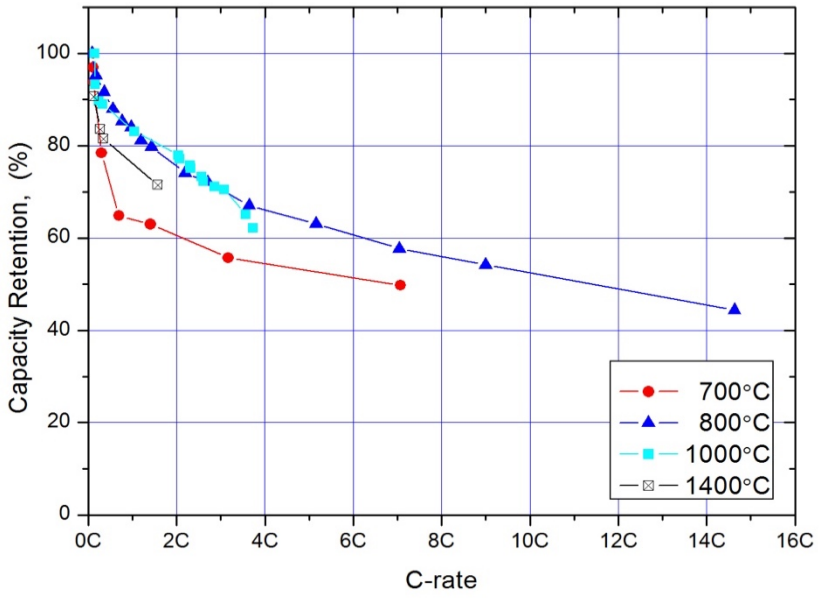
4D_Li+ battery: C-Rate

Introduction

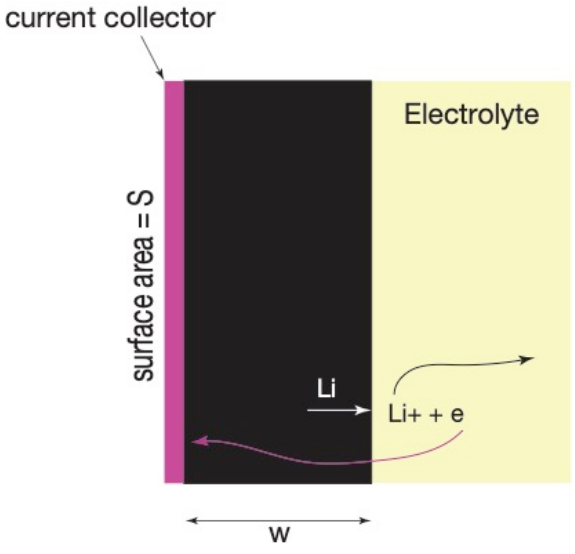
C-rate is the number of cycles per hour, and, therefore, has units of h^{-1}. It is the rate at which current is drawn from the battery. The capacity of the battery (expressed as the % of the theoretical capacity – obtained at very low currents) declines as the cycle time becomes faster.



The fundamental reason for this behavior is that at high currents only a part of the anode is subjected to charge and discharge – it is related to the diffusion of Li through the anode material. We illustrate this point by the example described below.

The Approach

For simplicity, consider a monolithic anode as shown below. It has a width of w and a surface area of S. The distance from which Li is drained from the anode depends on the diffusion distance, which is related to the coefficient of diffusion as follows



$$6Dt = L^2 \qquad (1)$$

The Analysis

In the figure given above 100% refers to the full width of the anode being engaged in the discharge capacity.

Draw normalized parameters to express the C-rate in terms of the parameters in Eq. (1) to show the dependence of the effective capacity as a function of the C-rate. In particular aim for the shape expressed in the experimental results.