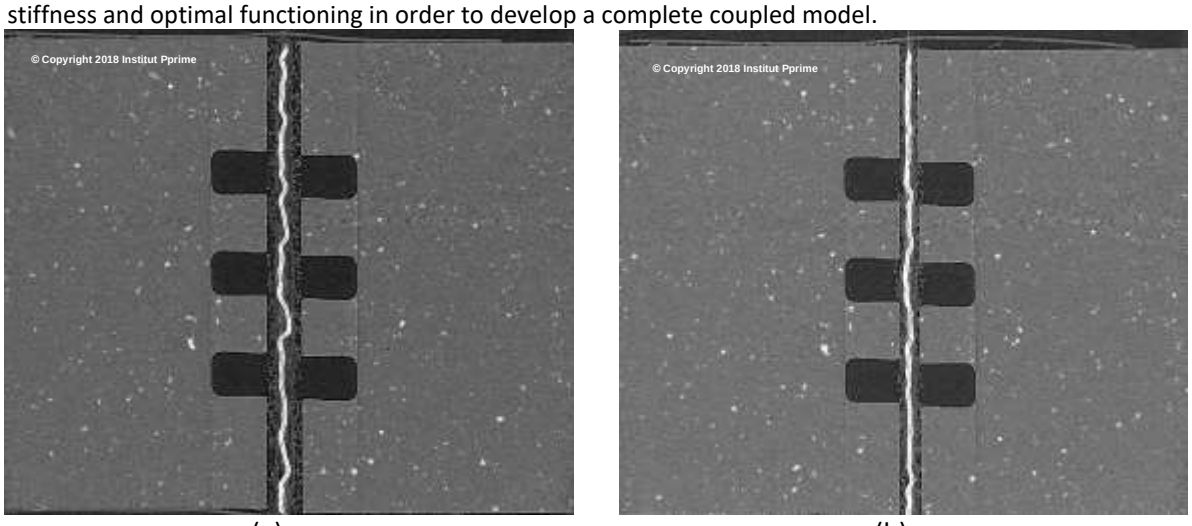
RECRUTEMENT ISAE ENSMA

FICHE DE POSTE

HOST INSTITUTION	PPRIME Institute – Department of Physics and Mechanics of Materials (DPMM) / Damage and Durability From 01/09/2019 to 31/08/2021
CONTACT	Pr Jean-Claude GRANDIDIER (jean-claude.grandidier@ensma.fr, +33 (0)5 49 49 83 41) Dr Anthony THOMAS (anthony.thomas@univ-poitiers.fr, +33 (0)5 49 45 39 04)
TYPE OF POST	PhD - students - CDD 36 months
LOCATION	Institut PPRIME - (UPR 3346 CNRS – ISAE-ENSMA – Université de Poitiers), ISAE-ENSMA, Poitiers, France
POSITION AND SALARY	PhD - students – Salary: xxx€ (Social security contributions included)
QUALIFICATION	Master 2

MISSION

The hydrogen-powered Proton Exchange Membrane Fuel Cell (PEMFC) provides electrical and thermal energy without local greenhouse gas emissions and is an ideal solution for automotive transportation, small and medium-sized power and thermal power plants and portable electronic applications. A PEMFC cell consists of a proton-conductive membrane electrolyte, separating two electrodes on each side of which is placed a gas diffusion layer (GDL) ensuring uniform distribution of reagents to the electrodes and facilitating water management in the cell. The whole is inserted between two feeding plates allowing the distribution of reagents, the evacuation of water and excess gases. This system is held by a set of clamping elements. The compression generated ensures contact and sealing. There is an optimal clamping pressure for performance and strength. This optimum is obtained experimentally and is part of the know-how [1-4]. Although the effects of assembly force are understandable, their modelling and control are a scientific lock because they require multiple couplings at different scales [5-6]. The purpose of the mission is to set up experiments under an X-ray µtomograph (Figure 1) to understand the correlation between stiffness and optimal functioning in order to develop a complete coupled model.



(a) (b)

Figure 1 –1cm² fuel cell within X-ray µtomograph under compression, (a) w/o force (b) w force of 125 N.

ACTIVITIES

The purpose of the thesis is to characterize and model the physical phenomena linking mechanical load to thermal and water electrical phenomena. At the moment, not all couplings are understood or quantified.

To increase this knowledge, the work will consist in implementing a micro fuel cell in operation under X-ray µtomography. The analysis of the volume images of the different components of the assembly will allow to evaluate the structural modifications and the 3D deformation fields as a function of the clamping pressure. These measures and observations will make it possible to identify local phenomena related to performance and sustainability limitations.

A multiphysical modeling of the experiment will be developed to quantify the stress fields in the different elements and thus evaluate the sources of damage. The tool will provide answers on the performance and improvement of the system's efficiency. This subject is part of the government's hydrogen plan H2020.

REQUIRED SKILLS

The recruited candidate must have skills in Simulation of energy systems, with a marked taste for the experimental and knowledge of finite element calculations. . A good knowledge of mechanics of materials and/or image processing will be

appreciated. Organizational and relational qualities are needed. Good knowledge of written and oral English is required.

INSTITUTION

The Department of Physics and Mechanics of Materials of the PPRIME Institute (Poitiers - FRANCE) has been working for several years on experimental characterization, modelling and numerical simulation (ABAQUS) of coupling between mechanical behaviour, damage and diffusion of gases in polymers. In particular, it has unique experimental set-up to study couplings between gas and materials, and X-Ray µtomography setup dedicated to in-situ testing.

REFERENCES

[1] M. Hamour, J. C. Grandidier, A. Ouibrahim, S. Martemianov, Electrical conductivity of PEMFC under loading, Journal of Power Sources 289 (2015) 160-167

[2] V.A. Raileanu Ilie, S. Martemianov, A. Thomas, Investigation of the local temperature and overheat inside the membrane electrode assembly of PEM fuel cell, International Journal of Hydrogen Energy 41 (2016) 15528-15537

[3] A. Thomas, G. Maranzana, S. Didierjean, J. Dillet et O. Lottin, Measurements of Electrode Temperatures, Heat and Water fluxes in PEMFCs: Conclusions about Transfer Mechanisms, Journal of The Electrochemical Society 160 (2013) F1-F14

[4] M. Hamour, J. P. Garnier, J. C. Grandidier, A. Ouibrahim, S. Martemianov, Thermal-Conductivity Characterization of Gas Diffusion Layer in Proton Exchange Membrane Fuel Cells and Electrolyzers Under Mechanical Loading, International Journal of Thermophysics 32 (2011) 1025-1037

[5] D. Bograchev, M. Gueguen, J. C. Grandidier, S. Martemianov, Stress and plastic deformation of MEA in running fuel cell, International Journal of Hydrogen Energy 33 (2008) 5703-5717

[6] D. Bograchev, M. Gueguen, J-C. Grandidier, S. Martemianov, Stress and plastic deformation of MEA in fuel cells : Stresses generated during cell assembly, Journal of Power Sources 180 (2008) 393-401

COMPLEMENTARY INFORMATION

The laboratory is classified in ZRR Restricted Zone, therefore any recruitment is subject to prior authorization from the Defense Security Officer

Chasseneuil, 25-04-2019

NOM : GRANDIDIER
Prénom : Jean-Claude

Signature :