Prediction of storage ageing in a lithium ion battery using data-driven model and electrochemical model

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Abstract

A hybrid vehicle battery spends around 70% of its time in storage at different temperatures compared to being cycled. However there is less work on the effect of storage on battery life time than on cycling. Storage lifetime prediction is often complicated due to interdependency of ageing mechanisms. This work analyses the feasibility of using a data-driven model and an electrochemical model, for an accurate prediction of electrical response of a battery under different storage conditions. The experimental investigation done by Jaguar LandRover engineers became the foundation for both data-driven and electrochemical models. In the electrochemical model, the Pseudo Two Dimensional model (P2D) equations are modified to include a continuous solvent reduction reaction responsible for capacity fade. A FORTRAN program was developed and finite volume based formulation was used to couple P2D equations with Butler-Volmer kinetics. The capability of the electrochemical model to predict the SEI layer growth and internal resistance increase under different storage conditions is compared with a data driven model and the experimental data, to analyse and quantify ageing. In this initial work, the analysis is limited to iso-thermal conditions since the dependency of temperature on cell performance is complex. The storage experiment can be divided into two main parts, the characterisation and the storage test. For storage test, the cells are stored at 25°C at three different SoC values, 20%, 50% and 90% and the capacity characterisation test has been performed after 73, 139, 202 and 297 days to calculate the capacity of the cell. Conclusions about the parasitic reaction are made based on the variation side reaction exchange current density.

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