# Fluoropolymers for Binder-Free High Capacity Cathodes

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Developing new high capacity cathodic materials is paramount for the next generation lithium batteries. Transition metal salts are widely used in current lithium batteries as cathodic materials, their capacities, however, are limited by the heavy nature of those elements. Carbon fluoride ($CF_x$) materials, used in primary lithium batteries since the 70s, are the high capacity cathodic materials that cannot undergo fast discharge because of their low conductivity and slow electron transfer kinetics associated with the $CF_x$ materials. Furthermore, the current $CF_x$ materials can only be prepared from high temperature reactions between graphite and fluorine gas, possessing significant safety threat for the production. Solving these problems for $CF_x$ based cathodic materials will significantly increase the capacities of current lithium batteries, benefiting many applications. In this presentation, we report a new type of fluorinated polymers that are much safer to prepare and can be used as high capacity cathodic materials. In addition to the safety and high capacity benefit, these materials do not require additional mechanical binding and conducting materials for cathode preparation.

These new fluoropolymer materials were fully characterized by electrochemical, spectroscopic, and scanning electron microscopic (SEM) methods. Electrochemical experiments were done in an argon-filled glovebox with residual $O_2$ and water levels below 1 ppm. Three electrode systems with a glassy carbon (GC) working electrode, a Pt counter electrode, and a Ag/AgCl reference electrode were used for the fundamental electrochemical characterization of these fluoropolymer-based cathodic materials in both 1,2-difluorobenzene (DFB)/0.1 M $TBAPF_6$ and propylene carbonate (PC)/1.0 M $LiPF_6$ solutions. The galvanostatic discharge and charge tests were done with prototype coin cells, assembled with cathodic materials on either GC or aluminum disc current collectors, lithium disc anodes, and fiberglass separators with 1.0 M $LiPF_6$ PC solution as electrolyte. Our initial results show that new cathode material possesses specific capacity of over $1.0\times10^3$ mAh/g (**Fig. 1**) with average voltage of 2.1 V (vs. $Li^+/Li$) at 0.125 C rate, giving specific energy of $2.2\times10^3$ mWh/g. Searching and optimizing the electrolyte solution for rechargeable applications at relatively low over-potential is currently underway in this laboratory.

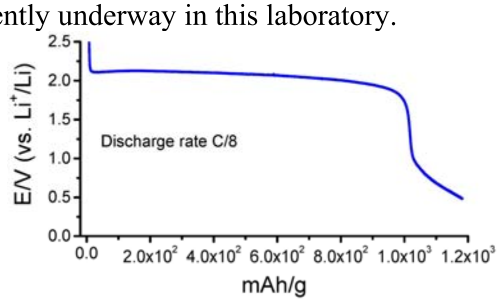


**Fig. 1**. Galvanostatic discharge properties of conducting fluoropolymer cathode.

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