The role of porosity in platinum-group-metal free electrocatalysts for PEM fuel cells

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Résumé

Polymer electrolyte membrane fuel cells (PEMFCs) are one of the solutions for the transition towards an emission-free way of producing energy. PEMFCs in fact, are electrochemical devices which transform chemical energy into electrical energy without harmful emissions, if hydrogen is used as a fuel. However, the cathodic reaction, namely the oxygen reduction reaction (ORR), is sluggish. The best activities so far are yet assured by platinum-based electrocatalysts, which suffer of stability problems. Moreover, Pt is scarce and expensive, its price being linked to the stock exchange (1).

Non-noble transition metals such us Fe and Co, with nitrogen and carbon, in the shape of M-N-C, are the most promising alternative to Pt-based electrocatalysts. Transition metal is the heart of the electrocatalytic site for ORR, while nitrogen coordinates the transition metal atoms linking them to the carbon-based structure. Carbon has the purpose of conducting electrons and providing high specific surface area and porous structure (2). The porous structure, in particular the microporous surface, is believed to provide a role in the formation of active sites for ORR (3), while the mesoporous structure plays a fundamental role in the working functioning on a PEMFC, favouring the transport of oxygen (reactant) and water (reaction product) (4). In fact, the microporosity of the carbon material has a great impact on flooding of the cathodic catalytic layer, limiting the performance of the PEMFC. If water is not properly removed, its accumulation into the pores leads to a decreasing fuel cell performance due to pore clogging and subsequent oxygen deficiency.

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