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Carbon Nanotube/felt composite as matrix for electrodes of lithium ion batteries

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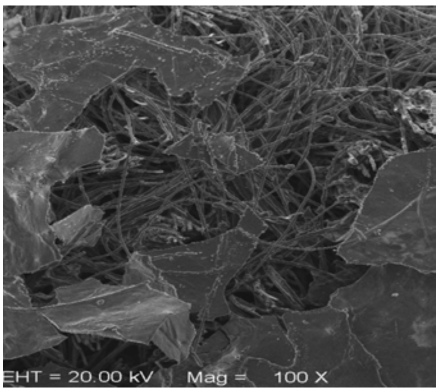
Abstract – CNT/felt composite can be used as support to development of electrodes of Li-ion battery, as shown in this work. The composite was prepared through chemical vapour deposition and was used to support the xerogel V_2O_5. The characterization of electrodes was carried out using electrochemical techniques and scanning electron microscopy (SEM). The V_2O_5 supported on CNT/felt matrix provide a excellent cyclability and a reversibility specific capacity of 160 $mAh.g^{-1}$ between 4 and 2V versus Li/Li^+ potential at a constant discharge/charge current of 95 $mA.g^{-1}$.

The electrodes traditionally used in lithium ion battery are prepared using polymer binders and metal foils, grids. In spite of the commercial successful of these electrodes in Li-ion battery the recycling of Li-ion battery is not an easy task. In addition, this kind of electrode requires a large geometric area to expose a large amount of active material. Thus, the development of a new type of design electrode is welcome for the Li-ion batteries. Here we show that carbon felt with good electronic conductivity is an alternative to the metal foils or grids used in Li-ion battery. The carbon substrate when loaded with carbon nanotubes becomes a composite material that allows act like an electronic support for several nanomaterials [1]. The active material used to demonstrate the viability of CNT/felt as support of lithium intercalation nanomaterials was the vanadium oxide (V_2O_5). This material can presents low fading capacity and reversible specific capacity whose value depend on structural order, and it is generally found larger than the theoretical capacity of LiV_2O_5 (147.38 $mAh.g^{-1}$). The carbon felt/CNT is also a lightweight composite and as the CNTs are bonded on carbon fibers of felt this one can not be breathed or easily extract from the substrate.

To preparation of CNT/felt composite was used the Chemical Vapor Deposition and the xg-V_2O_5 was prepared as described elsewhere [2]. The CNT/felt was immersed in the gel of xero-gel V_2O_5 (xg-V_2O_5). After the xg-V_2O_5 loading the xg-V_2O_5/CNT/felt electrode was heated for 1 hour in 200^oC under vacuum and more 3 hours in 300^cC at room atmosphere. The electrochemical characterization of disk electrodes with 8mm of diameter was carried out using 1 $mol.L^{-1}$ $LiPF_6$ in mixtures of ethylene carbonate and dimethyl. Figure 1 shows the SEM picture of composite xg-V_2O_5/CNT/felt electrode, and its electrochemical behavior under linear potential sweep chronoamperometry (voltamogramm). The SEM characterization shows that nanostructure of carbon substrate was completely filled by the xg-V_2O_5 yields an electrode with good mechanical stability and electrical conductivity. It is possible to see in high magnification that each carbon fiber of felt is cover by the xg-V_2O_5. The voltammogram at 0.5$V.s^{-1}$ shown in Figure 1 confirms that the answer of xg-V_2O_5/CNT/felt composite is control by the oxide and the electrode present low fading capacity. The xg-V_2O_5 composite electrode presents a reversibility specific capacity of 160 $mAh.g^{-1}$ at a constant discharge/charge current of 95 $mA.g^{-1}$ between 4 and 2V versus Li/Li^+. Therefore, these results show that the CNT/felt can be effectively used to development of electrodes of lithium ion battery without the use of metal foils.



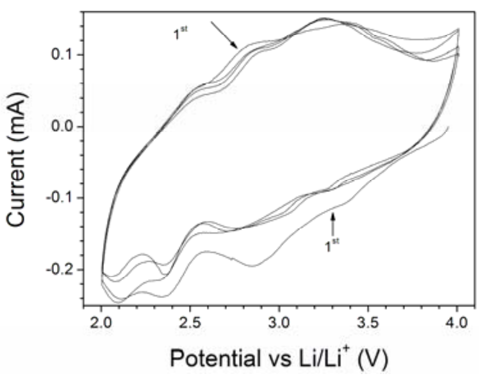


Figure 1: SEM picture of V_2O_5/CNT/felt electrode and its electrochemical behavior during linear potential scan.

References

[1] J. M. Rosolen *et all*, INPI Patent deposit (2009).