Predominant aging mechanism in Lithium-Ion Batteries related to various test profiles

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Energy and power density of lithium ion batteries declines with lifetime. A decrease in energy density originates from capacity fading, whereas power density shrinks with increasing internal cell resistance R_i. The temporal progression of R_i is suitably monitored by pulse measurements over the lifetime of a battery. Additionally, electrochemical impedance spectroscopy (EIS) is the method of choice to analyse the increasing cell resistance in detail. The individual contributions of (i) ohmic resistance R_0, (ii) contact resistance R_{CC} and (iii) charge transfer resistance R_{CT} and their course over lifetime become accessible, when EIS data are evaluated with the distribution of relaxation times method (DRT) [1] and an appropriate equivalent-circuit model [2].
We present the capability of this approach by characterizing begin-of-life (BoL) and end-of-life (EoL) high-power pouch cells (KOKAM 350 mAh), using a wide set of aging procedures. This battery type consists of a NCA-LCO blend cathode and a graphite anode. The relationship between test profile (temperature and charge/discharge rate) and predominant aging mechanism of the cell resistance is discussed in detail.

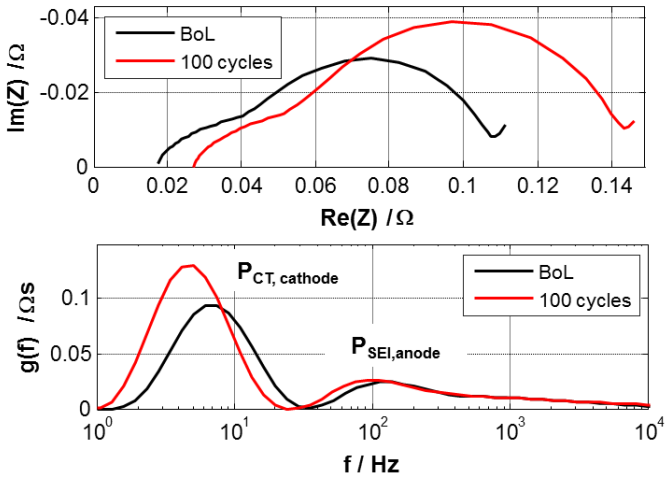

Figure 1: EIS and DRT data at SoC40 for BoL and after 100 cylces at 60 °C and 0.5C charge/1C discharge. A significant increase of R_0 and $R_{CT,cathode}$ is visible.

References:

[1] H. Schichlein, A.C. Müller, M. Voigts, A. Krügel, E. Ivers‐Tiffée, Journal of Applied Electrochemistry 32 (2002) 875‐882.
[2] J. Illig, M. Ender, T. Chrobak, J.P. Schmidt, D. Klotz, E. Ivers-Tiffée, Journal of the Electrochemical Society 159 (2012) A952-A960.