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Lithium-Ion battery state of health (SOH) analysis by entropymetry

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BACKGROUND

- Battery SOH assessment is an important task as SOH controls the cell’s energy and power performance.
- Accurate determination of SOH enables efficient usage of batteries extending life and enhancing safety.
- Because of versatility of LIB chemistries there is no universal online SOH assessment method over the lifespan.
- Current SOH assessment methods are mostly based on full discharge performance, which is inconvenient and time consuming.

THIS STUDY

- Lithium-ion cells have been cycled and entropy has been measured for different SOH. Entropy (∆S) profiles have been measured thanks to the following equation:

\[
\Delta S = nF \left( \frac{\partial \text{OCV}}{\partial T} \right) \text{x (state of charge)}
\]

- Then the SOH has been modeled as functions of the entropy using machine learning techniques.

METHODOLOGY

- A classification algorithm has been applied to the profiles. It has been found that by learning, some algorithms are able to correctly identify the battery reference from ∆S profile as shown in the confusion matrix.

RESULTS

- This diagram explains the process in order to estimate battery SOH from thermodynamic data. The process is based on two main tasks: learning and estimating.
- To learn, a database is filled and updated, then models are generated. This happens when thermodynamics data and information on the battery is already known, such as reference, chemistry or SOH.
- To estimate SOH from thermodynamic data, we will first identify the battery type if not known already. This is done thanks to the database and machine learning models.

- SOH estimated with Thermodynamic data and machine learning algorithms.

- Graphs in the first row represent ∆S data between 3.7 and 3.9 volts of the OCV at different ageing. Each graph of this row corresponds to a given battery.
- In the second row, the graphs represent SOH evolution with ageing. The measured one are compared with the one predicted with multiple linear regression model from ∆S profiles. Each graph of this row corresponds to a given battery.
- It has been found that it is possible to predict SOH from ∆S at some specific SOC.

REFERENCES