

Ether sulfones with additives for electrolytes in rechargeable lithium ion batteries

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Sulfones are well known for their wide electrochemical windows, hence potential applications in rechargeable lithium ion battery [1-5]. In a previous publication [6] we described a series of ether sulfones which showed electrochemical window higher than 5.5V. However, due to the inadequate formation of solid electrolyte interface (SEI) needed for the long battery cycle life, they are limited in their commercial applications. Here we report how the inclusion of favorable additives, either molecular (vinylene carbonate (VC), propylsulfone (PS) or salt additive (such as LiBOB) or their combination, in the formulations of ether sulfone electrolytes, can yield lithium button cells batteries with very favorable characteristics. (Refs to VC???.. Wu??)

Fig. 1 shows that with 1wt% of VC addition to 1.0M LiPF₆/EMES (ethylmethoxyethyl sulfone) the charge/discharge capacity of the cell becomes comparable to that of a reference cell (identical fabrication) based on the now-classical carbonate electrolyte (LiPF₆ in a mixture of ethylene carbonate (EC) and dimethyl carbonate (DMC) (1/1 in volume)), under the same charge/discharge conditions.

Also shown in Fig. 1, are results for a simple 1.0M LiBOB-in-EMES solution in which the charge/discharge capacity of the cell first increases then decreases, but eventually stabilizes. However, with addition of 1wt% VC, the charge/discharge capacity of the cell quickly stabilizes after initial SEI formation period.

Fig. 2 shows the charge/discharge capacities of the cells based on 1.0M LiPF₆/EMES solutions with VC and LiBOB as additives that cycled under different current densities. As can be seen from the figure that these cells are more sensitive to current density changes, which is primarily due to the relatively high intrinsic viscosity of the ether sulfone. Fig. 3 shows the cycling performance of the 1.0M LiBOB/MEMS (methoxyethyl methyl sulfone) solution with 2wt% VC that cycled under different current densities as specified in the figure. The effect of viscosity on capacity can be clearly seen here i.e. when the current density is increased the capacity is decreased; when the current density is reduced to previous level the capacity is restored to the previous level.

It is clear that VC is a very beneficial additive for the ether sulfone electrolytes in terms of SEI formation and cell cycling. Additional results obtained under careful control of the purity and moisture level in the solvents and additives, and their effects on cell performance, will be presented elsewhere.

References:

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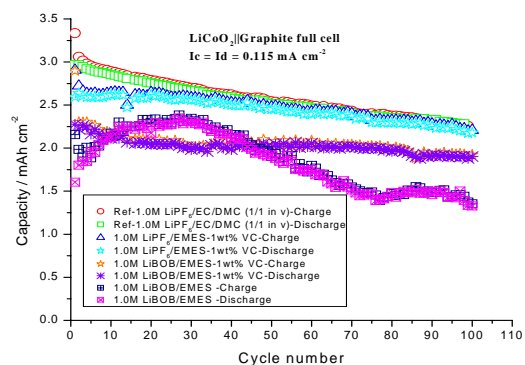


Fig. 1. The comparison of the cycling performance of Li button cells using different salt electrolyte solutions, under the current density of 0.115mA cm⁻².

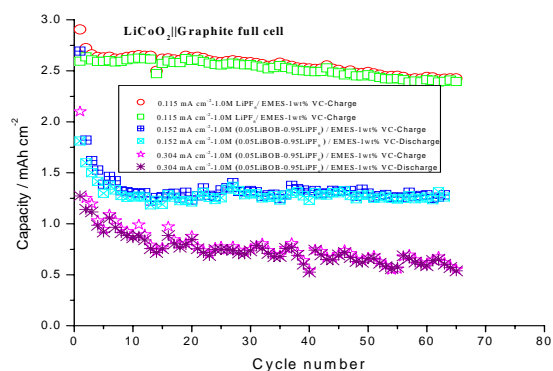


Fig. 2. The comparison of the cycling performance of different salt solutions and combinations under different current densities specified in the figure.

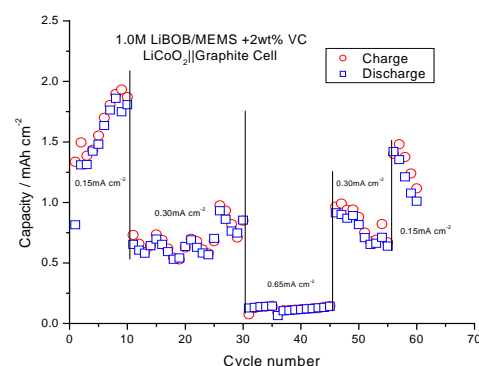


Fig. 3. The cycling performance of the 1.0M LiBOB/MEMS solution with 2wt% VC as additive under different current densities as specified in the figure.