

Investigation of the μHz to mHz frequency range of commercial lithium-ion cells

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Measurements of the relaxation behavior of commercial lithium-ion cells show, that equilibration of the potential can exceed several hour, depending on SOC and cell chemistry. In case of a commercial cell with LiFePO_4 cathode, equilibration was not reached after 100h at SOC=0% and $T=25^\circ\text{C}$.

Such relaxation times result from slow processes like solid-state diffusion, differential intercalation capacity [1] and self-discharge. Those are favorably analyzed by time-domain techniques (GITT, etc.), as EIS measurements require much longer measurement times. Further insight was gained by the calculation of the distribution of relaxation times (DRT) [2,3]. However, this sequential procedure can be replaced by an even faster approach.

A new and easy method for the evaluating pulse-measurements is presented, which furthermore allows direct access to the distribution of relaxation times (DRT).

The practicability of the new method is compared to a method based on the Fourier transform [4].

Two commercial cells are investigated:

- (1) a stacked pouch cell comprising a blend cathode with NCA/LCO and
- (2) a cylindrical cell with a LFP cathode.

For both cells impedance measurements and the DRT are presented for a variation of the SOC and down to frequencies as low as $10\mu\text{Hz}$.

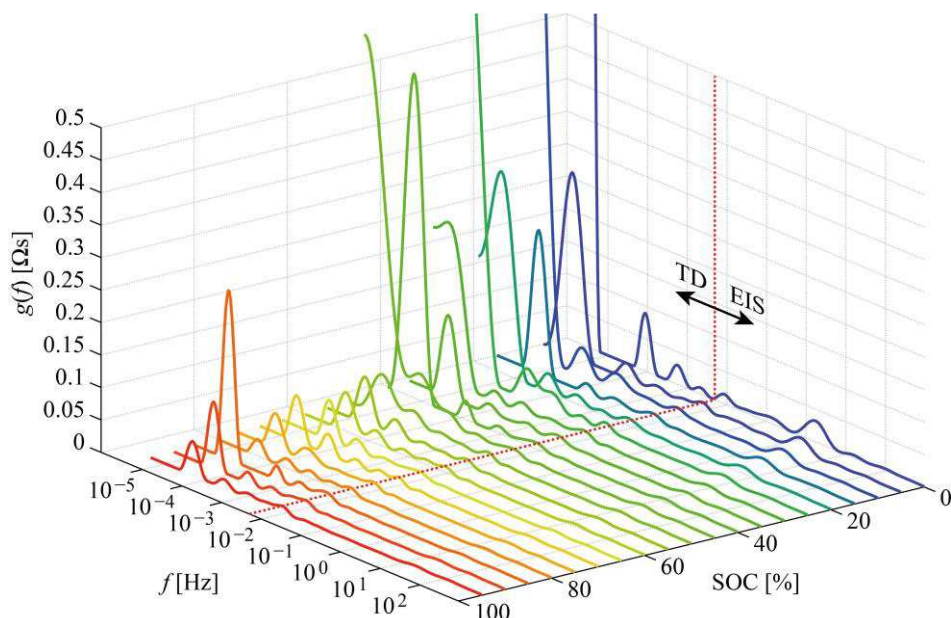


Figure 1: Distribution of relaxation times (DRT) of a commercial with NCA/LCO blend cathode for a variation of the SOC. The broad frequency range becomes accessible by combining EIS and the newly introduced pulse measurement method.

References

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- [4] D. Klotz et al., *Electrochim. Acta*, 56, 8763 (2011).