MEAsureD

Optimizing High-Temperature PEMFC for HDV

The MEAsureD project will revolutionize the performance and durability of high-temperature polymer electrolyte membrane fuel cells (HT-PEMFCs). Through a collaborative effort between Advent and the University of Stuttgart (USTUTT), the project aims to enhance the electrode structure of HT-PEMFCs, focusing on two primary avenues: the development of new ionomers and the optimization of catalysts.

New Ionomers: Enhancing Conductivity and Durability

A significant part of this endeavor involves the introduction of a phosphonic acid functionalized poly(pentafluorostyrene) ionomer, known for its superior acid retention and hydrophobic properties. Initial results are promising, with the ion-pair technology involving this ionomer achieving a current density of 1.1 W/cm² at 0.4 V and 160°C, and 1.6 W/cm² at 0.45 V and 240°C under H_2/O_2 conditions.

USTUTT, in collaboration with Advent, will focus on optimizing the production of the ionomer. The goal is to identify alternative synthetic methods that are both reproducible and well-controlled to reduce costs. Additionally, USTUTT will develop new phosphonated polymers, including non-fluorinated and partially fluorinated variants, and quaternary ammonium functionalized polyaromatics containing fluorine atoms. These new ionomers aim to provide optimized ion-conduction pathways and effectively bind the supported catalyst particles at high temperatures (>160°C).

New Catalysts: Maximizing Efficiency and Minimizing Platinum Use

Current state-of-the-art ion-pair HT-PEMFC systems use PtRu/C at the anode and Pt/C or Pt alloys/C at the cathode. Advent developing catalysts with lower Platinum content to achieve the KPI of the project.

The project will develop membrane electrode assemblies (MEAs) and fuel cell components in two main work packages (WP1 and WP2). These include:

– High-Temperature PEMs: These membranes will offer high proton conductivity and stability above 160°C.
– Advanced Electrodes: Incorporating next-generation ionomers, innovative catalysts, and new electrode fabrication techniques.
– Bipolar Plates: Enhancing availability and durability to meet the needs of heavy-duty vehicle (HDV) end-users.

The new HT-PEMFC electrode structure aims to improve performance at high cell voltages and durability under dynamic driving conditions, meeting the Strategic Research and Innovation Agenda (SRIA) Key Performance Indicators (KPIs) for HDVs.

Significance and Exploitation

The advancements in HT-PEMFC technology will benefit Advent's operations. The technology will be exploited by Advent, the fuel cell manufacturer, with assessments by original equipment manufacturers (OEMs) in the Advisory Board, paving the way for future innovations in fuel cell technology for heavy-duty applications.

In summary, MEAsureD's efforts in optimizing HT-PEMFC electrode structures through innovative ionomers and catalysts promise significant advancements in fuel cell technology, particularly for heavy-duty vehicles, enhancing performance, durability, and cost-effectiveness.

MEAsureD Project Holds 18-Month Consortium Meeting in Valencia

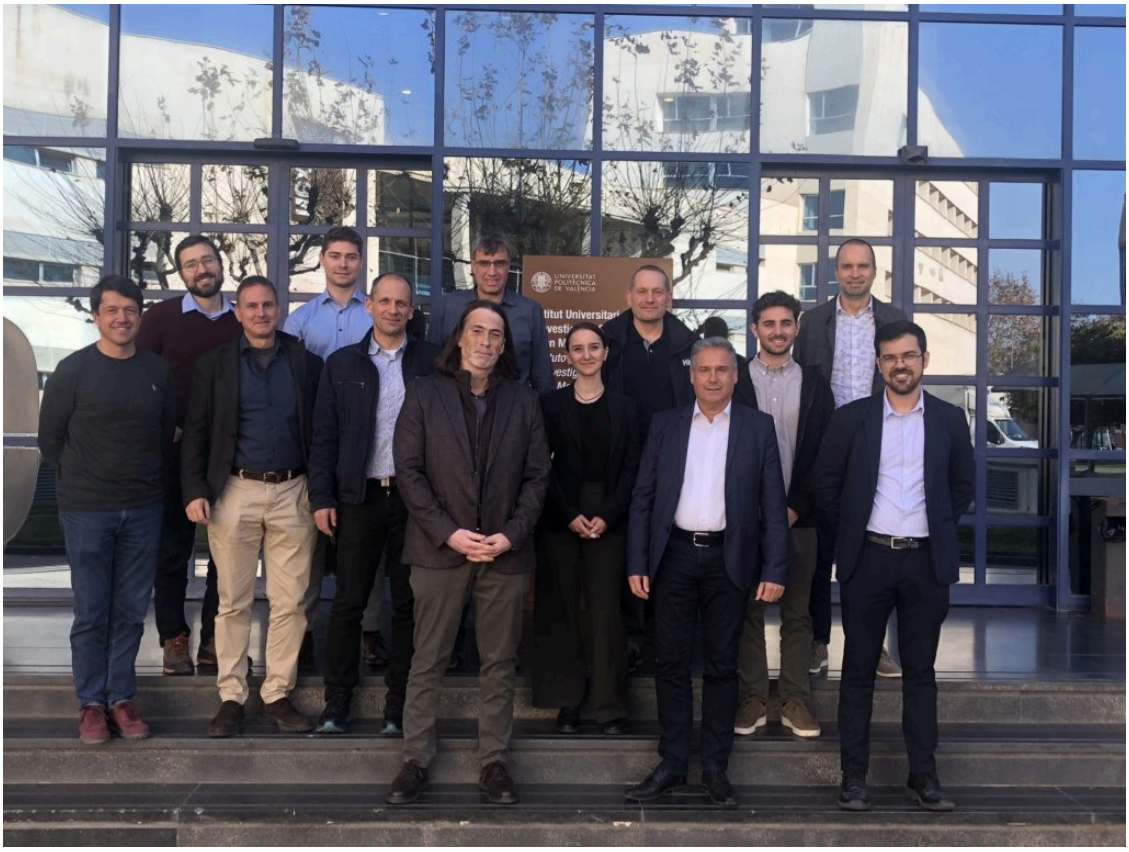
The MEAsureD project held its 18-month c, Spain. The event brought together project partners to share technical achievonsortium meeting on December 2nd and 3rd, 2024, at the UPV facilities in Valenciaements, discuss challenges, and provide updates on the development of a new generation of High-Temperature Proton Exchange Membranes (HT-PEM MEAs).

Presentations highlighted key progress in HT-PEM MEA technology, while discussions addressed technical issues and ensured alignment on administrative and communication activities. A tour of the UPV facilities capped off the first day, offering participants insight into the research environment.

The meeting reflected strong engagement and commitment from all partners, demonstrating significant progress in line with the project's workplan. Many thanks to the MEAsureD team for their contributions to the success of the event.

2nd Workshop: Heavy Duty Vehicles Advancements with the use of HT-PEM Fuel Cells

Advent, TU Graz, AVL, and UL took part in a workshop organized by UPV and Advent titled “Heavy Duty Vehicles Advancements with the Use of HT-PEM Fuel Cells,” held in Valencia, Spain. During the workshop, the Project Coordinator from Advent Technologies presented the MEAsureD project, highlighting its progress and key achievements. Additionally, the Project Coordinator from the PEMTATIC project provided an overview of their project, offering valuable insights into advancements in fuel cell technology for heavy-duty vehicles.



Articles about the MEAsureD technology benefits from each company’s standpoint.

University of Stuttgart
Germany

USTUTT, as the Task Leader for Task 1.2, has made significant progress in the last year of the MEAsureD project. An Efficient control over molecular weights of the catalyst binder (PWN) was achieved by using RAFT polymerization technique and radical transfer agent. The reduction of molecular weight of the binder stand for better

During the 18M consortium meeting, USTUTT has presented methylated polyvinylpyridinium as an alternative ionomer. A membrane based on this ionomer has been tested in the HT-PEMFC and delivered peak power density of 1.6 W cm-2 at 180°C using oxygen on the cathode side. The performance at broad temperature range from 20 to 200°C was recorded and the accelerated stress test (temperature cycling from 160 to 80°C) showed a stable performance of the system up to 100 cycles (~ 10 days).

USTUTT has presentedthese results in an invited talk at HiPEM-Tech2024 (https://hipem-tech2024.dtu.dk/)in Copenhagen Denmark.

The MEAsureD project aims to revolutionize the durability and performance of high-temperature polymer electrolyte membrane fuel cells (HT-PEMFCs) for heavy-duty vehicles (HDVs). Graz University of Technology (TUG) leads Work Package 2 (WP2), focusing on durability testing of newly developed HT-PEMFC materials.

TUG employs advanced electrochemical in-situ measurement techniques, including polarization curves recorded between 160 to 180 °C and electrochemical impedance spectroscopy (EIS), complemented by ex-situ characterization methods such as scanning electron microscopy and exhaust gas analysis. TUG is also pioneering approaches for monitoring phosphoric acid leaching via effluent water analysis, ensuring a comprehensive assessment of material performance and durability.

In collaboration with Advent and supported by all MEAsureD partners, TUG developed a testing procedure for the parametrization of single-cell HT-PEMFCs, tailored for HDV applications. TUG is together with Universitat Politècnica de València (UPV) generating an accelerated stress test (AST) profile that mimics real-life HT-PEMFC operation in HDVs. The AST profile is developed by considering standardized transport routes through Europe and the influence of critical HDV operating parameters such as temperature and stoichiometry on performance and degradation.

This enables the assessment of the durability of new materials under typical HDV conditions, ensuring long-term reliability and robustness. The testing procedure and

The project's holistic approach, combining experimental data from TUG's durability testing and simulations from the project partners AVL, UPV and University of Ljubljana (UL), aims to deliver cost-effective and high-performing MEAs tailored for the HDV sector. The advancements in HT-PEMFC technology, promise setting new standards in performance, durability, and cost-effectiveness for heavy-duty applications, supporting a more sustainable future in transportation.

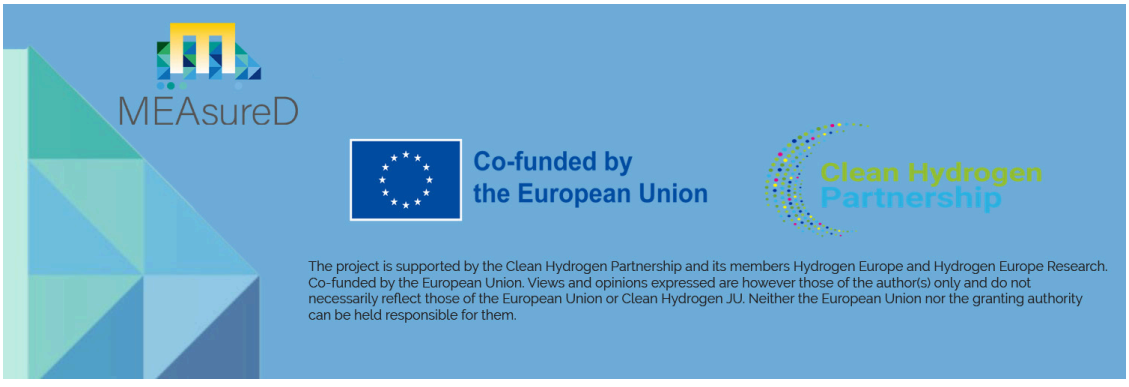
AVL is one of the world's leading mobility technology companies for development, simulation, and testing in the automotive industry and in other sectors such as rail, marine, and energy. Based on extensive in-house research activities, AVL delivers concepts, technology solutions, methodologies, and development tools for a greener, safer, and better world of mobility and beyond. The company supports international partners and customers in their sustainable and digital transformation. The focus lies on the areas of electrification, software, AI and automation. In addition, AVL supports companies in energy-intensive sectors on their way to a greener and more efficient energy generation and supply.

The project MEAsureD offers the opportunity for expanding AVL's simulation methodology into the area of HT-PEM fuel cell technology for HD applications. In this context, AVL advances its multi-physics 3D-CFD simulation technology towards modelling of HT-PEM fuel cells adopting advanced ion-pair membranes to enable detailed spatially resolved analysis of the heat, mass and charge transport processes on cell level. In addition, a simulation workflow is developed that enables a virtual upscaling of detailed single-cell models to full stack configurations aimed for use in transient HT-PEM fuel cell system simulations. For this purpose, a methodology is elaborated for derivation of computationally efficient reduced dimensionality models from detailed multi-physics 3D-CFD simulation results. Moreover, the resulting scalable multi-physics simulation approach is complemented by degradation models provided by partner University of Ljubljana for application on HT-PEM fuel cell and stack level. Validation of the simulation methodology is achieved via comparison of simulation results with experimental data provided by partner TU-Graz.

The resulting simulation methodology is then used for supporting the analysis and optimization of the anode and cathode flow-field design and MEA sub-component

degradation characteristics of the optimized cell configuration, a virtually upscaled full scale stack model representation is set up and combined with suitably configured BoP and thermal management sub-systems and linked to a representative HD-truck vehicle model. The performance of the ion-pair membrane technology is then assessed on the basis of simulated real-world drive cycles by comparison of representative HT-PEM vehicle performance indicators with LT-PEM reference data.

After successful completion of the project MEAsureD, the achievements regarding the validated scalable simulation methodology for analysis and assessment of the performance and degradation characteristics of HT-PEM fuel cells adopting the advanced ion-pair membrane technology shall become an integral part of the simulation tools AVL FIRE™ M and AVL CRUISE™ M. The simulation tools shall be marketed via AVL's worldwide network of sales representatives and technical centers. Additionally, the results and findings obtained in the course of the project will further strengthen AVL's expertise in applying advanced simulation technology to support the development and optimization of future green fuel cell technologies.



MEAsureD

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