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 versality 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

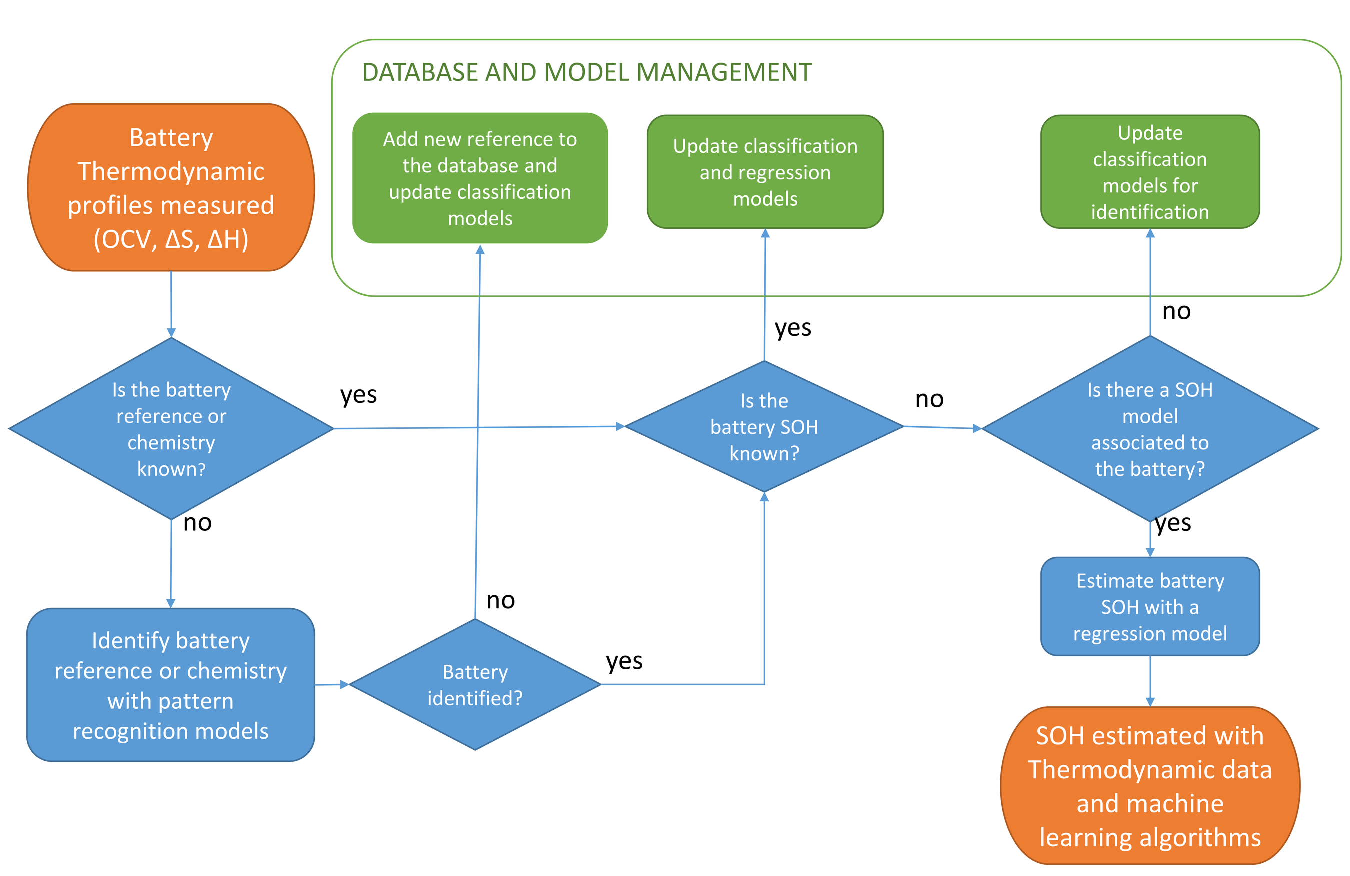
- Lithium-ion cells have been cycled and entropy has been measured for different SOH. Entropy (ΔS) profiles have been measured thanks to the following equation:

$$\Delta S = nF\left(\frac{\partial\, OCV}{\partial T}\right)_x$$

OCV (open-circuit voltage), T (temperature), x (state of charge)

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

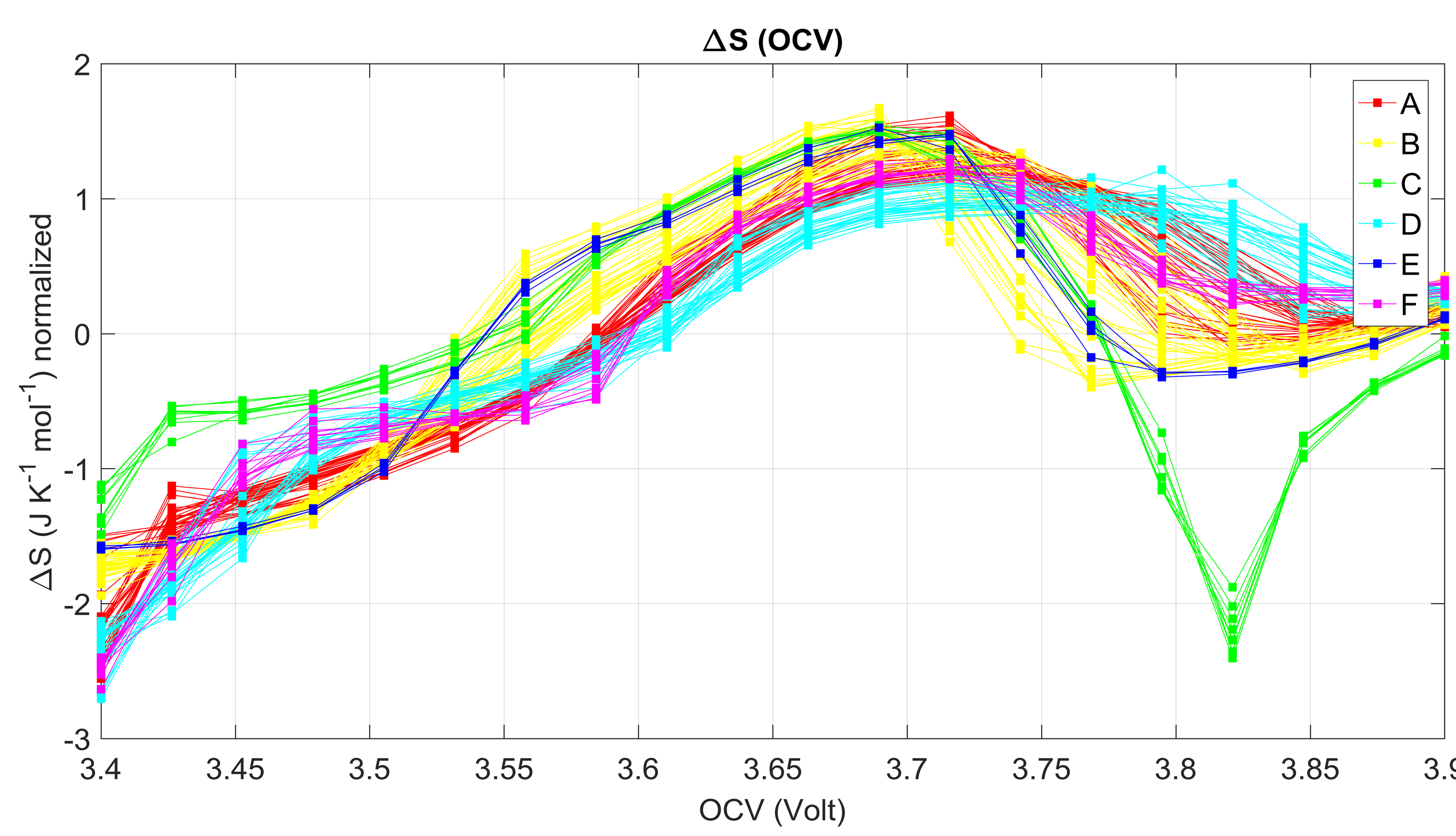
METHODOLOGY

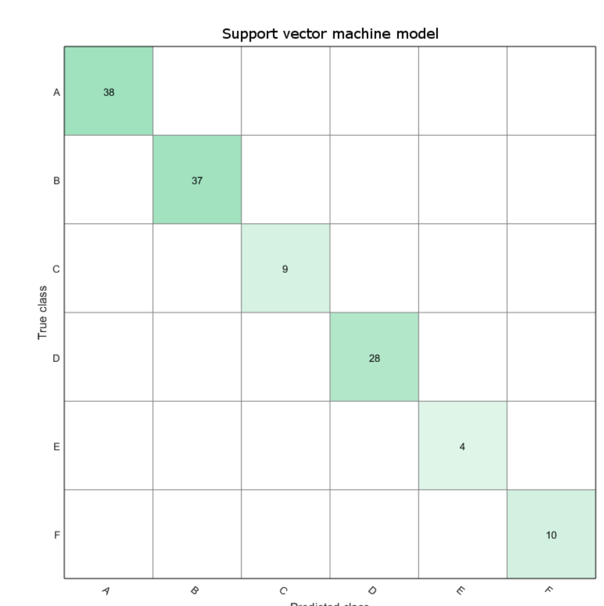


- This diagram explains the process in order to estimate battery SOH from thermodynamic data. The process is based on two main tasks: learning and estimating.
- To learn, a database is filled and updated, then models are generated. This happens when thermodynamics data and information on the battery 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. Once known, SOH is estimated with previously found machine learning models.

RESULTS

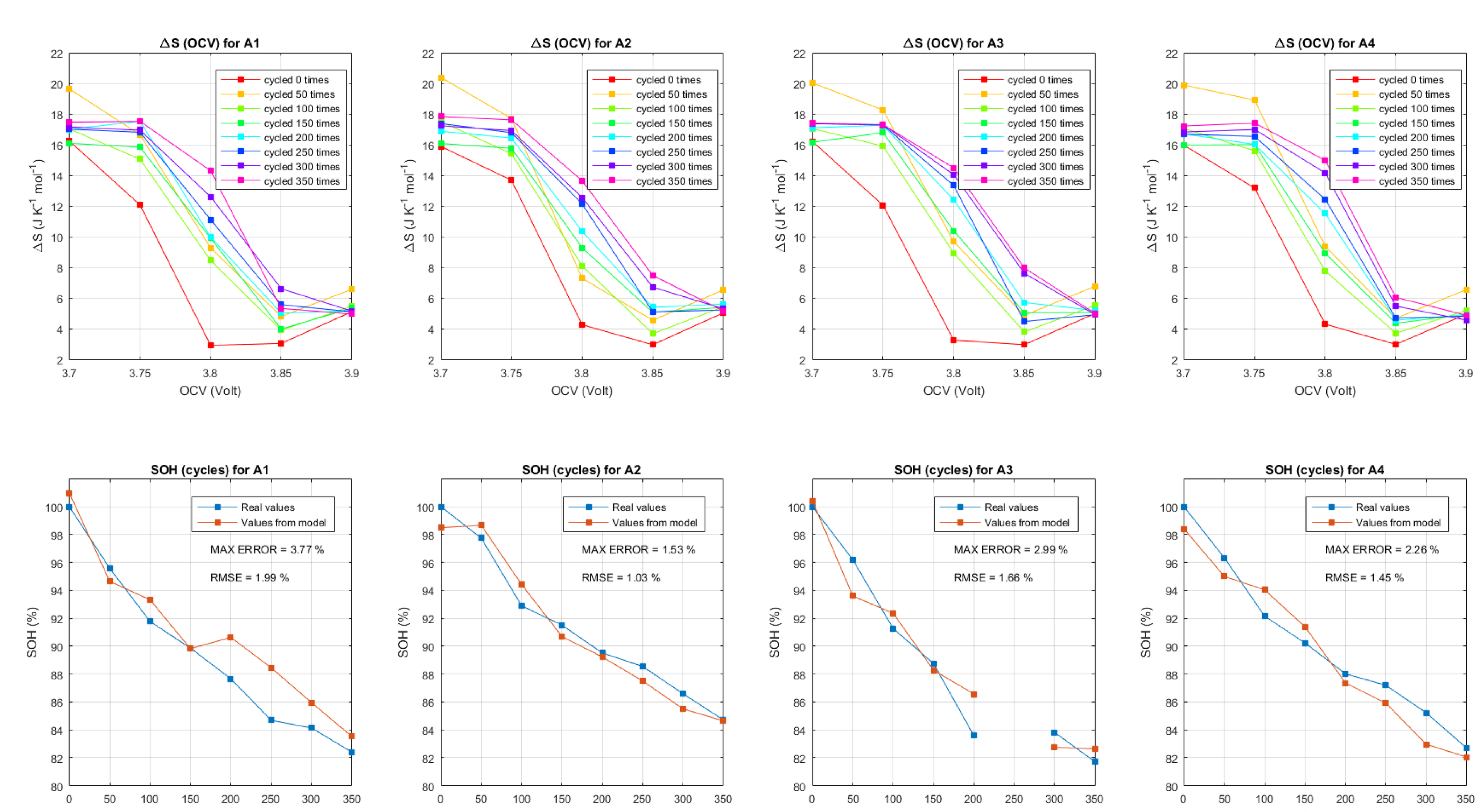
BATTERY IDENTIFICATION





- An important number of ΔS profiles have been measured for six battery references. Some of the references have been also aged.
- A classification algorithm have been applied to the profiles. It has been found that by learning, some algorithms are able to correctly identify the battery reference from ΔS profile as shown in the confusion matrix.

SOH ANALYSIS



- Graphs in the first row represent ΔS 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 ΔS profiles. Each graph of this row corresponds to a given battery.
- It has been found that it is possible to predict SOH from ΔS at some specific SOC.

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