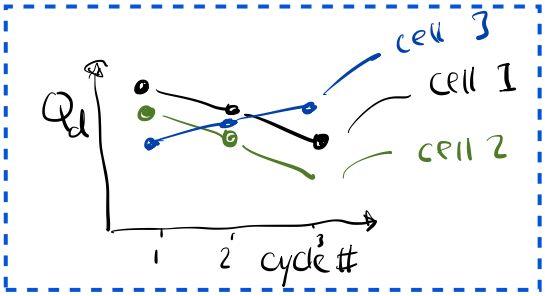
Discuss cell metrics that can be extracted from the data. 11/8/2021

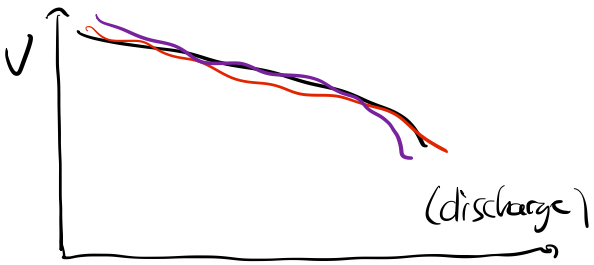
Pre-Conditioning : ★ Check coin cell stability, reproducibility ★ Are coincells as stable as full cells?



C/20, 1C

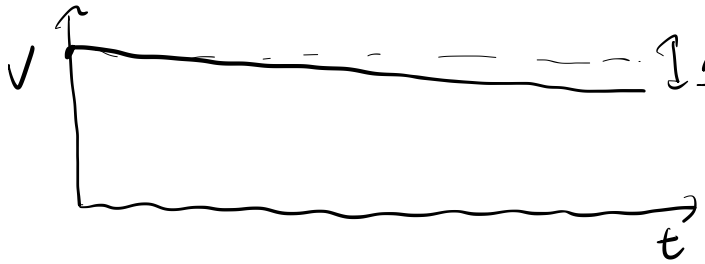
{NMC, LFP, Gr}

C/150 ~ OCV curve



{NMC, LFP, Gr}

Voltage monitoring (<50% capacity retention cells)



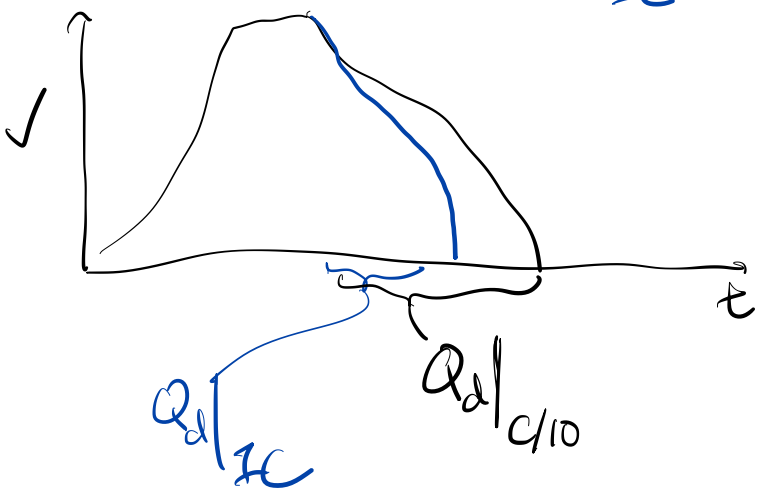
★ Q: are these cells self-discharging?

★ Is the self-discharge characteristic different between fast-formation cells and baseline formation cells?

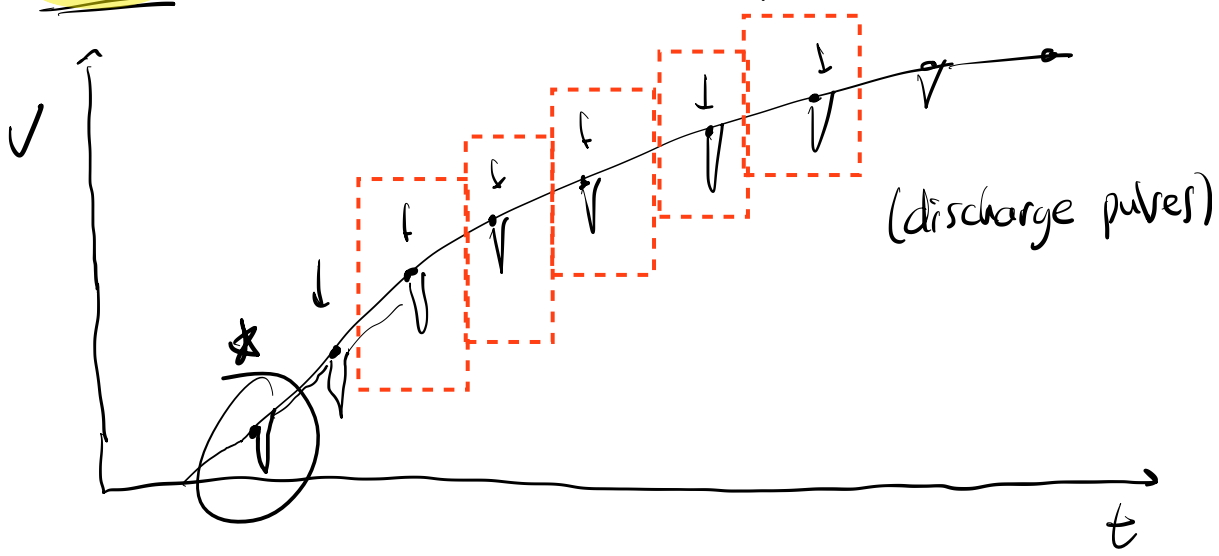
		Formation Type	dV/dt
cell	1	FF	2mV/hr
	2	FF	3mV/hr
	3	BF	
	4	BF	

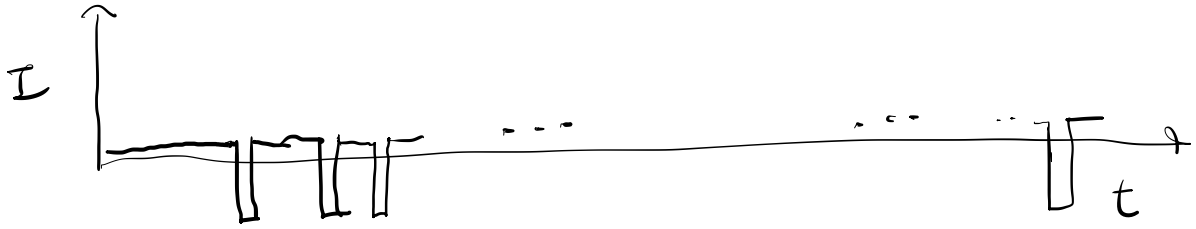
Capacity Diagnostic (C/10)

1C

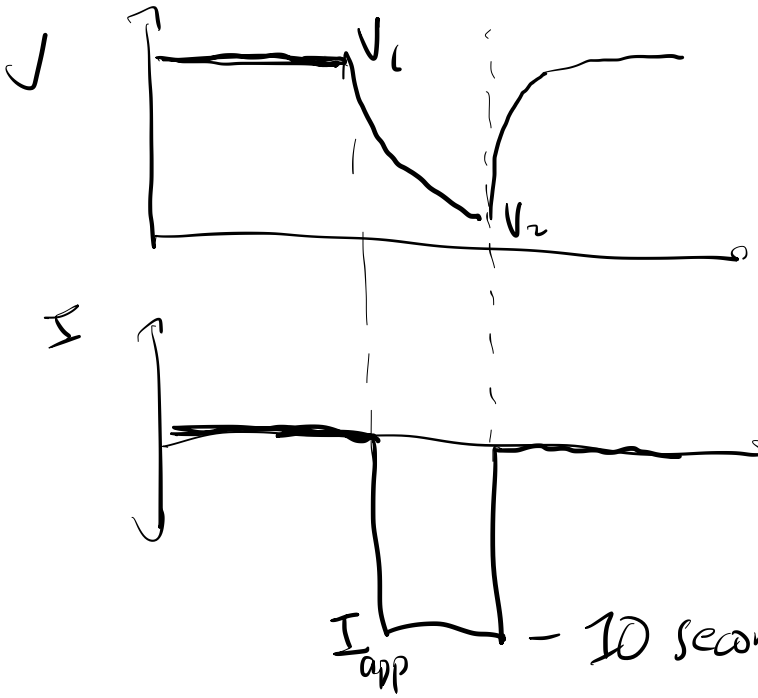


HPPC (resistance characterization)



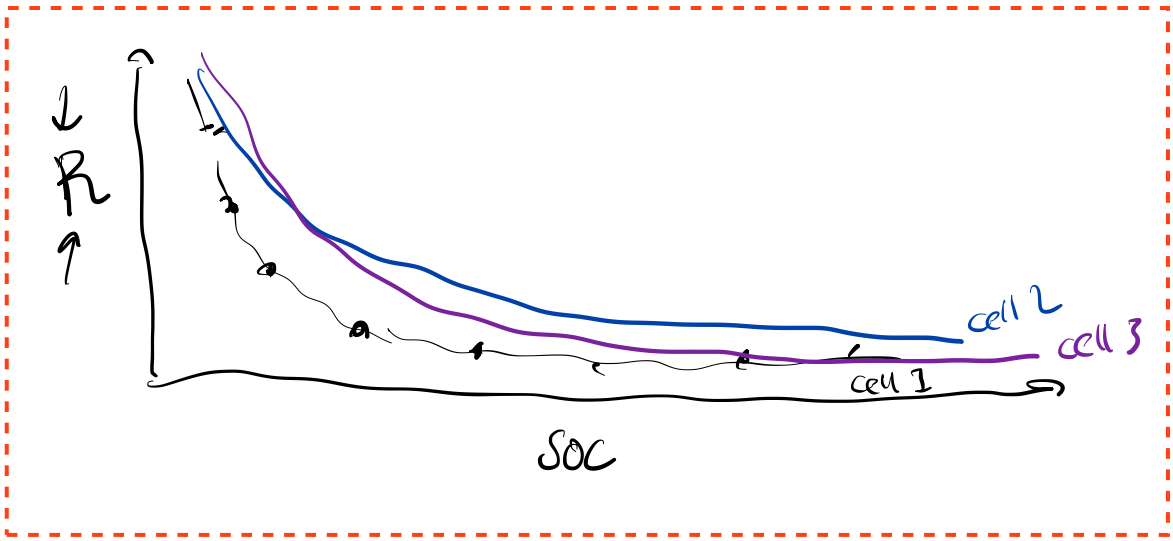


Zoom in to (*)



$$R = \frac{V_1 - V_2}{I_{app}}$$

– 10 second, 1C discharge pulse.
(C/5 discharge for coin cells)



$R_{anode} + R_{cathode} \stackrel{?}{=} R_{cell}$.

Roger

anode cathode

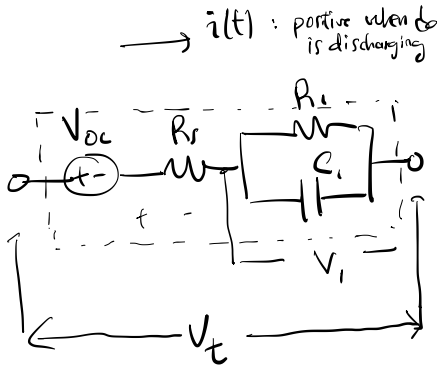
Iaro

Rate Dependence

- How slow do we need to go to approximate an OCV curve? Is it material dependent?

(not discussed)

OCV - R - RC model captures "exponential decay" behaviour of cells:



$$V_t(t) = V_{OC}(z(t)) - V_{R_s}(t) - V_1(t) \quad \text{(KVL)}$$

$$V_{OC}(z(t)) - i(t)R_s - i_{R_1}(t)R_1$$

$$z(t) = z(t_0) - \frac{1}{Q_{max}} \int_{t_0}^{t} i(\tau)d\tau$$

$$z[k+1] = z[k] - i[k]\Delta t / Q_{max}$$

$$i = i_{R_1} + i_{C_1} \quad \text{(KCL)}$$

$$i = i_{R_1} + C_1 \frac{dV_1}{dt}$$

$$i = i_{R_1} + R_1 C_1 \frac{di_{R_1}}{dt}$$

$$\frac{di_{R_1}(t)}{dt} = -\frac{1}{R_1 C_1} i_{R_1}(t) + \frac{1}{R_1 C_1} i(t)$$

Taylor Series approximation:

$$\frac{i_{R_1}[k+1] - i_{R_1}[k]}{\Delta t} R_1 C_1 + i_{R_1}[k] = i[k]$$

$$\dot{x}(t) = ax(t) + bu(t) \Rightarrow x(t) = e^{at}x(0) + \int_0^t e^{a(t-\tau)} b u(\tau) d\tau$$

$$i_{R_1}[k+1] = \exp\left(-\frac{\Delta t}{R_1 C_1}\right) i_{R_1}[k] + \left(1 - \exp\left(-\frac{\Delta t}{R_1 C_1}\right)\right) i[k]$$