Parameters Aging on the Li-ion Batteries Based on $LiFePO_4$ Cathode Material

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Introduction

The successful commercialisation of Li-ion gel polymer batteries for portable electronic devices has led to other applications where the thickness and weight of batteries are important. A considerable investment in this battery technology that utilises $LiCoO_2$ cathodes has been made. However, lower-cost cathode materials are required for many applications such as in EV and HEV[1,2]. Recently, $LiFePO_4$ was investigated intensively as a potential cathode material for rechargeable Li-ion batteries[2,3] because of its low cost and safety.

In this paper, we report the results obtained with natural graphite/gel electrolyte/$LiFePO_4$ cells. The mixed salts LiTFSI-$LiBF_4$ in EC-GBL solvent and the same molar concentration of the individual salts were used to study the salt effect. The effect of carbon additives in the cathode on cell performance was also investigated.

Experimental

Two cell configurations, Li-ion (natural graphite/$LiFePO_4$) and Li-metal (Li/$LiFePO_4$), were evaluated. These cells contained $LiBF_4$, LiTFSI or mixtures of these salts in EC/GBL (1: 3). The Li/$LiFePO_4$ cells with 1-15% conductive carbon in $LiFePO_4$ were used to study the cathode performance. Charge-discharge cycling and slow cyclic voltammetry of the cells were carried out using the galvanostatic method (MacPile^R, Claix, France). AC impedance spectroscopy was used to investigate the interface phenomena. The test cells were maintained at an optimum compression of 10psi. during the test. Both types of cells were evaluated at different rates between the voltage limits of 2.5V to 4V. A Bitrode cycler was used for long-term cycling tests.

Results

The salt effect was studied in Li-ion configuration by using EC-GBL (1:3) with $LiBF_4$ and LiTFSI salts. For the mixed salt (1M LiTFSI + 0.5 M $LiBF_4$ in EC/GBL), we find high capacity fade compared to the same molar concentration of the single salts (LiTFSI or $LiBF_4$) (Fig.1).

The data in Figure 2 show that increasing the carbon content in the iron phosphate cathode has a dramatic effect on high-rate performance. A 6% carbon content seems to be a good compromise with energy and power, with 65% of the reversible capacity at 2C-rate and 62% at 3C-rate. Even with 1% carbon, we obtain more that 50% of the reversible capacity at 3C-rate.

References

1- http://berc.lbl.gov/BATT/BATT.html.
2- K. Striebel et al., 11th IMLB, Monterey CA (June 2002), abstract # 125.
3-N. Ravet et al. J. Power Sources, 97-98 (2001) 503-50.

Acknowledgment

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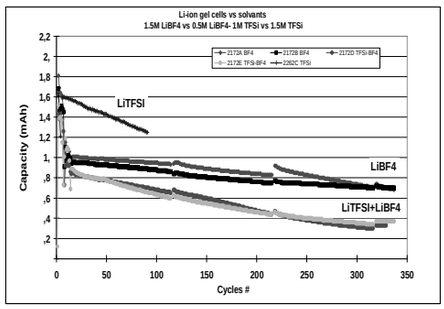

Fig. 1: Cycle Performance of $LiFePO_4$/ gel/ natural graphite cells with different salt ratios, all at 1.5M total salt

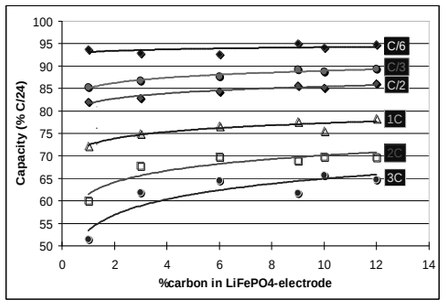

Fig. 2: C-rate of $LiFePO_4$/Li, cathode with different carbon content