Vertically aligned carbon nanotubes based materials for high energy hybrid supercapacitors

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Oral, Congrès NT16, August 7-13, 2016, Vienne, Autriche

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The aim of this project is to develop innovative electrodes materials with high specific capacitance based on vertically aligned carbon nanotubes (VACNT) to be included in supercapacitors with improved specific energy. To achieve this, we will develop new pseudocapacity positive electrode materials based on vertically aligned carbon nanotubes (VACNT) modified by Electronic Conducting Polymers (ECP) and/or manganese oxide electrodeposited in a controlled manner.

In this study, the growth of VACNT by catalytic chemical vapour deposition using mixed aerosol [1] has been adapted for different metal substrates (stainless steel or Al) with controlled and optimized morphologies (length, density, diameter…). VACNT are then used as electrode support material through the development of preparation methodologies of various VACNT/PCE nanocomposite electrodes through electrochemical polymerization with various techniques on VACNT carpets used as templating electrode [2].

VACNT are also used as the 3D matrix hosting the electrodeposition of nanostructured MnO2 with the objective to optimize the electrochemical parameters in order to deposit the oxide homogeneously throughout the entire depth of the carpet. The electrodeposition is performed in different media and from different MnO2 precursors [3]. Several pre-treatments of the VACNT with oxygen have been thus performed to act on the hydrophobic character of the pristine forest. Oxide film growth by CVD has also been tested.

The materials and composites have been characterized by scanning and transmission electron microscopies as well as spectroscopies (SEM, TEM, Raman, SEM-EDX and XPS) in order to examine the morphology, the localization and the thickness of the PCE or MnO2 deposits and their relation to the measured specific capacitance performances.

[1] C. Castro, et al., Carbon 48 (2010) 3807-3816.
[2] S. Lagoutte, et al., Electrochimica Acta 130 (2014) 754-765.
[3] A. Mery, et al., *Journal of Power Sources 305* (2016) 37-45.