Investigations on Lithium Deposition as a Function of Current Densities with an Optically Accessible Cell

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Abstract

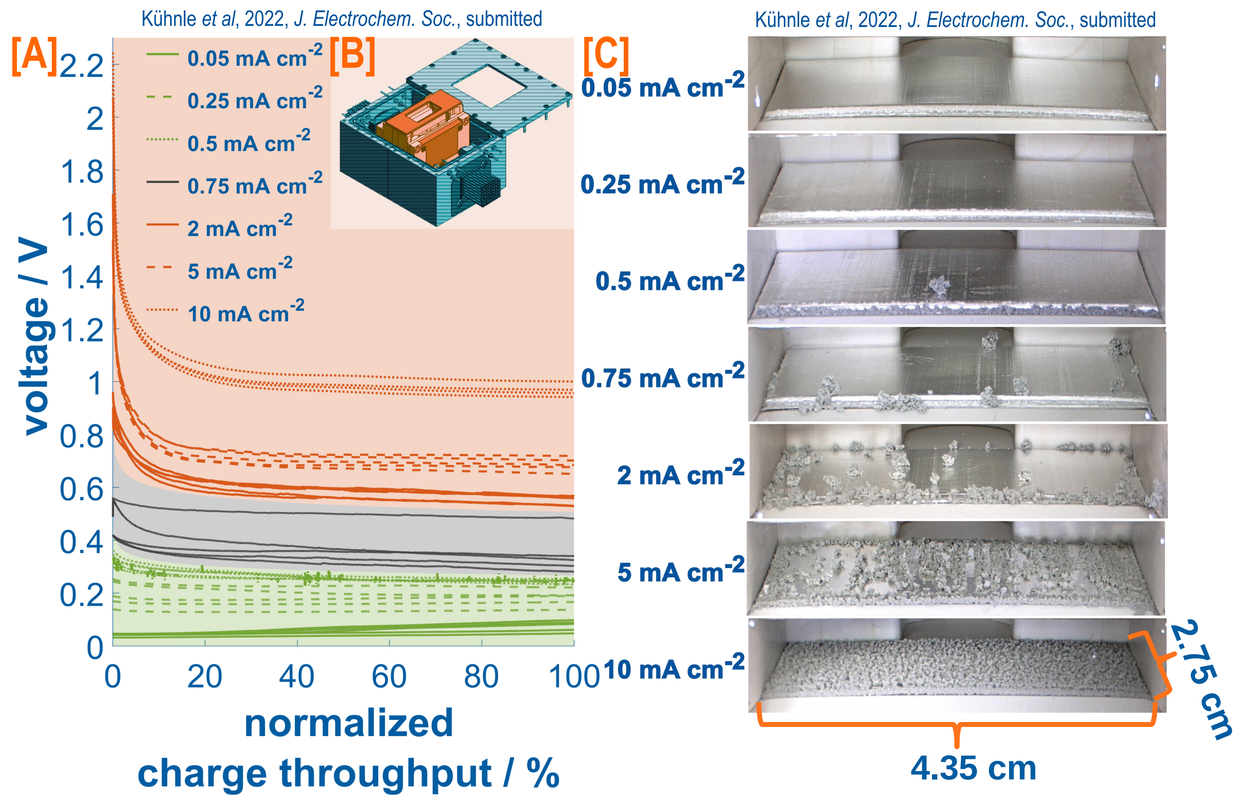
Li-metal deposition on Li-metal surfaces as a function of the current density (*J*) was investigated at RT in a symmetrical face-to-face optical cell. After a constant contact time between Li and an electrolyte (LP30), a charge of 39.24 As (10.9 mAh) was applied at various *J*. Constant current (CC) experiments, electrochemical impedance spectroscopy (EIS) and in situ images were recorded and put into context.

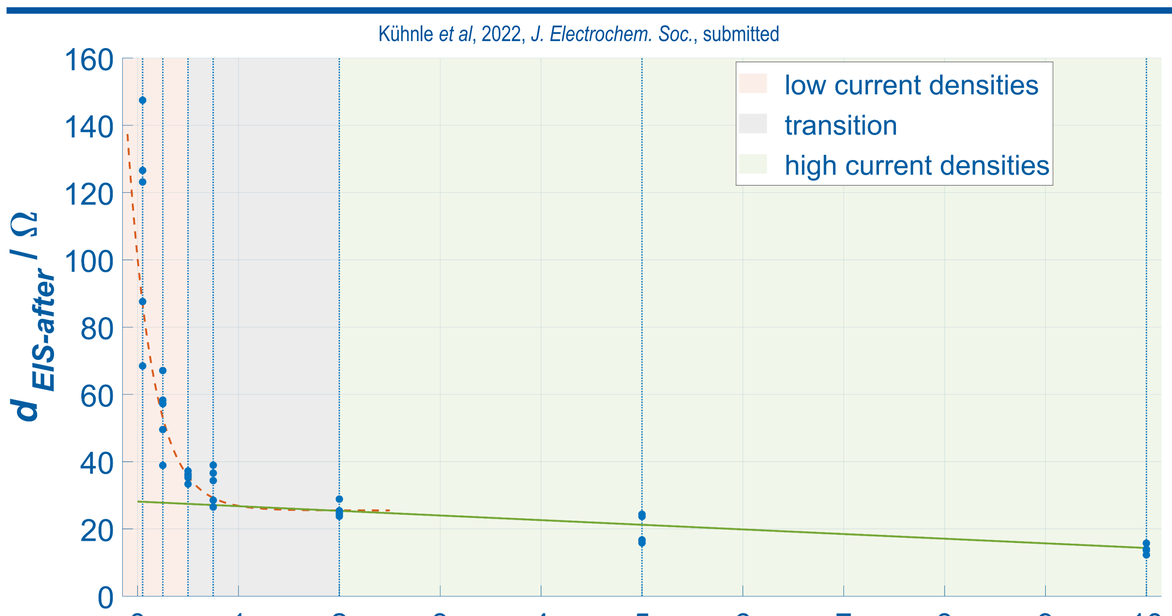
Conclusion

Two regimes and a transition area were identified for Li-metal deposition as a function of the current density. The current dependency has a significant impact on electrochemical and optical deposition characteristics. It must be carefully evaluated to what extent the results of low-current density experiments can be transferred to future industrial applications.

CC-Phase & Li-Deposition

- **Experimental setup:** Optically accessible in situ setup as published in Kühnle *et al* 2021 *J. Electrochem. Soc.* **168** 020510.
  Main components: Custom-made optical cell **[B]**, potentiostat, digital microscope, thermometer.
- **Testing procedure:** (1) initial 3-h electrode-electrolyte-contact, (2) EIS before CC-phase, (3) CC-phase, (4) EIS after CC-phase**.**
- **CC-phase:** *J* between 0.05 - 10 mA cm^{-2}.
- **[A]**: Voltage curves over normalized charge throughput at various *J*. Two regimes (low and high *J*) and a transition area.
- **[C]**: Representative Li-metal deposition pattern on Li-surfaces as a function of the *J*.



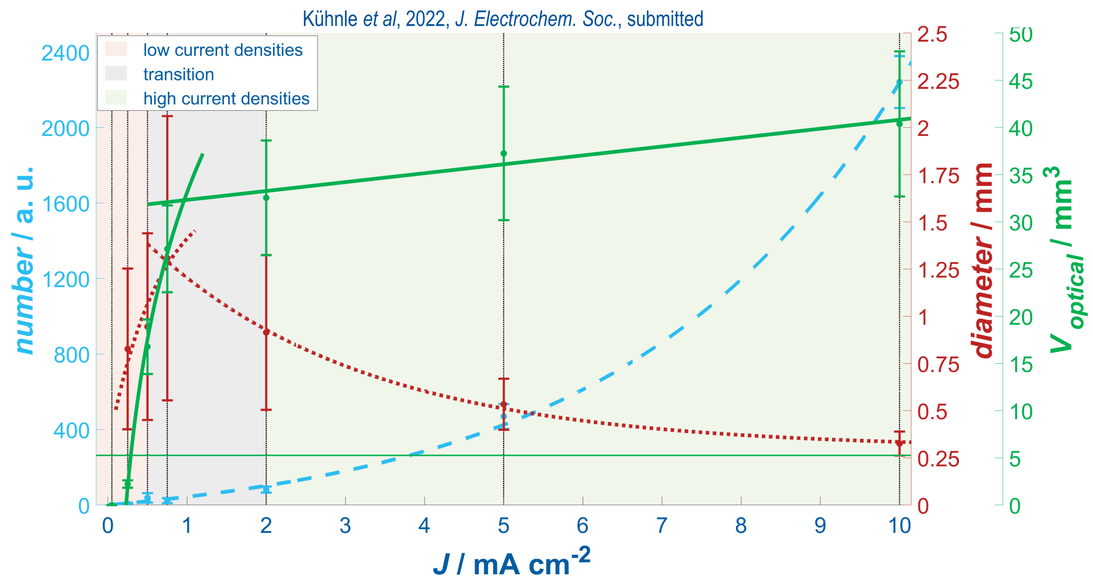


EIS-Measurements

- EIS-measurements (Nyquist-plots) of symmetrical Li||Li cells show one dominant semicircle.
- EIS-semicircle diameter (d_{EIS}) can be given as numerical value in Ω.
- **Before CC-phase:** Before CC-phase, all $d_{EIS\text{-}before}$ scatter around a common mean value. No trend visible.
- **After CC-phase:** After transfer of 39.24 As at different *J*, the $d_{EIS\text{-}after}$ show two regimes for low and high *J* with a transition area.
- Exponential vs. linear behavior.

Optical Deposition Parameters

- Manual evaluation of mean Li-deposition parameters from recorded in situ images, as given in [C].
- From low to high J, the…
- … **mean particle number *N*** increases exponentially.
- … **mean particle diameter *L*** first increases, then decreases, approaching an asymptote.
- … **total visible mean Li-deposition volume *V*** initially significantly rises, then increases further but less steep.



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