Battery electrodes assessed by tomography methods and transmission line models

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Battery performance can be designed by chemical composition and microstructure of positive and negative electrodes. Tomography methods are best-suited [1,2,3] to classify electrodes according to various characteristics. X-ray Tomography (µ-CT) and Focused Ion Beam/Secondary Electron Microscopy (FIB/SEM) deliver comprehensive sets of 3D microstructures with resolutions in the µm to nm scale. An in-depth analysis results in phase fractions, porosity, surface area, particle/agglomerate size and tortuosity of high-energy and high-power cells. Electrochemical impedance spectroscopy [4,5] in the time and in the frequency domain combined with transmission line modelling are applied for an extended performance analysis of the same type of electrodes. It will be shown, that the lithium-ion transport in the electrolyte-filled pore phase contributes considerably to the total electrode polarization, as the effective ionic conductivity of the electrolyte changes significantly with porosity and tortuosity of the pore phase. Furthermore, charge transfer resistance at the electrode/electrolyte interface and contact resistance at the electrode/current collector are quantified and discussed in the context of microstructure characteristics of high-energy and high-power lithium-ion batteries.

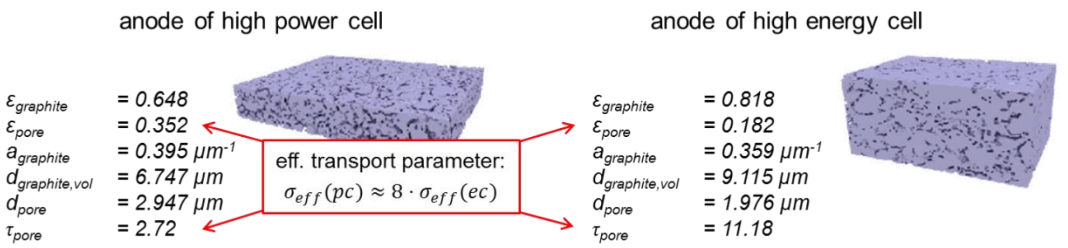

Figure 1:3D reconstructions and microstructure parameters of high-power and high-energy graphite anodes

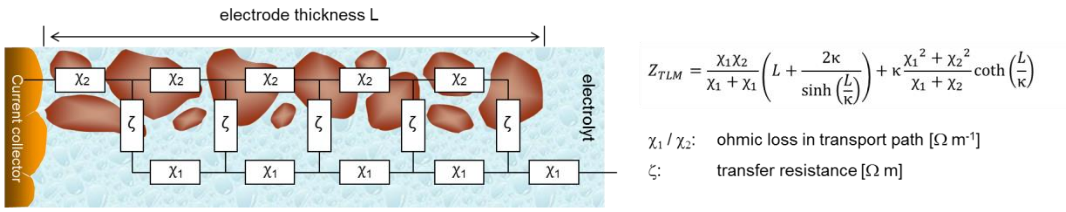

Figure 2: Two-line Transmission Line Model (TLM)

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