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NANOSTRUCTURED AND NANOCOMPOSITE MATERIALS FOR ENERGY CONVERSION

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To overcome the degradation of component materials over time, that are still hindering the widespread adoption of Proton Exchange Membrane Fuel Cells (PEMFC), novel materials and original methods of elaboration are needed. Our approach is based on the use of nanofibres and their multiscale assembly to produce innovative energy materials with specific architectures and interfaces, and improved properties. Such materials are prepared with the versatile, cost-effective and up-scalable electrospinning technique. The nanometre size and the 1D morphology of the fibres and the porous structure of the obtained web are expected to bring associated advanced properties, in particular with regard to directional and mechanical properties and mass transport, with beneficial effects on the performance and lifetime of the resulting membrane-electrode assemblies. Due to its inherent adaptability and applicability, electrospinning can be applied to all stages of the preparation of PEMFC core materials, from electrolyte membranes to electrodes. On the one hand, we are developing composite ionomer membranes based on electrospun webs of inorganic materials and polymers, as well as their chemical functionalization, which demonstrated to reinforce the membranes while keeping high proton conductivity; on the other hand, we are preparing nanofibrous electrocatalyst supports including carbon, metal, metal carbide, oxide nanofibres and nanotubes with extended durability and high electrical conductivity. In parallel, we are developing Pt deposition techniques leading to extended metal surfaces onto the electrospun materials, including Ni and Cu galvanostatic displacement, self-terminated Pt electrodeposition and electrochemical atomic layer deposition. These novel morphologies will enable higher platinum exploitation and increased stability. The assembly of these materials will allow the development of a new generation of PEMFC materials in which the components are fabricated entirely by electrospinning and with the possibility of scale-up at industrial level.

Biography

Sara Cavaliere is Lecturer at the University of Montpellier, Institut Charles Gerhardt for Molecular Chemistry and Materials since 2009. She received her PhD in Chemistry and Materials Science in 2006 in Versailles, France, after graduating from University of Milan, Italy. She worked as Postdoctoral Fellow at the University of Freiburg, Germany, and Lyon, France. Her research interests focus on design, synthesis and characterisation of nanostructured and nanofibrous materials for proton exchange membrane fuel cells and water electrolysers. In 2017 she was awarded the CNRS Bronze Medal and joined the Institut Universitaire de France as a Junior Member.

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