Electrolytes for High Voltage NMC Li-ion Cells

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Increasing the voltage of Li-ion batteries is one of the best ways to increase their energy density. However, there is no commercial electrolyte available for these high voltage cells since state-of-the-art electrolytes containing organic carbonates and typical salts are prone to decompose at high potentials. In this presentation, three electrolyte systems including ethylene carbonate (EC) – ethyl methyl carbonate (EMC), sulfolane (SL) – EMC and fluorinated carbonate mixtures composed of fluoroethylene carbonate (FEC) and bis(2,2,2-trifluoroethyl) carbonate (TFEC) with some selected additive blends were tested in high voltage $Li[Ni_{0.4}Mn_{0.4}Co_{0.2}]O_2$(NMC442)/graphite pouch cells. Figure 1a shows the voltage drop during storage at 40°C (500 h) as a function of initial open circuit voltage for the NMC442/graphite pouch cells with the three different electrolytes. Figure 1a shows that at 4.5 V or above, FEC:TFEC-based electrolytes have significantly smaller potential drops than EC:EMC-based or SL:EMC-based electrolytes, suggesting less electrolyte oxidation occurs in FEC-TFEC-based electrolytes at high potentials. Figure 1b shows the discharge capacity vs cycle number for NMC442/graphite pouch cells with the three different families of electrolytes. Figure 1c shows the difference between average charge and discharge voltage (ΔV) vs cycle number for the same cells shown in Figure 1b. Figures 1b and 1c show that cells using the FEC:TFEC-based electrolyte have the best capacity retention and least impedance growth during long term high-voltage cycling (to 4.5 V) at 40°C.

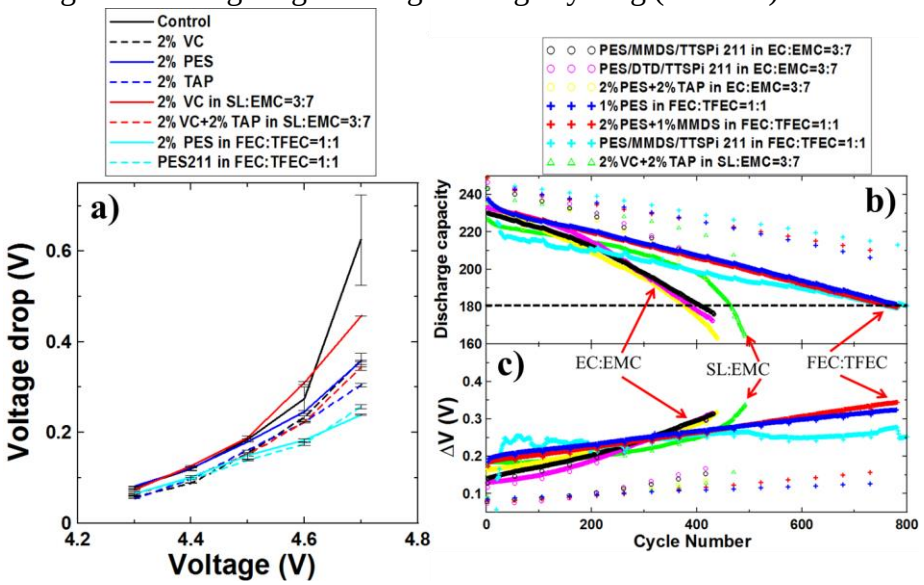

Figure 1. a) Voltage drop vs. initial open circuit voltage during storage at 40. ± 0.1°C for 500 h, b) discharge capacity vs cycle number and c) ΔV vs cycle number for NMC442/graphite pouch cells containing EC:EMC, SL:EMC and FEC:TFEC electrolyte systems containing selected additive combinations. The long-term cycling is between 2.8 and 4.5 V at C/2.4 (100 mA) and 40C.