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Introduction

Rechargeable Lithium-ion batteries are ubiquitous in consumer electronics such as cell phones, laptops and tablet computers. Due to their high energy density they were introduced in automotive and aerospace applications and emerge now also into large energy storing facilities. Depending on the materials for the anode, cathode, and electrolyte the voltage, capacity, lifetime, and safety of Lithium-ion batteries can change dramatically. The Reliability Science and Technology Laboratory performs cell and battery characterization, degradation and lifetime testing as well as modelling and materials analysis. Automated test stations provide a unique capability for characterization and testing of cells, cell packs and large batteries.

Cell Testing

The 12-channel cell tester will be used to perform research on degradation and failure mechanisms of electrochemical storage units, i.e. mainly Lithium-ion cells. The cell tester is equipped with a multiplexed frequency response analyzer (1 mHz to 30 kHz) for comprehensive impedance characterization. Customized charge / discharge profiles (time and current, power, or voltage) with a resolution of 10ms enables real life stress testing.

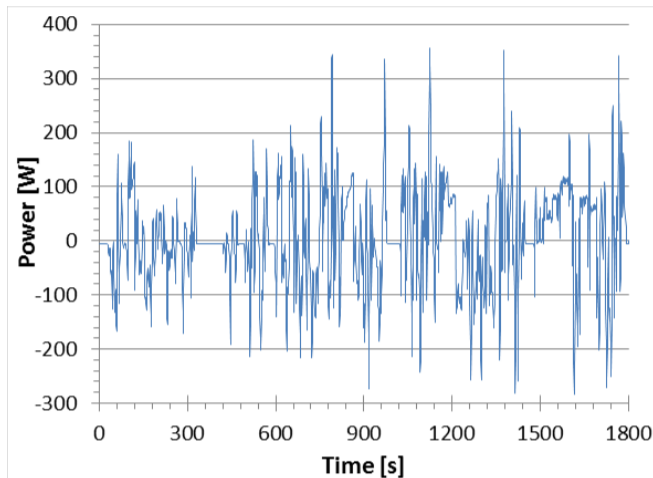


Fig. 2 Cell power profile derived from drive cycle

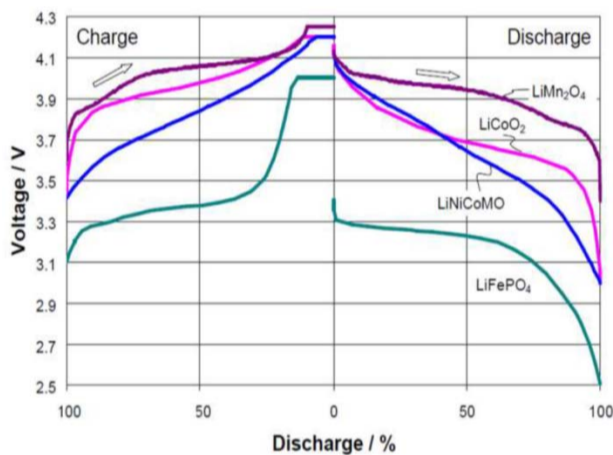


Fig. 1 Charge and discharge behaviour of different Li-Ion cell cathode materials

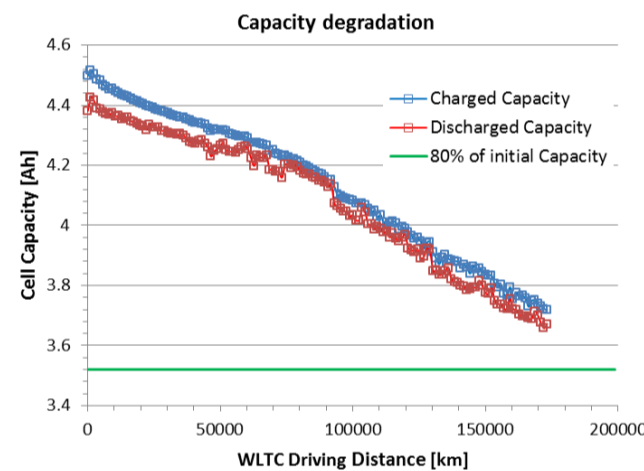


Fig. 3 Cell capacity degradation due to drive cycles



Cell Tester Specification

Voltage $5V \pm 1mV$
 Current $100A \pm 50mA, 300A \pm 150mA$
 Minimum step time 10ms

Safety chambers

Chamber volume 2 x 210 liters
 Temperature range $-40^{\circ}C$ to $+100^{\circ}C$
 N2 Inertisation
 Overpressure exhaust, Safety locks

Battery Testing

The large 500 kW battery tester with grid feedback is a unique facility in Switzerland for the characterization and stress testing of high power batteries used in electro-mobility and energy storage. The battery under test is placed in a temperature controlled safety container ($-30^{\circ}/+30^{\circ} C$) made inert with nitrogen. Several robust gas, temperature and flame sensors monitor the battery under test and the atmosphere in the container. A self stored program control system guarantees for reliable and safe operation. Worst case scenarios such as fire and explosion are contained by a sand extinguisher and pressure relief panels.

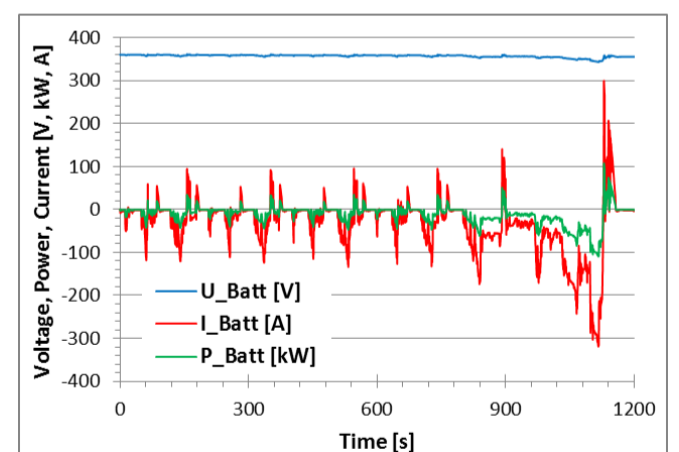


Fig. 4 Drive cycle stress profile for electric car Li-Ion battery

Battery Tester Specification

Voltage 50 to 500V $\pm 2V$
 Current $1000A \pm 5A$
 $dI/dt = 50ms$ (25-100%)
 Minimum step time 100ms
 Waveform: test drive cycles
 Total Harmonic Distortion $< 1.5\%$
 AC ripple $< 2.5\%$
 Converter efficiency $> 91\%$

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