Introduction
Lithium ion batteries are limited by their susceptibility to failure at high temperatures. The objectives of our research are:
➢ Identify failure mechanisms of Li ion battery electrodes after cycling under different temperatures and discharge loads
➢ Establish a relationship between failure, temperature, and discharge load

Methodology
➢ Run Li ion cells at 20°C and 45°C under 10A and 20A for each temperature
➢ Construct coin cells from electrode materials for electrochemical testing
➢ Observe morphology changes in electrodes via scanning electron microscopy (SEM) and energy dispersive x-ray spectroscopy (EDS)
➢ Observe changes in crystallinity via X-ray diffraction (XRD)

Results
Fig 1: Cycling at high temperatures causes significant impedance in Nickel-Cobalt-Aluminum (NCA) cathode

Graphite 10A vs 20A (@ RT)

Fig 2: Increasing discharge load has little effect on impedance in graphitic anode

NCA Cathode RT vs 45°C (@ 20A)

Fig 3: EDS element mapping of graphitic anode cycled at 45°C under a 20A discharge load; the presence of fluorine and phosphorous indicates solid electrolyte interphase (SEI) growth on the anode. This is a major degradation mechanism of Li ion cells.

Fig. 4: XRD peaks for NCA cathode

Conclusions
➢ Increasing temperature has a significant impact on impedance (resistance to ion flow)
➢ Increasing discharge load causes a minor increase in impedance
➢ Solid electrolyte interphase (SEI) may be observed via fluorine and phosphorous deposits from LiPF6 electrolyte
➢ XRD does not detect changes in crystallinity; therefore, no new crystalline phases are present

Future work
➢ Higher resolution imaging techniques such as transmission electron microscopy (TEM) will be necessary to observe the SEI morphology
➢ Research materials that are resistant to deterioration at elevated temperatures
➢ Test materials via half-cell construction, characterization

Literature cited

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