DIAPASON2 : DIAgnostic of Fuel Cell for automotive and stationnary aPplicAtion without inStrumentatiON phase 2.

Type of project: Project funded by the ANR
January 2011 ➔ September 2014.

Coordination: Coordinator : Philippe Moçoteguy (PhD), EiFer, France.
Philippe.mocoteguy@eifer.org

Partners: EIFER, European Institute For Energy Research, France.
FCLAB, Fuel Cell Laboratory, CNRS Research Federation, France.
IFSTTAR, Institut Français des Sciences et Technologies des Transports, de l'Aménagement et des Réseaux, France.
Université d'Aix-Marseille, France.
CEA, Commissariat aux Energies Alternatives, France.
3D+, France.

Project's general objective

The large scale deployment of fuel cells will only be possible if it is robust enough to ensure service continuity to the customer. This needs efficient fault diagnostic tools.In a first phase, DIAPASON 1 project resulted in the development of different diagnostic algorithms for water management in PEMFC. These were based on either model or pattern recognition approaches. It also resulted in the realisation of a GMR (Giant Magneto Resistance) based data acquisition cardboard that was validated on a full stack. On this basis, DIAPASON 2 project aimed at developing new algorithms, with a higher efficiency and a broader range of fault detection. In parallel, it aimed at improving the GMR sensors performances and integrating them in a unique SiP (System in Package) component. Manufactured by a semiconductor, the data acquisition cardboard had to integrate the new developed algorithms. In fine, the whole had to be validated on a real system.

Used methods and applied technologies

New signal or pattern recognition based algorithms were integrated in new electronic components using GMR sensors. In a first step, the performances of the GMR sensors developed during the 1st phase were improved. Then, a dedicated System in Package (SiP) component was developed. Manufactured by the SME 3D+, it integrates: a GMR monitoring cell, calculation unit and memories. In parallel, diagnostic algorithms were developed according to a 3 steps approach: data labelling, extraction and classification of relevant parameters. For the data labelling part, a physical model and a k-mean based classifier were used. For parameters extraction, 4 methods and 3 classifiers were considered. But the needs of minimal calculation time and memory size resulted in the selection of an algorithm combining Fisher Discriminant Analysis and Support Vector Machine. The integrated hardware-software tool was finally validated on a real system, operated in different faulty conditions. It allows diagnosing in real time the state of individual or clustered cells, distributed along the stack. It can also be integrated in on-board monitoring systems.

Major results

The project resulted in:

- The development of diagnostic algorithms using signal based methodologies.
- The selection of the methodology presenting the best compromise between diagnostic reliability and easy integration in the chip: Fisher Discriminant Analysis (FDA) + Support Vector Machine (SVM).
- The development of a SiP integrated component.
- The realization of 2 cardboards integrating the selected algorithm and their validation on real systems.

This project paves thus the way to the realization of on-board diagnostic or lifetime estimation tools.