Performance, Safety and Cost of Li-Ion Polymer Battery using $LiFePO_4$ as Cathode Material

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Introduction

Many goals, such as low cost, long calendar life, safety and high power capability, have been established for rechargeable lithium batteries in hybrid electric vehicles (HEVs) and other transportation technologies [1,2]. Synthetic graphite and Co-containing cathodes used in commercial cells will need to be replaced with natural graphite and cathode materials based on lower-cost materials, such as those containing iron and manganese. $LiFePO_4$ has been studied as the cathode-active material for Li rechargeable batteries because of low-cost, low toxicity and relatively high theoretical specific capacity of 170mAh/g [3]. We have been studying pouch cells prepared with $LiFePO_4$ cathodes combined with natural graphite anodes with liquid electrolytes [4, 5] However, as Chen and Dahn have already reported [6] small particle sizes need more carbon coating. Recently, Takahashi [7] reported extremely long cycle life or their $LiFePO_4$/graphite cells.

The aim of this presentation is to show the performance of $LiFePO_4$/graphite cells using gel electrolyte. In addition, the safety of the anode, cathode and gel will be described. An estimate of cost of the cell using $LiFePO_4$ and gel electrolyte with and without a separator will be compared with cells using $LiCoO_2$.

Results and discussions

Ten laminated cells and five large cells (3 electrodes for *in situ* gel formation) were assembled with carbon-coated $LiFePOO_4$ (Phostech) and spherical natural (Hydro-Québec) and PVDF coated onto treated Cu current collectors. The cathodes used a carbon–coated Al current collector. The electrolyte was 10 wt% multi-branched polyether and 90 wt% of 1.5 M LiFSI in EC + PC + DMC (1/1/3), which was used to avoid HF formation and side reactions. LIFSI was selected because of its high conductivity and stability against $LiPF_6$.

Figure 1 shows the cycle life of a laminated cell (100 %DOD, C/1). Its capacity fade was less than 0.5 % per cycle. The 3-electrode cell was tested without a separator. This cell showed a steady cycle life (100 %DOD, C/1), and lost less than 5 % of capacity after 500 cycles.

To compare the cost of cells using $LiCoO_2$ vs. $LiFePO_4$, an estimate was made according to reference [8]. Our calculations show clearly that the cost of a 18650 cell using $LiFePO_4$ (2.3 Ah) is ~40 % less than a comparable $LiCoO_2$ cell (0.77$/cell vs. 1.3$/cell). In addition, if the $LiFePO_4$ cell is constructed without a separator (coated gel on anode or cathode side), the cell cost will be half the actual cost of commercial Li-ion cells.

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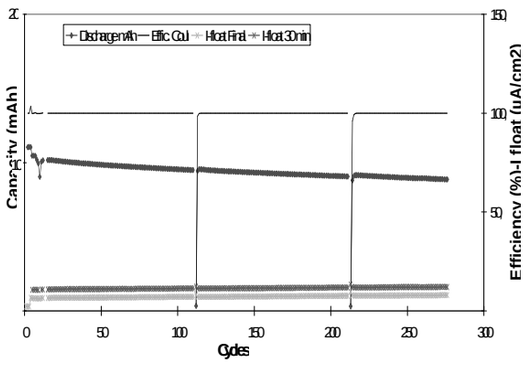

Fig.1