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in operando Kelvin probe force microscopy of solid-state batteries

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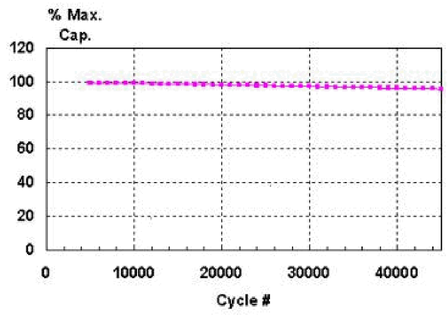
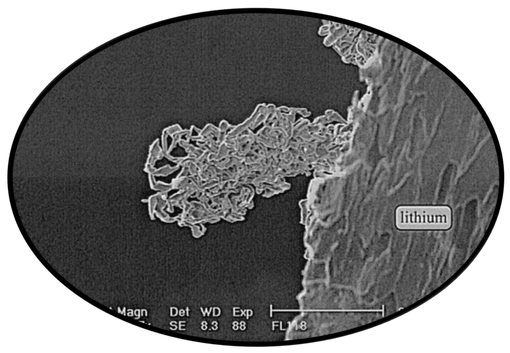
All solid-state batteries (SSBs)

Excellatron, www.excellatron.com/advantage.htm 2010



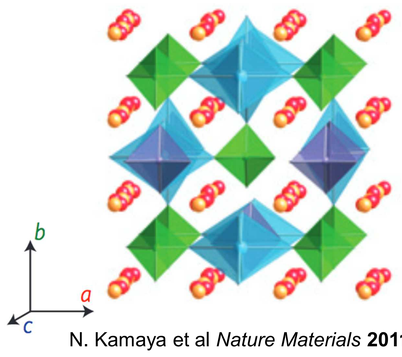
Cyclability – low capacity fade



Safety - no dendrite formation
High energy density – Li anode

F. Orsini et al *Journal of Power Sources* **1998**, *76*, 19

$Li_{10}GeP_2S_{12}$ $\sigma > 10\ \mathrm{mS\ cm^{-1}}$

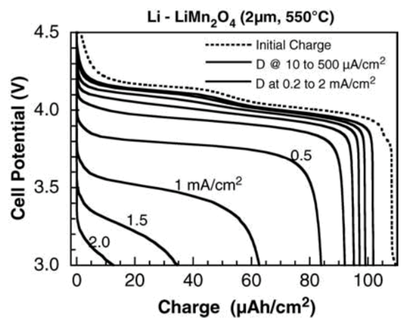


N. Kamaya et al *Nature Materials* **2011**, *10*, 682

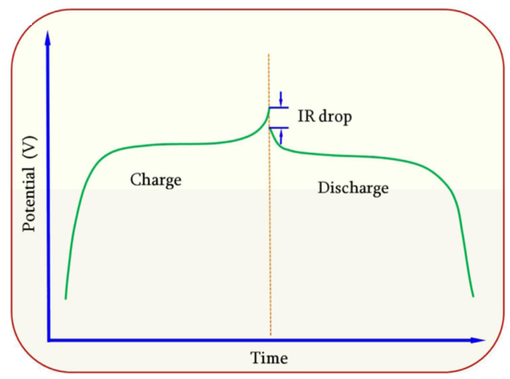
New high conductivity electrolytes are being developed

Challenges

Dudney, N. J. *Mat. Sci. and Eng. B* (2005) *116*(3), 245–249

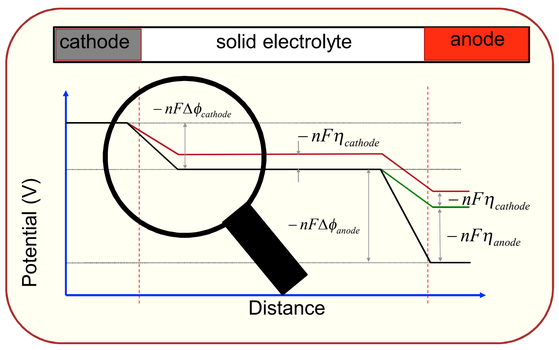


Low power density



Large overpotentials

C. Liu et al *Materials Today* (2016) *19*(2), 109–123



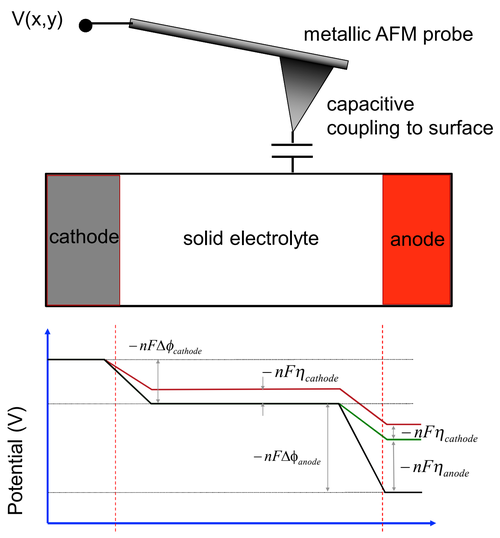
Interface limited transport – how can we study interface?

Our Approach

Goals of this Study

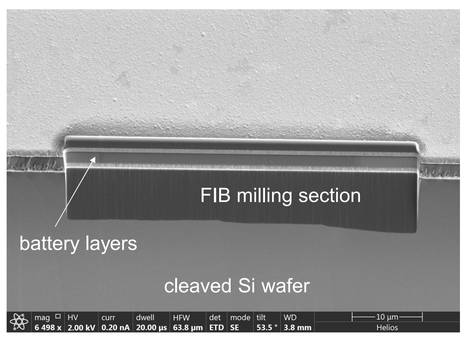
- **locate and investigate high impedance interfaces**
- **image depletion / interphase regions**
- **model the charge discharge overpotentials**
- **results to guide design of new high-power SSBs**

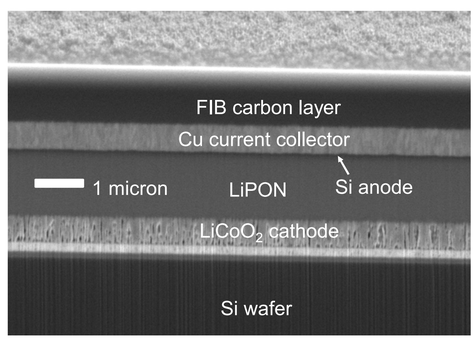
Kelvin probe force microscopy
(measure potential of battery layers)



1

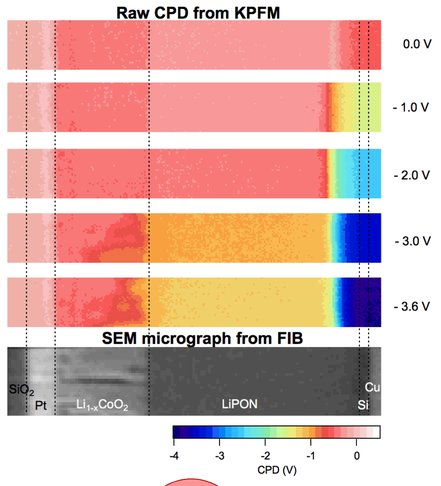
Focused Ion Beam Milling
(expose battery layers)





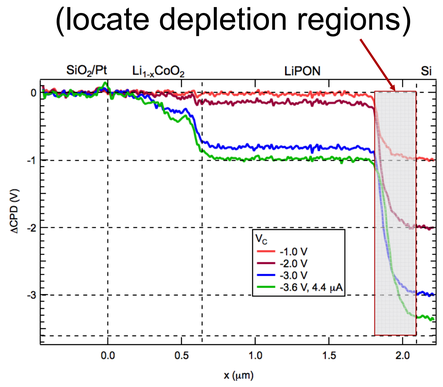
2

in operando Imaging of Potentials



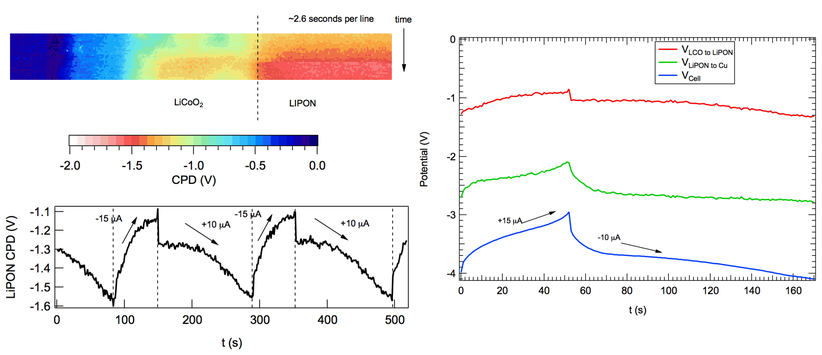
3

Extract Potential Profiles
(locate depletion regions)



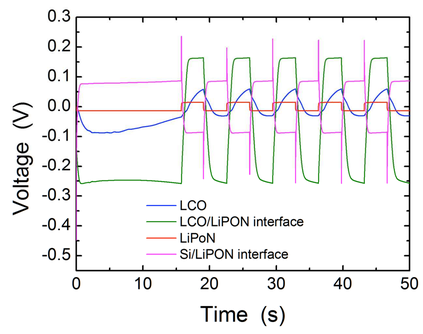
4

time resolved images
(charge/discharge)



5

modeling of the overpotentials
(COMSOL)



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