Introduction of a Testbench – Localized pressure analysis to optimize lithium-ion battery lifetime

Hendrik Laufen[1,2], Sascha Berg[2,4], Julian Engeser[4,5], Fabian Frie[1,2], Dirk Uwe Sauer[1,2,3]

[1]Chair for Electrochemical Energy Conversion and Storage Systems, Institute for Power Electronics and Electrical Drives (ISEA), RWTH Aachen University, Jägerstrasse 17-19, 52066 Aachen, Germany

[2]Juelich Aachen Research Alliance, JARA-Energy, Germany

[3]Institute for Power Generation and Storage Systems (PGS) @ E.ON ERC, RWTH Aachen University, Germany

[4]Chair for Aging and Lifetime Prediction of Batteries, Institute for Power Electronics and Electrical Drives (ISEA), RWTH Aachen University, Jägerstrasse 17-19, 52066 Aachen, Germany

[5]Fraunhofer Institute for Solar Energy Systems ISE, Heidenhofstrasse 2, 79110 Freiburg, Germany

Lithium-ion battery technology continues to experience increases in energy and power density. While changing lithium-ion cells' rising requirements, the service life has to remain the same of even be increased. Upstream battery cell development is increasingly focusing on the mechanical behavior of the cells to optimize battery life. Most lithium-ion battery cells in state-of-the-art battery modules or systems of modern electric vehicles are loaded with pressure. The external pressure on the cells can contribute to decreasing the cell's capacity fade. Still, cells experience an inhomogeneous degradation due to an irregular current distribution and geometric inhomogeneities. By applying local pressures on cell's surface the current distribution inside the cell can be altered and be managed to aim for a homogeneous current distribution. A uniform current distribution is expected to contribute to homogenizing the aging of a cell. Therefore, the local pressure of a cell over a lifetime needs to be fully investigated.

To investigate the local pressure a test setup is required, which enables tracking the pressure of a preloaded cell with sufficient resolution over calendaric or cyclic aging periods. Requirements for the testbench are a precise adjustment of the default pressure, a spatially resolved pressure measurement, and a material with defined stress-strain properties to compensate for the swelling of the cell in a predefined pressure range. Additionally, the mechanical stiffness of the testbench is required to minimize the pressure inhomogeneities of the testbench itself.

This poster presents a test setup to investigate the local pressure of a lithium-ion pouch cell over lifetime. Containing stiff aluminum plates as rigid case, compression pads enable a defined swelling compensation, while the integrated pressure sensors provide the required pressure measurement. The adjustment routine of the default pressure is introduced. Additionally, first cyclic and calendaric measurements results are exhibited.

Based on measurement results possible surface modifications of the aluminum plate to apply a pressure distribution on the cell are presented.