NextGen Develops Safe, All-Solid-State, CFx Primary Battery Technology

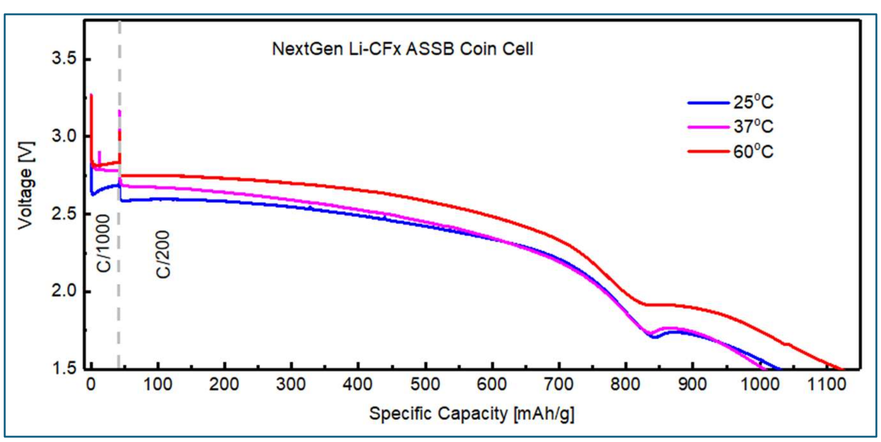
Scientists at NextGen Battery Technologies, LLC, (NextGen) have developed an all-solid-state, carbon monofluoride (Li-CFx) lithium primary battery (ASSB) technology that is safer than current state-of-the-art primary batteries using liquid electrolytes, while attaining comparable performance levels and operating voltages.

According to Dr. Tej Poudel, Senior Scientist, "The Li-CFx development is an offshoot of our proprietary, solid-state electrolyte development funded by a Phase II Grant from the National Science Foundation. Our success with Li-CFx primary batteries is attributable to the tailoring of its solid electrolyte, based on the recognition that solid-state electrolytes play different roles with respect to interfacial and functional requirements within the cathode, and when they serve as the electrolyte separating the cathode and anode, making them distinct systems. Each possess a specific level of ductility, however both are suitable for use in a roll-to-roll form factor. We also evaluated our technology against comparable commercial cells running at varying discharge rates and found that our cell voltage was comparable to that of current products."

He continued, "The operation of Li-CFx cells at elevated temperatures is problematic for Li-CFx with liquid electrolytes. Fire safety and discharge tests at varying temperatures, which show improvements in voltage and energy density as temperatures increase, support the high temperature capabilities of our ASSB. For the fire safety test, the team directed 1900º C propane flame at a section of free-standing solid polymer electrolyte/separator (SPE). The SPE separator discolored in the area subjected to the fire, but no flame was generated on the separator.

In addition, there was no flame propagation to the rest of the separator. This confirms the thermal stability and non-flammable nature of SPE. This property could be particularly attractive for Li-CFx applications in elevated temperatures, such as defense monitoring devices and downhole oil and gas drilling telemetry. This stability will also offer manufacturers of Li-CFx batteries a pathway to avoid cost-prohibitive packaging changes associated with currently proposed shipping safety regulations."

Figure 1 charts discharges at the rate of C/200 for - 60°C, 37°C, and 25°C. After an initial burn-in of 50 hours at C/1000, the cells were fully discharged at the higher rate. The cells continued to show an excellent cell voltage of ~2.65 V, and a capacity of 1025 mAh/g at the cutoff voltage of 1.5 V. Note the presence of a stable lower voltage (1.8 V) plateau, a useful indicator that the battery is nearing end-of-life.



This plateau is such that discharging to a voltage of 0.5 V yields another 55% in battery capacity. Li-CFx applications can require short pulses at higher discharge rates for communication and heart stimulation when used in human implantable batteries, as well as by batteries for data transmission in higher temperature monitoring or security applications.

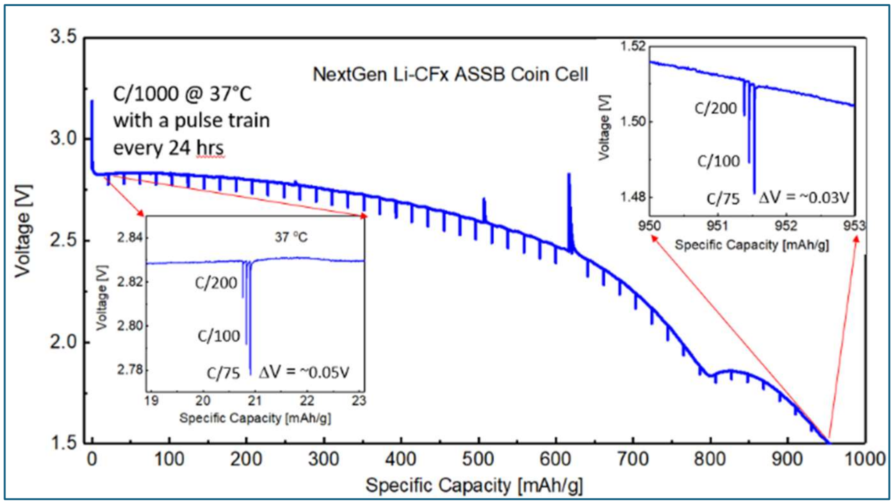


Figure 2 indicates that NextGen's ASSB Li-CFx can support rapid pulses of C/200, C/100, and C/75 every 24 hours with nominal voltage drop at all discharge levels.

"We also demonstrated that cathode swelling during discharge of our ASSB Li-CFx technology is reduced to approximately 1/3 of that typically experienced with commercial liquid-electrolyte Li-CFx batteries. This unique behavior can yield increased cell capacity by reducing the traditional need to leave void space in the cell to accommodate swelling," Dr. Poudel explained.

In summary, NextGen has optimized the Li-CFx all-solid-state battery performance with a newly developed high-conductive solid electrolyte. The ASSB Li-CFx cell performance is approaching that of conventional Li-CFx batteries. This project sets the stage for Li-CFx all-solid-state primary batteries for the commercial market, including batteries for high-temperature applications in which the use of conventional liquid electrolytes is problematic. This technology will be essential for the implementation of safer battery technology in medical devices, military equipment, and aerospace. NextGen attributes its success both to the qualities of its polymer electrolyte system and to its response to the recognition of the inherent differences in the roles of the electrolyte in the cathode and in the separator, and the electrochemical demands placed on them.

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