PACEEP 41 : Bipolar Plates for PEM Fuel Cells: Aluminum and Stainless Steel coated via Physical and Chemical Processes

Dechamps Marie[1], Haye Emile[2], Lafort Adeline[3], Lucas Stéphane[2], Job Nathalie[1]

[1] University of Liège, Department of Chemical Engineering – Nanomaterials, Catalysis, Electrochemistry, Building B6a, 4000, Liège, Belgium

[2] University of Namur, LARN-NISM, 61 Rue de Bruxelles, 5000, Namur, Belgium

[3] AC&CS CRM Group, Allée de L'Innovation 1, B57 Quartier Polytech 3, 4000, Liège, Belgium

PEM fuel cells (FCs) convert hydrogen and oxygen into water, releasing electricity. Bipolar plates are the key components that are responsible for the distribution of gas and the recovery of the electric current, while simultaneously supporting the catalytic layer. For long-term operation, these plates must resist to acidic, humid environment and relatively high temperatures without significant degradation of their properties, especially their electrical conductivity. In addition, for mobile applications, the plates' weight is critical, as they account for over 80% of the device weight. The use of lighter substrates can significantly reduce the overall system weight. As a result, current FCs use thin coated stainless plates. One possibility is to replace stainless steel by aluminum.

Technologies such as Physical Vapor Deposition (PVD) and wet chemistry are currently used for the coating of bipolar plates. PVD, especially magnetron sputtering, provides high-quality, thin coatings with minimal environmental impact. Wet chemistry methods provide precise control over coating thickness and composition. However, challenges remain for large-scale implementation of durable, high-performance coatings. The use of aluminum substrates is challenging due to Al_2O_3 formation, which affects conductivity. It is also important to enhance the coating adhesion through optimized interface and surface preparation to avoid delamination either during the channel formation by hydroforming or upon FC use. Additional challenges include minimizing defects in the coating since those can affect the resistance to corrosion, and decreasing contact resistance between the plate and the Gas Diffusion Layer.

Following the results obtained in a previous project, in which a coated stainless steel solution was developed, this PhD project aims to replace stainless steel with an aluminum substrate to reduce the PEM's weight and volume. The goal is to develop and optimize lightweight, strong and economically viable bipolar plates for PEM fuel cells, by combining vacuum techniques (PVD) and wet chemistry processes.