Maximum safe charge current prediction of power batteries based on the thermal runaway data

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Abstract: The $LiNi_{0.8}Mn_{0.1}Co_{0.1}O_2$/Silicon-carbon lithium ion battery is used in the plug-in electric vehicle due to its high specific energy. The mileage of electric vehicles can be improved by increasing the energy density of batteries, but the charging process becomes a more challenge issue since the excessive charging current results in high temperature while the thermal stability of NCM811 material is poor. Also, the increasing of temperature may cause the thermal runaway of lithium ion battery. In this work, in order to study the thermal runaway prevention during charging process, the NCM811/Si@C battery model is set up, and the simulation results are verified by the experimental results. Based on the thermal runaway data, the maximum safe charge current under different ambient temperature is predicted, and the relationship between maximum safe charging current and ambient temperature is found.

Model and Verification: This model mainly includes two parts, electrochemical and heat transfer, which are interrelated with temperature. it is necessary to verify both the voltage and temperature change of the battery during charge process.

The lithium ion battery model shows in the Fig. 1. The left model is a 1:1 model built with reference to the actual lithium ion battery, and the middle is a detailed view of the y-axis magnified 50 times, the right model is a single cell.

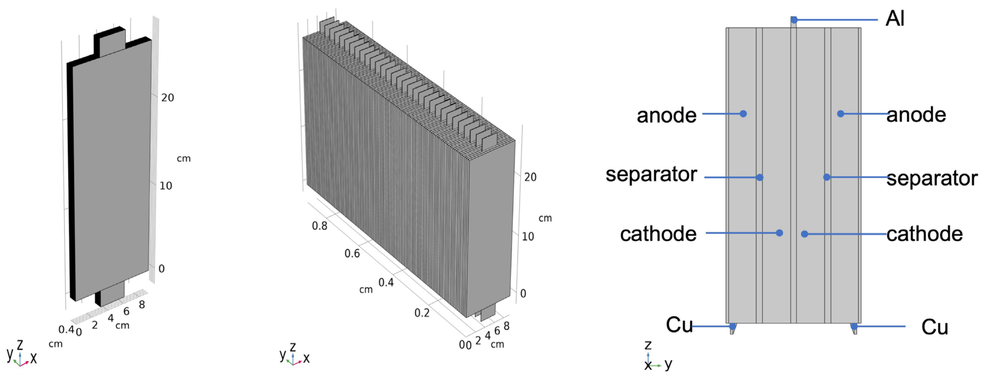

Fig. 1. Model of lithium ion battery

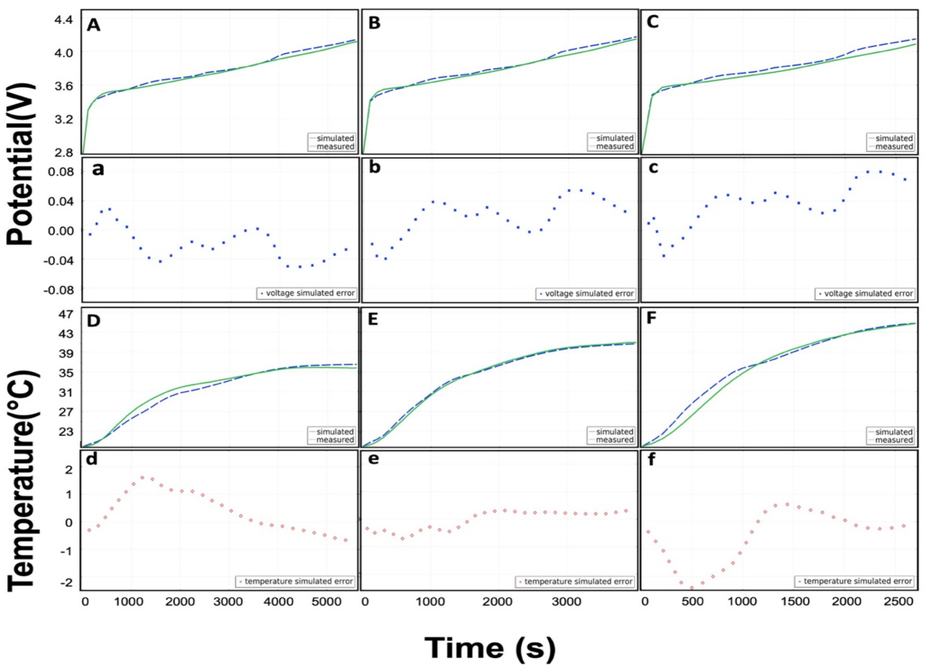

Fig. 2. Model verification by different charge current

Result:

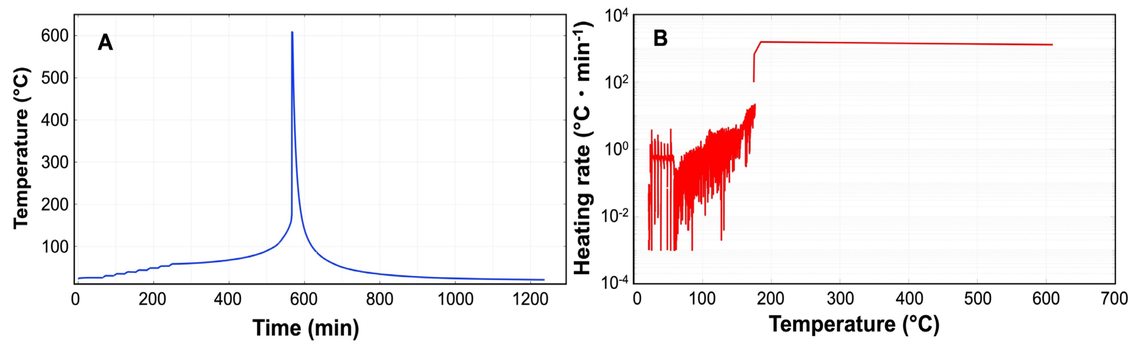

Fig. 3. Thermal runaway data of lithium ion battery

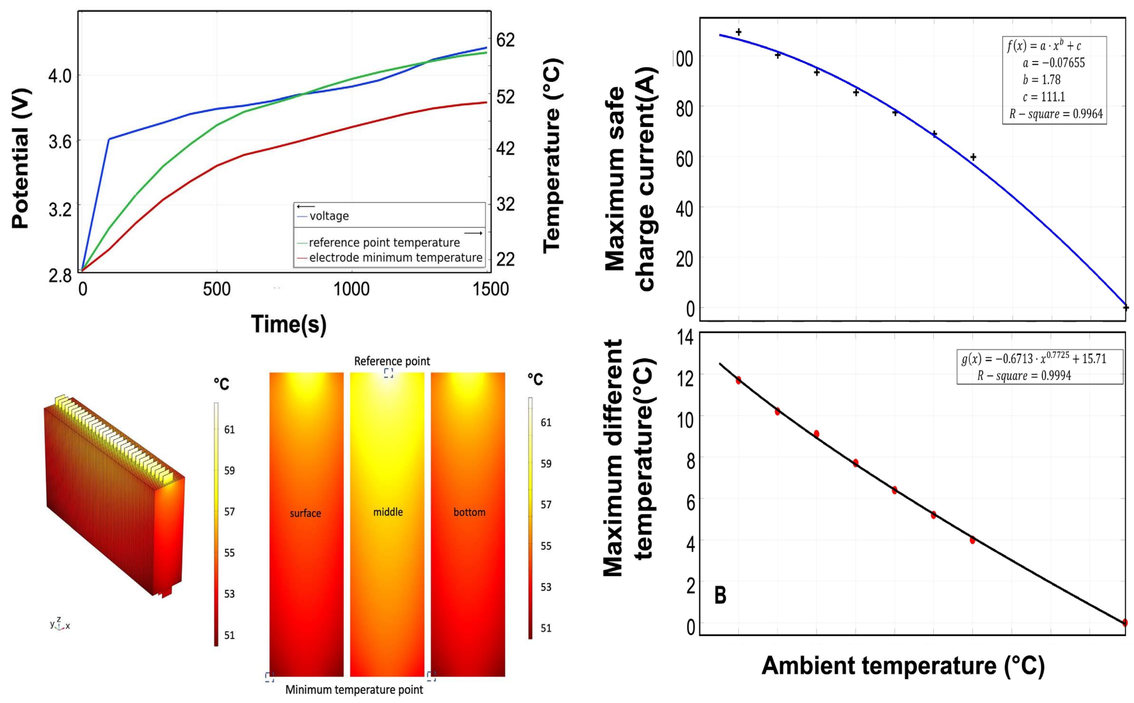

Fig. 4. Temperature change simulation till the charged end

Length(mm)	528	264	198	132	44	33
Width(mm)	46	92	122.7	184	552	736
Ratio	11.48	2.87	1.61	0.72	0.08	0.04

Tab. 1. Scanned battery design parameters

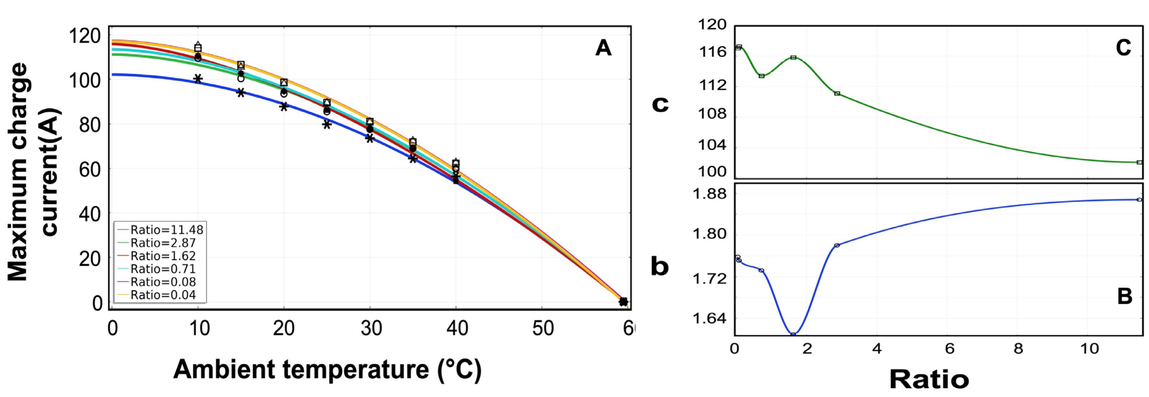

Fig. 5. Relationship between maximum safe charger current and the ambient temperature.

Conclusion: The significance of this work is to be able to provide the safe charging current and the guidance on the safe use of the battery. Also, the scanning results will be favorable to the battery design.

References:

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2. Y. Ye, Y. Shi, N. Cai, J. Lee, X. He, Electro-thermal modeling and experimental validation for lithium ion battery, J. Power Sources. 199 (2012) 227–238.