High-Voltage Cathode Model Systems by Atomic Layer Deposition for Li-ion Batteries

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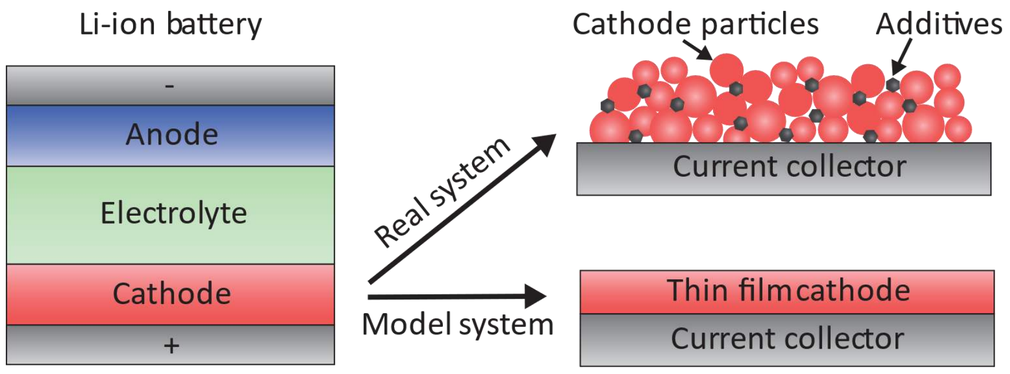
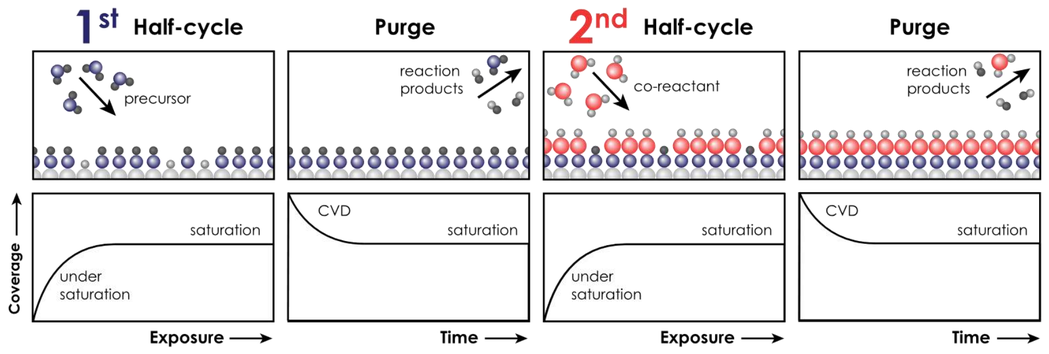
Thin Film Model Systems of High-Voltage Cathodes

A society based on renewable energy sources requires Li-ion batteries with higher energy densities. This can only be reached by adopting high-voltage cathodes. However, **parasitic reactions** at the **cathode-electrolyte interface** cause short battery lifetimes and hinder commercialization. Research on **stabilizing this interface** requires **simplified model systems** of high-voltage cathode materials with a controlled surface structure. In this work lithium nickel oxide (LNO) thin films are fabricated by atomic layer deposition (ALD), which gives **precise control** over film thickness and compostion.

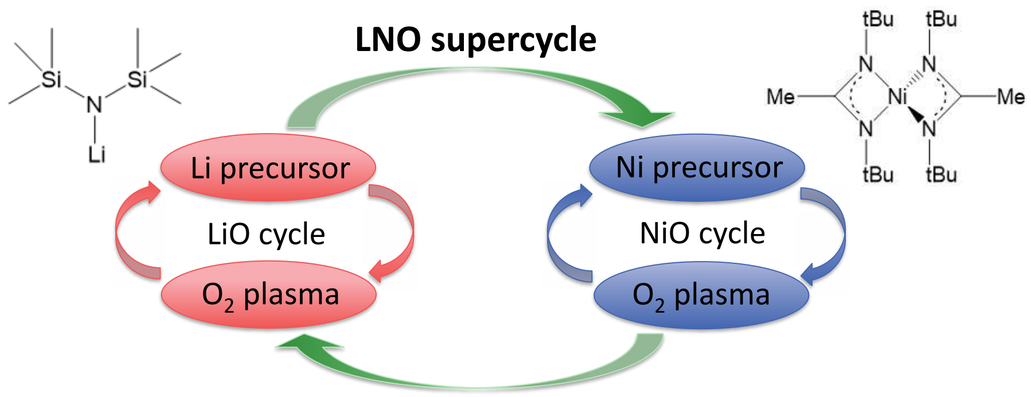


Atomic Layer Deposition



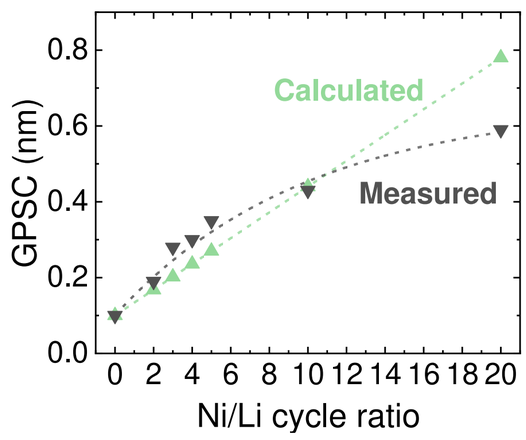
Harm Knoops, AtomicLimits image library (2020)

An ALD cycle consists of two **self-limiting** halfcycle reactions. LNO is grown using a **supercycle** approach. The **Ni/Li cycle ratio** is varied to study its effect on the film growth and composition.



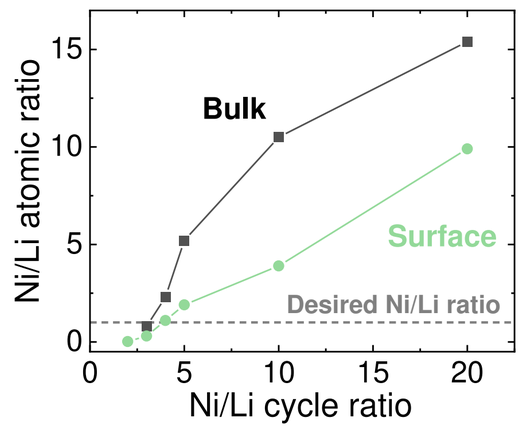
Film Growth

The growth per supercycle (GPSC), measured by in-situ spectroscopic ellipsometry, does **not follow** the calculated, **linear behavior**.



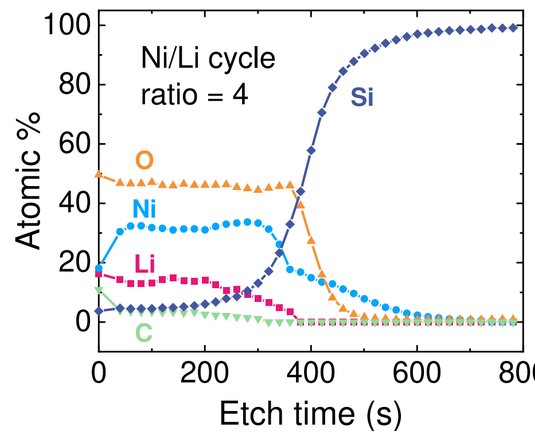
Film Composition

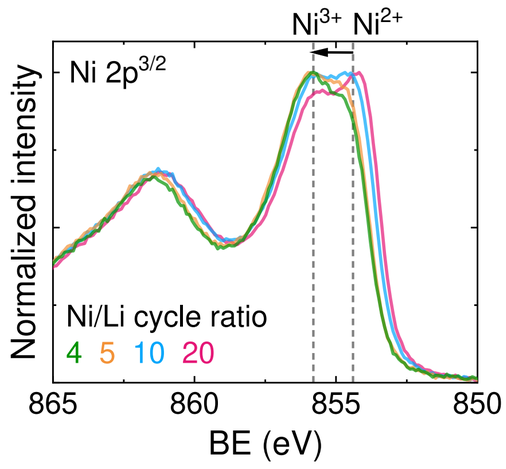
XPS measurements show a **higher Ni/Li atomic ratio in the bulk** than on the surface of LNO films due to Li_2CO_3 formation upon air exposure.



Depth profiles show **low levels of C and Si** contamination in the bulk.

The Ni oxidation state shifts to the **desired Ni^{3+}** with decreasing Ni/Li cycle ratio.





Outlook

Electrochemical measurements will be performed on these LNO films to study the effect of **material properties** on the **performance** as high-voltage cathode.

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