MAST3RBOOST PROJECT, AN INITIATIVE FOR EUROPEAN VEHICLE DECARBONIZATION THROUGH IMPROVEMENTS OF HYDROGEN STORAGE

MAST3RBoost, Maturing the Production Standards of Ultraporous Structures for High Density Hydrogen Storage Bank Operating on Swinging Temperatures and Low Compression, is a European project which aims to provide a solid benchmark of **cold-adsorbed H_2 storage (CAH_2)** at low compression (100 bar or below) by maturation of a new generation of ultraporous materials (Activated carbons, ACs, and Metal Organic Frameworks, MOFs) for mobility applications, i.e., H_2-powered vehicles, including road and railway, air-borne and water-borne transportation. The goal is to achieve a 30% increase of the working capacity of H_2 at 100 bar (vs. MOF-5, one of the current record holders) reaching 10 wt.% and 44 g_{H2}/l^{PS} [(1)], by turning the lab-scale synthesis protocols into industrial-like manufacturing processes. **Reaching these figures would bring significant advances on Hydrogen storage banks and, therefore, to Europe's decarbonization**.

Carbon dioxide emissions are a problem across the world and a big part of them are produced among the transport sector. **In Europe they constitute already one third of all CO_2 emissions with over 1,000 million tons**, representing a big threat for human health as well as one of the largest contributions to the climate change. Decarbonization of the economy and, in this case, of the transport sector is urgent. There have been improvements with the **Fuel Cells and Hydrogen (FCH) batteries**, **which have proven to be a promising solution for the decarbonization** of trucks, buses, ships, trains or large cars. With the larger vehicles being potential early adopters, this new industry has the potential to generate a **130 billion € market in the European Union alone**.

The problem is that, at the moment, the state-of-the-art technology for Hydrogen storage on board based on compression at 700bar, has reached 25 g_{H2}/l^{sys} [(2)], a number which is still low considering that the market-entry goal is to fit 5 kg of H_2 in a gasoline equivalent tank (80 kg/90 l). **In fact, the complexities associated to an efficient H_2 storage are causing a very slow penetration of Fuel Cell Electric Vehicles (FCEVs)**. **MAST3RBoost**'s goal is to reach at least 40 g_{H2}/L^{sys}, which is a significant milestone that would help **to provide the market with an actual FCEV replacement to the current internal combustion engines**, which are big contributors to the EU's greenhouse gas emissions.

Based on a new generation of Machine Learning-improved ultraporous materials – such as Activated Carbons (ACs) and high-density MOFs (Metal-organic Frameworks) –, **MAST3RBoost** project **will enable a disruptive path to meet the industry goals by developing the first worldwide adsorption-based demonstrator at the kg-scale**. Lightweight vessels –embedding the ultraporous materials– will be created taking advantage of the innovative Wire-Arc Additive Manufacturing, with dedicated shapes to better fit on-board specific transportation spaces.

Recycled raw materials for the manufacturing of the ultraporous materials will be actively pursued, both from waste agroforestry biomass and from solid urban waste. The research and development process will be performed applying **Life Cycle thinking strategies to minimise overall environmental impacts and improve economic performance** of the hydrogen storage system from the design phase.

[1] g_{H2}/l^{PS}: grams of hydrogen stored per litre of adsorbent material under "Pressure Swing" conditions (100 bar to 5 bar)
[2] g_{H2}/l^{sys}: grams of hydrogen stored per litre of complete system including vessel and balance of plant under actual operation regime

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

This project is funded in the topic HORIZON-CL4-2021-RESILIENCE-01-17 by the European Health and Digital Executive Agency. It is a Research and Innovation Action project with a budget of 4,638,414.00 €, 100% funded by the EU.

Coordinated by **Envirohemp**, the project will last for four years and counts on thirteen partners from eight different countries: **Envirohemp S.L.** (Spain); **Contactica S.L.** (Spain); **Agencia Estatal Consejo Superior de Investigaciones Científicas** (Spain); **CIDETEC Surface Engineering Institute** (Spain); **Spike Renewables SRL** (Italy); **EDAG Engineering GMBH** (Germany); **Nanolayers OU** (Estonia); **LKR Leichtmetall Kompetenzzentrum Ranshofen GMBH** (Austria); **University of Pretoria** (South Africa); **Council For Scientific And Industrial Research** (South Africa); **Stellantis** (old PSA Groupe) (Portugal); **TWI** (UK); **University of Nottingham** (UK).

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