Probing battery electrochemistry \textit{in situ} at atomic scale

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**In Operando** electrochemical reactions of electrodes and ions revealed at atomic resolution

Experimental setting of a miniature half-cell battery observed in a high-resolution transmission electron microscope.

Lithiation of a single Co$_3$O$_4$ nanocube: [Co$_3$O$_4$ +2Li $\rightarrow$ 3Co + 2Li$_2$O]

**Top:** time-resolved *in-situ* HREM of the lithiation of a Co$_3$O$_4$ nanocube (with reaction time). The scale bar in red is 5 nm.

**Bottom:** Schematic of structural transformation from spinel Co$_3$O$_4$ to Li-ion inserted Li$_x$Co$_3$O$_4$, Co-rich Co-Li-O clusters and interconnected Co$^0$-clusters embedded in Li$_2$O.

We plan to apply atomic scale observation of charging and discharging for several important electrodes of high capacity and rechargeable batteries. This will be applied beyond the scope of lithium-ion battery, to other system such as sodium-ion and aluminum-ion batteries.