Anode-less Lithium-ion cells
Investigating influence of current collector surface morphology on ‘anode-less’ batteries

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Introduction
Anode-free batteries offer improved energy densities over graphite or lithium metal anodes, by having Li metal plate on to the current collector during charging. However due to the lack of a Li reservoir, Li losses directly decrease deliverable capacity and limits cyclability. Therefore Anode-free cells are held back by repeated SEI formation, dead lithium (both Li loss processes) and dendrites.

Electrochemical Data: comparing cycling performance
Coulombic Efficiencies were calculated by dividing stripping capacity by charging capacity and present initial plating morphologies.

Investigating fluorine content of Cu Surfaces with EDX
Data suggest flowery plating has potentially higher Fluorine to Phosphorus ratio than mossy lithium indicating SEI and morphology are related.

Conclusions
- Cu-2-T outperforms Cu-1-T in terms of CE and shows dense flowery plating
- Higher Fluorine concentration found on flowing plating relative to mossy lithium
- Dead lithium observed from 1st cycle
- Rests in discharged state result in spikes in CE

Next steps
- Copper 2 will be used as current collector in Degradation project going forward
- Further investigation into why CE spikes after rests and more extensive work on the fluorine content in the SEI are needed.

Methodology
Produced 50/50 coin cells to create consistent plating conditions across the different coppers for SEM imaging.

Electrochemistry: investigating fluorine content of Cu Surfaces
The cells were then deconstructed, and the Li plated copper samples were imaged under the SEM using the air transfer module.

Initial plating morphologies comparisons.
Plated a small amount of Li
- Observed flat flowery plating on both coppers
- Potentially denser flowery-like plating on Copper 2
- Regions of un-plated copper observed on both samples

Development of mossy plating with increasing capacity
- Flowery morphology lithium plating first at low capacity.
- Thinner dendrites form later covering flowery lithium

Imaging dead lithium after 1st cycle
Stripped as much lithium as we could after plating (1 cycle)
- Observed dead lithium, even in the flowery morphology

DNP Method to study SEI on Li dendrites
NMR DNP offers increased sensitivity and selectivity that not only gives chemical composition measurements but also spatial arrangement.

Large enhancement implies close to Li metal and hence Inner SEI. Spectra suggest Li salt in inner SEI and Fluorine species existing in outer. Results suggest reformation of SEI in the cycling of coppers treated and untreated.

References

