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# A study of Linear and Nonlinear Aging in Lithium-Ion Cells by Neutron Diffraction

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Commercial 18650-type C/LiNi0.33Mn0.33Co0.33O2 lithium-ion cells were exposed to different charging, discharging and resting conditiones to understand their influence on the aging behaviour. When cycled with a standard 1C charging and discharging rate and different resting times, the cells show a nonlinear capacity fade after a few hundred equivalent full cycles. By increasing the discharging current or decreasing the charging current, the lifetime improves and results in a linear capacity fade. The neutron diffraction experiment reveals a loss of lithium inventory as the dominant aging mechanism for both linearly and nonlinearly-aged cells. No structural degradation of electrode materials, or their deactivation was seen. With ongoing aging, we observe an increasing capacity loss in the edge area of the electrodes. Whereas the growth of the solid electrolyte interphase defines the early stage, linear aging, marginal lithium deposition is supposed to cause the later stage, nonlinear aging.

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