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Nanofibers by electrospinning: intriguing nanomaterials for electrochemical conversion of environmental resources

Thanks to the agreement signed in 2015 during the COP21 Conference held in Paris, the European share of renewable electricity in the overall energy production will dramatically increase over the next decades. In this scenario, production and technological processes driven by electrical energy are gaining a renewed interest. Electrochemical conversion and synthesis are among them, and nanomaterials are expected to play a crucial role. They can be designed to be integrated as electrodes in devices for energy production from light and water, as well as in reactors for CO_2 electrochemical conversion. In this frame, nanofibers have attracted great interest since they can be obtained by a relative simple and low-cost process. Indeed electrospinning offers several possibilities and strategies to design nanofiber-based nanostructures with different arrangement, composition and morphology. Electrodes are needed, that must be chemically stable, support electro-catalysts, be electrically conductive and show high surface areas to increase the number of accessible reaction sites. In this view carbon-based nanofibers (CNFs) are extremely attractive to design electrodes for electrochemical processes. Moreover, their elctrocatalytic behavior can be fine-tuned by the proper selection of the starting precursor, in order to design N doped CNFs. Polyacrylonitrile (PAN) and other natural organic materials (as several wastes) can be used as carbon precursors able to induce N-doping inside the material, combining high yield of carbonization and high nitrogen content. CNFs doped with heteroatoms like nitrogen, have indeed established among the most promising noble-metal-free alternatives to catalyze the CO_2 reduction reaction for the synthesis of new valuable products. The same nanomaterials can be successfully used to catalyze the oxygen reduction reaction (ORR). Other catalysts can be successfully processed by electrospinning as manganese oxides (Mn_xO_y), resulting in easy to integrate catalyst for the fabrication of well-performing electrodes.

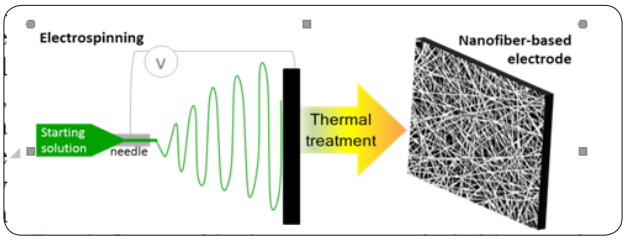

Figure 1: Overview of the electrospinning process for the fabrication of nanofiber-based electrodes

Recent Publications

1. Garino N et al. (2016) Microwave-assisted synthesis of reduced graphene oxide/sno2 nanocomposite for oxygen reduction reaction in microbial fuel cells. ACS Applied Materials & Interfaces. 8(7):4633-4643.
2. Bella F et al. (2015) Dispelling clichés at the nanoscale: the true effect of polymer electrolytes on the performance of dye-sensitized solar cells. Nanoscale. 7(28):12010-12017.
3. Delmondo L et al. (2016) Nanostructured MnxOy for oxygen reduction reaction (ORR) catalysts. Applied Surface Science. 388:631-639.

4. Massaglia G and Quaglio M (2017) Semiconducting nanofibers in photoelectrochemistry. Materials Science in Semiconductor Processing. 73:13-21. Doi: 10.1016/j.mssp.2017.06.047.

5. Salvador G P et al. (2017) Green synthesized nitrogen-doped carbon-based aerogels as environmental friendly catalysts for the oxygen reduction in microbial fuel cells. Energy Technology. Doi: 10.1002/ente.201700615..

Biography

Marzia Quaglio graduated in Material Science Engineering at the Politecnico di Torino and received her PhD in Electronic Devices from the same institute. She is a Researcher at the Center for Sustainable Future Technologies (CSFT) of the Italian Institute of Technology (IIT). Her research activity started with a main focus on MEMS/NEMS processing for the fabrication of Lab on a Chip. She collaborated with Professor Cerrina at the University of Wisconsin-Madison as a Fellow. In 2009 she joined IIT, contributing to the start-up of the newly established center of IIT. She is currently involved in the reactors and processes division, with interest on the development of new electrode materials and catalysts for (bio)-electrochemical reactors for CO_2 conversion.

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