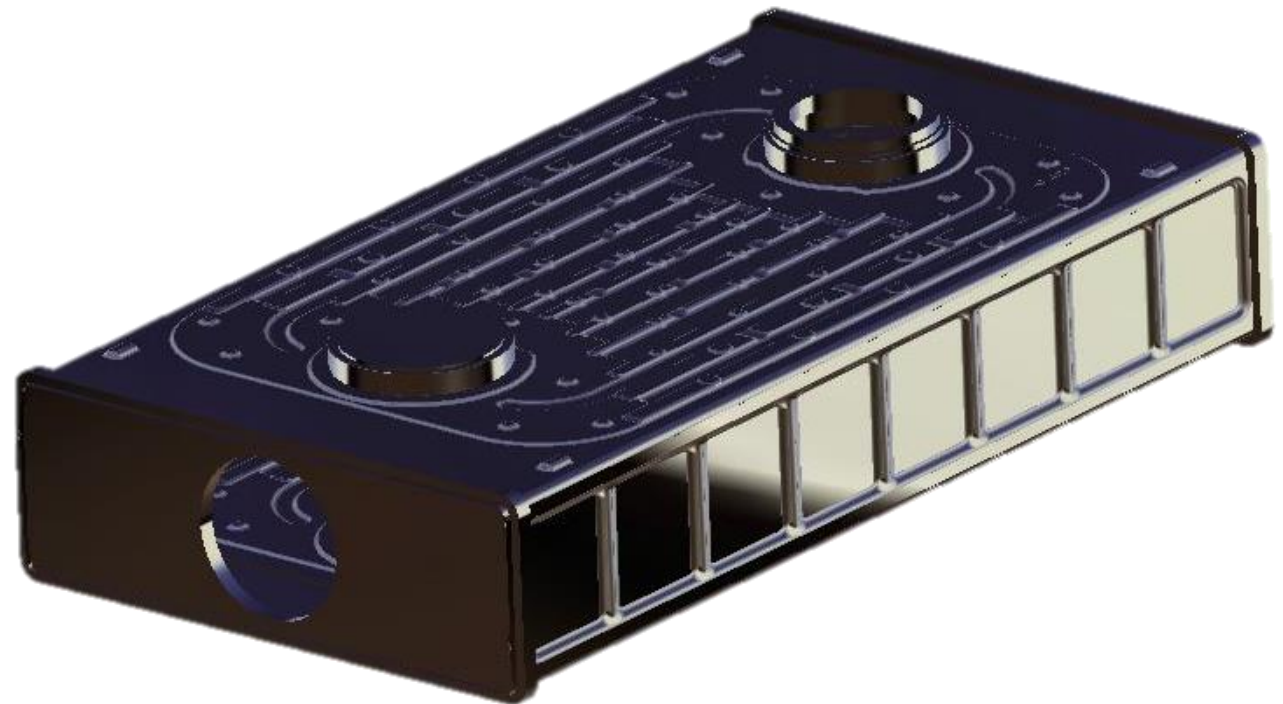
Senior's CAPH has a contra flow design.

Effectiveness is over 90%.

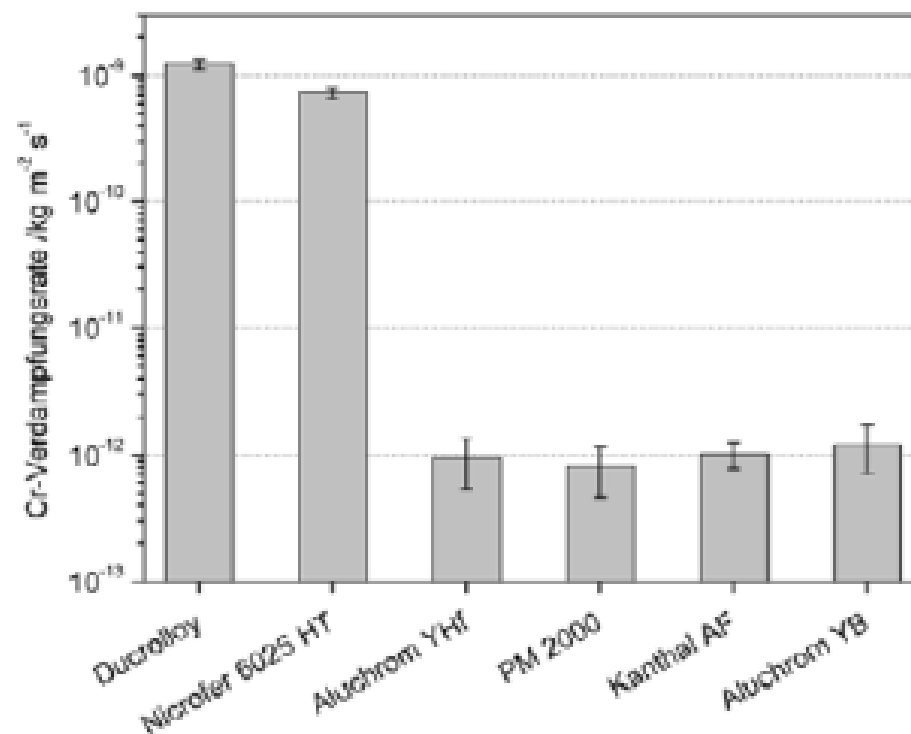
Temperatures up to 1000C.

Very low pressure drop for both fluids.

A patent has been applied for on plate design.



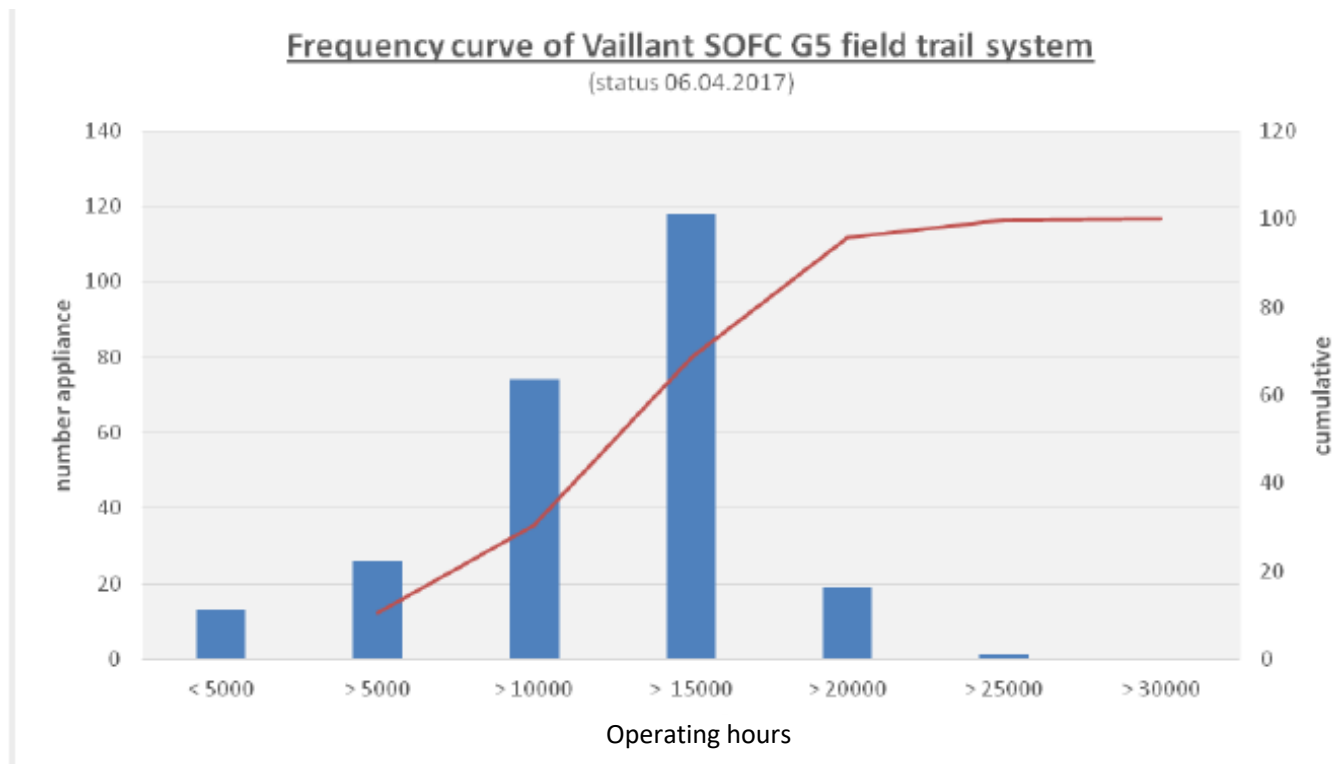
## Aluchrom significantly reduces the amount of Cr leakage vs other materials:



Chromium evaporation rate of different materials

Source: Dissertation M. Stanislawski, FZ Julich, 2006

## Proven robustness through millions of hours of in-field testing:



Source: Vaillant GmbH

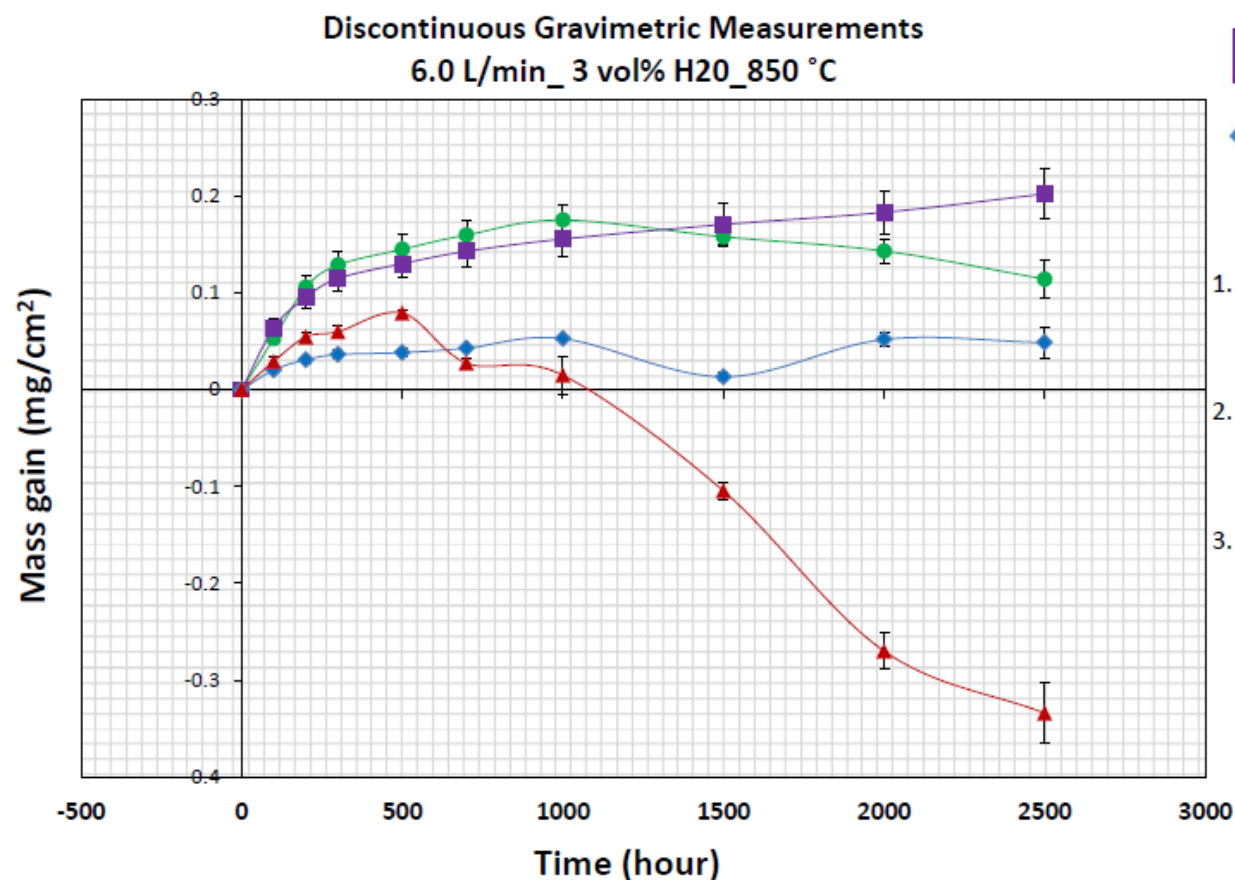


## Green Cr deposits shown on Inconel plate vs Aluchrom:



Different amount of chromium deposits in Inconel 625 (top) and Aluchrom (bottom) heat ex-

# Plot of mass gain to show improved performance of Aluchrom



- 1. The mass gain value of AluChrom 318 keeps increasing even after 2500 hours, which means aluminium oxide keeps growing on top.
- 2. The mass gain value of Aluminised 309 starts to decrease after 1000 hours, which means the aluminium oxide peel off from the surface.
- 3. Inconel 625 has relatively lower mass gain indicating that the Cr evaporation is very large.

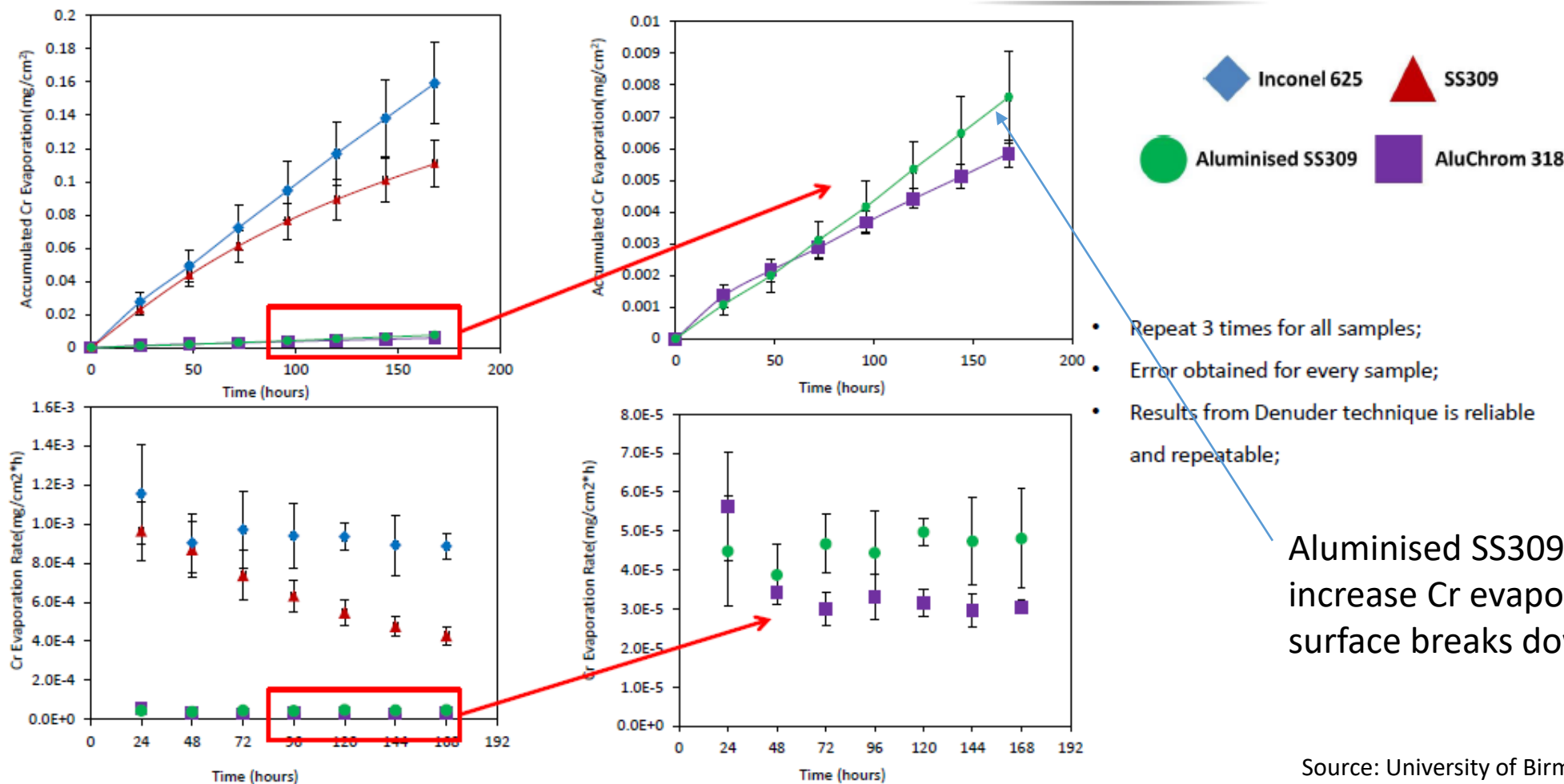
**Material:** Inconel 625; AluChrom 318; Uncoated SS309; Aluminised SS309.

**Test Conditions:** 850 °C; 6.0 L/min Airflow; 3 vol% H<sub>2</sub>O.

**Equipment:** Normal tubular glassware for high temperature corrosion test;  
Denuder Technique for evaporated Cr collection.

Source: University of Birmingham

# After only 150 hours, Aluchrom shows improved Cr leakage rates vs all other materials



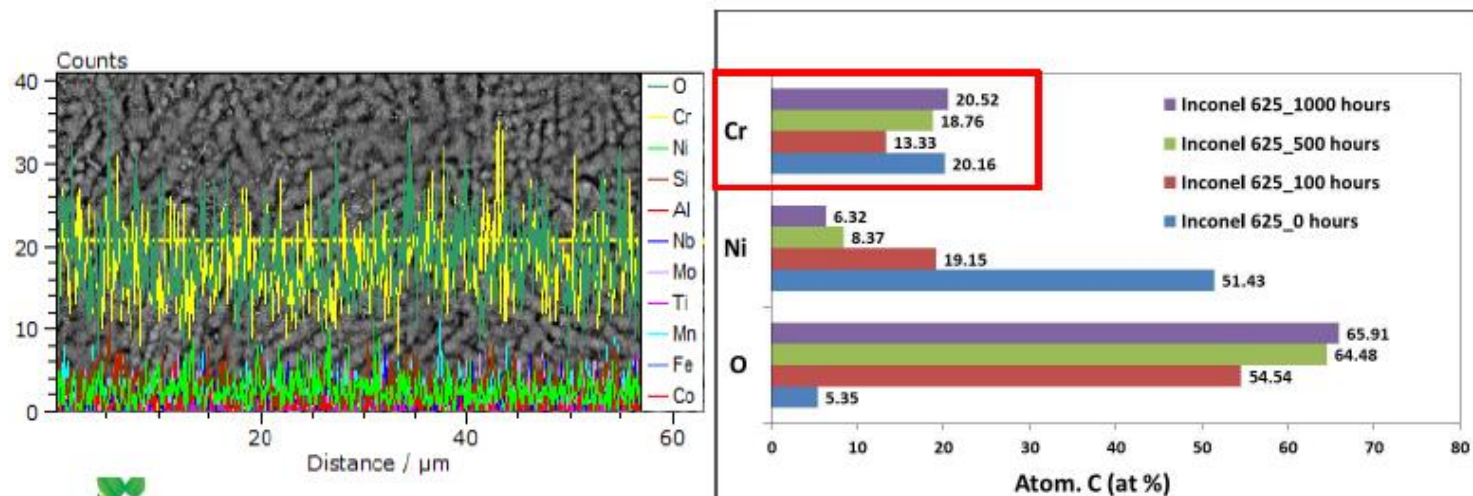
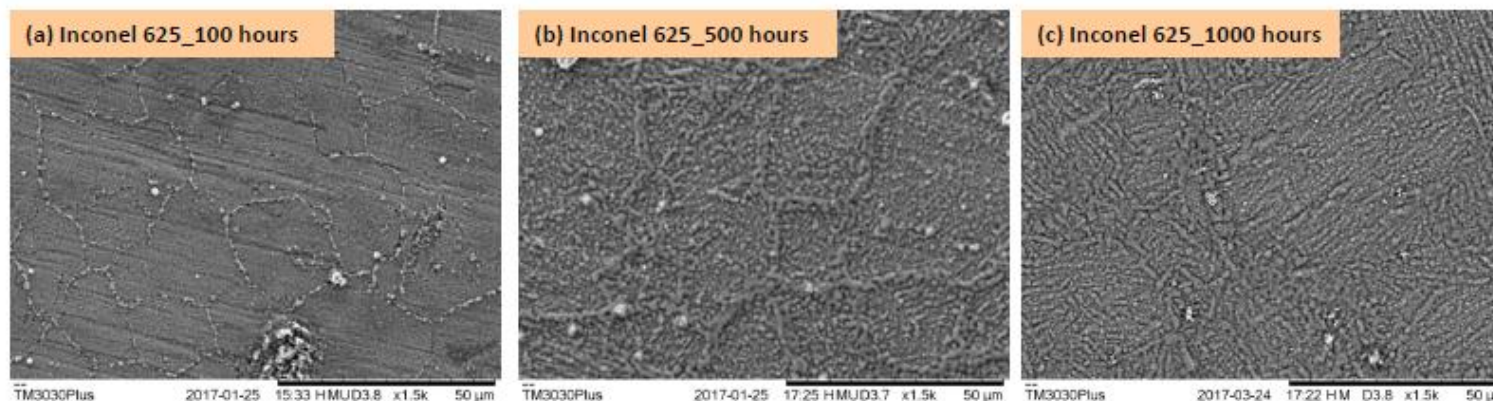
- Repeat 3 times for all samples;
- Error obtained for every sample;
- Results from Denuder technique is reliable and repeatable;

Aluminised SS309 starting to increase Cr evaporation as surface breaks down

Source: University of Birmingham



# In Inconel, Cr oxide forms on surface and remains



HEATSTACK

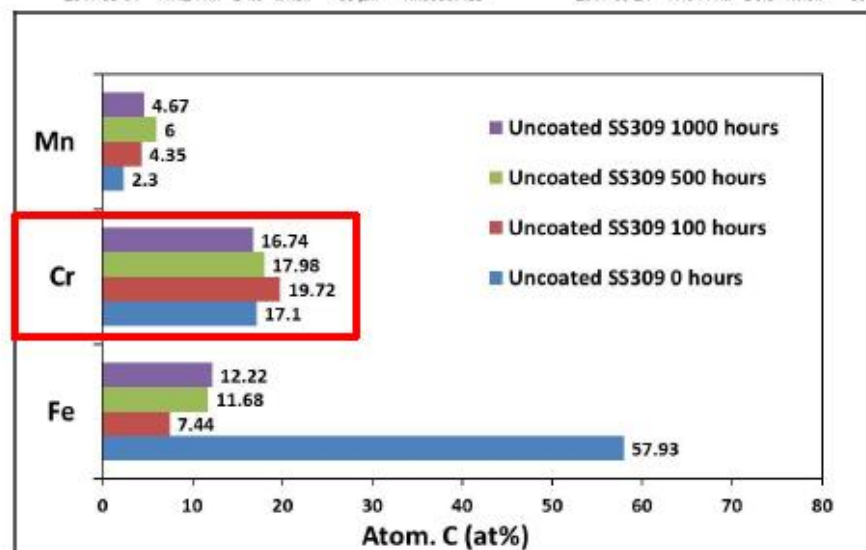
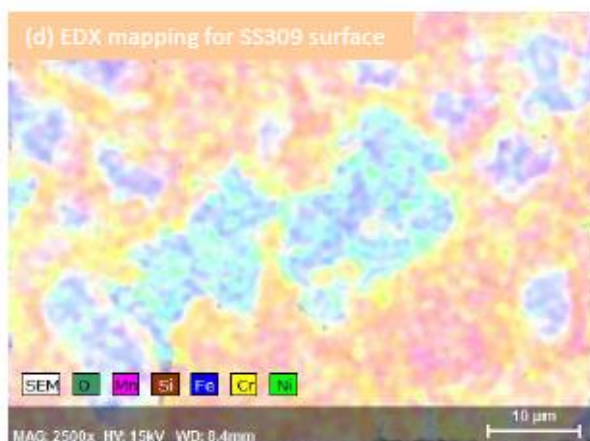
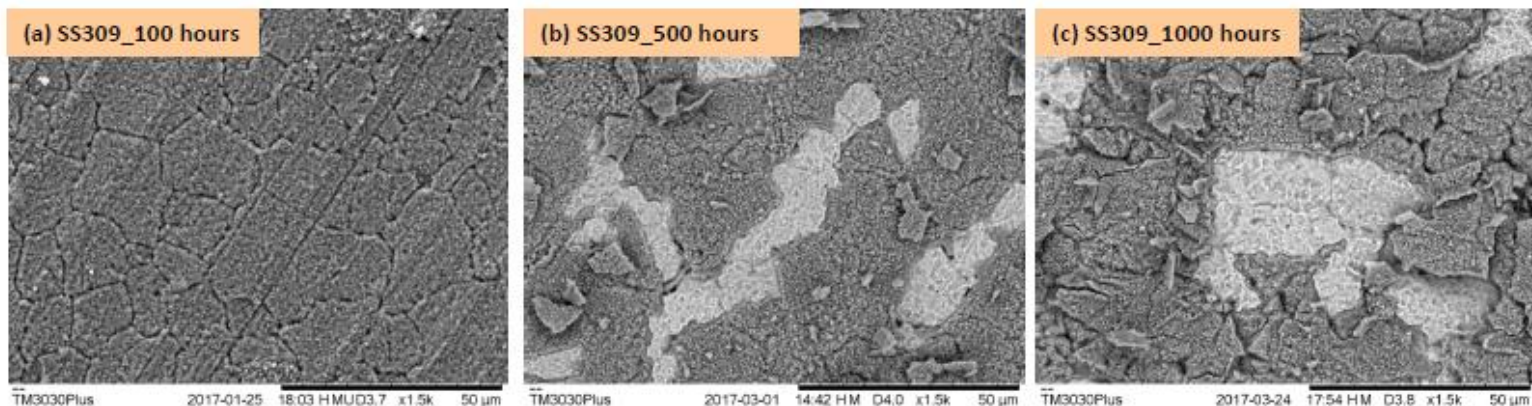
Material: Inconel 625

**Test Conditions:** 850 °C; 6.0 L/min Airflow; 3 vol% H<sub>2</sub>O.

**Equipment:** Normal tubular glassware for high temperature corrosion test;  
Denuder Technique for evaporated Cr collection.

Source: University of Birmingham

# SS 309 forms Cr oxide, which spalls and breaks from surface



Material: SS309

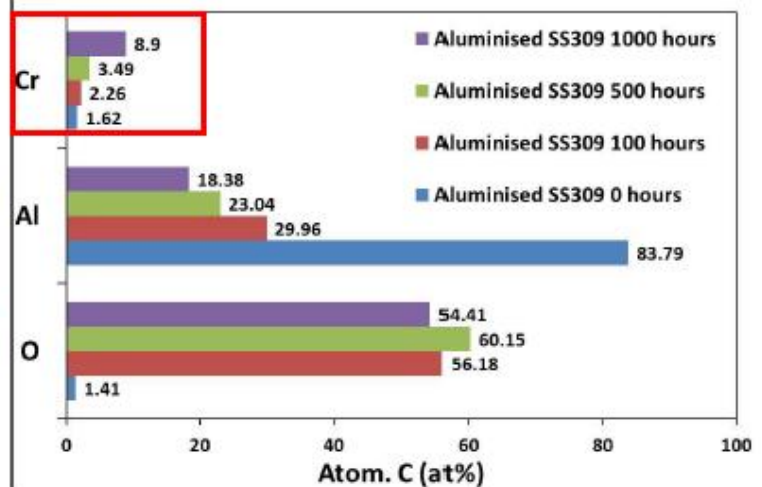
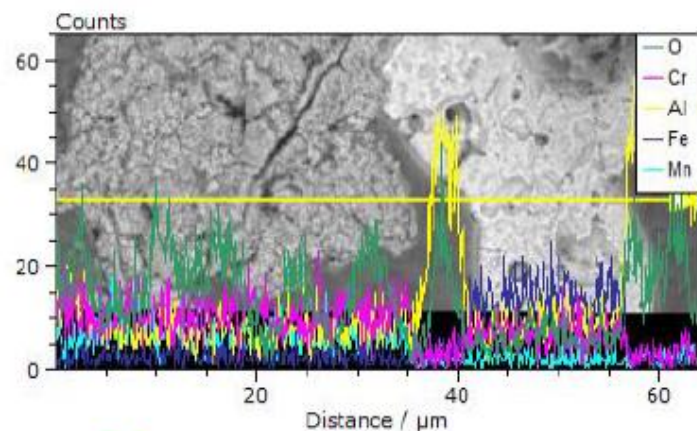
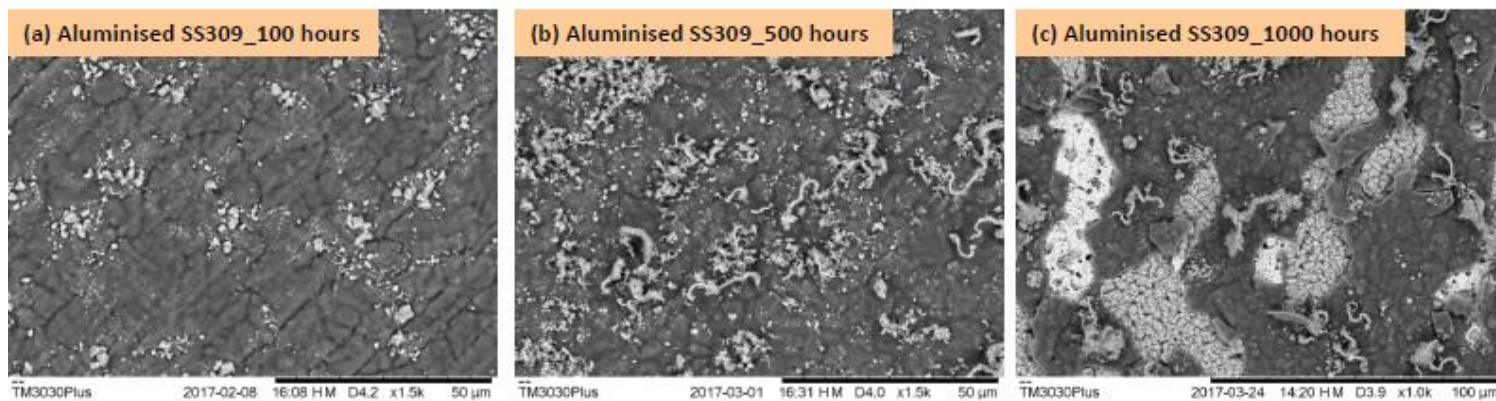
**Test Conditions:** 850 °C; 6.0 L/min Airflow; 3 vol% H<sub>2</sub>O.

**Equipment:** Normal tubular glassware for high temperature corrosion test;  
Denuder Technique for evaporated Cr collection.

Source: University of Birmingham



# Aluminised SS309 loses Alumina surface, and is replaced by Cr oxide



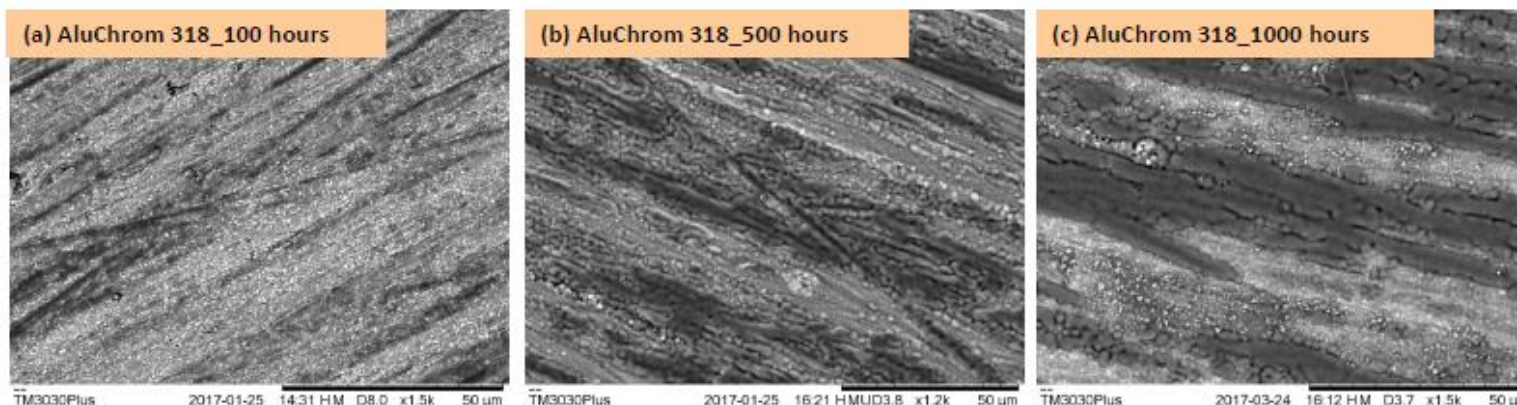
Material: Aluminised SS309

**Test Conditions:** 850 °C; 6.0 L/min Airflow; 3 vol% H<sub>2</sub>O.

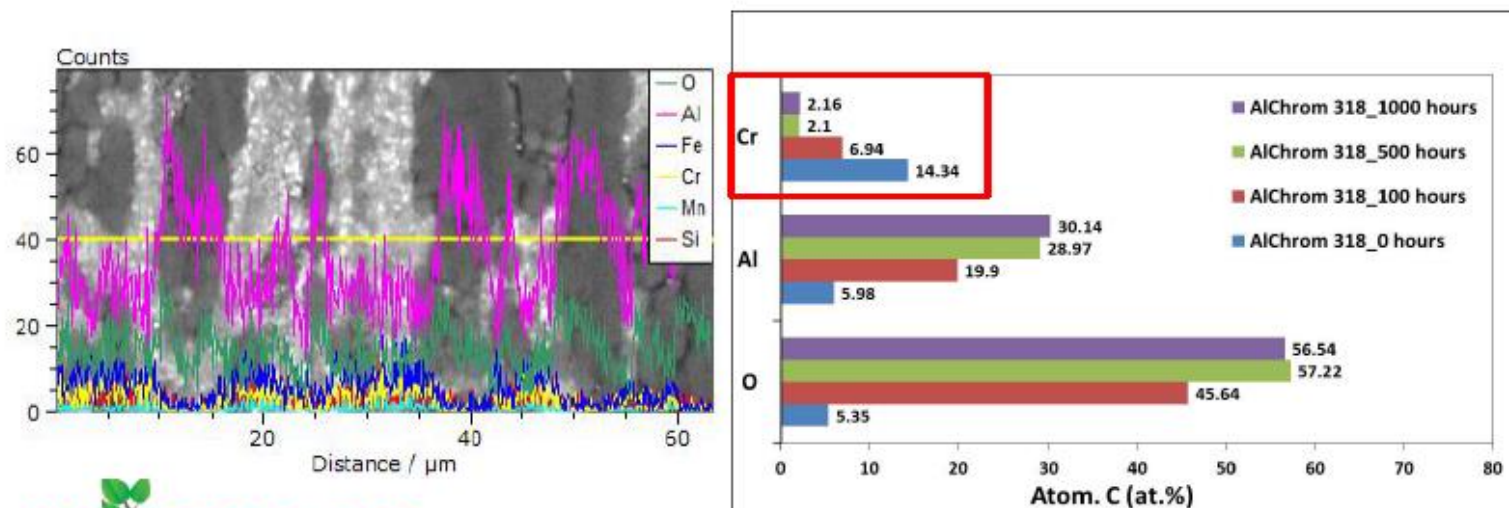
**Equipment:** Normal tubular glassware for high temperature corrosion test;  
Denuder Technique for evaporated Cr collection.

Source: University of Birmingham

# Aluchrome surface reduces Cr oxide content & increases Alumina layer



Senior will introduce a pre-installation high temperature conditioning process to generate the Al oxide layer both delivery to the customer



Material: AluChrom

**Test Conditions:** 850 °C; 6.0 L/min Airflow; 3 vol% H<sub>2</sub>O.

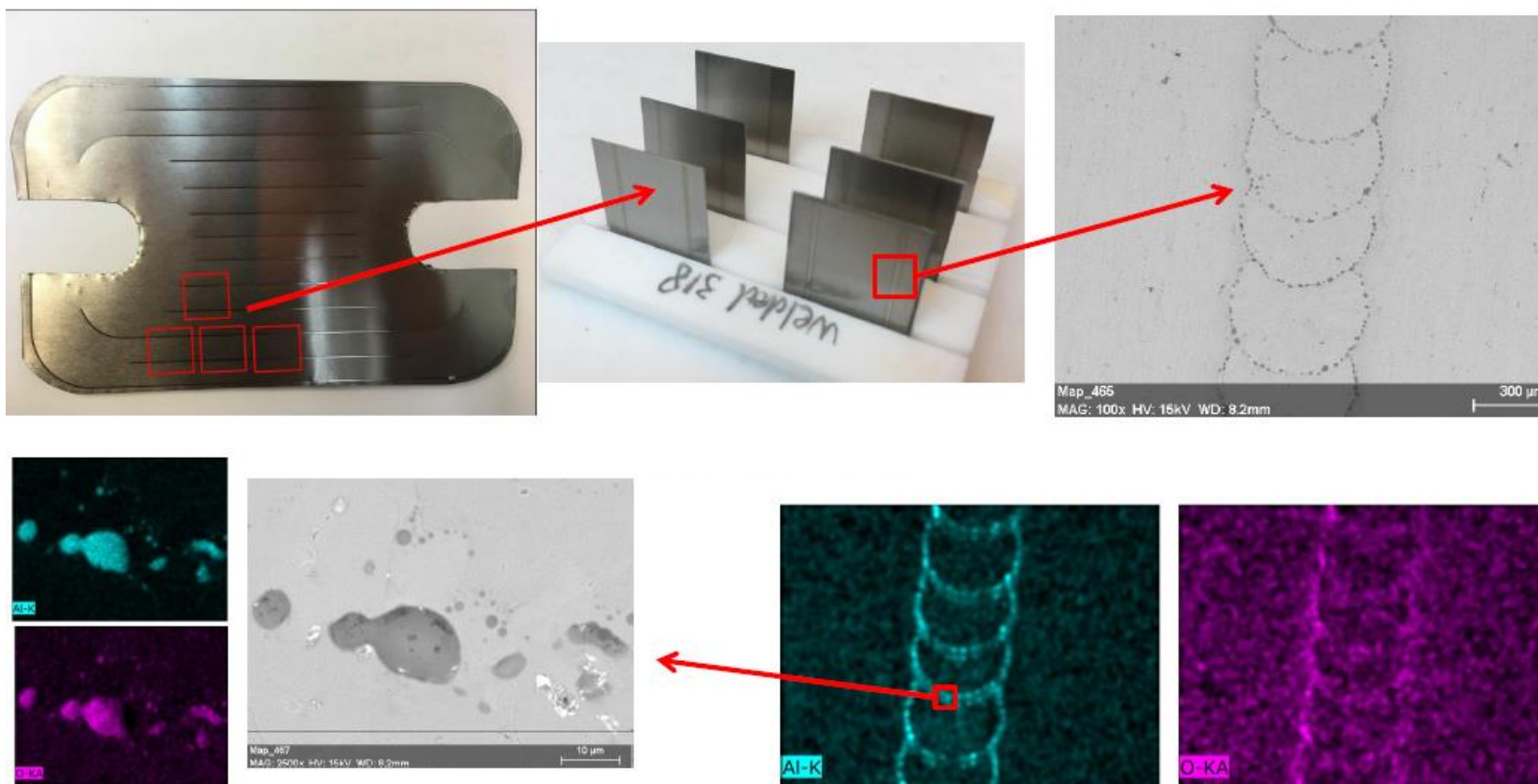
**Equipment:** Normal tubular glassware for high temperature corrosion test;  
Denuder Technique for evaporated Cr collection.

Source: University of Birmingham



# Testing shows that laser welding of plates increases Alumina content of surface further

Welded AluChrom 318 (non-exposure)



Source: University of Birmingham



## Summary

Senior has developed a CAPH for use in fuel cell microCHP systems, using Aluchrom, which gives significantly reduced Cr evaporation compared to our competitor's alternatives.

Our CAPH has proven its robustness through millions of hours of in-field and laboratory testing.

We are working with a number of the world's leading Fuel Cell and mCHP system manufacturers to bring this solution to market at an affordable price to the end user.

For all enquiries please contact [info@seniorflexonics.co.uk](mailto:info@seniorflexonics.co.uk)

