

Advances on Nafion-based composites for high temperature proton exchange membrane fuel cells.

Elisabete Inacio Santiago¹, Bruno Ribeiro Matos¹, Mauro André Dresch², Roberta Alvarenga Isidoro¹, Fábio Coral Fonseca¹

¹Instituto de Pesquisas Energéticas e Nucleares, ²Universidade Federal de Mato Grosso

e-mail: elisabete.santiago@gmail.com

PEMFC (Proton exchange membrane fuel cell) is considered a promising and efficient hydrogen fuelled electrical power source. However, PEMFC faces several technical problems, such as sluggish electrode reaction kinetics involving the limiting rate of the oxygen reduction and alcohol oxidation reactions, and high resistance to ion transport that could be surpassed with increasing of the operation temperature. The main impediment for such a temperature increase is the water dependent performance of the state-of-the-art Nafion electrolyte. Above 80 °C water starts to evaporate considerably and Nafion microdomains begin to shrink, disrupting its percolative structure, leading from a conductor to insulator transition. In this work, the incorporation *in-situ* or *ex-situ* of an inorganic phase with hydrophilic properties, such as TiO₂ and SiO₂, into Nafion membranes has been evaluated as an interesting alternative to produce stable electrolytes able to operate at higher temperatures (130°C). The physical-chemistry and electrochemical characterisation has shown that the inorganic particles located in both the nonionic and ionic regions of the ionomer have important contributions to enhanced thermal stability and water uptake. Such features resulted in significant improvements of the PEMFCs using composite electrolytes tested at high operating temperature and low relative humidity. In addition, remarkable enhancement on the DEFC (Direct Ethanol Fuel Cell) performance (122 mW cm⁻²) has been obtained as a result of an increase of ethanol oxidation reaction rate promoted by the combination of enhanced catalyst activity and high temperature of operation using stable composite Nafion-SiO₂ electrolytes.

E.Santiago thanks CNPq, CAPES, and FAPESP (2014/09087-4, 2014/50279-4, and 2015/23621-6) for financial support.