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N-doped carbon-based nanofibers as oxygen reduction reaction catalysts

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This work is focused on the development of N-doped carbon nanofibers (N-CNFs) as catalyst for the oxygen reduction reaction (ORR). In devices for energy storage and production, as microbial fuel cells and li-air batteries, oxygen can be used as the terminal electron acceptor. The overall efficiency of these devices is limited by the low kinetics of the ORR. A catalyst layer must be used, to enhance the direct ORR, ensuring a number of electrons as close as possible to the ideal value of 4. Platinum is currently the best performing catalyst, however its scarcity, limited durability and high-cost, have made necessary to identify efficient substitutes. In this view nanomaterials can play a crucial role for further improvement in this area of catalysis. The development of nonprecious materials as alternative catalysts is among the pursued strategies. Nanostructured non-metal carbon-based materials, especially doped with heteroatoms like nitrogen, have established among the most promising noble metal free alternatives. In this work focus is given to the optimization of N-CNFs, especially in terms of their content of graphitic, pyrrolic and pyridinic nitrogen defects, as well as their high surface area. N-CNFs have been prepared by electrospinning, starting from a polymeric solution of polyacrylonitrile in N,N-dimethylformamide. As fabricated nanofibers were stabilized at 280°C in air and then thermally treated up to 900°C under inert atmosphere. X-ray photoelectron spectroscopy confirmed a high content of graphitic nitrogen and a proper amount of pyridinic one in CNFs, leading thus to improve ORR performances. Good electrochemical properties of the samples were established by rotating ring disk electrode (RRDE). An electron transfer number of 3.9 has been obtained for the N-CNFs processed at the higher temperature.

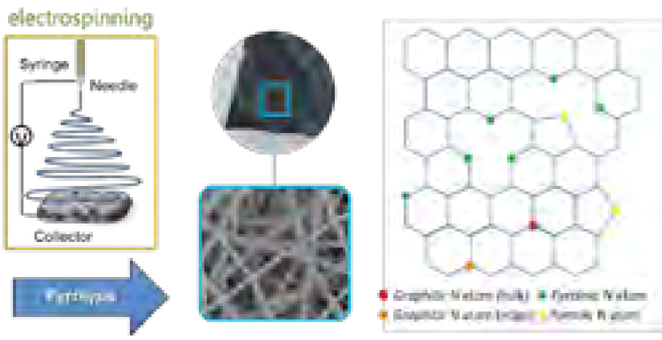

Figure 1: Electrospinning is used to fabricate polymer-based (i.e. PAN) nanofibers. They are converted to carbon-based nanofibers during the pyrolysis step. During the thermal treatment the creation of N-based defects can be controlled

Biography

Marzia Quaglio is a Researcher at the Center for Space Human Robotics of the Italian Institute of Technology (IIT). She graduated in Materials Engineering at the Politecnico di Torino and received her PhD in Electronic Devices from the Politecnico di Torino. Her research activity started with a main focus on MEMS/NEMS processing for the fabrication of life-science devices. She collaborated with Professor Cerrina at the University of Wisconsin, Madison for her research work. In 2009, she joined IIT contributing in the start-up of the Center for Space Human Robotics. She is currently involved in the Reactors and Processes division, with interest in the development of new electrode materials and catalysts for (bio)-electrochemical systems for CO_2 conversion.

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