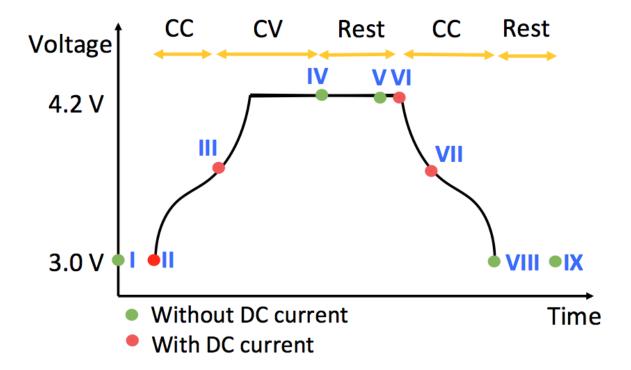
Supplementary Information

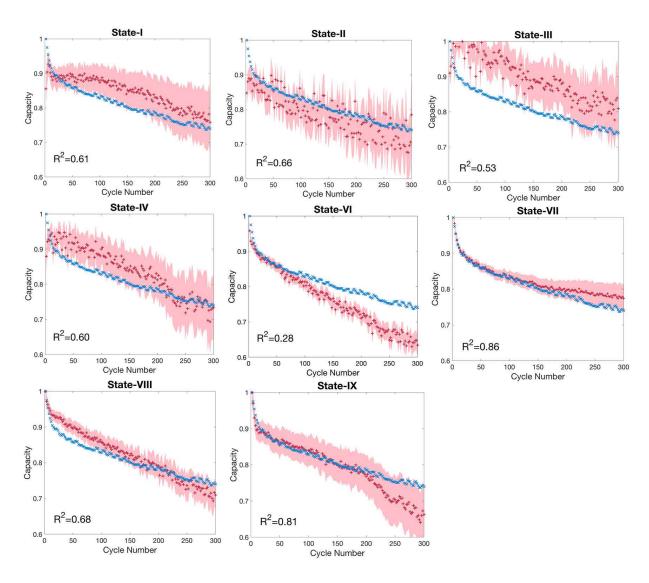
Identifying degradation patterns of lithium ion batteries from impedance spectroscopy using machine learning

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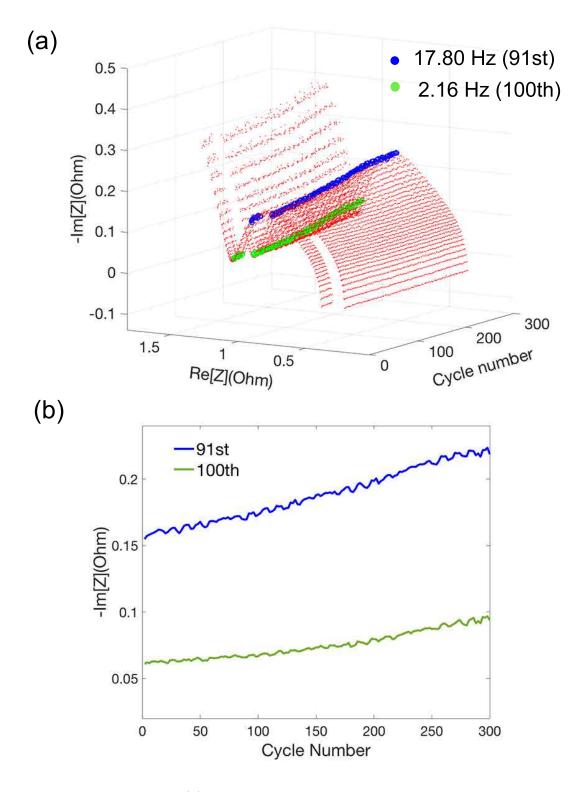


Supplementary Figure 1 – EIS data are collected at nine different states (representing as I-IX) during constant current-constant voltage (CC-CV) charging and discharging: II:

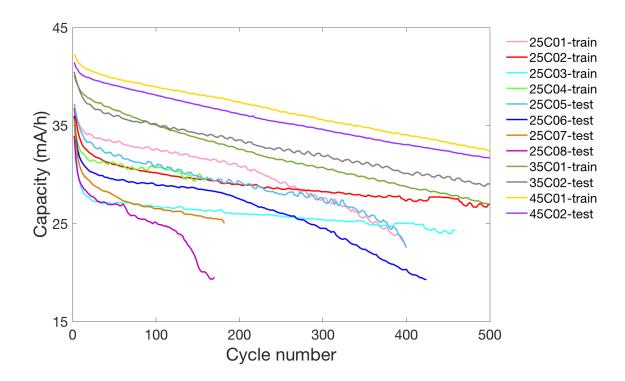
Before charging; II: Start charging; III: After 20 minutes charging; IV: After charging and before resting; V: After 15 minutes rest; VI: Start discharging; VII: After 10 minutes discharging; VIII: After discharging and before resting; IX: After 15 minutes rest. The red (green) dots correspond to with (without) DC current.



Supplementary Figure 2 – The estimation results of the EIS-Capacity GPR model for 25C02 cell cycled at the other eight different states (I-IX). The red curve shows the estimation of capacity, and the shaded region indicates \pm 1 standard deviation. The testing EIS in each panel are collected at states I-IX, respectively. The blue dashed lines are the measured capacity. The coefficient of determination (R^2) is shown on the left bottom in each panel.



Supplementary Figure 3 – (a) The EIS spectra mapping along cycle numbers of 25C01 cell at state V (red dots). Blue and green curves indicate the two most salient frequencies of 17.80 and 2.16 Hz, respectively. (b) The imaginary part of the salient frequencies show a positive linear correlation with the cycle number.



Supplementary Figure 4 – The capacity retention curves of all cells (marked with different colors). 25C01-25C04, 35C01 and 45C01 cells are training group. 25C05-25C08, 35C02 and 45C02 are testing group.

Cells Input	25C05	25C06	25C07	25C08
EIS (ours)	8.57	18.19	5.25	5.03
Capacity and voltage curves	43.22	34.28	38.14	73.20

Supplementary Table 1. The root-mean-squared error (RMSE) of our EIS-based method and the method using the discharging curve as input.