MnO_2 - carbon nanofiber composites for flexible supercapacitors

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Flexible energy-storage devices have recently attracted a great attention due to the increasing need for sustainable energy in modern portable electronics. Their applications mainly include wearable displays, artificial electronic skin and distributed sensors [1-3]. In the seek for fabric-like electrodes for supercapacitors, decorating carbon nanofibers (CNFs) with pseudocapacitive metal oxides such as MnO_2, appears as a sound approach. Moreover, MnO_2 is a pretty bad electronic conductor and, in addition to this opportunity for the design of flexible electrodes, CNFs as a conductive substrate is anticipated to provide an enhanced conductivity and, eventually, an improvement of the power capability of the electrode material. In this context, a facile and inexpensive synthetic route to fabricate flexible electrodes based on MnO_2-CNF composite materials is presented in this work. Various MnO_2 allotropes were selected for the decoration of CNFs: 1*D* cryptomelane and OMS-5, 2*D* birnessite, and 3*D* spinel phases (Figure 1).

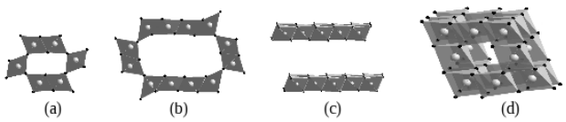

Figure 1. Crystallographic structures of MnO_2 cryptomelane (a), OMS-5 (b), birnessite (c) and spinel (d)

Depending on the chosen allotropes, various morphologies were obtained: birnessite and cryptomelane MnO_2 nanoflakes grown vertically on individual CNF, OMS-5 conformal layer at the surface of the CNFs, thus building hierarchical coaxial architecture, and spinel nanoparticles aggregated at the CNF surface (Figure 2).

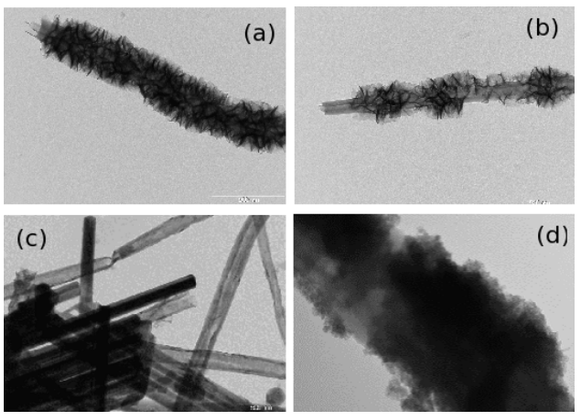

Figure 2. TEM image of MnO_2 allotropes -coated CNF birnessite (a), cryptomelane (b), OMS-5 (c), and spinel (d)

The resulting composite materials were tested as positive electrode materials for supercapacitors by cyclic voltammetry, galvanostatic and EIS measurements. An extensive study of the charge-storage characteristics of MnO_2 –coated CNFs was carried out in relation to corresponding MnO_2 microstructures/morphologies.

References

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