



H₂ PhD day

September 12th, 2025 – ULB Solbosch, Brussel

12h-12h15: Welcoming of the e-WallonHy members

12h15 - 12h45: Pathways towards valorization & update from IIS e-WallonHY & (Catherine Archambeau, CRM, PLO)

**13h-14h30 Network lunch & Poster session
(consortium + members e-WallonHY)**

14h30 - 16h30 : TiNTHyN thematic workshop

- 14h30 : Ir. Vincent THOMAS – Safran Aero Boosters
- 15h05 : Pr. Jean-Luc DELPLANCKE (ULB- ex JU FCH)
- 15h55 : Dr. Julien SCHWEICHER (Fluxys)

16h30 - 17h00 : Network reception



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1. Hydrogen production

Poster 01: Flow-engineered 3D printed electrodes for enhanced bubble evacuation during alkaline water electrolysis

Bubble evacuation is a challenge in alkaline water electrolyzers constructed in a zero-gap configuration with porous electrodes. Metal 3D printing allows tuning the electrode geometry to have both high catalytic surface area and bubble evacuation enhancement. This work considers triply periodic minimal surface (TPMS) geometries printed in Inconel 625 and pure Ni. Structured TPMS with a dual layer have achieved a substantial reduction in overpotential, mimicking our recent advances observed with bi-layer foams. The electrodes are tested under industrially relevant conditions and at different flow rates. CFD results are also performed to compare the performances.

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Promoters: Joris Proost (UCLouvain) & Benoit Scheid (ULB)

Poster 02: Evaluation of the activity of Ni-based materials for water splitting in alkaline media by SECCM

Alkaline water splitting is regarded as a sustainable pathway for H₂ generation in energy storage. Herein, we propose an approach to create electrodes with controlled heterogeneity. Their electrochemical activity is then evaluated using a high-throughput microscale technique: Scanning Electrochemical Cell Microscopy (SECCM). In this way, the performance of a wide range of local chemical compositions is assessed within a single experiment. We present a glimpse of our promising results, highlighting the broad applicability of this methodology to various sample types.

Presenter & main promoter: Jon Ustarroz (ULB) & Nathalie Job (ULiège)

PhD student: Anton Voronkin anton.voronkin@ulb.be

Poster 03: High-Chromium Porous Steels for Metal-Supported Solid Oxide Electrolysis Cells

Hydrogen is playing an increasingly important role in the transition to zero-carbon energy. Solid oxide electrolysis cells (SOECs) constitute a promising system for efficient hydrogen production. More specifically, metal-supported SOECs (MS-SOECs) offer numerous advantages thanks to their robust metal support, which provides high mechanical strength, redox resistance, thinner electrolytes and good resistance to thermal cycling. However, the metal substrate can also cause problems such as Fe-Cr interdiffusion at the MS/cathode interface, thermal expansion stresses and chromium poisoning, which reduce electrochemical performances. This research focuses on the development of porous metal supports to improve oxidation layer stability and gas transport under real-world conditions, as well as on the processing of barrier layers to block harmful interdiffusion. These improvements aim to extend the lifespan of MS-SOECs and reduce the cost of hydrogen production

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Promoters: Thomas Pardoën (UCLouvain) & Pascal Jacques (UCLouvain)

Poster 04: Hydrogen production from ammonia cracking using a dielectric barrier discharge assisted by catalysis under atmospheric pressure

Ammonia is gaining strong interest as a hydrogen carrier for transportation and renewable energy applications. Efficient technologies to produce hydrogen from ammonia are therefore essential. Plasma-based processes represent a promising solution thanks to their flexibility and rapid on-demand operation. In this work, a dielectric barrier discharge (DBD) reactor has been developed for ammonia cracking under room temperature and atmospheric pressure, enabling hydrogen production without greenhouse gas emissions. Moreover, the integration of catalysts into the plasma discharge offers the potential for plasma-catalyst synergy, further enhancing hydrogen yield and improving process efficiency.

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Promoters: François Reniers (ULB) & Eric Gaigneaux (UCLouvain)

2. Hydrogen storage and transportation

Poster 05: Toward tougher metallic materials for high-pressure hydrogen storage

Hydrogen plays a central role in the transition toward a zero-carbon economy, but safe storage and transport at high pressure remain critical challenges. The present work focuses on fully metallic (Type I) pressure vessels, for which hydrogen embrittlement, i.e. the degradation of mechanical properties of materials in contact with hydrogen, becomes more severe with increasing pressure. To address this issue, new alloys and multilayer solutions must be developed and should combine low hydrogen permeability, high resistance to embrittlement, strong mechanical performance, and cost-effectiveness for large-scale applications. The well-established electrochemical permeation technique is employed to assess hydrogen diffusivity in metals.

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Promoters: Pascal Jacques (UCLouvain) & Thomas Pardoen (UCLouvain)

Poster 06: Polymers and gas permeability: a structural synergy

Gas permeability through polymer matrices is a phenomenon influenced by various factors intrinsic to the materials. Among these factors, the chemical structure and crystallinity of the polymers play a key role. On the one hand, different chemical structures will not interact in the same way with the gas, these interactions being influenced by the functional groups present in the polymer chain. On the other hand, the higher the crystallinity of a polymer, the less the gas will diffuse through it. In addition, the dominance of a specific crystalline structure will affect the passage of gas differently.

This study thus aims on exploring the relationship between chemical structure, crystallinity and gas permeability. Three polymers are used: a polyolefin, an aliphatic polyamide and an aromatic polyamide, all of undoubted commercial interest and easily tuneable properties. Understanding the structure-properties relationship is essential for the development of polymers tailored to the requirements of specific high-value added/emerging applications.

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Promoters: R. Mincheva (UMons), J.-M. Raquez (UMons), Y. Olivier (UNamur)

Poster 07: Study, Modeling, and Computing Pressure of Losses in Green Hydrogen Pipelines

The Wallonia region of Belgium aims to transition its modern hydrogen infrastructure. However, the challenges posed by hydrogen transport are significantly different from those encountered with natural gas. Hydrogen is much lighter than natural gas, and its flow velocities are considerably higher, reaching up to 40–50 m/s in pipelines. This results in a much higher risk of erosion, which must be accounted for in pressure loss studies. The degradation of the internal pipeline surface can lead to increased surface roughness, thereby significantly amplifying pressure losses.

The objective of this research is to analyze pressure losses in hydrogen pipelines due to material embrittlement and to develop solutions that minimize these losses during transportation. Currently, the study relies on numerical methods and gas flow equations to assess pressure drops. This approach enables the analysis of hydrogen gas properties, pipeline materials, friction factors, pipeline efficiency, and other relevant parameters.

The study aims to compute pressure losses with high precision over very long distances while accounting for strong wall interactions and components such as valves. To address this challenge, the study will integrate numerical fluid dynamics methods with structural modeling of the pipeline. It will account for long-term friction effects, erosion over several years, radial pressure gradients (mixing pressure drop), acceleration effects, and gravity influences, considering the non-classical behavior of gaseous hydrogen (GH₂).

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Promoters: Patrick Hendrick (ULB) & Jean-Philippe Ponthot (ULiège)

Poster 08: Designing Porous Frameworks for Hydrogen Storage: from Divalent-Metal MOFs to Flexible COFs

Metal–Organic Frameworks (MOFs) and Covalent Organic Frameworks (COFs) are highly tunable porous materials with strong potential for hydrogen storage. Our work focuses on C₄ ligand-based MOFs (e.g., fumaric, maleic acid) with different divalent metals and on imine-linked COFs, where linker substitution and framework flexibility are expected to influence H₂ adsorption behavior. By comparing sorption isotherms across these tailored structures, we aim to identify correlations between structural modifications and hydrogen uptake. Promising preliminary results have already been obtained with magnesium gallate, showing the potential of such systems for efficient H₂ sorption. This approach provides insights into how linker chemistry and electronic environment can be leveraged to guide the design of next-generation porous materials for hydrogen storage.

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3. End user applications of hydrogen

Poster 09: Development of Hollow Bimetallic Catalysts Supported on Nanostructured Carbons for Sustainable PEM Fuel Cell Electrodes

PEM fuel cells convert hydrogen into clean electricity, but conventional Pt/C catalysts degrade over time. The present work aims to improve durability by alloying Pt with Co and using carbon xerogels (CXs) with tailored pore textures to enhance stability and efficiency.

PhD student: Ali Haider Ali.Haider@uliege.be

Promoters: Nathalie Job (ULiège) & Sophie Hermans (UCLouvain)

Poster 10: Characterizing Protective Coatings for PEMFC Bipolar Plates: Transitioning from Stainless Steel to Aluminum Substrates

Stainless steel is widely used for bipolar plates in Proton Exchange Membrane Fuel Cells (PEMFC) due to its strength and corrosion resistance. However, to lower both weight and production costs, aluminum emerges as an attractive alternative thanks to its low density and affordability. One of its major drawbacks is its poor corrosion resistance in the acidic and humid environment of the fuel cell. This poster presents the characterization of a protective coating, originally effective on stainless steel, now applied to aluminum substrates.

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Promoters: Nathalie Job (ULiège) & Emile Haye (UNamur) emile.haye@unamur.be

Poster 11: A Physics-Informed Graph Neural Network Framework for Reduced-Order Modeling of Synthetic Fuel Combustion

The urgent need to decarbonise the energy sector has driven the search for alternative fuels that can reduce greenhouse gas emissions while enabling efficient and scalable combustion technologies. Among the most promising candidates are ammonia (NH_3) and hydrogen (H_2): hydrogen as a zero-carbon energy carrier, and ammonia as both a hydrogen vector and a fuel. However, their adoption poses key challenges: hydrogen requires infrastructure adaptation and can lead to higher NO_x emissions, while ammonia's low reactivity may cause incomplete combustion, fuel slip, and further NO_x formation.

This work focuses on the development and application of advanced numerical frameworks to model the combustion of ammonia, hydrogen, and their blends under realistic operating conditions. The goal is to retain predictive accuracy while reducing the computational costs associated with high-fidelity CFD simulations. To enable the prediction of Chemical Reactor Networks (CRNs) across novel conditions and geometries, the project leverages **physically-informed** Graph Neural Networks (GNNs) as a core methodology. CRNs are graph-based representations in which nodes correspond to reactors and edges to inter-reactor flows. By learning latent representations of both node features (e.g., temperature, species concentrations, pressure) and graph topology (reactor connectivity), GNNs can capture the non-linear spatial dependencies and complex chemical interactions that characterise reactive flow systems.

Ultimately, this research is expected to accelerate the deployment of clean combustion technologies and contribute to climate-neutrality goals, including those outlined in the European Green Deal and the IEA Net Zero Roadmap, thereby delivering impact across multiple scales.

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Promoters: Alessandro Parente (ULB) & Véronique Dias (UCLouvain)

Poster 12: Numerical simulation of hydrogen sloshing in tanks

This research focuses on applying the Particle Finite Element Method (PFEM) to simulate sloshing in hydrogen tanks during transportation. The large fluid motions inside the reservoirs can generate significant loads on the tank walls and lead to complex fluid-structure interactions. To address these challenges, this work combines two main aspects: the experimental validation of sloshing induced by vertical tank motions, and the development of new remeshing strategies in PFEM aimed at reducing mass variation and improving simulation accuracy.

Researcher: Eduardo Fernandez Sanchez

Promoters: Jean-Philippe Ponthot (ULiège) & Patrick Hendrick (ULB)

Poster 13: Silica coating of PEM fuel cell Pt/carbon electrocatalysts to enhance durability upon operation

This project aims at mitigating the deactivation of Proton Exchange Membrane Fuel Cells (PEMFCs) catalysts by using silica-coating methods. Platinum supported on carbon black (Pt/CB) is the most commonly used ORR catalyst due to its high activity, but the harsh operating conditions of the fuel cell leads to degradation. Here we propose to use Carbon Xerogel (CX) as carbon support, as it is possible to control its meso/microporosity enabling optimization of the mass transport properties. In addition, by covering the Pt/C catalyst with a porous but protective silica layer, the particles are prevented from dissolution and sintering.

Researcher: Lucas Elvira

Promoters: Sophie Hermans (UCLouvain) et Nathalie Job (ULiège)