

Development of carbon/MnO₂ coated on nanofiber textile electrodes for hybrid solid-state supercapacitors

Antonio J. Paleo^{1*}, Antonino Brigandì², Fernando Ferreira¹, Ana M. Rocha¹, Pietro Staiti² and Francesco Lufrano²

¹University of Minho, Department of Textile Engineering, Centre for Textile Science and Technology (2C2T), Campus de Azurém, 4800-058 Guimarães, Portugal

²CNR-ITAE, Istituto di Tecnologie Avanzate per l'Energia "Nicola Giordano", 98126 Via S. Lucia, 5 - Messina, Italy

*(ajpaleovieito@2c2t.uminho.pt)

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 (MnO₂) 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 MnO₂, carbon black, graphite fibers, PVDF in DMA. A 1M Na₂SO₄ 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 200 h). Besides, these textile-based capacitors also showed really slow self-discharge.

Acknowledgments

This work was partly financed by FEDER funds through the Competitvity Factors Operational Programme - COMPETE and by national funds through FCT – Foundation for Science and Technology (project POCI-01-0145-FEDER-007136). A. J. Paleo acknowledges the European COST Action CA15107- Multi-Functional Nano-Carbon Composite Materials Network (MultiComp) that conceded him a Short Term Scientific Mission (STSM) at CNR-ITAE of Messina.