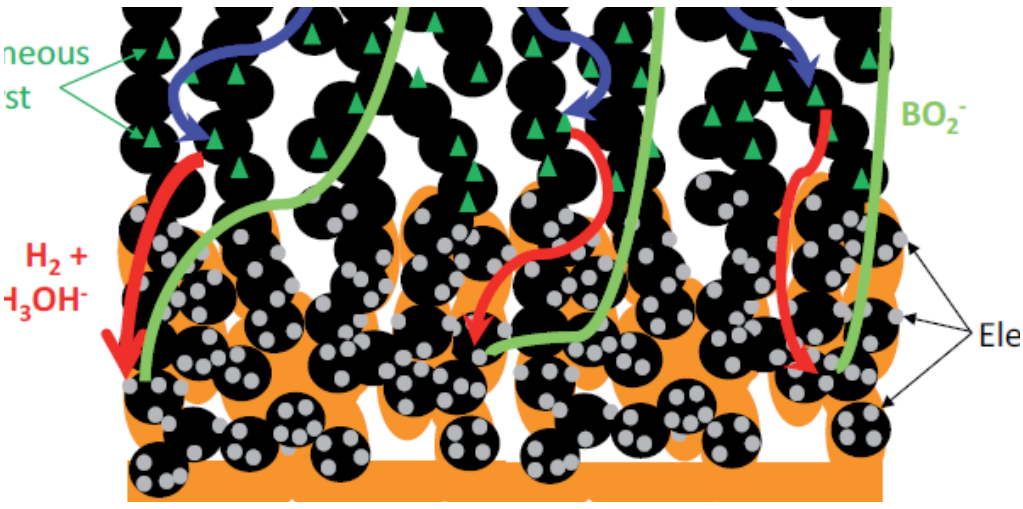
ANR 2016
MOBILE DIRECT BOROHYDRIDE FUEL CELLS (MOBIDIC)



Gaël Maranzana, Pr, Université de Lorraine
Jérôme Dillet, Ir, CNRS

In summary, the main objective of MobiDiC is to optimize the practical performance of DBFCs, i.e. to benefit from the large energy density of the BH4- species, and to build a demonstrator that outperforms the present DBFCs for an application in small electronic devices (power < 2 W, energy < 20 Wh), which are presently powered by energy-density-limited Li-ion batteries.

To that technologic goal, three main fundamental paths need to be paved. Firstly, the BOR needs to be investigated from a mechanism and kinetics perspective [31-34] in experimental conditions representative of small portable DBFC operation: [BH4-] ≥ 0.1 M, pH ≥ 14, 10 ≤ T ≤ 40°C. Secondly, the sequential pathway (partial BH4- dissociation/hydrolysis pathway + valorization of the by-products) must be examined in the real DBFC conditions on well-defined electrodes featuring different architectures, in order to unveil the mass-transfer and poisoning effects [33, 34]. We will explore the BOR on electrodes of increasing complexity, spanning from flat surfaces through carbon-supported metal nanoparticles, model 3D architectures of VACNFs and finally practical electrodes for real DBFC applications. Smooth electrodes can be investigated using a variety of electrochemical and spectroscopic methods, which will allow to understand the influence of the nature of the catalytic metal on the BOR pathways under experimental conditions representative of small portable DBFC operation. Investigation of carbon-supported metal nanoparticles is necessary to unveil eventual particle size effects. Application of VACNFs is essential for understanding mass-transfer effects and re-adsorption effects on the reaction completion. Thirdly, this strategy shall open the way to the elaboration of composite, gradient and multiple-(electro) catalysts electrodes, in which one part of the electrode generates the suitable species (e.g. BH3OH- and H2 from BH4-) in a heterogeneous catalysis reaction, the other one catalyzing its efficient and complete electrooxidation.

This original and innovative strategy (to date, neither gradient electrodes nor mechanistic/kinetics investigations in real conditions are mentioned in the DBFC literature) should enable us to develop highly-efficient electrocatalysts (or combination of electrocatalysts) for the DBFC anode (our final goal is to use non-noble ones like Ni, Co, etc.), tailor the best electrode structure/texture to optimize the reactant mass-transfer and reaction completion (maximize the faradaic efficiency) and build a portable DBFC system that displays high energy and power outputs, and long durability, so as to become the benchmark in the field of electric generators for small portable electronic devices. Our goal is to develop a high-performance DBFC for this application; if possible, we will develop low-cost and entirely non-noble electrodes for these systems.