Superior Performance of Fluorocarbonate Electrolytes over the conventional Electrolytes in Li-ion Half-cells

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Since introduction into commercial market by Sony Energytec, lithium-ion cells are seeing a burgeoning growth as the power source of choice for a variety of electronic gadgets including cell-phone, camcorder etc. Further, these are being considered for use in military and space applications. This chemistry has a favorable combination of energy and power. Although the energy/power performance of the cell at or near room temperature is good that at sub-ambient temperatures, especially below 0°C, is less than satisfactory. The probable cause for the poor performance has been investigated by Nagasubramanian *et al*[1]. and others[2] and has been associated with the large increase in the cathode-electrolyte interfacial resistance. A good low temperature performance is a prerequisite for acceptance for use in military and space applications. One of the ways to mitigate the growth of the cathode-electrolyte interfacial resistance is to use other novel fluorocarbonate solvents in the place of the conventional organic electrolytes based on dimethyl carbonate (DMC), diethyl carbonate (DEC) etc.

In this work we have studied the performance characteristics of MCMB carbon in trifluoroethyl methyl carbonate (3F-EMC) and trifluoroethyl ethyl carbonate (3F-DEC) mixed with ethylene carbonate (EC) and propylene carbonate (PC). The structures of the fluoro compounds are given below.

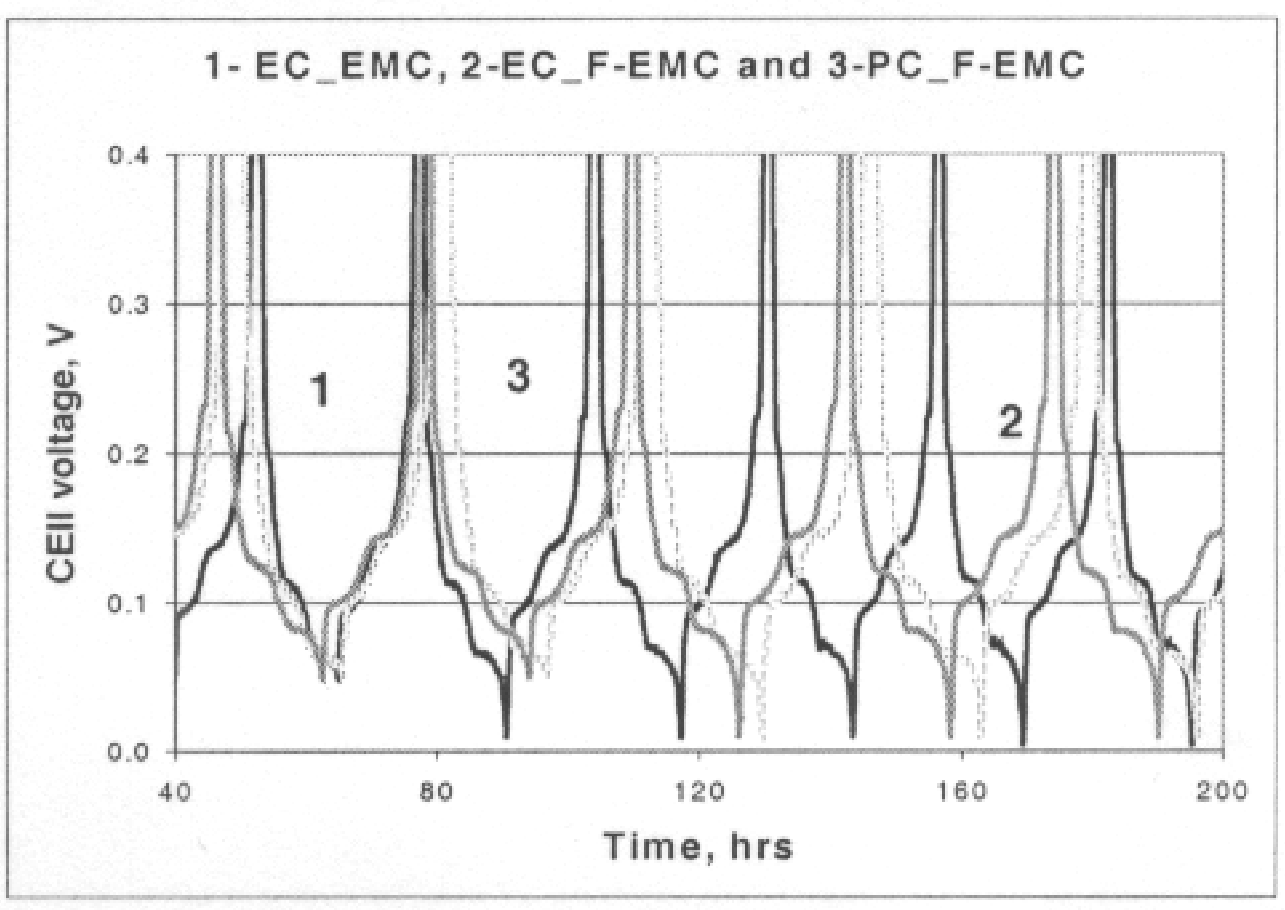

Figure 1. Charge/discharge characteristics of MCMB carbon in EC-EMC; EC –F_EMC and PC-F_EMC containing 1 M $LiPF_6$ at room temperature.

$CH_3OCOOCH_2CF_3$ (3F-EMC)
$CH_3CH_2OCOOCH_2CF_3$ (3F-DEC)

Binary electrolytes of one of the fluoro-solvents mixed with either PC or EC containing 1 M $LiPF_6$ were used in this study. MCMB carbon electrodes were evaluated in these electrolytes in "Tee" cells. Charge/discharge characteristics of MCMB in fluorocarbonate and nonfluoro-carbonate electrolytes are compared in Figure 1. The fluorocarbonate electrolytes perform better than the nonfluorocarbonate electrolytes.
Around 30% more reversible capacity was observed on carbon in fluorocarbonate electrolytes over the nonfluorocarbonate electrolytes. The superior performance of the fluorocarbonate electrolytes might have come from lower cell impedance. We measured the impedance of the cells at different temperatures. NyQuist plots of impedance at RT are given in Figure 2.

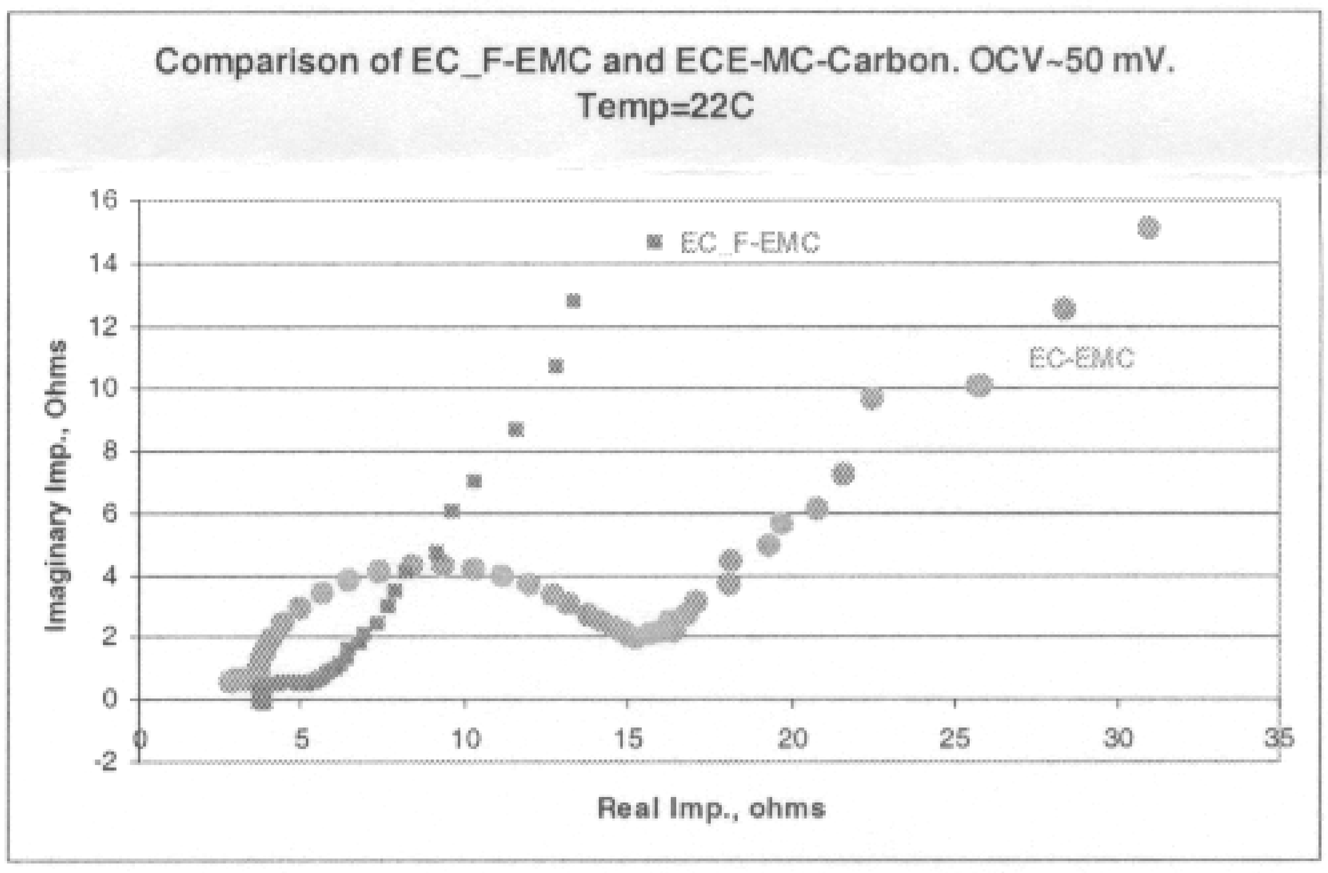

Figure 2. Impedance behavior of MCMB carbon in different binary electrolytes at RT.

The behavior at other temperatures is similar to the RT behavior. The impedance plots clearly show lower total cell impedance and a virtual absence of the interfacial impedance loop for the fluorocarbonate-containing electrolyte. Data on cathode half-cell and full cell studies will be discussed at the meeting.

Acknowledgment
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References:

1) G. Nagasubramanian, R. G. Jungst and D. H. Doughty, *J. Power Sources* 83, 193(1999).
2) Wu, Qunwei; Lu, Wenqua; Prakash, Jai, *J. Power Sources* 88, 237(2000).