HYP3D

HYDROGEN PRODUCTION IN PRESSURIZED 3D-PRINTED SOLID OXIDE ELECTROLYSIS STACKS

Project ID	101101274
PRR 2024	Pillar 1 – Renewable hydrogen production
Call topic	HORIZON-JTI-CLEANH2-2022-01-01: Development and validation of pressurised high temperature steam electrolysis stacks (solid oxide electrolysis)
Project total costs	EUR 2 543 398.75
Clean H_2 JU max. contribution	EUR 2 543 398.75
Project period	1.1.2023–31.12.2025
Coordinator	Fundació Institut de Recerca de l'Energia de Catalunya, Spain
Beneficiaries	3DCeram Sinto SAS, Centro Nacional de Supercomputación, Danmarks Tekniske Universitet, H2B2 Electrolysis Technologies SL, Politecnico di Torino, Snam SpA, Vac Tron SA

https://hyp3d.eu/

PROJECT AND GENERAL OBJECTIVES

The main goal of the HYP3D project is to deliver a new generation of ultra-compact, high-pressure, stand-alone solid oxide electrolyser cell (SOEC) stacks able to convert electricity into compressed hydrogen for P2G and hydrogen refuelling station applications. HYP3D manufacturing technology represents a breakthrough compared with traditional ceramic SOEC processing due to a significant reduction in the time to market (from years to months), the use of raw materials (76 % reduction)and the required initial investment (42 % reduction from conventional cell manufacturing plants, from the first MW) while introducing great flexibility and scalability to the production lines.

NON-QUANTITATIVE OBJECTIVES

- Develop disruptive electrolyte-supported SOECs based on 3D-printed 3YSZ and 8YSZ with non-flat geometry.
- Design high-pressure sealing based on 3D-printed self-tightening joints and optimised glass sealants with enhanced adhesion through surface modification.
- Fabricate ultra-compact and lightweight kW-range stacks.
- Build up a neural-network-based digital twin of the HYP3D stack able to run in high-performance computing environments.
- Design simple SOEL systems based on stand-alone HYP3D stacks for the particular applications of H_2 injection in the gas grid and on-site generation for hydrogen refuelling stations.

PROGRESS AND MAIN ACHIEVEMENTS

- The large-area cell 3D-printing processes were successfully optimised. 3YSZ 3D-printed cells were produced with good reproducibility and were successfully tested at atmospheric pressure, with performance in line with the literature.
- 8YSZ 3D-printing pastes were successfully developed and the printing process optimised.
- Commercial glass–ceramic sealants were successfully modified to increase their viscosity at operating temperatures with a refractory behaviour and possibly withstand the differential pressure and the shear stresses generated during operations in real conditions.
- A process for laser milling of metallic interconnects was developed to increase the surface roughness of the metals in the sealing regions, thus increasing the interlocking effect and the resistance to shear stresses.
- Protective coating deposition by electrophoretic deposition was developed and the sintering treatment optimised.
- First simplified thermomechanical and fluid dynamics simulations were successfully performed.

FUTURE STEPS AND PLANS

- Print and test 3YSZ large-area cells with high-pressure features.
- Develop high-pressure test stations and protocol without the use of pressure vessels.
- Optimise the debinding and sintering treatment for 8YSZ large-area cells.
- Validate the pressure resistance of the developed sealing approaches.
- Increase the level of complexity of the simulations.
- Build and test HYP3D short stack (five cells) at high pressure.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
Project's own objectives	Pressure	bar	5	Ambient pressure	
	Power per stack	kW	2.14	0.85 kW (by three-cell substack)	
	Injected current density	A/cm²	− 0.9 at 1.3 V	− 0.4 at 1.3 V	

Clean Hydrogen Partnership
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