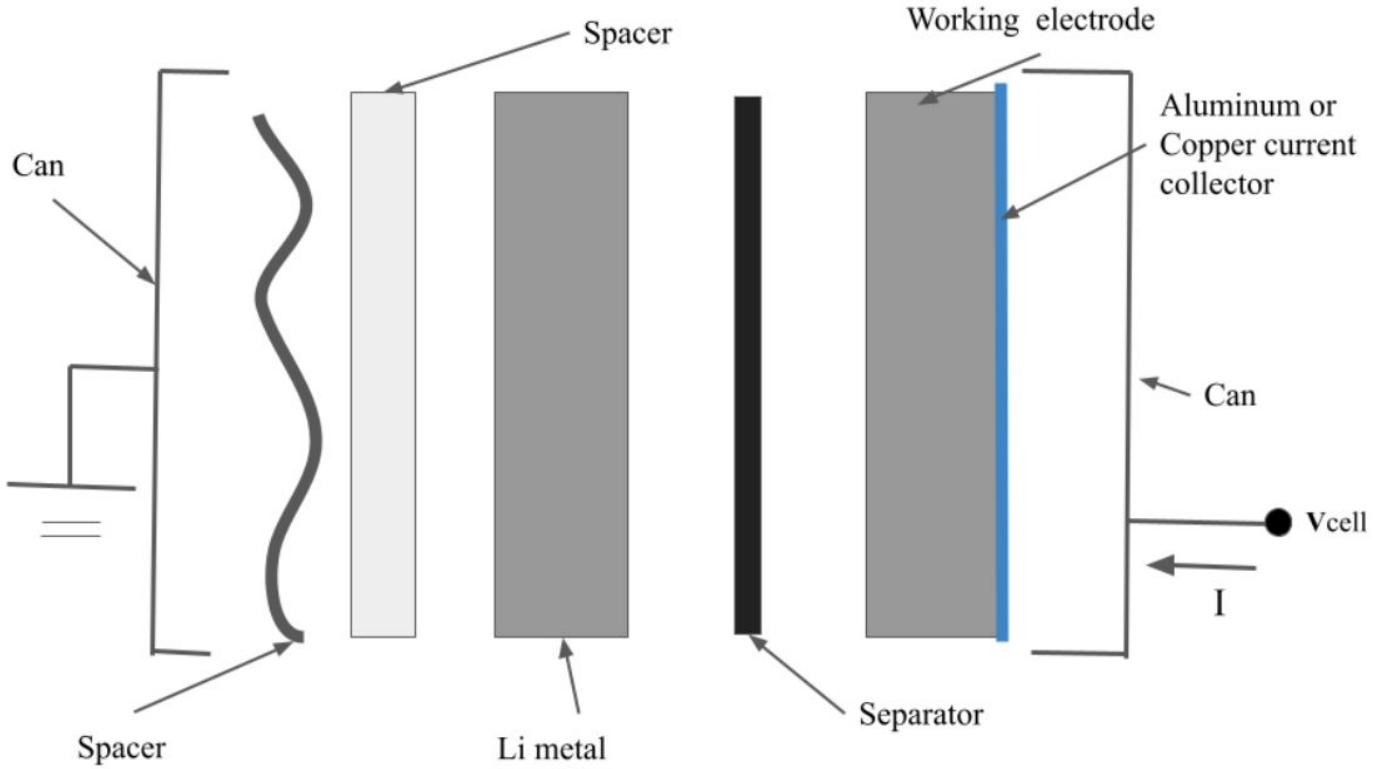
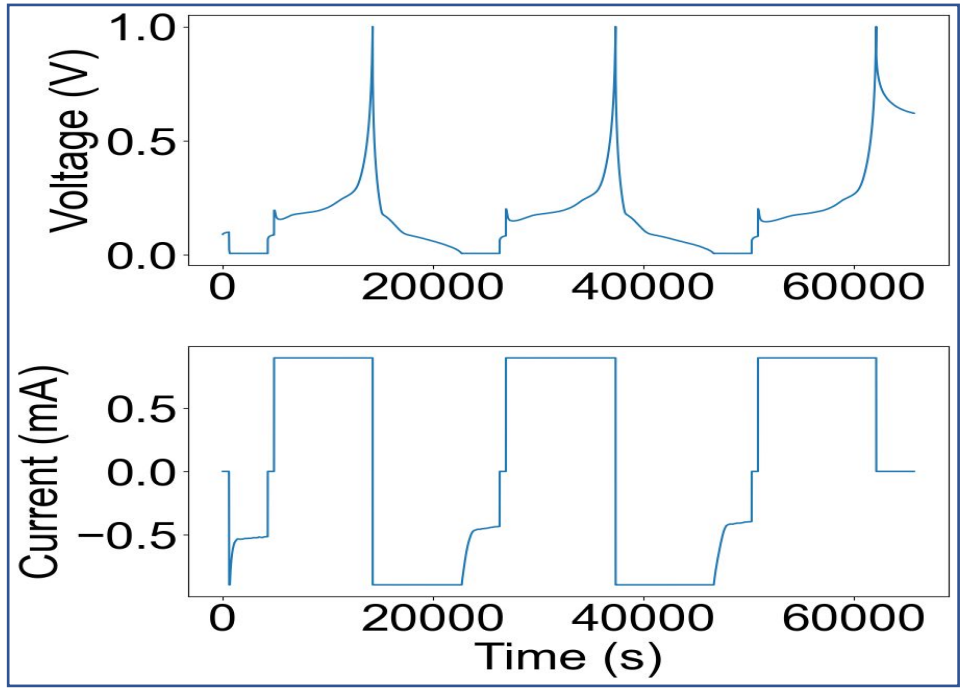
Introduction

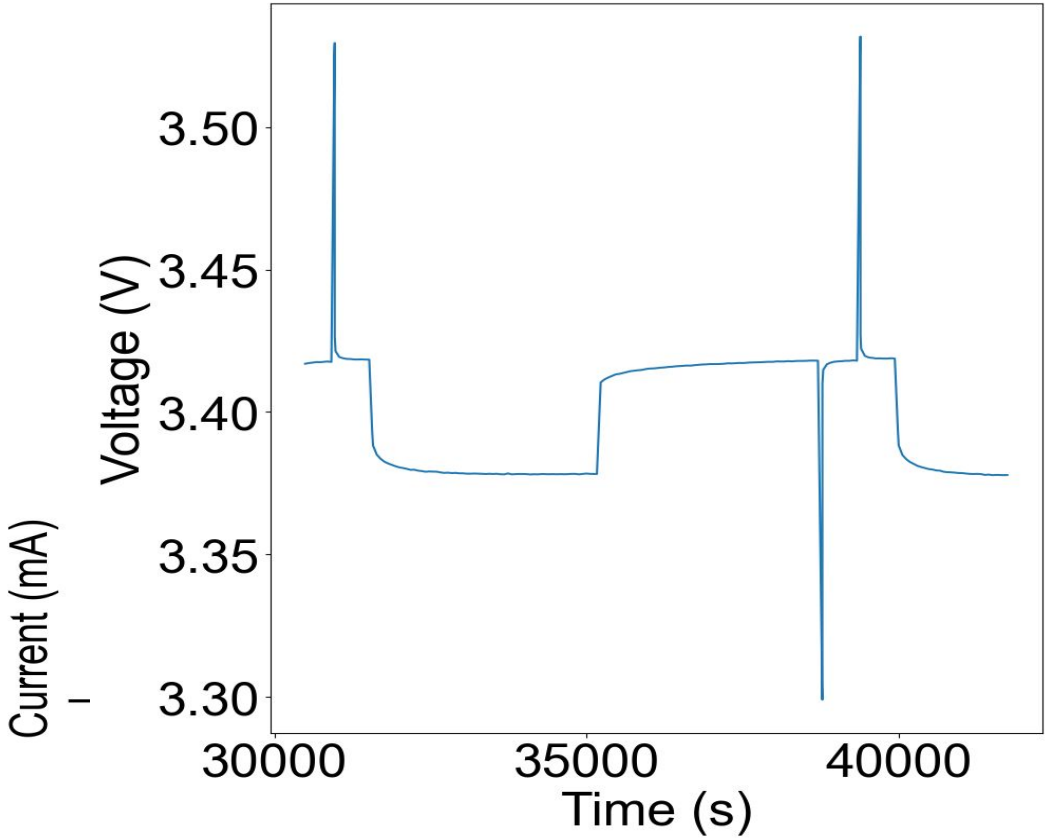


- The report goes over the reproducibility of coin cell data
- It also compares different materials between each other

Design of experiments

Precondition





- Precondition:
  - This protocol helps us calculate capacity of the coin cells
  - Batteries are discharged and charger at C/5 rate

- HPPC
  - This protocol helps us calculate the resistance of the battery
  - A 10-s C/5 pulse is used to calculate resistance. The process is repeat at all SOCs. The cells are discharged by a C/30

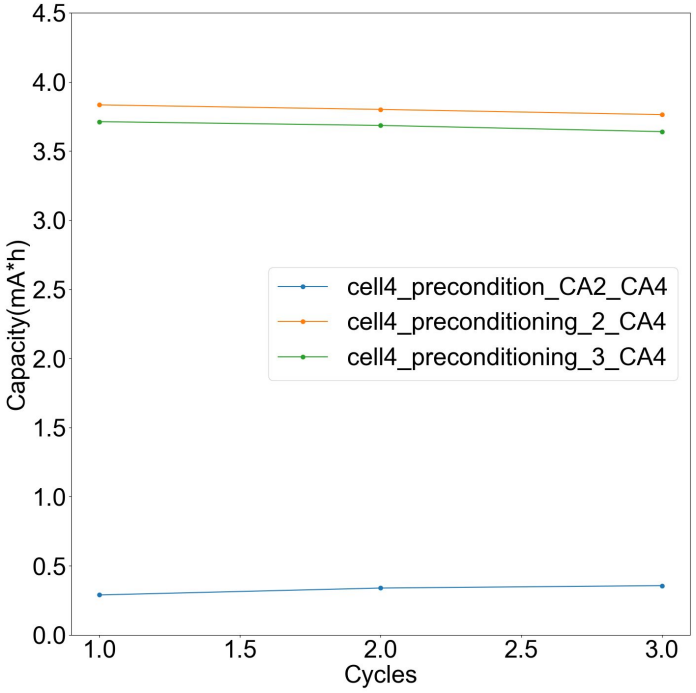
Design of experiments

Cell #	Material in Cell	Voltage (V)	Capacity (mAh)	Type of Holder	Channel	PreCondition	HPPC	C-50	C-150
1	NMC111	1.784	1.94		2	2	1		
2	NMC111	2.078	1.99	A	2	2(4)	3	1	
3	NMC111	2.010	2.02	B	4	2(3)			
4	LFP	3.029	2.93	A	4	1(2)			
5	LFP	2.871	2.96		4	2(3)			
6	LFP	3.029	2.77		4	2	2	3	
7	Sa1520	2.820	4.66	A	7	3(6)	2	3	1
8	Sa1520	2.980	4.49		8	2	1	2	
9	Sa1520	2.984	4.59		8	1			

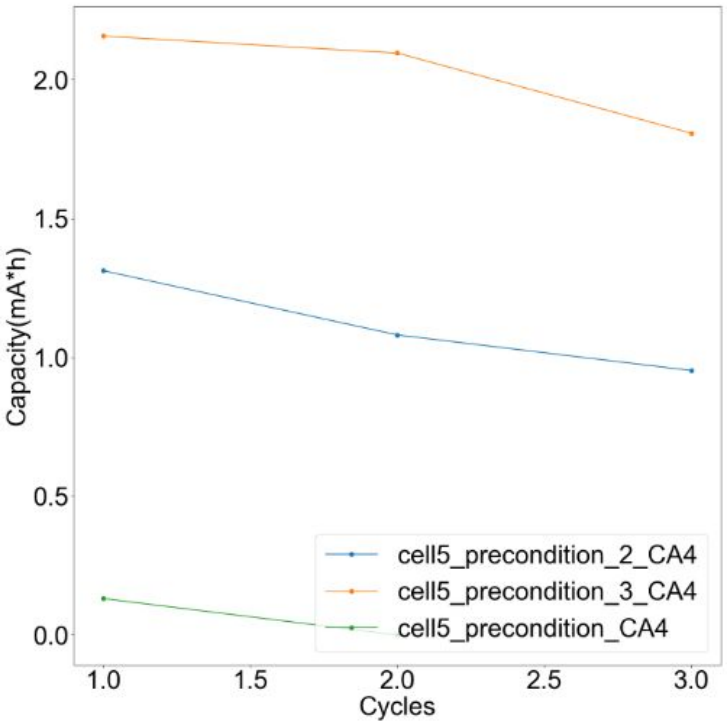
- We conducted 3 cells for each material
- We picked two cathodes and one anode: NMC111, LFP and Graphite(Sa1520)

Results: Pre-Conditioning - Same Cell

LFP:

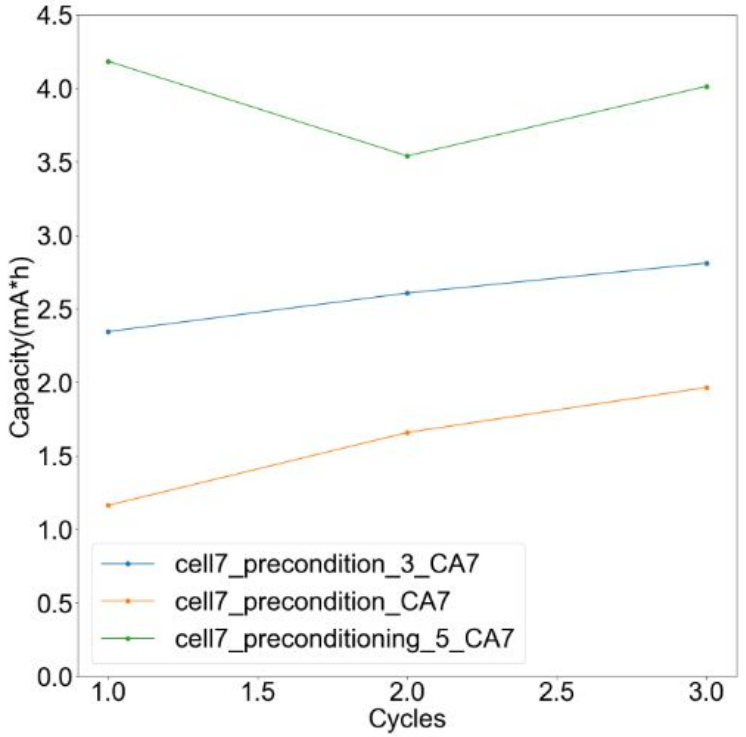


Theoretical: 2.9 mAh



Theoretical: 2.9 mAh

Graphite:

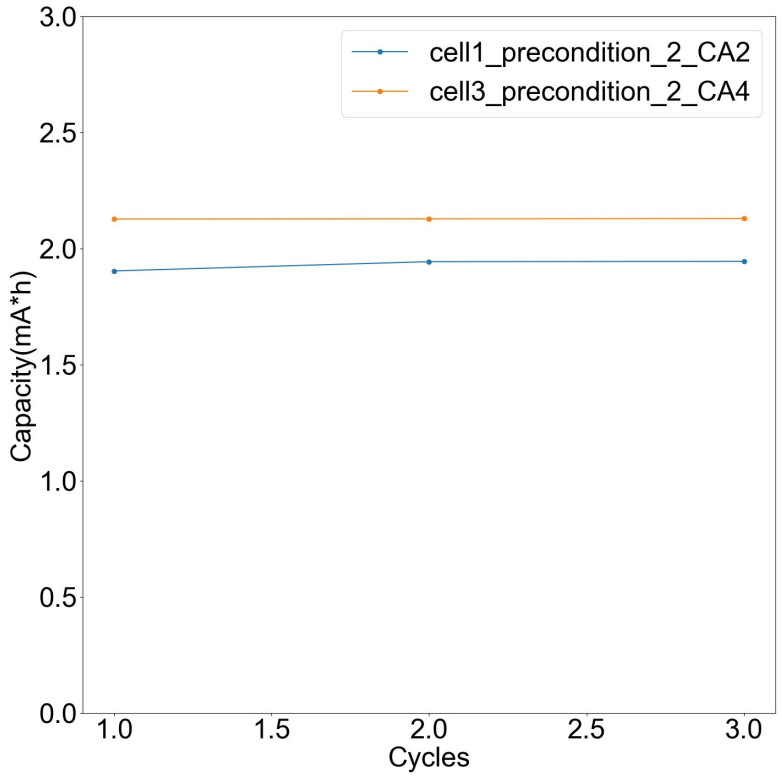


Theoretical: 4.6 mAh

- The capacity tends to increase after repeating preconditioning protocol
- Generally, the capacity is not stable
- An increasing trend over multiple cycles can be seen due to the possible deeper insertion of liquid electrolyte inside the layered graphite
- The decrease in capacity can be caused by multiple reasons including unstable SEI, dendritic growth and electrolyte leakage.

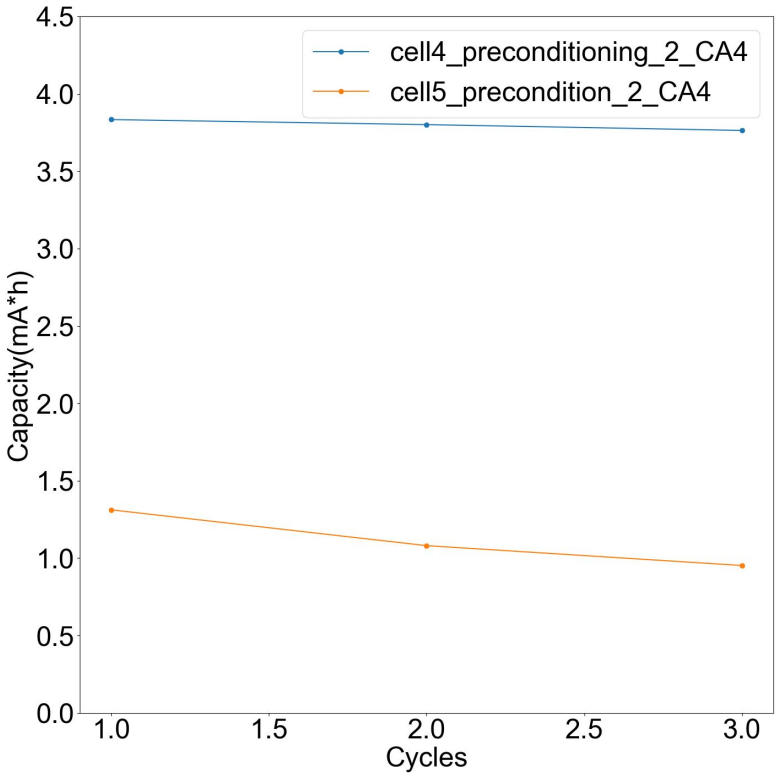
Results: Pre-Conditioning - Different Cell

NMC111:



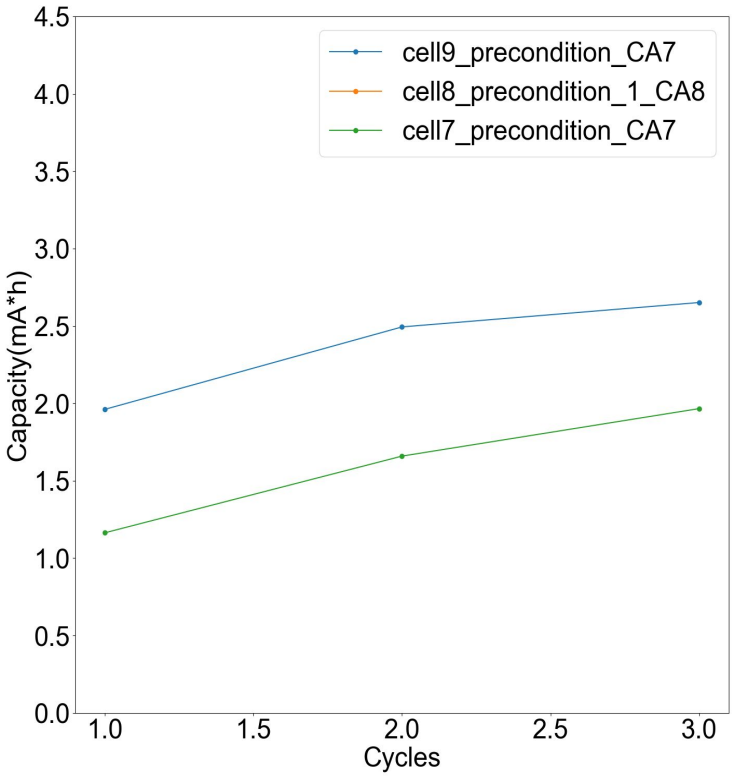
Theoretical: 2.0 mAh

LFP:



Theoretical: 2.9 mAh

Graphite:

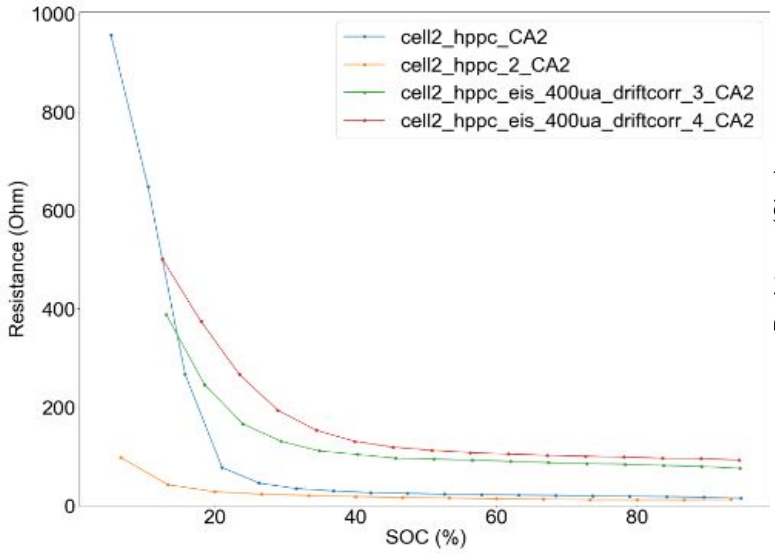


Theoretical: 4.6 mAh

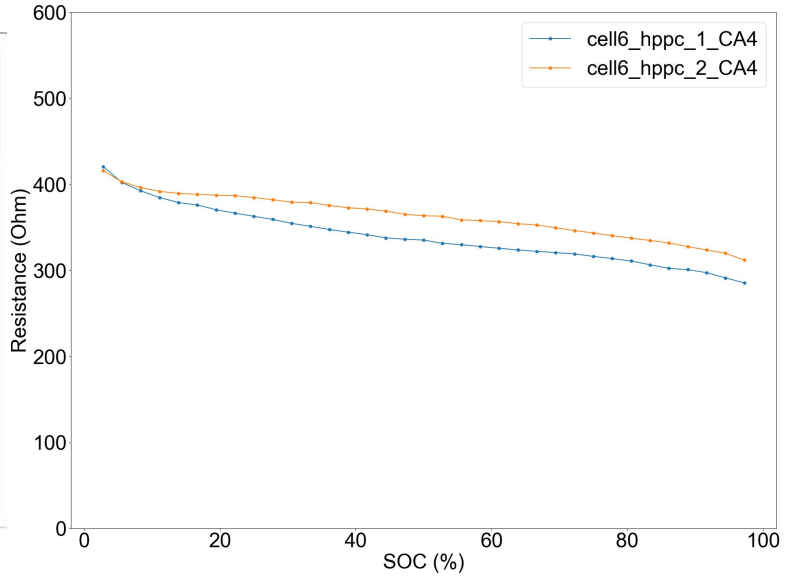
- The comparison between the same cycle provides more stable results
- A potential reason behind a great variation in LFP is the 3 month difference between cell 4 and cell 5

Results: HPPC

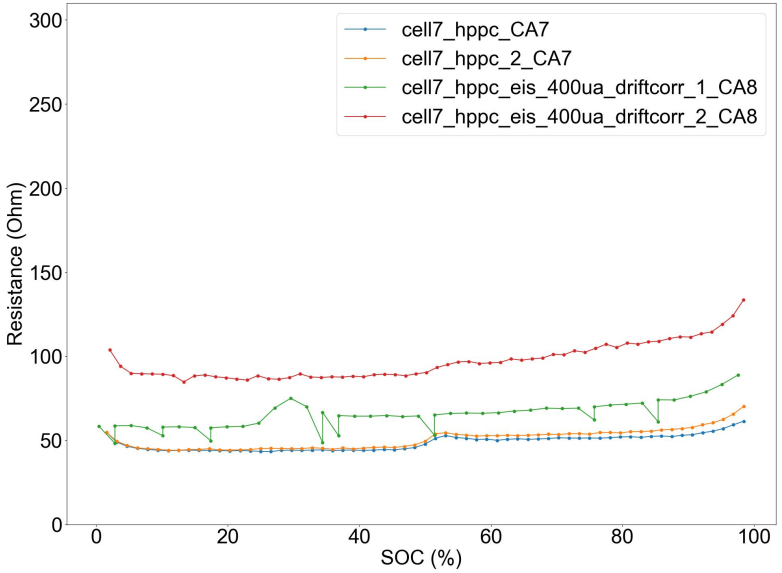
NMC111



LFP



Graphite



- Overall, resistance tends to increase as more protocols are ran.
- One of the possible reasons may be the resistance growth of lithium metal
- Graphite material has a distinctive bump at around 50% SOC which was reproduced in two different coin cells. Moreover both ends indicate an increase in resistance
- Moreover, Graphite expresses a much lower resistance compared to the two cathodes(300 - 400 vs 100)
- Each material has distinctive resistance shape and Graphite's graph was inverted since it is an anode

Conclusions

- Certainly, it is clear that careful management is necessary while working with coin cells: the data can be reasonably compared only if exactly the same sequence of protocols was run on the cell and if researchers keep track of the time

Future Work

- Explore electrochemical impedance spectroscopy to dive deeper in the processes of the coin cells.
- Possibly research the effect of time on the batteries
- Introduce a new independent variable: temperature of our coin cells