High-Temperature Carbon Monofluoride Batteries with Lithiated Silicon Anodes

Joseph C. Yeager(1), Yan Luo(1), and Robert J. Hamers(1,2)
(1) University of Wisconsin-Madison
1101 University Avenue, Madison, WI 53705
(2) Silatronix Inc.
3587 Anderson St. Suite 108, Madison, WI 54704

Carbon monofluoride (CF_x) is a well-known primary (non-rechargeable) cathode material for lithium-ion batteries. It is particularly notable for its very high energy density, flat discharge profile, and long shelf-stable lifetime. CF_x cathodes are typically paired with lithium metal anodes, but certain applications (such as deep-earth mining) demand batteries that can work at extremely high temperatures, even in excess of the melting point of lithium at about 180°C. In this presentation I will discuss our work using lithiated silicon anodes where we demonstrate operation at 190°C and above with traditional cast-film carbon monofluoride cathodes. A number of different electrolytes were tested and several, including tetraglyme, propylene carbonate, and an organosilicon compound were all shown to be viable in this extreme environment, all with $LiBF_4$ as the electrolyte salt. The system was also shown to function with a germanium anode, showing the generality of the approach extends beyond just silicon. To further investigate the chemistry of these cells, atmospheric sampling mass spectrometry provided direct testing of electrolyte stability at very high temperatures both alone and in the presence of electrode materials. Surface analysis techniques such as XPS also provide information about electrode behavior in these unusual conditions, especially about SEI layer formation. To our knowledge, the cells described in this presentation operate at the highest temperatures ever demonstrated for a lithium-ion battery.