NewSOC

Next Generation Solid Oxide Fuel Cell and Electrolysis Technology

European Hydrogen Week

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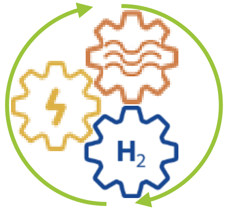
European Commission

Project Overview

- Call year: 2019
- Call topic: FCH-02-6-2019: New materials, architectures and manufacturing processes for Solid Oxide Cells
- Project dates: 1. January 2020 to 30. June 2023
- % stage of implementation 01/11/2021: 52 %
- Total project budget: 5 M €
- FCH JU max. contribution: 5 M €
- Other financial contribution: 0 €
- Partners (16): Technical University of Denmark, Commissariat à l'énergie atomique et aux énergies alternatives, University of Salerno, Institut de Recerca en Energia de Catalunya, Institute of Power Engineering, ECN part of TNO, Foundation for Research and Technology, The Centre for Research & Technology, Technical Research Centre of Finland, École polytechnique fédérale de Lausanne, Politecnico di Torino, Solid Power, Elcogen, Sunfire, Ceres Power, Hexis

Project Summary

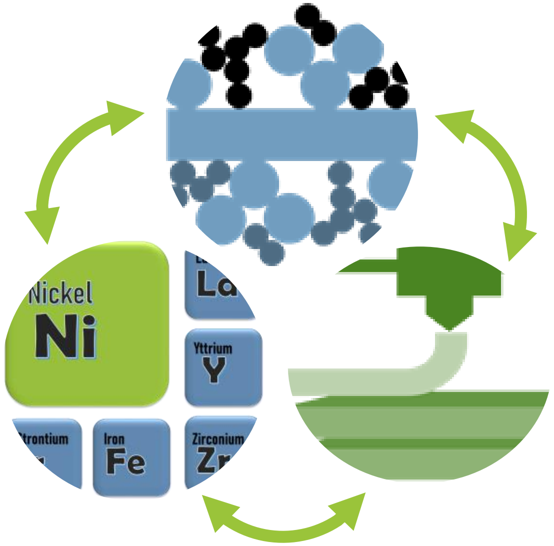
Solid oxide technologies (SOC: SOFC & SOE) are key enabling technologies efficiently linking the sectors power, gas, & heat and can therefore emerge as key players in the energy transition and future energy systems.



NewSOC aims at significantly improving performance, durability, and cost competitiveness of SOCs compared to state-of-the-art (SoA) and validating at the level of large cells and short-stacks, thereby moving the TRL from 2 to 4.

- 25% Increase of electrolysis current at degradation rates below 1%/1000 h
- 25% Reduction of the area specific resistance
- 25% Increase of cycling stability
- 25% Reduction of cell manufacturing costs, and
- 25% Reduction of toxic organics or materials during manufacture

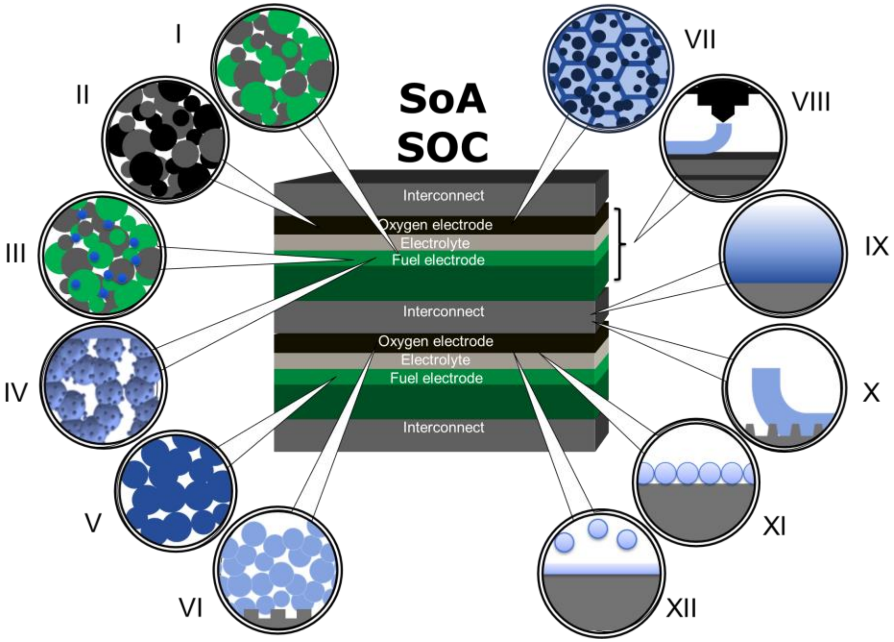
i. Structural optimisation and innovative architectures
ii. Alternative materials, and
iii. Innovative manufacturing



Project Summary

The NewSOC project proposes development of twelve concepts around SOC

I	Ni based fuel electrode
II	LSCF based oxygen electrode
III	Bi-metallic or tri-metallic Ni based fuel electrode
IV	Infiltrated, doped titanate backbone fuel electrode
V	Doped lanthanum chromite based fuel electrode
VI	Patterned electrode/electrolyte interface for Co-free oxygen electrode



VII	Honeycomb supported oxygen electrode
VIII	3D printing of SOC
IX	Protective coating through inkjet printing
X	Ceramic coatings with innovative interface concepts
XI	Thin film atomic layer deposition barrier layers
XII	Thin film room temperature sputtering barrier layer

Structural optimization: fuel electrode (CEA)

Achievement to-date

-0.75 A/cm^2
Ni depletion

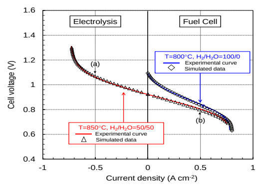
25% 50% 75%

-1 A/cm^2
No Ni depletion

i in SOE mode @ 750 °C
Ni depletion under long-term SOE operation

Targets:

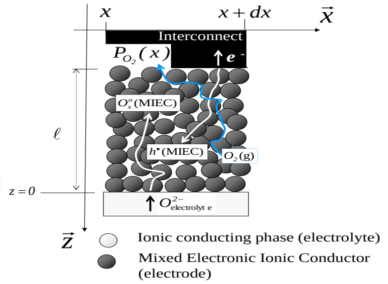
- *Identification and fabrication of optimal micro structure of Ni/YSZ SoA fuel electrodes for high performance in SOE mode*
- *Identification of Ni depletion as major degradation source in SOE mode and avoidance through optimum micro structure*



Electrochemical and Mechanical testing

Microstructural characterization

Modeling



Alternative materials: Co-free oxygen electrode (TNO)

Achievement to-date

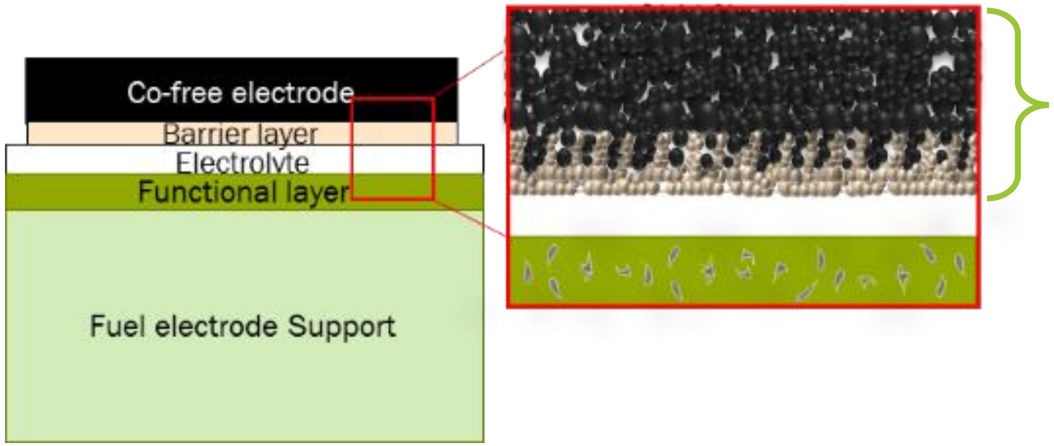
-0.75 A/cm² → -1.1 A/cm²

25% 50% 75%

i in SOE mode @ 750 ºC

Targets:

- *Reduce critical raw materials (CRM) content and SOC manufacturing costs with cobalt removal*
- *Improve performance and lifetime with novel electrode design for low-temperature SOC operations*



$(La,Sr,Ca)FeO_{3-\delta}$ perovskites

Optimum porosity

Profiling of the interfacial barrier layer

Innovative manufacturing: Magnetron sputtering of cathode barrier layers (UNISA)

Achievement to-date

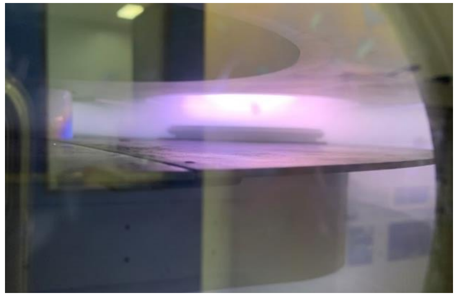
-0.75 A/cm^2 → -1 A/cm^2

25% 50% 75%

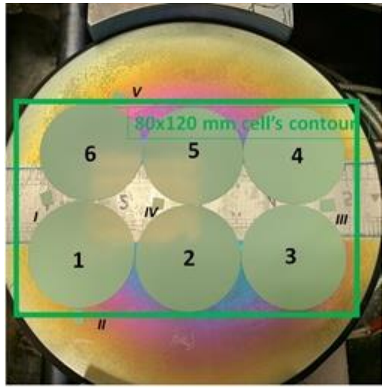
i in SOE mode @ 750 °C

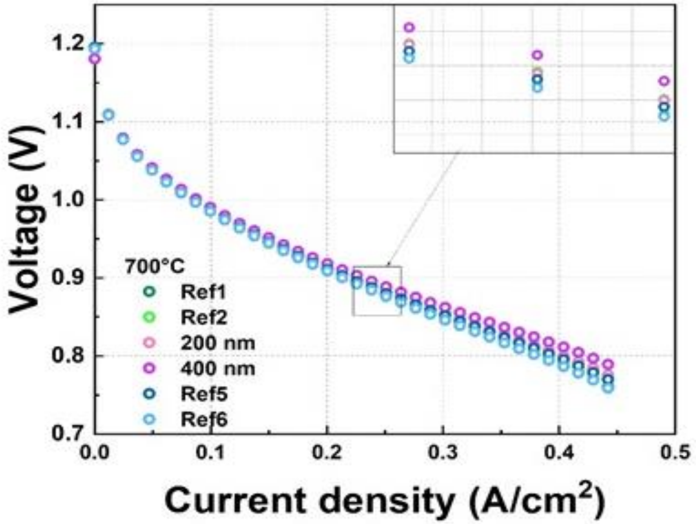
Targets:

- *Room Temperature Sputtering with no heating of the substrate to reach easier handling at industrial level*
- *Separate in-air thermal treatment to allow to maximize performance via grain-size optimization and integrate in industrial processes.*



Cell positioning vs. thickness / thickness distribution & performance



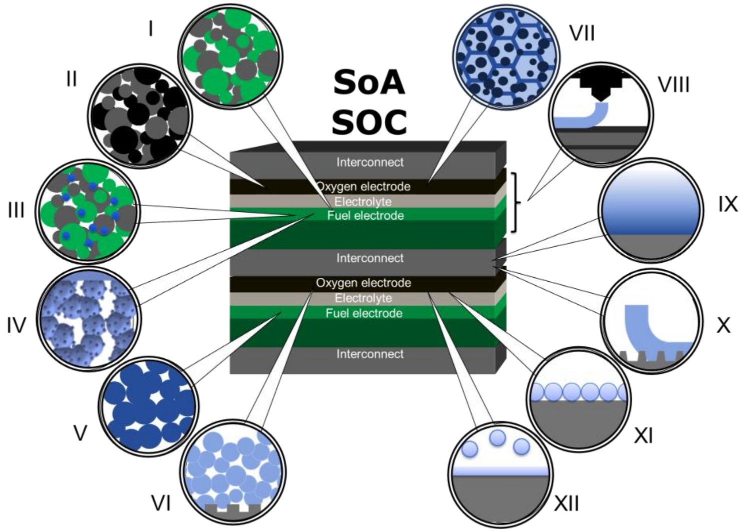


Progress in all 12 concepts achieved

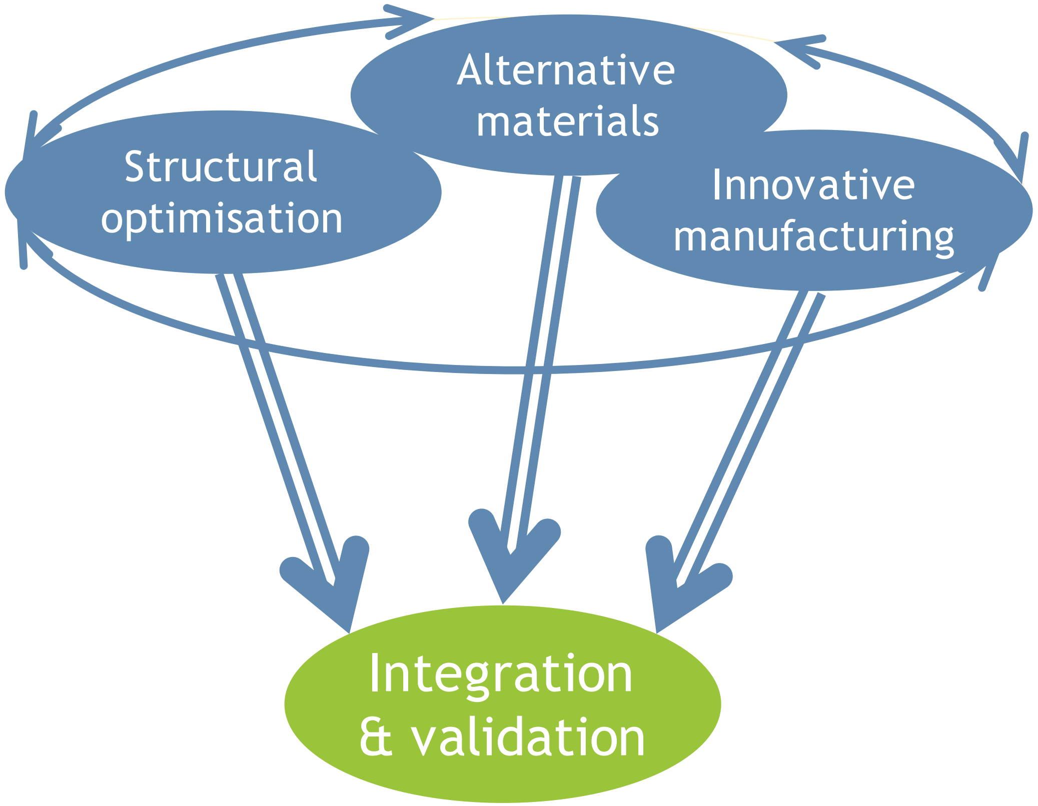
Achievement to-date

Performance
Durability
Costs

- *Improvements at electrode and cell level*
- *Discussion of integration into industrial cell/stack platforms*



Exploitation Plan/Expected Impact



Integration matrix

Research \ Industry	ASC	ESC	MSC
I. Ni based fuel electrode	✔	✓	
II. LSCF based oxygen electrode	✔	✓	
III. Bi-metallic or tri-metallic Ni based fuel electrode	✔	✔	✓
IV. Infiltrated, doped titanate backbone fuel electrode		✔	✓
V. Doped lanthanum chromite based fuel electrode	✓	✓	
VI. Patterned electrode/electrolyte interface for Co-free oxygen electrode	✔	✓	✓
VII. Honeycomb supported oxygen electrode	✔	✓	
VIII. 3D printing of SOC	✓		
IX. Protective coating through inkjet printing	✔	✔	
X. Ceramic coatings with innovative interface concepts		✓	
XI. Thin film atomic layer deposition barrier layers	✔	✓	
XII. Thin film room temperature sputtering barrier layer	✔		

✔ Planned integration
✓ Potential integration

Communication & Dissemination Activities

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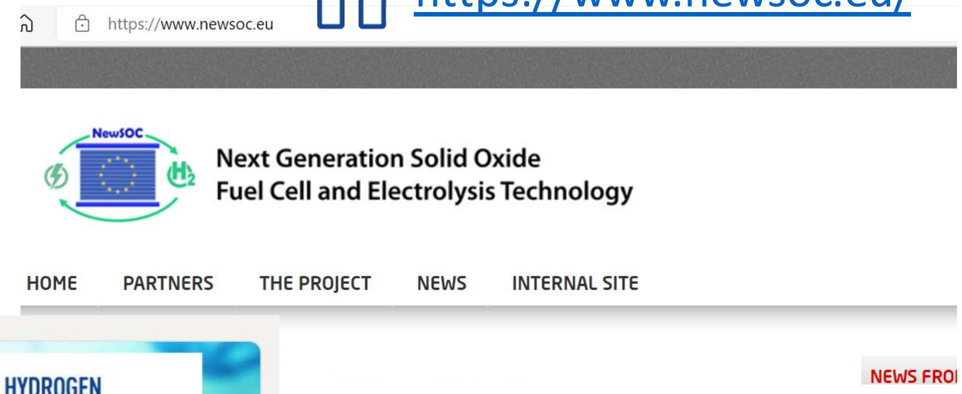
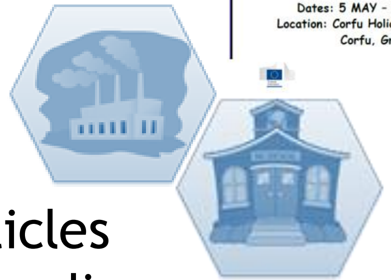


Linkedin

- 26 PhD & MSc students
- 10 Post Doc researchers

- Virtual workshop



- Five peer review articles
- Six conference proceedings
- 22 conference contributions

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