

## Polymerization Additives for Overcharge Protection in Lithium Ion Batteries

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While redox shuttle additives can provide limited overcharge protection and cell life extension for lithium ion batteries,<sup>1-3</sup> they cannot prevent catastrophic failure due to severe overcharging. Due to the paramount importance of safety, especially in the consumer battery market, where uncontrolled charging conditions and temperature extremes are more likely, protection mechanisms that prevent overheating, bursting or venting but end the useful life of the cell are acceptable. One approach involves electrolyte additives that are electropolymerized when the desired maximum charging potential is exceeded. A coating is thus deposited on the positive electrode with low electronic and/or ionic conductivity, inhibiting the further passage of current through the cell.<sup>4</sup> The polymerization reaction may also extend into the separator, immobilizing the electrolyte.

We have identified a number of additives with polymerization onset potentials ranging from 4.0 V to greater than 5.2 V vs.  $\text{Li/Li}^+$ . A typical microelectrode CV is shown in Figure 1. On the first sweep, a substantial anodic peak signals the onset of polymerization, which produces a resistive coating on the electrode surface.

The composition, morphology, and electrochemical properties of the polymers formed will determine the utility of these additives in providing reliable and inexpensive overcharge protection for high performance lithium batteries. Here we will present the results of electrochemical, microscopic and spectroscopic studies of these electropolymers.

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2. M. Adachi, K. Tanaka, and K. Sekai, *J. Electrochem. Soc.*, **146**, 1256 (1999).
3. US Patents 5,763,119, 5,709,968 (Sony).
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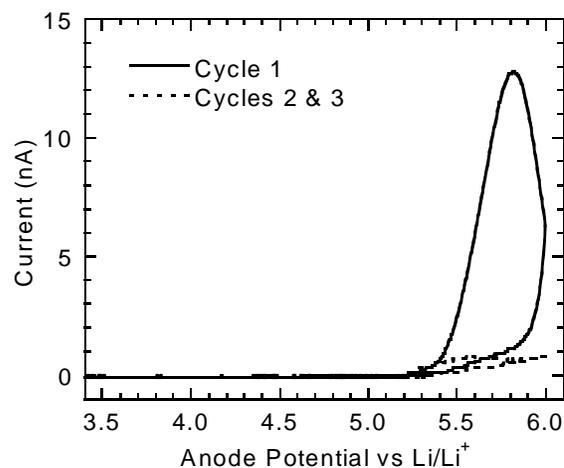


Figure 1. Pt microdisk electrode potential sweep data for polymerization additive in  $\text{LiPF}_6$  EC:2DMC. Additive conc. 0.1 M, sweep rate 20 mV/s.

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