

## **Carbon and MnO<sub>2</sub> materials on carbon nanofibers cotton textile substrate for hybrid solid-state supercapacitors**

**Francesco Lufrano<sup>1</sup>, Antonio J. Paleo<sup>1,2</sup>, Antonino Brigandì<sup>1</sup>, Fernando Ferreira<sup>2</sup>, Ana M. Rocha<sup>2</sup> and Pietro Staiti<sup>1</sup>**

<sup>1</sup>CNR-ITAE, Istituto di Tecnologie Avanzate per l'Energia "Nicola Giordano", 98126 Via S. Lucia, 5 - Messina, Italy

<sup>2</sup>University of Minho, Department of Textile Engineering, Centre for Textile Science and Technology (2C2T), Campus de Azurém, 4800-058 Guimarães, Portugal

This work is focused on the design and development of hybrid solid-state energy storage devices with high capacitive performance. In particular, the work includes, the preparation of carbon composite electrodes based on a carbon nanofibers (CNF) supported on a cotton fabric. The coating of CNF to the cotton cloth is obtained by the dip and dry method. On these so-obtained composite substrates, further layers of activated carbon (Norit A Supra Eur) and manganese oxide (MnO<sub>2</sub>) material have been subsequently deposited to enhance the electrochemical performances of negative and positive electrodes, respectively. The preparation of carbon-based active layers comprises the spreading on the negative CNF-substrate of a slurry containing the activated carbon (AC) material, graphite fibres and polyvinylidene difluoride (PVDF) in N,N dimethylacetamide (DMA). Whereas the positive electrode is prepared by spreading a slurry of MnO<sub>2</sub>, carbon black, graphite fibers, PVDF in DMA. A 1M Na<sub>2</sub>SO<sub>4</sub> solution impregnated in the porous paper separator (Nippon Kodoshi Corporation, Japan) and a polymer electrolyte membrane (Nafion 115) have been employed as electrolytes. The different supercapacitors were electrochemically characterized by cyclic voltammetry (CV), galvanostatic charge/discharge (G-CD), electrochemical impedance spectroscopy (EIS) and long-term cycling stability tests.

The hybrid carbon-based textile supercapacitors exhibited capacitance performance of 137 and 120 F/g with the porous separator and Nafion 115 membrane, respectively. Specially, the solid-state (Nafion membrane) hybrid device demonstrated very long stability in cycling (10000 cycles) and holding voltage condition at 1.6 V (more than 100 h). Besides, these textile-based capacitors also showed slow self-discharge.

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