Preparation of LiMnPO$_4$/C Nanocomposites and Their Electrochemical Properties

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Introduction

Although LiMnPO$_4$ has been an attracted candidate for substitution of LiCoO$_2$, the very low electronic and ionic conductivities suppress its possibility to be a practical cathode material for Li-ion battery. In our previous study [1], the carbon coated LiMnPO$_4$ was successfully prepared by a combination of spray pyrolysis and dry ball-milling. In this study, we investigate the physical and electrochemical properties of LiMnPO$_4$/C nanocomposites prepared by a combination of spray pyrolysis (SP) with wet ball-milling (WBM).

Experimental

The experimental setup was described in our previous paper [2]. The precursor solution was prepared by dissolving LiNO$_3$, H$_3$PO$_4$, and Mn(NO$_3$)$_2$.6H$_2$O in distilled water in stoichiometric ratio. The total concentration of precursor solution was 0.6 mol dm$^{-3}$. The feed solution was atomized at 1.7 MHz by an ultrasonic nebulizer and the generated droplets were carried into the reactor by N$_2$ + 3% H$_2$ gas. Reactor temperatures were varied from 200 to 500 °C. Then, the as-prepared powders were milled with 10 wt% of carbon by a planetary high-energy ball-milling at a rotating speed of 800 rpm, and then annealed at 500 °C in a N$_2$ + 3% H$_2$ atmosphere. Electrochemical measurements were carried out using coin-type cells (CR2032). Cycling performance of the cells was conducted galvanostatically at room temperature.

Results and Discussion

It is seen from the SEM images on Fig. 1 that the primary particle size of the LiMnPO$_4$/C nanocomposites is in the range of about 50 to 150 nm for all of the samples. Among them, the sample synthesized at 300 °C has the highest specific surface area as shown in Fig. 2. Moreover, from the TEM image, LiMnPO$_4$/C nanocomposites could be identified. Fig. 3 shows the first charge/discharge profiles of the LiMnPO$_4$/C nanocomposite which was synthesized at 300 °C by SP. The cell delivered a first discharge capacity of 118 mAh g$^{-1}$ at 0.05 C charge-discharge rate with a broad flat plateau around 4.1 V vs. Li/Li$^+$ and a small polarization loss.

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Literature cited


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