Electrochemical performance of Carbon / MnO_2 nanocomposites prepared *via* molecular bridging

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The constant increment in the study and development of energy storage devices, such as electrochemical capacitors (ECs), are related to an ever growing demand of energy of the actual society. Manganese oxide (MnO_2) has proved to be a very promising material due to its high energy density, low cost, environmental friendliness and natural abundance (1) and has been extensively studied for the last few years (2). Despite its interesting electrochemical performance, the use of MnO_2 is still limited in high power applications due to the intrinsic poor electrical conductivity of this material (10^{-5} or 10^{-6} $S.cm^{-1}$) (3). Up to now, one of the most viable approaches to solve this problem is the use of a conductive additive such as carbon for improving the percolation through the electrode.

Carbon has been used just as a simple mixture with manganese oxide (4,5) or as a substrate for the deposition of an ultrathin film of MnO_2. However, for the simple mixture, the power capability continues to be limited for commercial applications and in the case of the ultrathin films, the amount of active material (MnO_2) deposited on the carbon substrate is too low to be used in a commercial device.
The poor electronic conductivity limiting its use in high power applications is usually balanced by the addition of conducting additives.

In this work, the chemical bridging between MnO_2 and carbon particles by diazonium chemistry is presented. The resulting MnO_2-Carbon material was characterized by TGA, SEM as well as X-ray photoelectron spectroscopy (XPS) and transmission electron microscopy (TEM) to obtain information about the chemical environment and the morphology of the new composite material. (Figure 1).

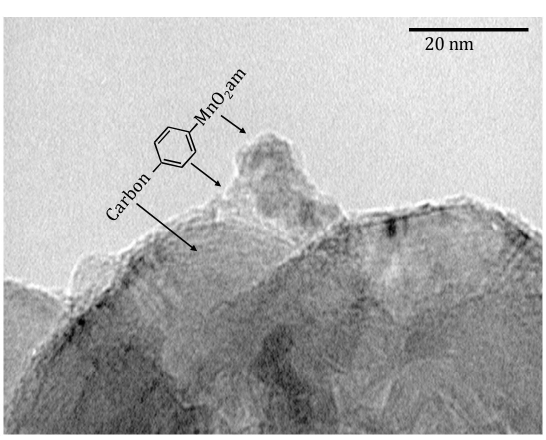

Figure 1: TEM image of a MnO_2 particle on the top of a carbon black particle

It seems that the intimate contact between the two materials through a bond can improve the homogeneity between the carbon and MnO_2 particles as well as the electron transport between them.

Different Carbon/MnO_2 ratios were prepared and the composite materials were used as electrodes in electrochemical capacitors. Their performance were evaluated by galvanostatic cycling at different cycling rates. The presence of molecular bridges clearly improves the specific capacity compared to a simple mixture of both materials (Figure 2).

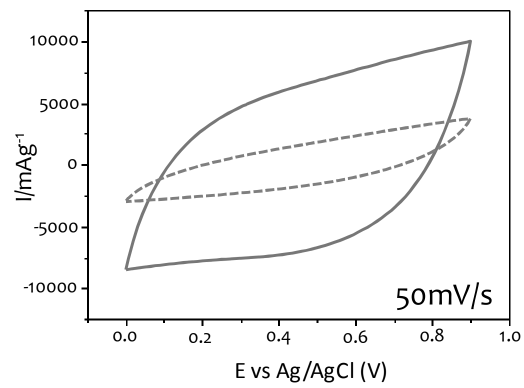

Figure 2: amorphous MnO_2 composite electrode cycled in 5M aqueous $LiNO_3$ electrolyte at 50mV/s; simple mixture (dashed line) and with molecular bridging (plain line).

The results show a better dispersion of both electrode components, thus enhancing the electronic pathway through the electrode. These results encourage the use of diazonium chemistry for the improvement of electrode materials in other energy storage applications (6).

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