Project: H02-14 "OMDinH2"

Project title: "OMDinH2 - Optical Monitoring Devices Integrated H2 Systems – Fuel Cell and Storage Tank for H2FCV".

Public summary

Reason: The main obstacles to widespread adoption of hydrogen (H2)-based systems are related to hardware costs and weight. Because there is no information on actual operational lifetime behavior of essential components, current H2 systems for industrial, automotive and aerospace applications are oversized and thus heavy, large and costly. If we could measure their performance we could improve safety, reduce size and lower total cost of ownership (TCO) of H2 systems including cost of leasing and insurance. It helps to establish value-based cost-price models. Society therefore urgently needs cheap, safe and reliable measurement technology integrated into H2 systems. Especially for two hardware components: the fuel cell and the H2 tank. Fiber optic sensors offer this; they can address specific conditions and requirements of both components, are potentially inexpensive to manufacture, can be placed in subsystems, and thus detect directly at the source. This enables lifetime and safety monitoring, lowers TCO, and enables mass market adaptation. This project is focused on industrial research on three types of sensor technologies, bringing them to TRL3-4, and ready for experimental development.

Goal of the project: Objective is perform research and initial tests in controlled conditions of three optical fiber sensor systems as optical monitoring devices (OMD) for H2 applications: 1) Integrated fiber Bragg grating (FBG) quasi-distributed (QD) sensor array systems for critical parameters, 2) Hollow Core Photonic Bandgap (HC PBG) gas analyser for monitoring contaminants in H2 fuel, and 3) coating based H2 leakage sensor as a safety gauge. Crucial sensing parameters will be determined by considering sensing needs from the end-user and available sensing solutions in the research field. The project will also address a major drawback of current local-level measurement that hinders widespread use, namely the invasive nature of the measurement. Aim is to obtain the maximum amount of information, while minimizing disturbances to nominal system operation. This project contributes to both goals and two topics of the subsidy. It focuses on new technologies that reduce cost and weight, and increase efficiency, safety and stability - lowering TCO of H2 systems. It introduces new (optical) measurement and analysis techniques for H2 systems which are cheap, scalable, and global replicable for every H2 system.

Partners: This project is an example of impact-oriented industrial research. It brings together a knowledge institute, TNO, with a product owner, Somni Solutions, and an end-user, Toyota Motor Europe. The research institute has the knowledge and facilities, the product owner the specific use-case knowledge and the end user various use-cases as well as the voice of the market. The partners holds key positions in the value chain for smart OMDs to be used in H2 systems:

- Early-stage research on Advanced fiber sensor technology led by research institute TNO;
- H2 leakage sensor concept research with and by Somni who will become the product owner;
- End-user FCV manufacturer Toyota to conduct joint research and to ensure market validation and acceptance at the end.

Short description of the activities: The project consists of five work packages, all strongly related to the main deliverables, and various sub-packages assigned to one or more stakeholders, all classified as I.O.:

1. Define sensing requirement and operating conditions for three optical fiber sensor systems;
2. Literature and theoretical study, and design sensor systems for critical sensing parameters;
3. Laboratory experimental setup of optical sensor systems and validate functionality, Integration of sensor 1 (FBG QD) in fuel cell and H2 tank composite;
4. Testing sensors in applied H2 systems and collecting sensory data;
5. Analysis of sensory data to obtain insight for their functionality and obtain proof-of-principle OMDs in H2 systems.

Result: The research will gain new insights to raise the TRL for the OMD systems: reaching TRL-3 for sensor 1 and 2; and TRL4 for sensor 3. Furthermore, a number of lab-scale prototypes and proof of principles will be built to support the above research results. After this project, the actual development of the sensors can start in order to have an industrial version ready to be marketed by 2024. The end result for H2 systems in general will be three measurement systems that will significantly improve safety and reduce costs and as such will open up the mass market. With the new knowledge gained, after this project, the consortium can continue to develop dedicated fiber sensors for integration into the fuel cell and tank systems.