Towards new battery electrolytes

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Room temperature ionic liquids attract the attention of many scientists dealing with lithium-ion batteries. This interest is caused by their unique properties: wide liquid range, wide electrochemical stability, good ionic conductivity, negligible volatility, non-flammability, etc. [1, 2]. The interest of lithium rechargeable batteries in electric vehicles (EVs) has been significantly increased in recent years [3, 4]. The substitution of a common, organic carbonate-based electrolyte with an IL-based electrolyte leads to a significant improvement in system safety and the reduction of environmental risks and negative impacts on human health.

Following this considerable growth seen in lithium storage batteries, accompanying the rises on demand on portable devices, CEA-Liten researcher workers are developing, with academe and industrial partners, original; low cost technologies, and are investigating novel families of battery electrolytes among them ionic liquids [5, 6].

In this work we examined the electrochemical performances of graphite (Cgr) or $Li_4Ti_5O_{12}$ (LTO) coupled with $LiFePO_4$ (LFP) at 60°C containing pyrrolidinium based ionic liquid and bis(trifluorosulfonyl)imide ($[TFSI]^-$) anion as an electrolyte. Different lithium salts (LiTFSI, $LiPF_6$, $LiBF_4$ and LiFSI) have been tested.
When the electrodes are combined in full cell configuration, the LTO/LFP cells containing IL-NTf_2/$LiNTf_2$ binary mixture show an excellent rate capability. However; contrary results obtained with IL-NTf_2/$LiPF_6$ (fig 1) due to low thermal stability at elevated temperature and lower dissociation constant than $LiNTf_2$.

As well know $LiPF_6$ is involved in solid-electrolyte interface formation on graphite [7]. On the other designs, full system configuration of Cgr/LFP with IL-NTf_2/$LiNTf_2$ and IL-NTf_2/$LiPF_6$ has been tested (fig 2). In the absence of carbonate additive no cycling was observed, however; with 5% co-additive Cgr/LFP containing IL-NTf_2/$LiNTf_2$ exhibits a good rate capability (more than 60% capacity retention) at C/10 rate after 100 cycles.

Further investigations are currently aimed on IL-NTf_2 with LiFSI and $LiBF_4$ along with some post-test, electrochemical stability, lithium ion insertion-deinsertion mechanism, and lithium ion diffusion.

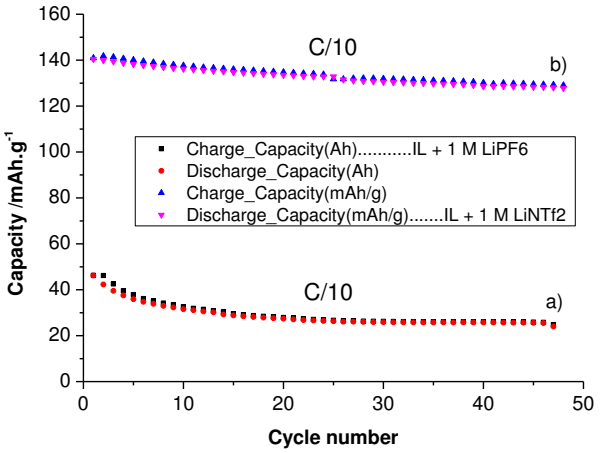

Figure 1 cell capacity of LTO/LFP at 60°C and C/10.

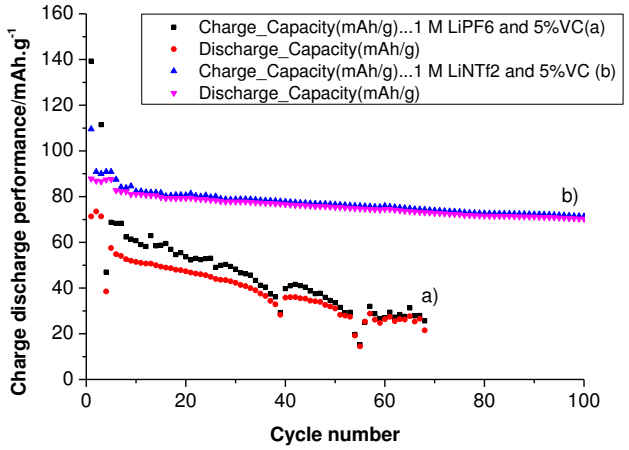

Figure 2 cell capacity of Cgr/LFP at 60°C and C/10.

References

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