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Determination of optimal carbon content on a particle size of LiFePO4/C cathode active nano-material for lithium-ion batteries

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Abstract: In order to optimize carbon content on $LiFePO_4/C$ particle size, three samples were synthesized by sol-gel method. The samples of $LiFePO_4/C$ were synthesized with the addition of 10, 30 and 50 % wt. of tartaric acid as a carbon precursor. All samples were characterized by XRD and SEM.

Keywords: Nano-material, EDS, SEM, XRD, Lithium-iron phosphate, Lithium-ion

1. Introduction

The application of lithium iron phosphate ($LiFePO_4$) as a potential cathode material for rechargeable lithium batteries. $LiFePO_4$ has offered several unique benefits when compared to conventional cathode materials such as $LiCoO_2$, $LiNiO_2$ and $LiMn_2O_4$ [1]. $LiFePO_4$ exhibits a flat discharge profile, good thermal stability, high theoretical capacity (~172 mAh/g) and environmentally friendly properties [2]. However, a significant problem with the use of this material lies in its conductivity. This is due to the one-dimensional diffusion (Figure 1) of Li^+ ions along the b axis formed by edge-shared LiO_6 octahedra, compounded by poor electronic and ionic conductivity from the $LiFePO_4$–$FePO_4$ interface [2].

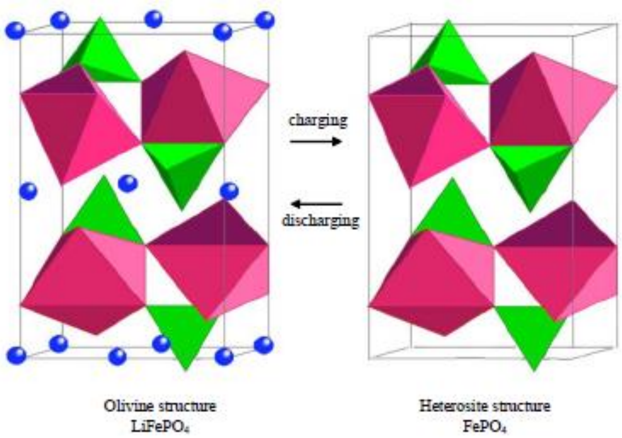

Figure 1. Crystal structures of $LiFePO_4$ (left) included one-dimensional tunnels and $FePO_4$ (right) during the charge/discharge Process [3].

2. Methods & Results

Two methods have been employed to circumvent the poor conductivity issue. The first is to reduce the grain size of the cathode particles, which would shorten the diffusion path length for both electrons and Li^+ ions. The second is the use of surface-modified $LiFePO_4$ with a conductive matrix made of carbon [4], copper [5] and silver [6], or doping with some guest species.

Various investigation results indicate that quality of carbon coating on the $LiFePO_4$ particle surface is determined by the carbon content can lead to a more uniform carbon distribution [7]. In this study, in order to optimize carbon content on $LiFePO_4/C$ particle size, three samples were synthesized. The samples of $LiFePO_4/C$ were synthesized with the addition of 10, 30 and 50 % wt. of tartaric acid as carbon precursor.

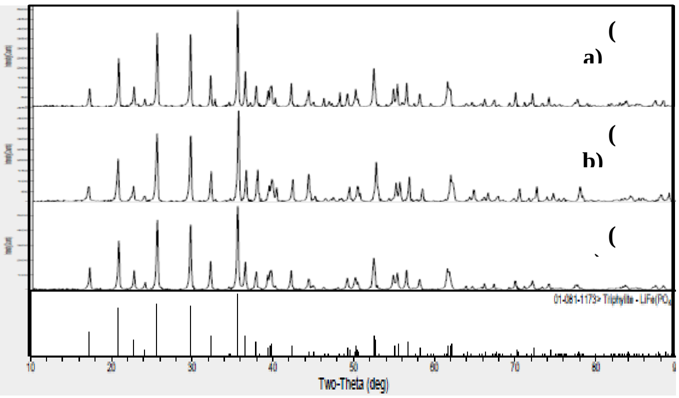

Figure 2. XRD patterns of the $LiFePO_4$ samples coated with different different carbon content (a. 50 % acid wt., b. 30 % acid wt., c. 10 % acid wt.)

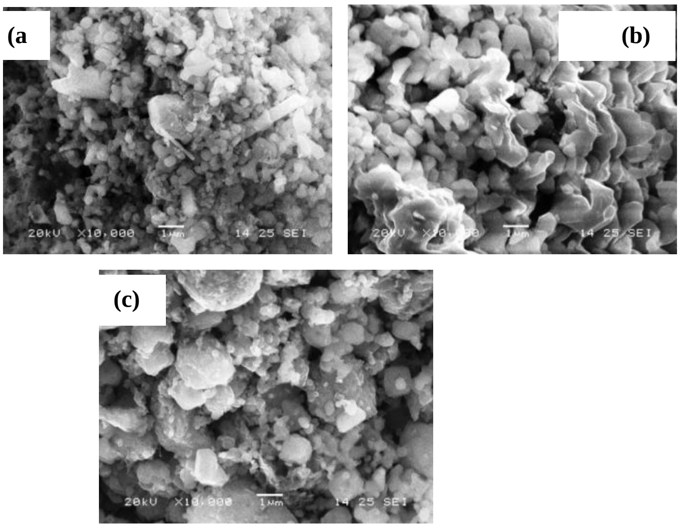

Figure 3. SEM images of the $LiFePO_4$ samples coated with different carbon content (a. 50 % acid wt., b. 30 % acid wt., c. 10 % acid wt.)

3. Conclusions

All samples were characterized by XRD and SEM as shown in Figs. 2 and 3, respectively.

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