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Section

Battery Performance, Ageing, Reliability and Safety

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Section Information

The energy storage systems (ESS) have limited life spans which can have a variety of consequences. These affect the cost of ownership, performances, environmental impacts, safety, the viability of the application in which they are used, etc. Potential topics of this section include but are not limited to:

- Optimal sizing and design with consideration of ageing
- Characterization techniques and performance dispersion
- Ageing characterization
- Innovative measurement techniques of ESS ageing
- Ageing modelling
- Battery Management System
- State-of-health (SOH) estimation
- Prognostic and health monitoring
- Balancing circuits with consideration of the lifetime
- Energy management laws taking into account ageing
- Influence of ageing on cost and environmental analyses
- Multi-objective optimization strategies including ageing consideration
- Post-mortem analysis
- Second-life batteries
- Electrical and thermal safety issues
- Life-cycle and techno-economic assessment
- Safety investigations, testing and accidents analysis
- Safety modelling
- Safe cell and battery pack design
- Safety monitoring

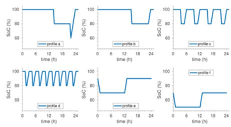
Section Battery Performance, Ageing, Reliability and Safety

Featured Papers

DOI: 10.3390/batteries6010014

Modelling Lithium-Ion Battery Ageing in Electric Vehicle Applications—Calendar and Cycling Ageing Combination Effects

Authors: Eduardo Redondo-Iglesias, Pascal Venet and Serge Pelissier

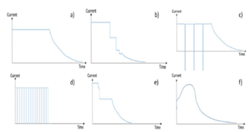


Abstract: Battery ageing is an important issue in e-mobility applications. The performance degradation of lithium-ion batteries has a strong influence on electric vehicles' range and cost. Modelling capacity fade of lithium-ion batteries is not simple: many ageing mechanisms can exist and interact. Because calendar and cycling ageings are not additive, a major challenge is to model battery ageing in applications where the combination of cycling and rest periods are variable as, for example, in the electric vehicle application. In this work, an original approach to capacity fade modelling based on the formulation of reaction rate of a two-step reaction is proposed. A simple but effective model is obtained: based on only two differential equations and seven parameters, it can reproduce the capacity evolution of lithium-ion cells subjected to cycling profiles similar to those found in electric vehicle applications.

DOI: 10.3390/batteries8020016

Radial Thermal Conductivity Measurements of Cylindrical Lithium-Ion Batteries—An Uncertainty Study of the Pipe Method

Authors: Markus Koller, Johanna Unterkofler, Gregor Glanz, Daniel Lager, Alexander Bergmann and Hartmut Popp

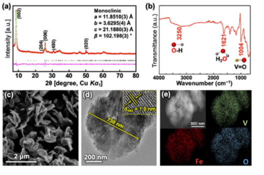


Abstract: A typical method for measuring the radial thermal conductivity of cylindrical objects is the pipe method. This method introduces a heating wire in combination with standard thermocouples and optical Fiber Bragg grating temperature sensors into the core of a cell. This experimental method can lead to high uncertainties due to the slightly varying setup for each measurement and the non-homogenous structure of the cell. Due to the lack of equipment on the market, researchers have to resort to such experimental methods. To verify the measurement uncertainties and to show the possible range of results, an additional method is introduced. In this second method the cell is disassembled, and the thermal conductivity of each cell component is calculated based on measurements with the laser flash method and differential scanning calorimetry. Those results are used to numerically calculate thermal conductivity and to parameterize a finite element model. With this model, the uncertainties and problems inherent in the pipe method for cylindrical cells were shown. The surprising result was that uncertainties of up to 25% arise, just from incorrect assumption about the sensor position. Furthermore, the change in radial thermal conductivity at different states of charge (SOC) was measured with fully functional cells using the pipe method.

DOI: 10.3390/batteries7030054

Layered Iron Vanadate as a High-Capacity Cathode Material for Nonaqueous Calcium-Ion Batteries

Authors: Munseok S. Chae, Dedy Setiawan, Hyojeong J. Kim and Seung-Tae Hong

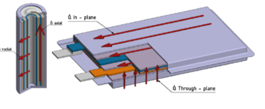


Abstract: Calcium-ion batteries represent a promising alternative to the current lithium-ion batteries. Nevertheless, calcium-ion intercalating materials in nonaqueous electrolytes are scarce, probably due to the difficulties in finding suitable host materials. Considering that research into calcium-ion batteries is in its infancy, discovering and characterizing new host materials would be critical to further development. Here, we demonstrate $FeV_3O_9 \cdot 1.2H_2O$ as a high-performance calcium-ion battery cathode material that delivers a reversible discharge capacity of 303 mAh g^{-1} with a good cycling stability and an average discharge voltage of ~2.6 V (vs. Ca/Ca^{2+}). The material was synthesized via a facile co-precipitation method. Its reversible capacity is the highest among calcium-ion battery materials, and it is the first example of a material with a capacity much larger than that of conventional lithium-ion battery cathode materials. Bulk intercalation of calcium into the host lattice contributed predominantly to the total capacity at a lower rate, but became comparable to that due to surface adsorption at a higher rate. This stimulating discovery will lead to the development of new strategies for obtaining high energy density calcium-ion batteries.

DOI: 10.3390/batteries7030046

Detection of Lithium Plating in Li-Ion Cell Anodes Using Realistic Automotive Fast-Charge Profiles

Authors: Matteo Dotoli, Emanuele Milo, Mattia Giuliano, Riccardo Rocca, Carlo Nervi, Marcello Baricco, Massimiliano Ercole and Mauro Francesco Sgroi



Abstract: The widespread use of electric vehicles is nowadays limited by the "range anxiety" of the customers. The drivers' main concerns are related to the kilometric range of the vehicle and to the charging time. An optimized fast-charge profile can help to decrease the charging time, without degrading the cell performance and reducing the cycle life. One of the main reasons for battery capacity fade is linked to the Lithium plating phenomenon. This work investigates two methodologies, i.e., three-electrode cell measurement and internal resistance evolution during charging, for detecting the Lithium plating conditions. From this preliminary analysis, it was possible to develop new Multi-Stage Constant-Current profiles, designed to improve the performance in terms of charging time and cells capacity retention with respect to a reference profile. Four new profiles were tested and compared to a reference. The results coming from the new profiles demonstrate a simultaneous improvement in terms of charging time and cycling life, showing the reliability of the implemented methodology in preventing Lithium plating.

Invitation to Submit

Artificial Intelligence-Based State-of-Health Estimation of Lithium-Ion Batteries
Guest Editors: Prof. Dr. Remus Teodorescu and Dr. Xin Sui
Deadline: **30 September 2022**

Electrochemical, Thermal, and Safety Properties of Lithium and Post-Li Materials and Cells II
Guest Editor: Dr. Carlos Ziebert
Deadline: **31 December 2022**

Lithium-Ion Batteries Aging Mechanisms II
Guest Editor: Dr. Mauro Francesco Sgroi
Deadline: **12 January 2023**

Batteries and Supercapacitors Aging II
Guest Editors: Prof. Dr. Pascal Venet and Dr. Eduardo Redondo-Iglesias
Deadline: **30 June 2023**

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