

## Cycling performance of low-cost lithium ion batteries with LiFePO<sub>4</sub> cathode

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Rechargeable Lithium ion batteries are pushed recently for more and more demanding applications. After more than a decade since their commercialization, being used mostly for power portable electronic, and communication devices (e.g. cellular phones). Li ion batteries are considered as main electrical storage devices for electric vehicles due to their high energy density. A lot of researchers throughout the world work on improving electrodes materials and electrolyte systems for this battery technology, in order to maximize both energy and power density of Li batteries. Highly challenging is development of high voltage cell with low price, long life, environmental safety, and high specific energy [1, 2].

Over the past years, transition metal oxides, such as LiNiO<sub>2</sub> and spinel LiMnO<sub>4</sub> have been studied as cathode materials in lithium batteries. These materials have shown good cyclability and high capacity at potential (around 4 V versus Li/Li<sup>+</sup>). So far, LiCoO<sub>2</sub> has been the main cathode material used in Li-ion batteries due to its high energy density. However, the questionable long term supply of cobalt material that is Co-free is needed rapidly to prepare for the future application Li-ion battery technology in HEV's. Since the demonstration of LiFePO<sub>4</sub> by Padhi et al [as potential cathode materials, considerable interest has been generated due to its safety, low fabrication cost, non-toxicity, a reasonable high theoretical capacity and environmentally friendly nature [3-6].

In this work, we assembled and tested low-cost full cell configuration based on LiFePO<sub>4</sub> and containing ionic liquids (C<sub>1</sub>C<sub>n</sub>Im-NTf<sub>2</sub>; n=4, 6 and 8) based on bis(trifluorosulfonyl)imide ([TFSI]<sup>-</sup>) anion as the electrolyte media. The cycle performance, life, electrochemical stability of this cell is reported, along with some post-test, electrochemical diagnostics of the components after cycling. It worth to mention that lithium ion LTO/LFP cells employing IL-electrolyte were realized and found to deliver a full discharge capacity, even more important, the cycling done at 60°C and 80°C, which can't be safely achieved with conventional, organic solvent based electrolytes.

As clearly shown in fig 1, when the electrodes are combined in a full cell configuration, the LTO/LFP cells

show an excellent rate capability at 60°C in contrary to the results at 25°C. The LTO/LFP cells are able to exhibit the almost full capacity with about 130mAh/g obtained at 0.05C (10 cycles) and 0.1C (>25 cycles) at 60°C.

Table 1 self-diffusion coefficient of different ion species of IL/LiNTf<sub>2</sub> mixture.

IL/LiNTf <sub>2</sub>			
D <sub>ion</sub> x10 <sup>-11</sup> / (m <sup>2</sup> .s <sup>-1</sup> )			
T (°C)	D <sub>C1C6Im<sup>+</sup></sub>	D <sub>NTf2<sup>-</sup></sub>	D <sub>Li<sup>+</sup></sub>
5	2.2	4.5	1.4
<b>25</b>	6.7	6	<b>3.1</b>
40	17.4	11.3	7.2
<b>60</b>	37.4	26.3	<b>15.1</b>
<b>80</b>	73.7	49.5	<b>30.8</b>

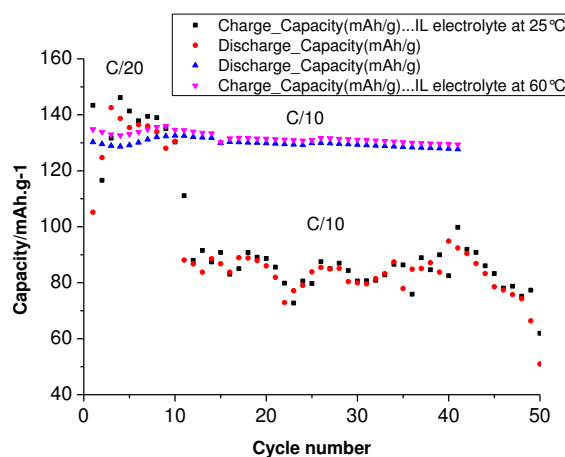


Figure 1 Cell performance of IL with LTO/LFP at different temperature.

The low performance obtained at 25°C mainly due to the viscosity of the ionic liquids/Li-salt mixture as shown in table 1. On the other designs, the full system configuration of Cgr/LFP exhibits a good rate capability with more than 60% discharge capacity retention at C/10 rate after 100 cycles with vinylene carbonate (VC)-co additive. These results will be discussed later.

## References

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