



Electrodeposition of MnO₂ on VACNT and the use of these composites in supercapacitor devices

Ahmed Fakhry, Mathieu Pinault, Émeline Charon, François Tran Van, Fouad Ghamouss

► To cite this version:

Ahmed Fakhry, Mathieu Pinault, Émeline Charon, François Tran Van, Fouad Ghamouss. Electrodeposition of MnO₂ on VACNT and the use of these composites in supercapacitor devices. ChemOn-Tubes2016, Apr 2016, Brussels, Belgium. cea-02349640

HAL Id: cea-02349640

<https://cea.hal.science/cea-02349640>

Submitted on 5 Nov 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Electrodeposition of MnO₂ on VACNT and the use of these composites in supercapacitor devices

Ahmed FAKHRY^a, Mathieu PINAULT^b, Emeline CHARON^b, François Tran-Van^a, Fouad Ghamouss^a

^a Laboratoire Physico-Chimie des Matériaux et des Electrolytes pour l'Energie, Université François Rabelais, Parc de Grandmont, 37200 Tours, France

^b CEA-Saclay, DMS/IRAMIS/NIMBE UMR3685, Bat. 522, 91 191 Gif sur Yvette Cedex, France

Manganese oxide is one of the most promising oxide based composites due to its low cost, friendly environmental aspect and pseudocapacitive performances¹⁻². The electrochemical performances of MnO₂ are largely dependent on its morphological properties and specific surface area. The association of carbon nanotubes (CNT) with MnO₂ can be interesting in order to improve the electronic conductivity and the electrochemical performances of the composite. Nevertheless, the main works use a chemical way for the preparation of the composites that is why the morphological control is still difficult³⁻⁴.

In this work the vertically aligned CNT (VACNT) films previously grown on stainless steel by aerosol-assisted CCVD⁵ are used as 3D matrix host for the electrodeposition of nanostructured MnO₂. The main objective is to optimize the electrochemical parameters in order to deposit homogeneously the oxide inside the entire depth of the films. The MnO₂/CNT ratio is optimized to obtain the best performances in term of specific capacitance and impedance. The electrodeposition is made in different media and from different MnO₂ precursors. Similarly, various electrochemical techniques such as cyclic voltammetry, chronopotentiometry or sequenced chronopotentiometry are used for the electrodeposition. Various parameters have been studied including the size of the CNTs and their coating depending on the used technique, the deposition time, the applied potential and/or current.

Electrochemical characterization (cyclic voltammetry, galvanostatic cycling, and electrochemical impedance spectroscopy) of the nanocomposite CNT-MnO₂ are performed. A three electrodes cell is used for the deposition and the electrochemical studies of the nanocomposite to highlight accurately the electrochemical behavior of the electrode. The materials and composites have been characterized by scanning and transmission electron microscopy (SEM, TEM, SEM-EDX and XPS) in order to examine the morphology, the localization and the thickness of the MnO₂ deposit. Indeed, in addition to its dependence to MnO₂/CNT mass ratio, the electrochemical performances of the nanocomposite are also linked to the thickness (resistivity of the MnO₂ film) and the homogeneity of the deposits (depth of deposition). These composites are then used as electrodes for supercapacitors.

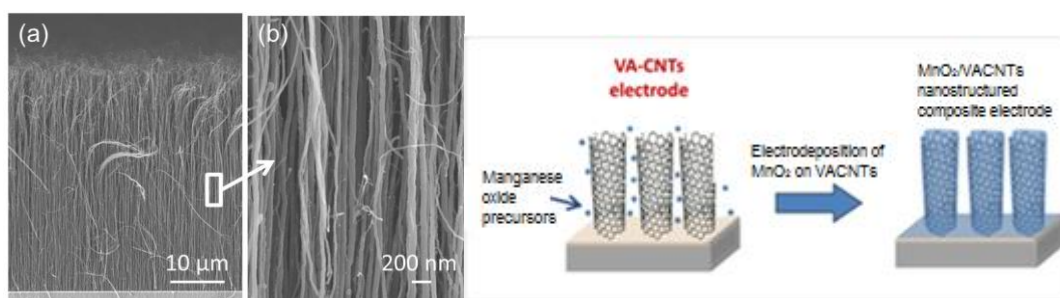


Figure: SEM micrograph of (a) VACNT carpet grown on stainless steel substrate (showing (b) the very good alignment degree of the nanotubes)

References

1. H. Wang, C. Peng, J. Zheng, F. Peng, H. Yu, Materials Research Bulletin, 48 (2013) 3389-3393
2. K-W. Nam, C-W. Lee, X-Q. Yang, B. Cho, W-S. Yoon, K-B. Kim, Journal of Power Sources, 188 (2009) 323-331
3. B. Xu, M-L. Ye, Y-X. Yu, W-D. Zhang, Analytica Chimica Acta, 674 (2010) 20-26
4. R. Amade, E. Jover, B. Caglar, T. Mutlu, E. Bertran, Journal of Power Sources, 19 (2011) 5779-5783
5. M. Pinault, V. Pichot, H. Khodja, P. Launois, C. Reynaud, M. Mayne-L'Hermite, Nano Letters, 5 (2005) 2394-2398