# METPROCELL

## INNOVATIVE FABRICATION ROUTES AND MATERIALS FOR METAL AND ANODE SUPPORTED PROTON CONDUCTING FUEL CELL (FCH JU GA No. 277916)

**Duration:**

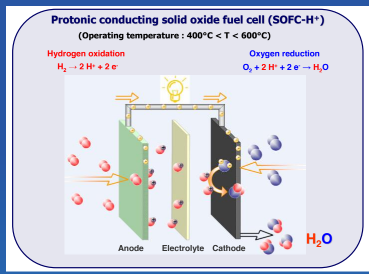
01/12/2011 - 30/11/2014

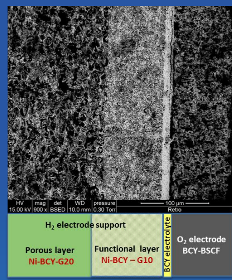
**Application Area:**

Stationary Power generation and CHP

**Budget:**

Total budget: € 3,436,092.40 /
FCH contribution: € 1,822,255.00




**Partnership / consortium list:**

Coordinator: FUNDACION TECNALIA RESEARCH & INNOVATION (Spain)
Partners: EIFER (Germany), CNRS / MARION TECHNOLOGIES S.A. (France)/ , DTU /TOPSOE FUEL CELL A/S (Denmark), Ceramic Powder Technology AS (Norway), HÖGANÄS AB (Sweden)

## Summary / main objectives of the project:

- Development of new electrolyte and electrode materials with enhanced properties for improved PCFCs dedicated to 500-600°C.
- Suppress the post- sintering steps using alternative manufacturing routes based on thermal spray technologies and plasma EVD.
- Assess the potential of both metal and anode supported cell architectures to obtain the next generation of PCFCs.
- Bring the proof of concept of PCFCs by the set-up and validation of short stacks for APU and gas/micro-CHP (first complete PCFC stack units).
- Assess the PCFC technology as electrolyser.

## Technical accomplishment / progress / result

- New materials for PCFCs: (1) BCY and BCZY electrolytes fully sintered at 1200°C with high protonic
- conductivity ($\sigma_{H+}$: 7 mS.cm$^{-1}$/ dense >95%). (2) Ni-BCZY anode layers and supports sintered at 1200°C with conductivity > 1000 S.cm$^{-1}$ at 600°C and porosities around 40% (ASR: 0.07Ω.cm$^2$ @ 600°C in a $H_2$ / 3% $H_2O$). (3) Architectured BSCF/BSCF-BCY10 and $Pr_2NiO_4$/$Pr_2NiO_4$-BCY10 cathodes with ASR < 0.5 Ω.cm$^2$ at 600°C and $\sigma_e$> 100 S·cm$^{-1}$. Porous ferritic stainless steel supports with TEC values of around 10.5·10$^{-6}$ K$^{-1}$ and improved oxidation resistance at 600°C in air through surface stabilization with RE elements.
- Atmospheric plasma sprayed BCY/BCZY-NiO anodes with ASR values down to 0.45 Ω.cm$^2$.
- Anode supported single cells with an active surface of 3.14 cm$^2$ and power density of 140 mW.cm-2 (Ni-BCYZ/BCYZ-ZnO/BCYZ-BSCF) and 196 mW.cm-2 (Bi-layered Ni-BCY/BCY/BCY-BSCF) @ 0.65V/600°C.

## Contribution to the ProgrammeObjectives:

- The PCFC technology could significantly contribute to industrialise the FC technology by improving the cell characteristics and lowering drastically the system costs. The following impacts are expected:
- Reduction of the manufacturing steps, through the implementation of innovative fabrication routs with none post-sintering needs.
- The possibility to reduce the service temperature under 600 °C will be notably useful to prolong the service life of the metal supports potentially beyond current benchmarks of 40.000 hours.
- The new PCFCs may offer some further advantages for the environment such as higher fuel utilisation in comparison to the SOFC technology.
- Increase of system efficiency, through a better utilization of the heat produced and a smaller BoP, a lower operating temperatures down to 600 °C, a reduction of the energy consumption of at least 7- 10% and the elimination of the fuel dilution (since water is formed at the cathode).

## Future Steps:

1 - Cell improvement to obtain at least 200 mW.cm$^{-2}$ @ 0.65V, 600°C under wet hydrogen.
2 - Elaboration of at least 22 stack cells (footprint of 120 x 120 mm$^2$).
3 - Performance validation of single stack cells in terms of degradation rate (2% or less over 500 h).
4 - Manufacture of short stacks (5 cells/stack).
5 - Validation of cell performance at stack level under relevant industrial conditions.

## Conclusions, major findings and perspectives:

- Well-functioning electrode and electrolyte layers have been obtained by conventional processing routes with electrochemical properties beyond the initial targets.
- Optimised anode and metal supports available for the manufacture of single cells at lab-scale.
- Based on single cell tests at lab-scale, a first generation of anode supported stack cells will be manufactured in the next for the construction of first complete PCFC stack units.
- Alternative manufacturing routes based on thermal spray and plasma EVD methods may play a decisive role in the journey to achieve well-functioning metal supported cells. Their lower maturity level will, however, retard the demonstration of this technology at stack level.

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