Supplementary Materials for

Real-World Approach for Evaluating Capacity Fading in Lithium-ion Batteries Using Novel Cyclic Testing Methods

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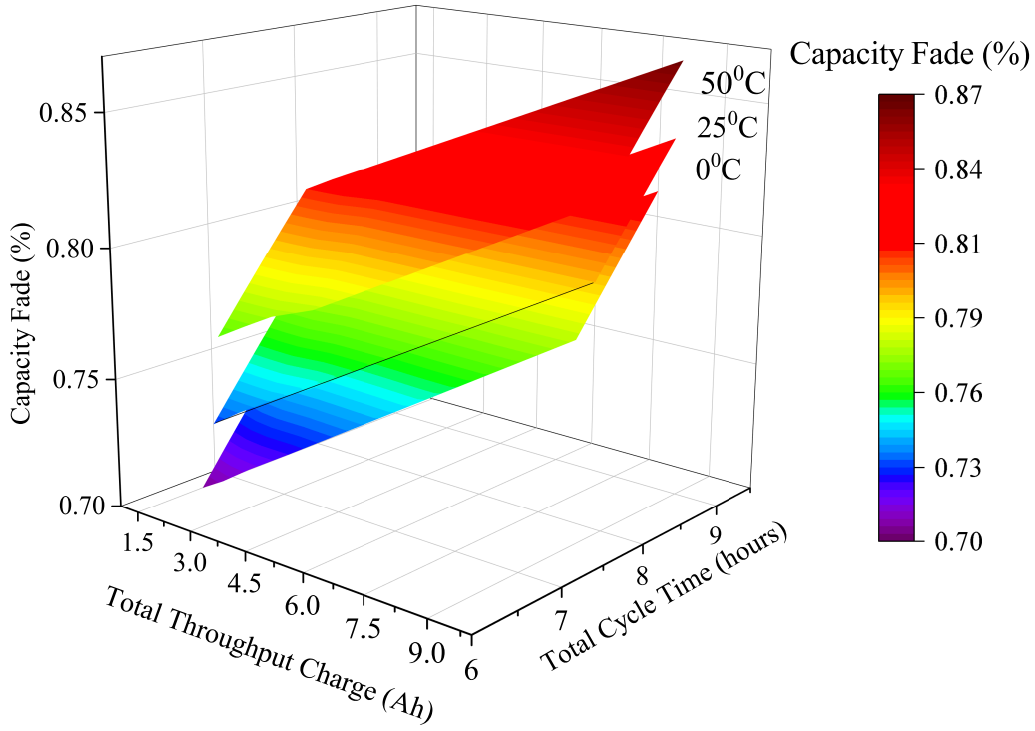
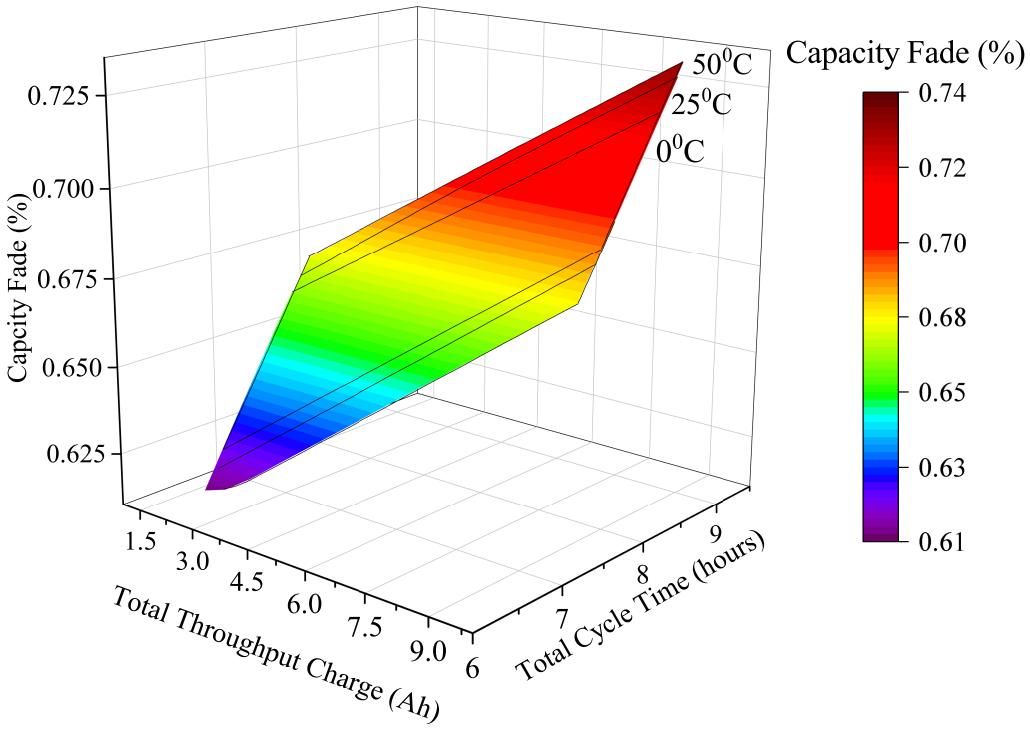
1 Supplementary Figures

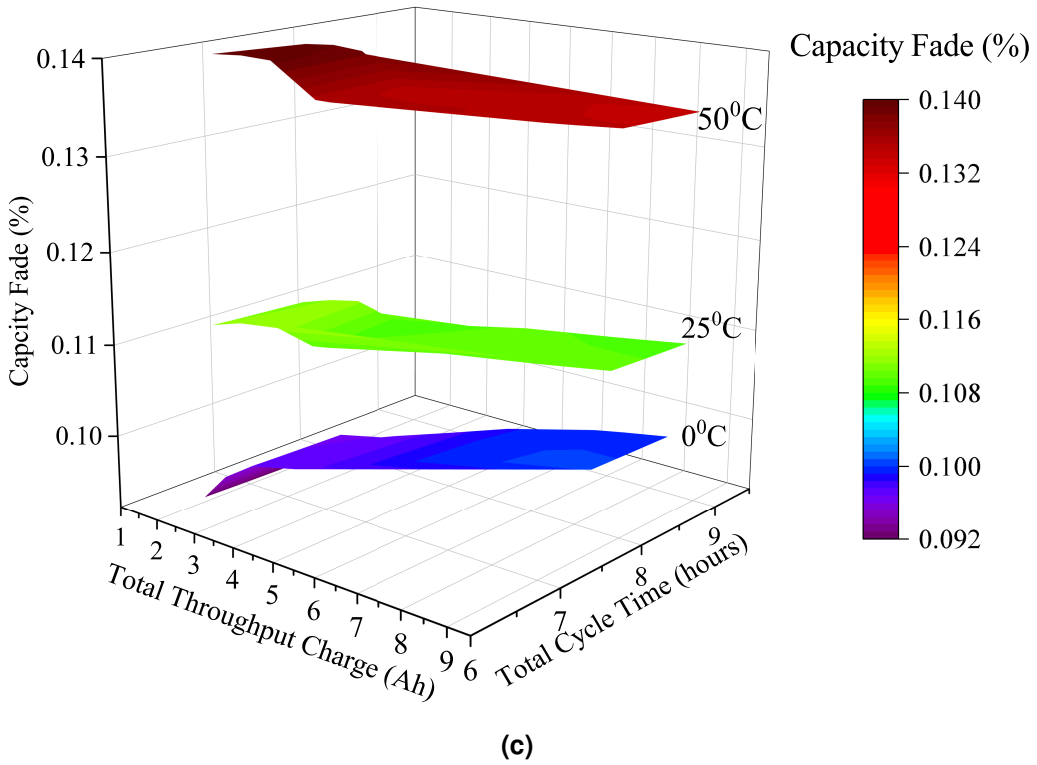
1.1 Capacity fade with altering temperature



(a)

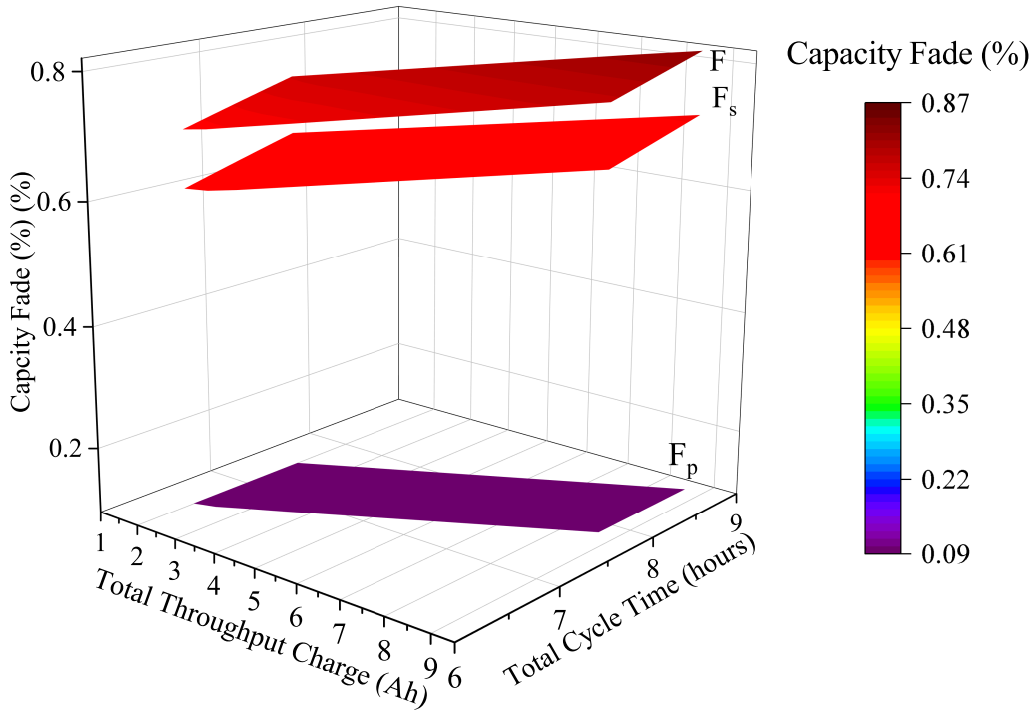


(b)

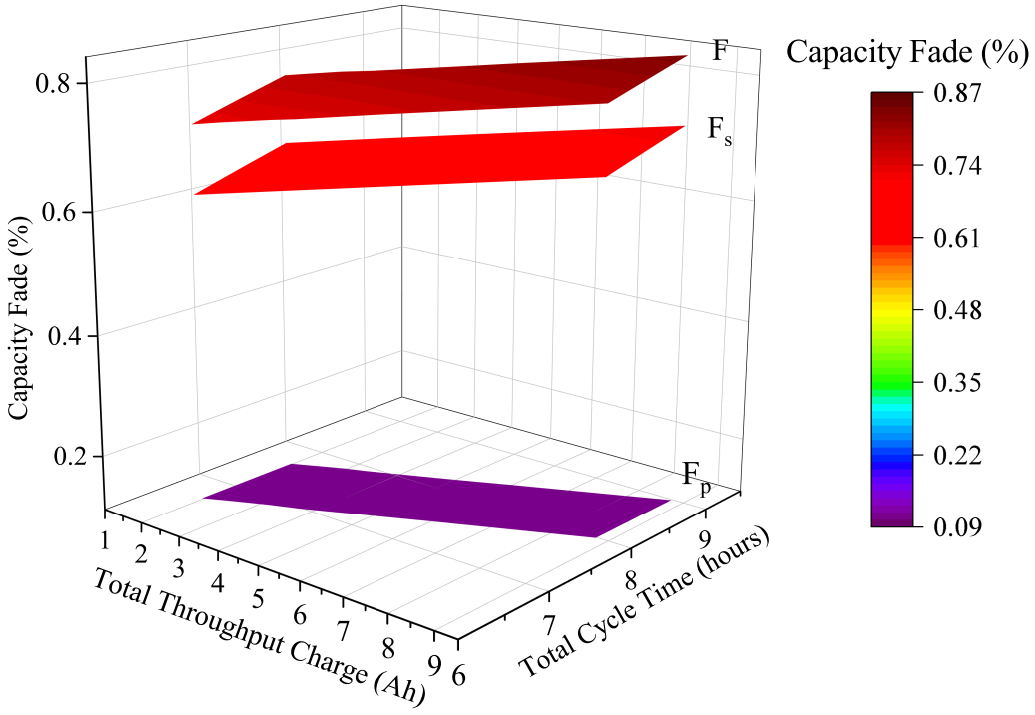


(c)

Fig. S1 Capacity fading is expressed as LLI (%) with altering temperature.(a) Total fading under different ambient temperatures @0.5C charge rate and 2 hours rest period, (b)Fading due to SEI layer growth under different ambient temperatures @0.5C charge rate and 2 hours rest period, (c) Fading due to lithium plating under different ambient temperatures @0.5C charge rate and 2 hours rest period.


Capacity Fade (%)
0.87
0.74
0.61
0.48
0.35
0.22
0.09
F
F_s
F_p
Capcity Fade (%) (%)
0.8
0.6
0.4
0.2
1 2 3 4 5 6 7 8 9
Total Throughput Charge (Ah)
6 7 8 9
Total Cycle Time (hours)

(a)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Capacity Fade (%)
0.8
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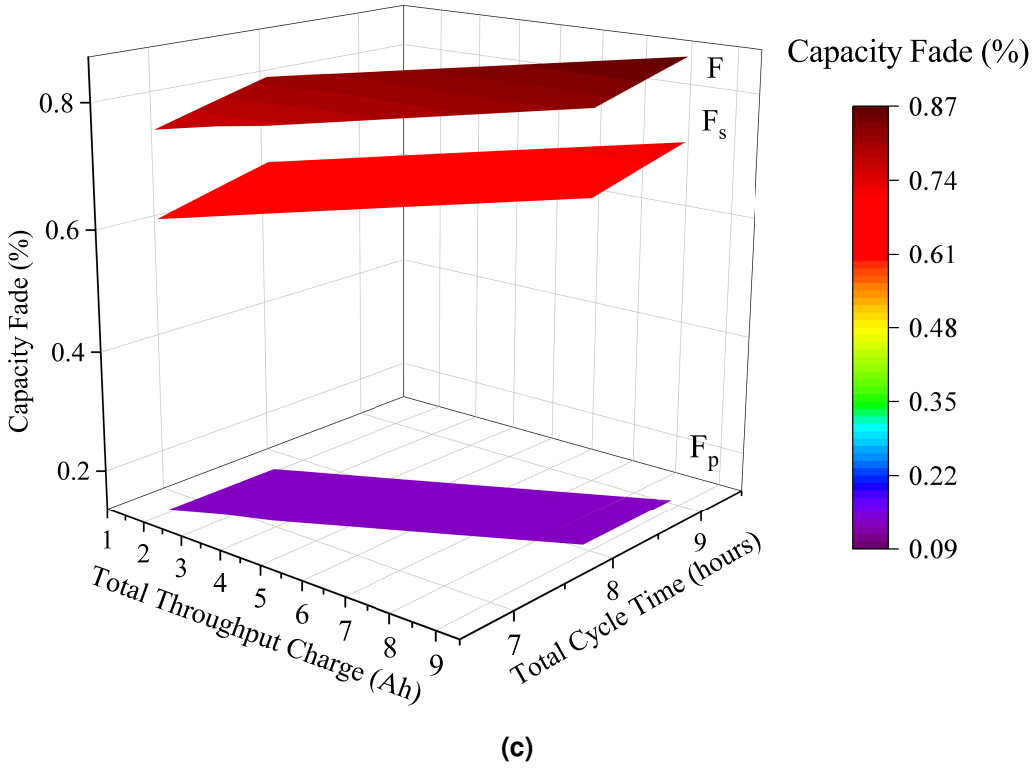
0.4
0.2
1 2 3 4 5 6 7 8 9
Total Throughput Charge (Ah)
6 7 8 9
Total Cycle Time (hours)

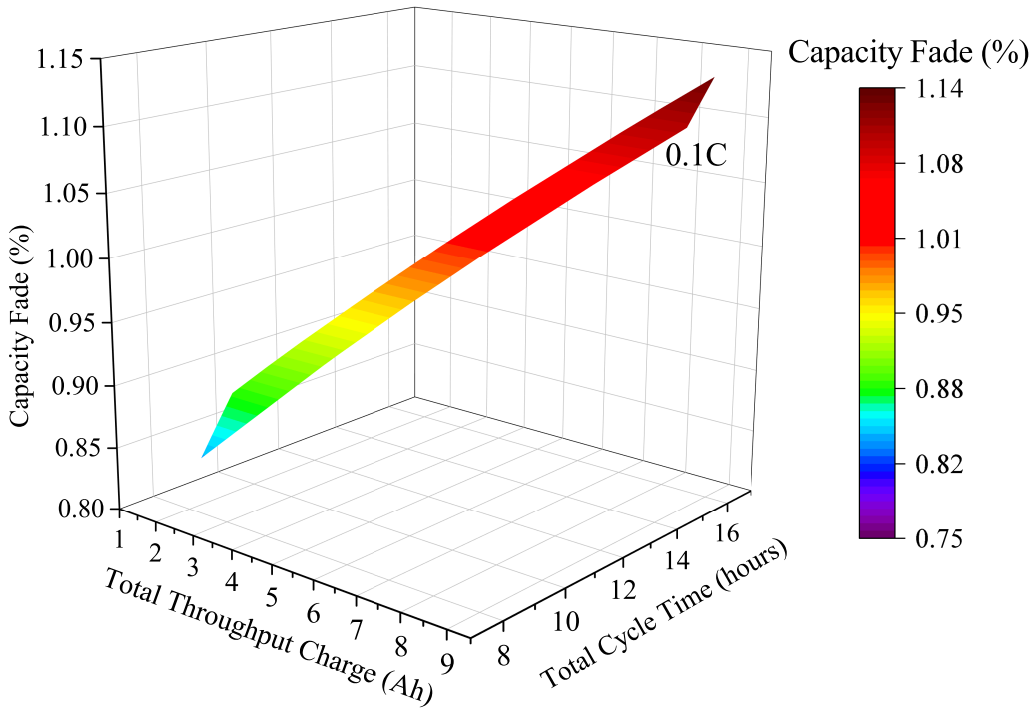
(b)



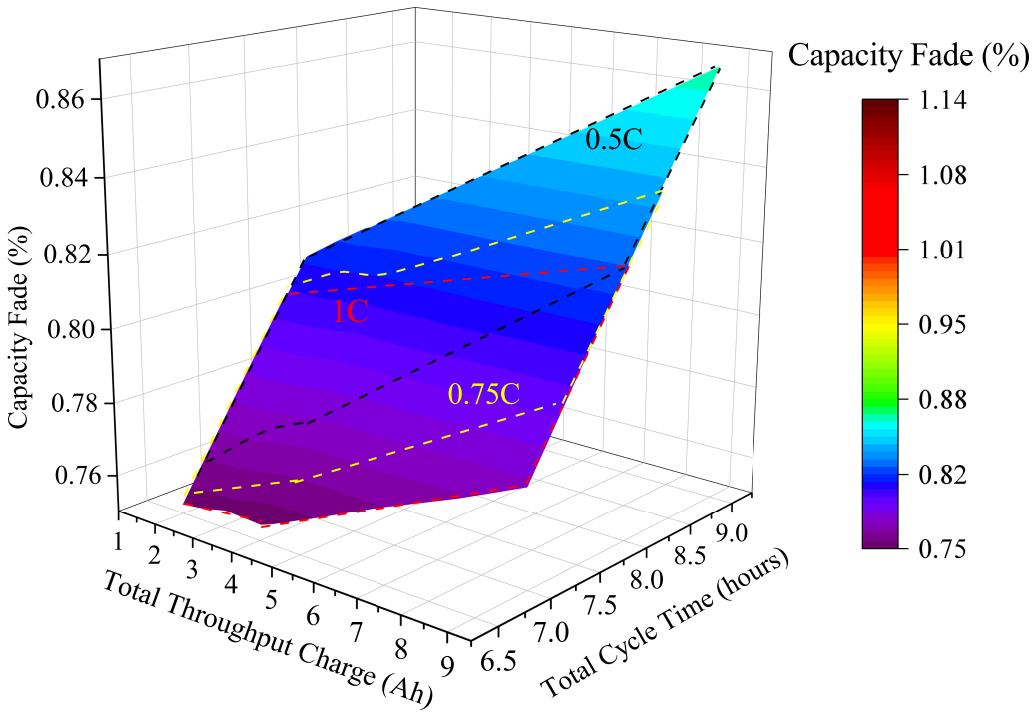
(c)

Fig. S2 Capacity fading is expressed as LLI (%) with altering temperature.(a) Individual fading at 0^0C @0.5C charge rate and 2 hours rest period, (b) Individual fading at 25^0C @0.5C charge rate and 2 hours rest period, (c) Individual fading at 50^0C @0.5C charge rate and 2 hours rest period

1.2 Capacity fade with altering charge rate

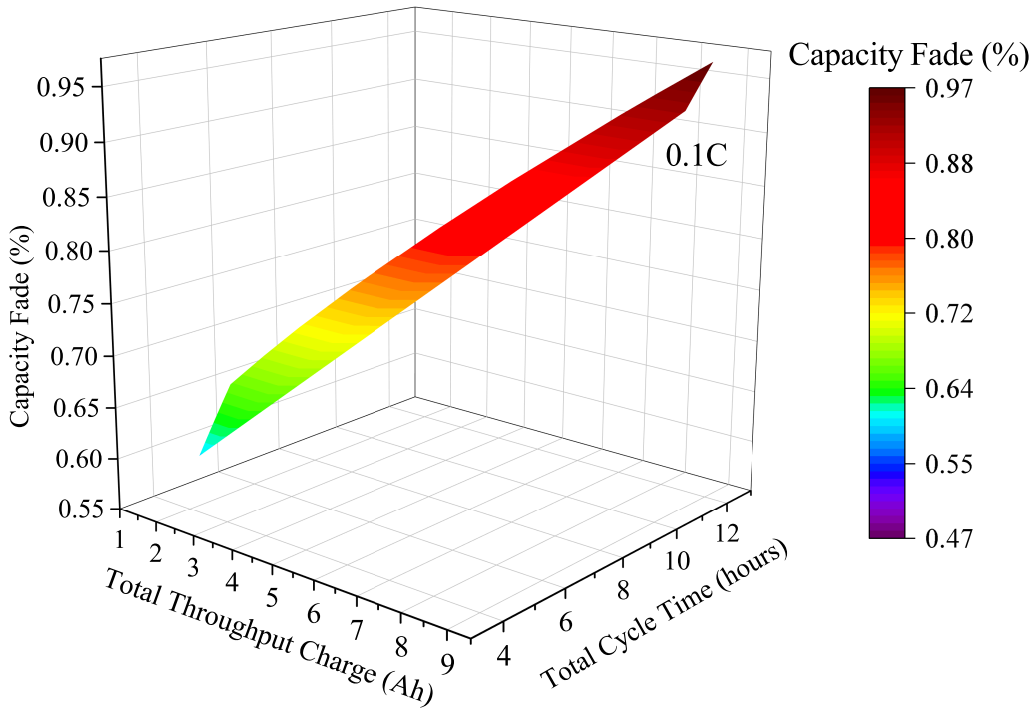


(a)

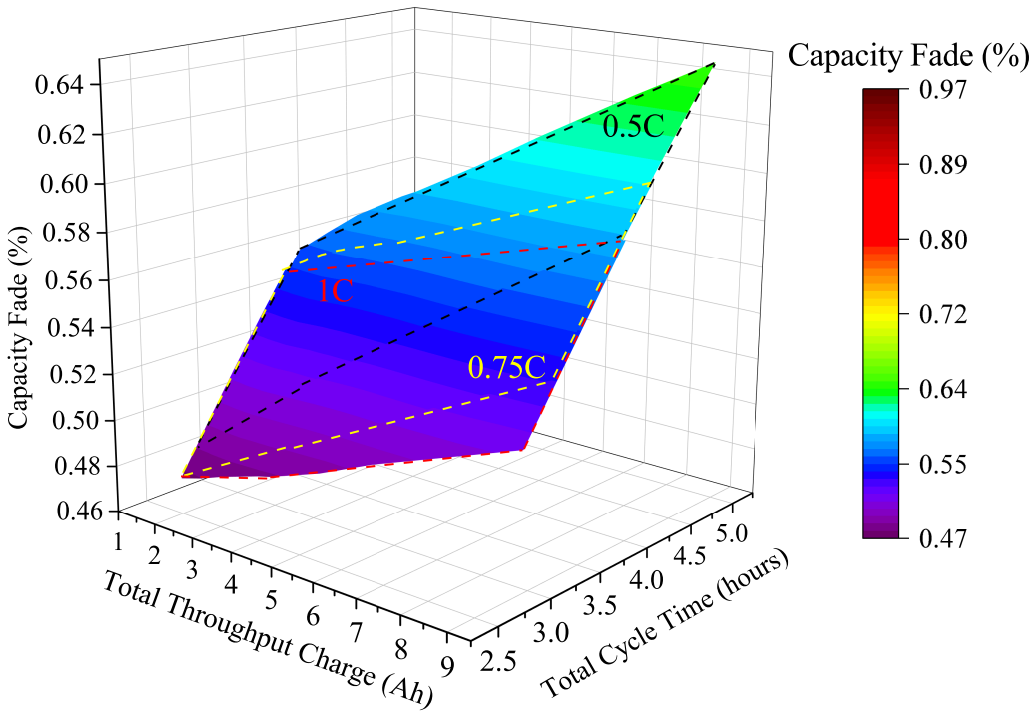


(b)

Fig. S3 Capacity fading is expressed as LLI (%) with altering charge rate. (a) Total fading at 0.1C charging rate @50^{0}C and 2 hours rest period, (b) Total fading under different charging rates viz. 0.5C, 0.75C, 1C.

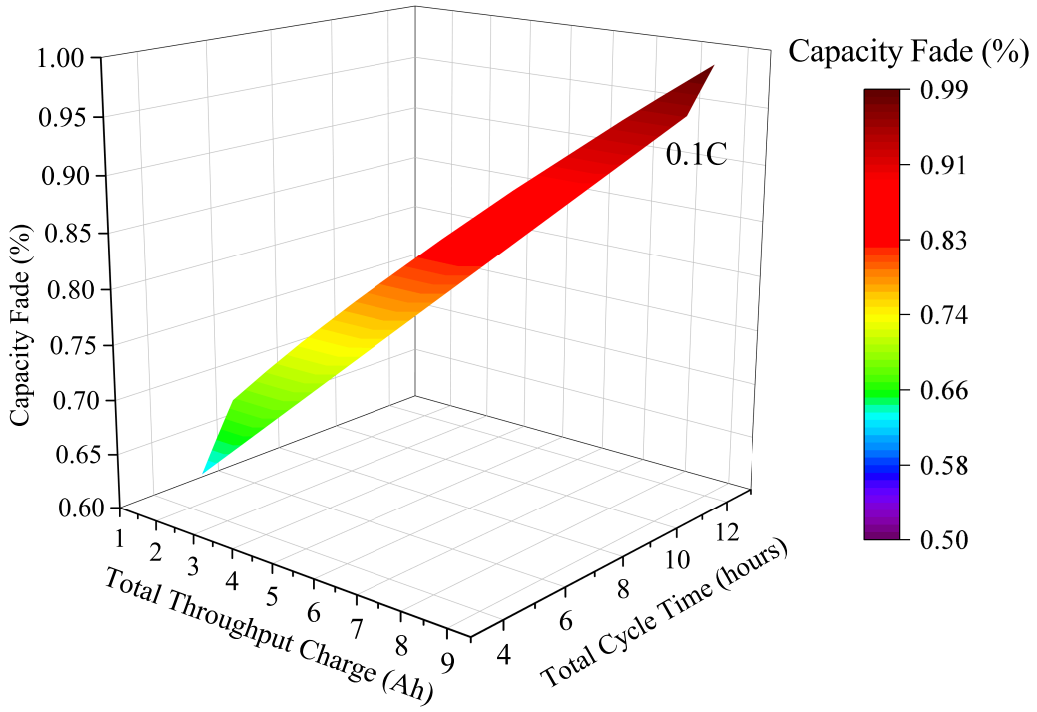


(a)

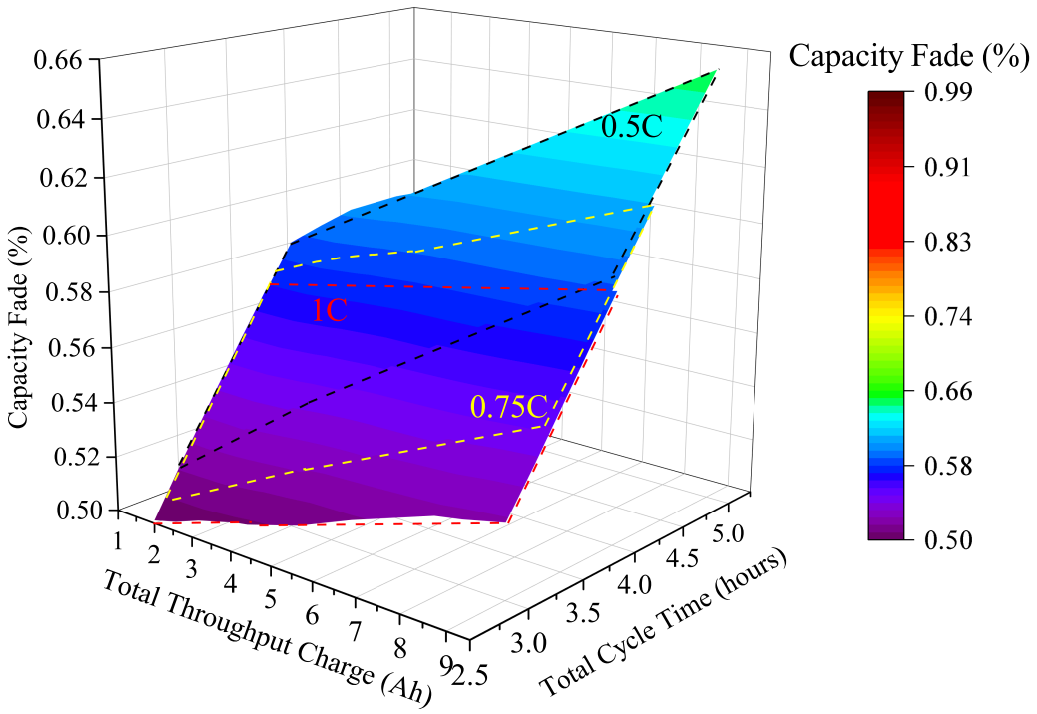


(b)

Fig. S4 Capacity fading is expressed as LLI (%) with altering charge rate. (a) Total fading at 0.1C charging rate @25^{0}C and no rest period, (b) Total fading under different charging rates viz. 0.5C, 0.75C, 1C.



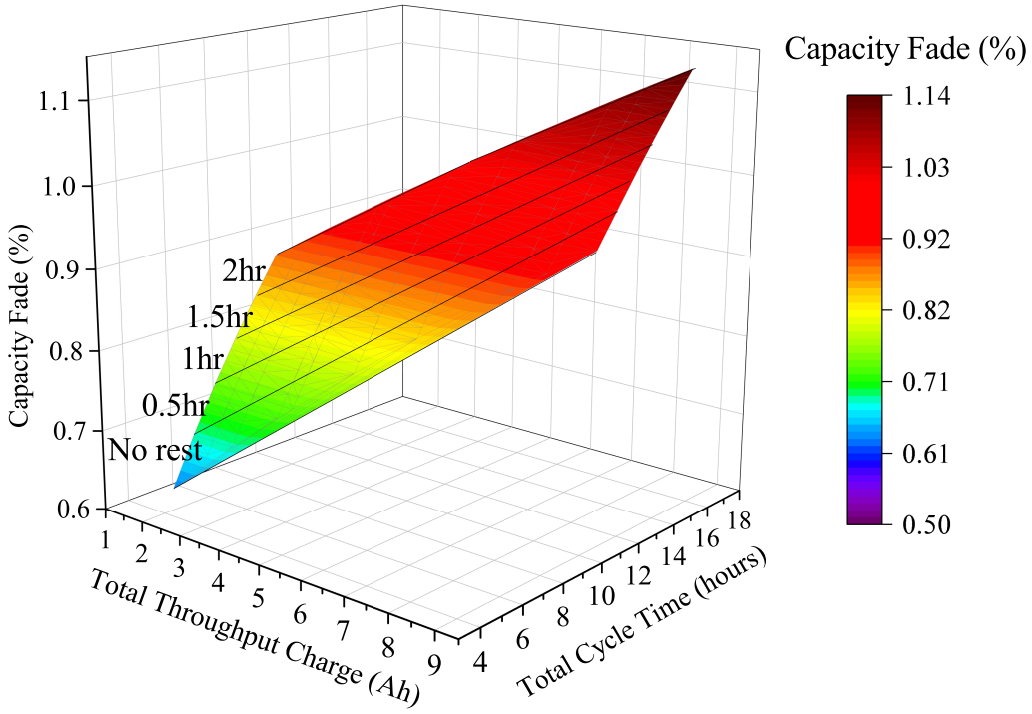
(a)



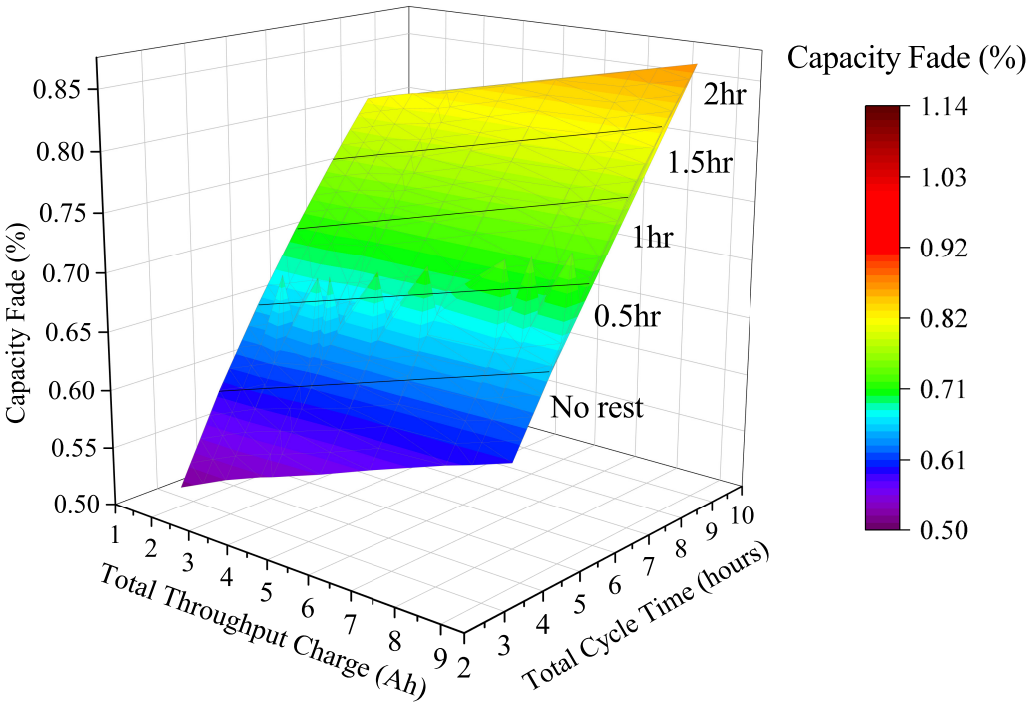
(b)

Fig. S5 Capacity fading is expressed as LLI (%) with altering charge rate. (a) Total fading at 0.1C charging rate @50^{0}C and no rest period, (b) Total fading under different charging rates viz. 0.5C, 0.75C, 1C.

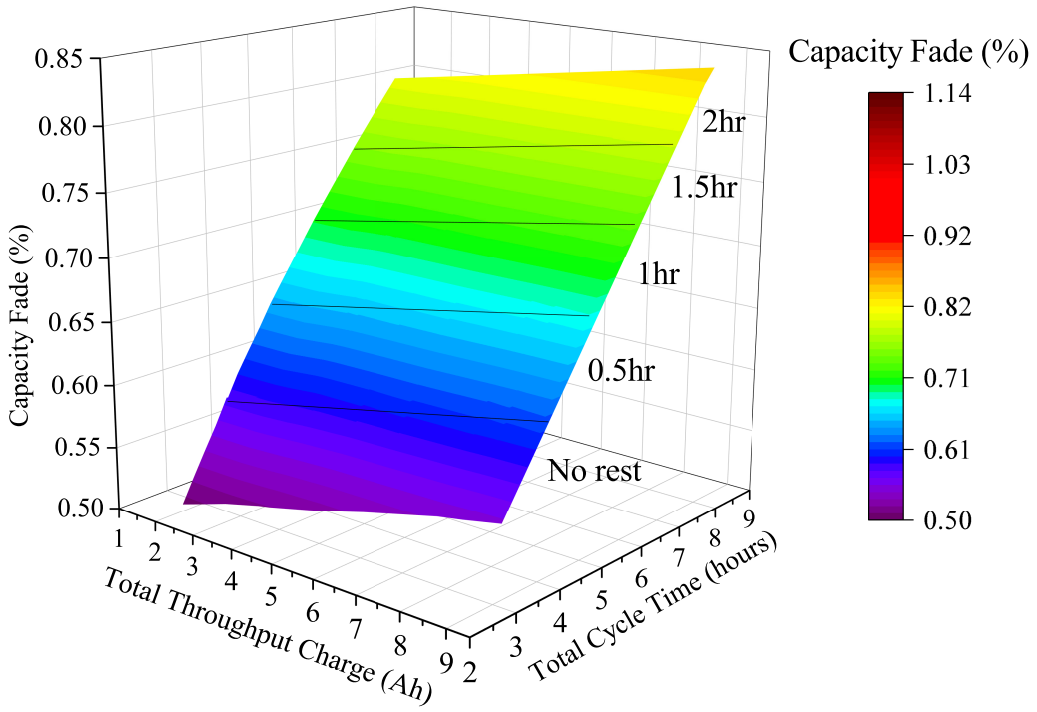
1.3 Capacity fade with altering rest period



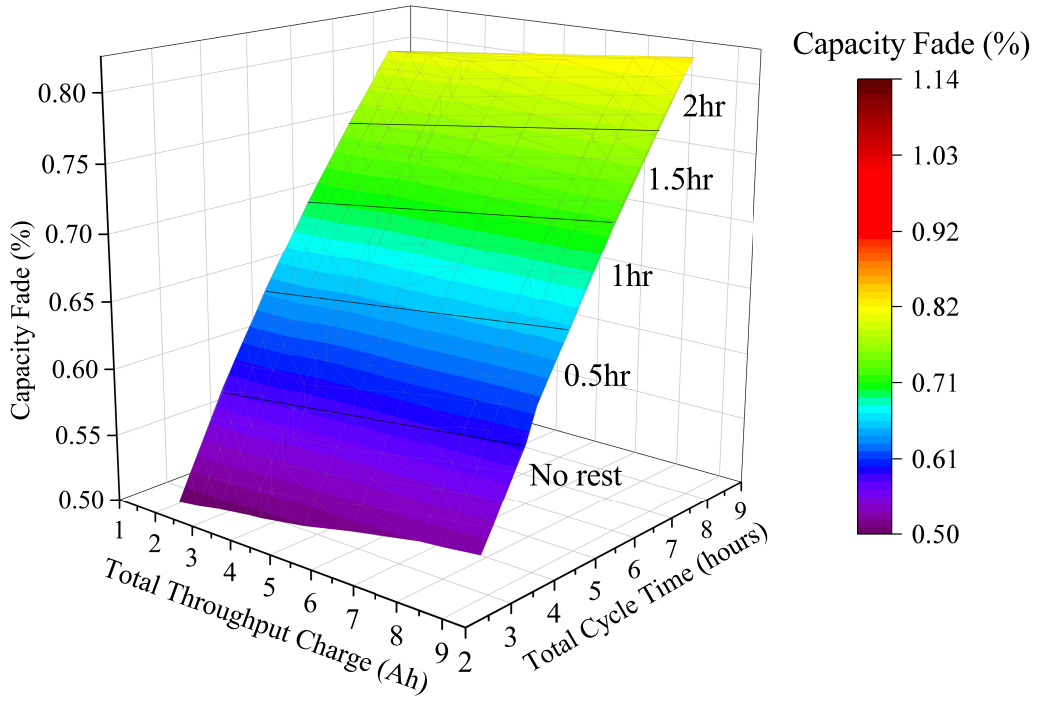
(a)



(b)



(c)



(d)

Fig. S6 Capacity fading is expressed as LLI (%) with altering rest periods @50^{0}C ambient temperature.(a) Total fading at 0.1C charge rate under different rest periods, (b) Total fading at 0.5C charge rate under different rest periods, (c) Total fading at 0.75C charge rate under different rest periods, (d) Total fading at 1C charge rate under different rest periods.

2 Supplementary Table

Table S1 LGM50 21700 cylindrical cell parameters and specifications provided by the manufacturer.

Macroscale geometry		
Negative current collector thickness	1.20E-05	[m]
Negative electrode thickness	8.52E-05	[m]
Separator thickness	1.20E-05	[m]
Positive electrode thickness	7.56E-05	[m]
Positive current collector thickness	1.60E-05	[m]
Electrode height	6.50E-02	[m]
Electrode width	1.58	[m]
Cell cooling surface area	5.31E-03	[m^2]
Cell volume	2.42E-05	[m^3]
Current collector properties		
Negative current collector conductivity	58411000	[$S.m^{-1}$]
Positive current collector conductivity	36914000	[$S.m^{-1}$]
Density		
Negative current collector density	8960	[$kg.m^{-3}$]
Positive current collector density	2700	[$kg.m^{-3}$]
Specific heat capacity		
Negative current collector-specific heat capacity	385	[$J.kg^{-1}. K^{-1}$]
Positive current collector specific heat capacity	897	[$J.kg^{-1}. K^{-1}$]
Thermal conductivity		
Negative current collector thermal conductivity	401	[$W.m^{-1}. K^{-1}$]
Positive current collector thermal conductivity	237	[$W.m^{-1}. K^{-1}$]