# EVOLVE - Evolved materials and innovative design for high-performance, durable and reliable SOFC cell and stack


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- CerPoTech SA, Trondheim , Norway
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- Institut Polytechnique de Grenoble (INP), Grenoble, France
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EVOLVE FUEL CELL
Materials and design for high performance solid oxide fuel cell

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SEVENTH FRAMEWORK PROGRAMME
New Energy World JU
fuel cells & hydrogen for sustainability


## Motivation & Objectives

- State of the art SOFC technologies are still facing issues especially toward redox cycling and toward sulfur tolerance.
- The major issue is related to the use of Nickel both as structural and catalytic compounds at the anode side

> EVOLVE aims at addressing these issue by developing a new cell architecture without nickel as structural component.

**Cell Concept:**
The innovative architecture is based on a composite metal-ceramic substrate stable under redox cycles:

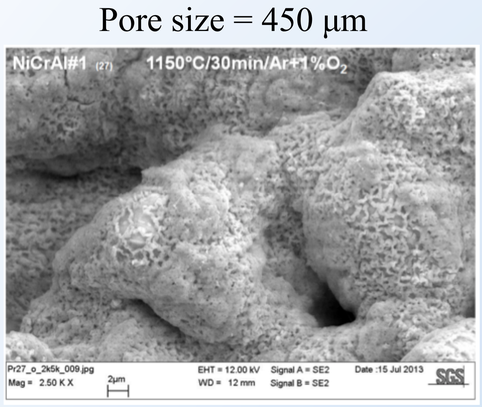
- The metal substrate is made of an alumina forming alloy able to protect the metal underneath in case of exposure to air.
- The ceramic is an electronic conducting perovskite based material able to provide good current collection.
- This substrate support thin active layers, especially a perovskite base materials.

**Objectives:**
- Demonstrate the feasibility of the cell concept
- Obtain competitive power density compared to other existing cell design and similar conditions

## Material development

### Metal Foam

NiCrAl foam composition (wt %)
Ni-19.8 Cr-9.8 Al-70.4.
Pore size = 450 µm

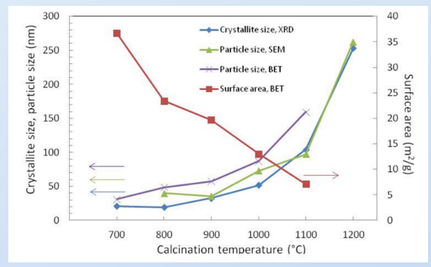


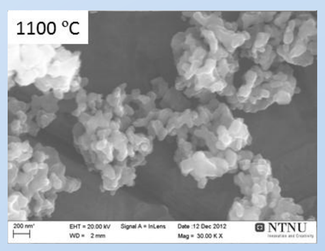

Pre-oxidation: **1150°C for 30 min in Ar +1%$O_2$ atmosphere**

Surface composition : **$Al_2O_3$**

### Ceramic Powder

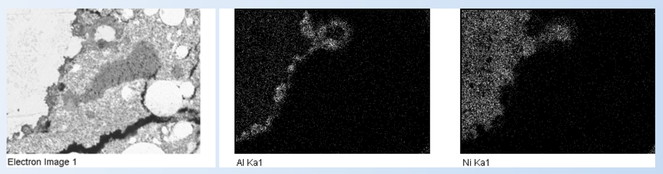
$Sr_{0.9}La_{0.1}TiO_3$ (LST) powder was prepared by spray pyrolysis



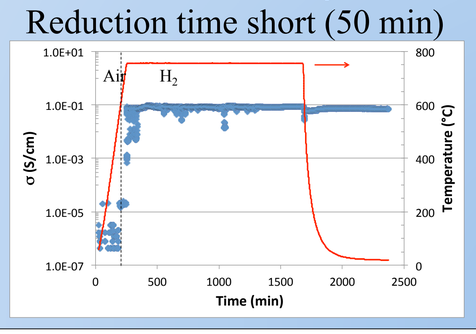

Calcination: **1100°C in Air**

### Composite Substrate




Composite NiCrAl – LST after thermal treatment at 950°C for 24h
Interphase mainly of $Al_2O_3$

Reduction with $H_2$ at 750 °C
Effective Conductivity = 0.1 S/cm
Reduction time short (50 min)




## Cell manufacturing and testing

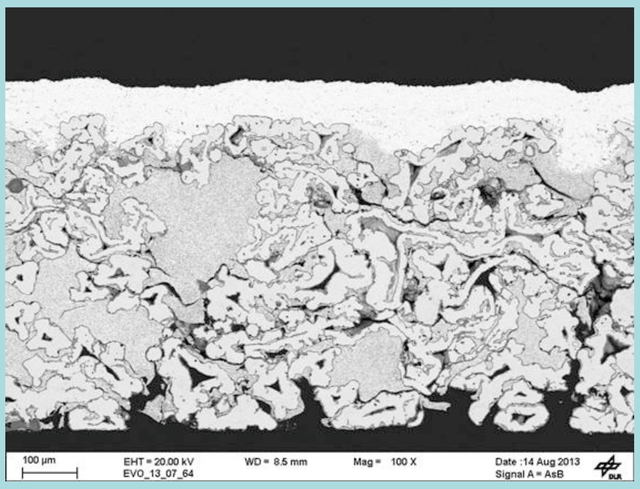



Figure 1: BSE SEM Cross section of the anode Electrolyte Half Cell of EVOLVE Prototype

- Vacuum Plasma Spraying was used for the manufacturing of a 70µm thick Electrolyte (Figure 1)
- First EVOLVE Cell Prototype have been produced on the basis : NiCrAl-LST | YSZ | YSZ-LSM
- The power density measured at 750°C was limited at about 20 mW/cm² at 0,7V with $H_2$ /Air as Fuel / Oxidant
- No quantifiable degradation after galvonstatic aging of the cell at 0,8V for 180h (Figure 2)

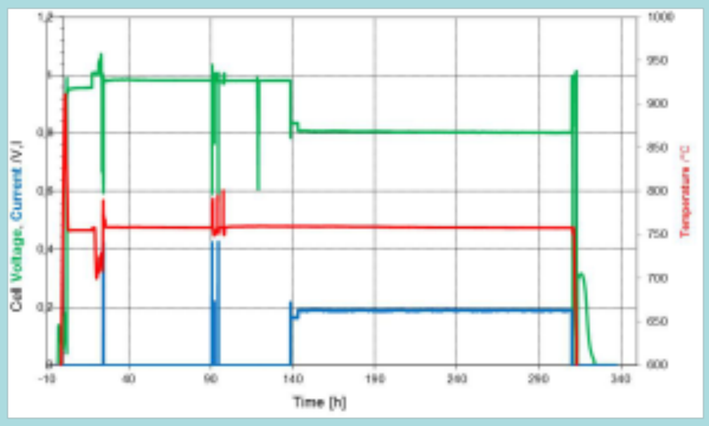



Figure 2: Voltage variation as a function of current over the time of the EVOLVE Cell prototype.

## Conclusion & Challenges

- ➢ The set of materials considered for the EVOLVE cell are compatible under tested conditions
- ➢ Possibility to manufacture the cell in air still need to be demonstrate. This is link to the properties of LST (Need of high temperature reduction for activation of electronic conductivity)
- ➢ Development and implementation of thin electrolyte by EB-PVD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