Summary of this week

- We have now fully derived ESC cell model: describes SOC-dependent OCV, ohmic and diffusion voltages, hysteresis
- ESC "state equation" describes all dynamic effects (cf. slide 4 re. A_{RC}, B_{RC}, A_H)

$$\underbrace{\begin{bmatrix} z[k+1] \\ i_R[k+1] \\ h[k+1] \end{bmatrix}}_{x[k+1]} = \underbrace{\begin{bmatrix} 1 & 0 & 0 \\ 0 & A_{RC} & 0 \\ 0 & 0 & A_H[k] \end{bmatrix}}_{A[k]} \underbrace{\begin{bmatrix} z[k] \\ i_R[k] \\ h[k] \end{bmatrix}}_{x[k]} + \underbrace{\begin{bmatrix} -\eta[k]\Delta t/Q & 0 \\ B_{RC} & 0 \\ 0 & A_H[k]-1 \end{bmatrix}}_{B[k]} \underbrace{\begin{bmatrix} i[k] \\ \mathrm{sgn}(i[k]) \end{bmatrix}}_{u[k]}$$

- ESC "output equation" computes voltage

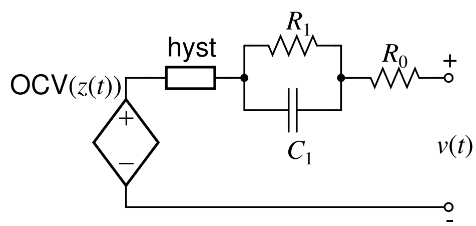
$$v[k] = \text{OCV}(z[k], T[k]) + M_0 s[k] + M h[k] - \textstyle\sum_j R_j i_{R_j}[k] - R_0 i[k]$$

Summary of this week (continued)

- Model be visualized as an equivalent circuit
- Mathematically it comprises two coupled equations

$$\begin{aligned} x[k+1] &= A[k]x[k] + B[k]u[k] \\ v[k] &= f(x[k], u[k]) \end{aligned}$$

- This "state-space" model structure will be vitally important in Course 3 of the specialization, on SOC estimation



Where from here?

- We now begin to consider how to find the parameter values of the model equations
- You will learn how to find the static parts of the relationship
  - What kinds of lab equipment are needed to characterize a particular cell?
  - What laboratory tests do we perform?
  - How do we compute coulombic efficiency?
  - How do we determine cell OCV?
- You will also see Octave/MATLAB code to perform these computations

Credits

Credits for photo in this lesson

- "What's next?" on slide 2: By Sarah Reid, [CC BY 2.0 (https://creativecommons.org/licenses/by/2.0/)], https://www.flickr.com/photos/sarahreido/4683295771

In the earlier slides, note that

$$A_{RC} = \begin{bmatrix} \exp\left(\frac{-\Delta t}{R_1C_1}\right) & 0 & \cdots \\ 0 & \exp\left(\frac{-\Delta t}{R_2C_2}\right) & \\ \vdots & & \ddots \end{bmatrix}, \qquad B_{RC} = \begin{bmatrix} \left(1-\exp\left(\frac{-\Delta t}{R_1C_1}\right)\right) \\ \left(1-\exp\left(\frac{-\Delta t}{R_2C_2}\right)\right) \\ \vdots \end{bmatrix}$$

$$A_H[k] = \exp\left(-\left|\frac{\eta[k]i[k]\gamma\Delta t}{Q}\right|\right)$$