Abstract #996, 224th ECS Meeting, © 2013 The Electrochemical Society

A New Low Cost Synthesis Method for $LiFePO_4$

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Lithium iron phosphate, $LiFePO_4$ has gained wide acceptance as the cathode material of choice for safe, large format Li-ion battery applications [1]. Since $LiFePO_4$ possesses a low intrinsic conductivity (around 10^{-9} S/cm) carbon-coating methods or suitable preparative approaches must be employed to produce a composite product incorporating a conductive component [2].

In this study we describe a new, solid state synthesis method for the preparation of high purity and highly conductive $LiFePO_4$. Cost analysis indicates that this preparative approach will be significantly less expensive than any currently employed solid-state manufacturing method. The proprietary approach does not require the inclusion of carbon to enhance the electronic conductivity [2], but does allow the use of low cost Fe^{3+} precursors such as Fe_2O_3 or $FePO_4$. Advantageously, the preparative approach may be carried out at relatively low synthesis temperatures (typically 500-600°C).

Figure 1 depicts the refined X-ray powder diffraction data for a representative sample of the $LiFePO_4$ prepared using the new preparative method. The Rietveld refinement of the powder X-ray data was carried out using the GSAS (EXP-GUI) software package [3]. The calculated unit cell parameters are a = 10.3250(4) Å, b = 6.0055(2) Å, c = 4.6915(2) Å, cell volume = 290.90 (2) $Å^3$, in close agreement with literature sources [4].

Figure 2 shows the first cycle constant current cycling data (C/10) for a $LiFePO_4$ sample prepared by the new low-cost method. These low rate data reveal a reversible specific capacity of around 160 mAh/g, a figure which compares favorably with the theoretical performance (170 mAh/g) and also with state-of-the-art literature data [4].

In an extension of this preparative method a similar approach has been adopted to synthesize lithium iron manganese phosphate, $LiFe_{1-x}Mn_xPO_4$, as well as several other polyanion active materials.

References:
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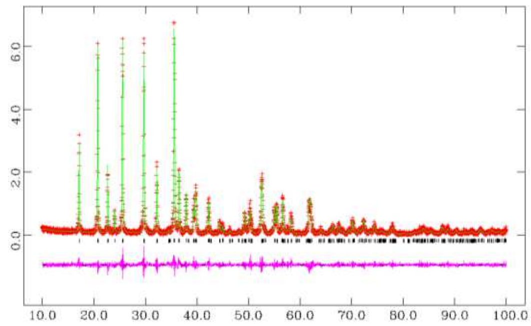

Figure 1: X-ray Diffraction. Rietveld refinement analysis (GSAS EXP-GUI) of a $LiFePO_4$ sample prepared by the new low-cost synthesis method.

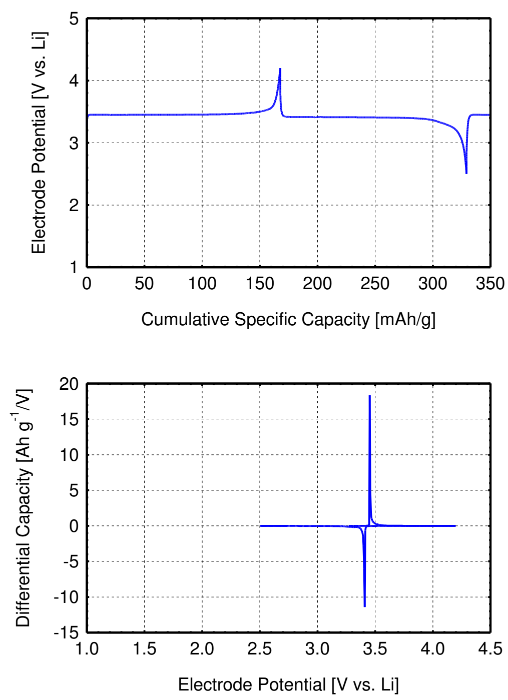

Figure 2: (Upper) First Cycle Electrode Potential versus Specific Capacity and (Lower) Differential Capacity Profile for a Li//$LiFePO_4$ cell cycled between 2.50 – 4.20 V. The $LiFePO_4$ was prepared by the new low-cost synthesis method.