

Impact of Electrolyte Additives on the Performance of High Voltage Spinel Cathode Materials for Lithium Ion Batteries

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The wide spread application of lithium ion batteries for use ranging from portable electronics and power tools to electric vehicles continues to place ever-increasing demands on the battery system to provide higher energy density, higher power density, and improved cycle life. One way to increase the energy density of batteries is to replace conventional cathode materials with high voltage spinel-type materials such as $\text{LiNi}_{0.5}\text{Mn}_{1.5}\text{O}_4$. However, spinel-based materials are well known for its manganese dissolution issues at elevated temperatures,¹ which can lead to poor capacity retention. There are also concerns on the instability of conventional carbonate electrolyte systems in contact with the cathode surface at high voltages ($>4.5\text{V}$).² The current popular approaches to this problem include cathode surface coating with inorganic compounds such as Al_2O_3 and Lipon,^{3,4} cathode material doping with transition metals such as Fe and Cr,^{5,6} and electrolyte additives.⁷⁻⁹

Our current focus is to develop electrolytes that can reduce capacity fading of high voltage cathode material during prolonged cycling in the higher operating potential range. In this work, efforts were made to investigate the impact of single additive or additive combinations on the performance of $\text{LiNi}_{0.5}\text{Mn}_{1.5}\text{O}_4$ materials in full cells.

Figure 1 shows the impact of vinylene carbonate (VC) additive to the electrochemical performance of $\text{LiNi}_{0.5}\text{Mn}_{1.5}\text{O}_4$ material. VC is a commonly used Solid Electrolyte Interphase (SEI) additive for lithium ion batteries. However, it is not suitable to be used for high voltage lithium ion batteries.

As shown in Figure 2, the cells using additive A at 2% level showed better cycling performance than the cells without any additives. The additive A in a combination with additive B further improved the cell capacity retention. Various other electrolyte formulations were also tested and more results will be presented at the meeting.

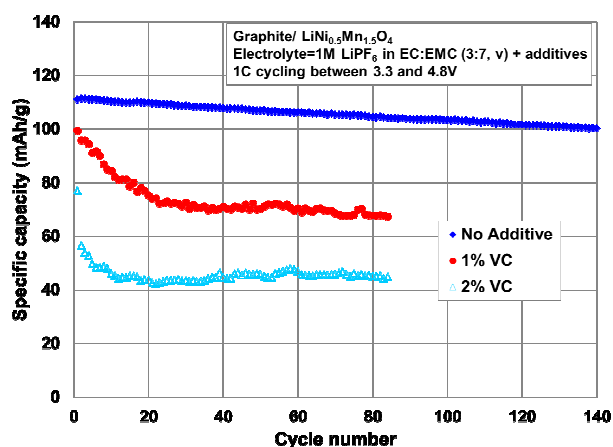


Figure 1 Discharge capacity vs. cycle number for graphite/ $\text{LiNi}_{0.5}\text{Mn}_{1.5}\text{O}_4$ cells using 1M LiPF_6 in EC/EMC (3/7 by volume) electrolyte with VC additive at different content levels. The cells were cycled at 1C rate between 3.3 and 4.8 V at room temperature.

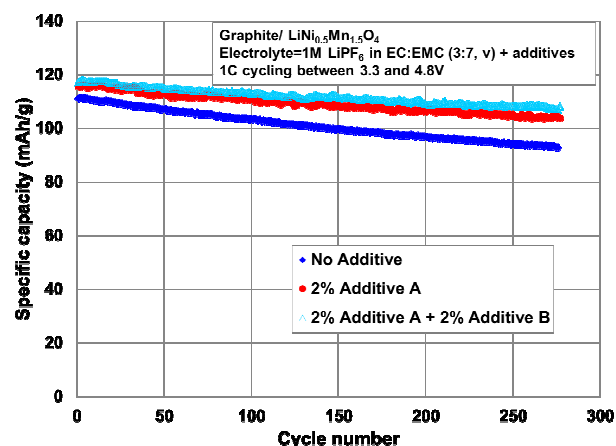


Figure 2 Discharge capacity vs. cycle number for graphite/ $\text{LiNi}_{0.5}\text{Mn}_{1.5}\text{O}_4$ cells using 1M LiPF_6 in EC/EMC (3/7 by volume) electrolyte with or without additives. The cells were cycled at 1C rate between 3.3 and 4.8 V at room temperature.

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