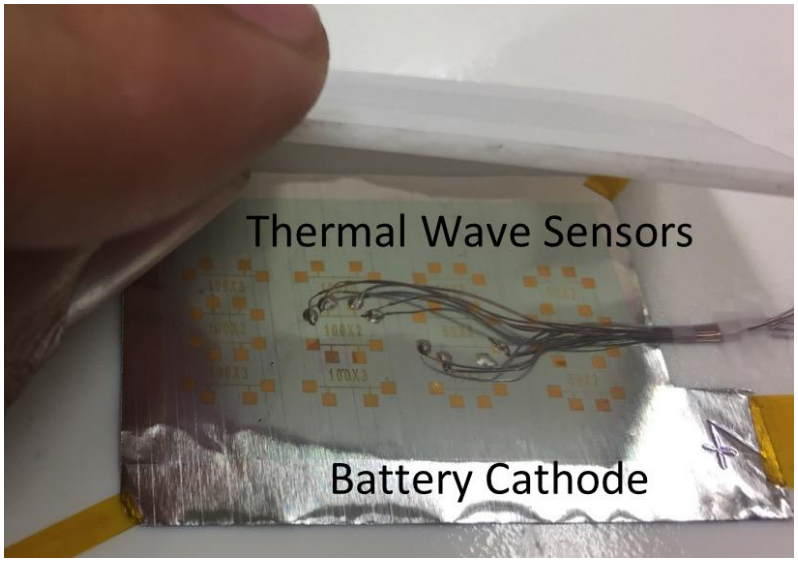
Thermal Wave Sensors for Clean Energy Technology Development



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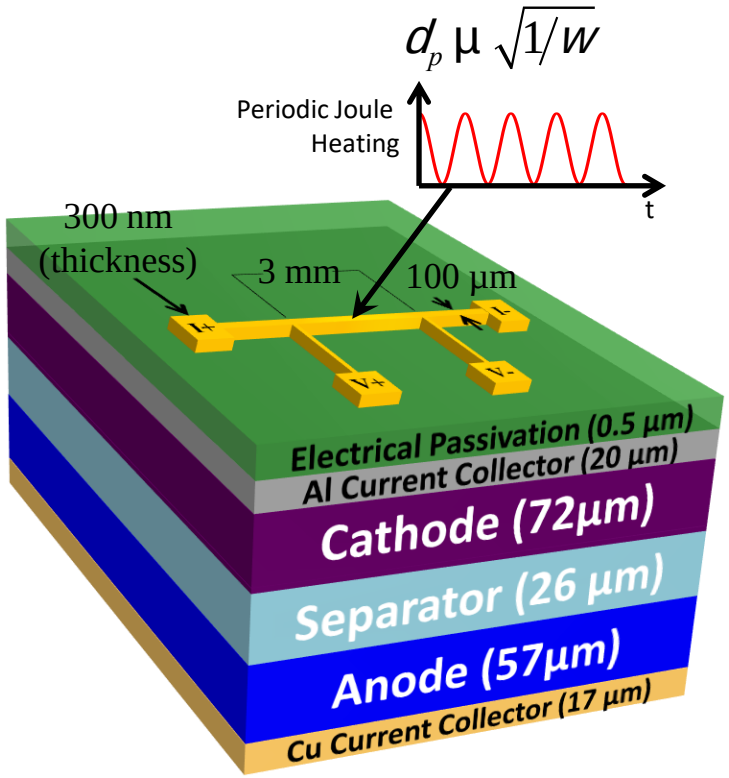
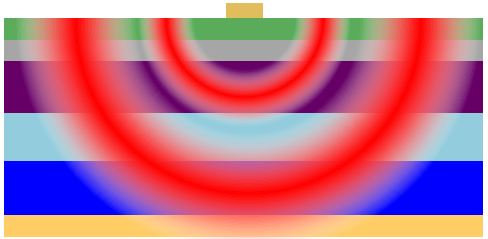
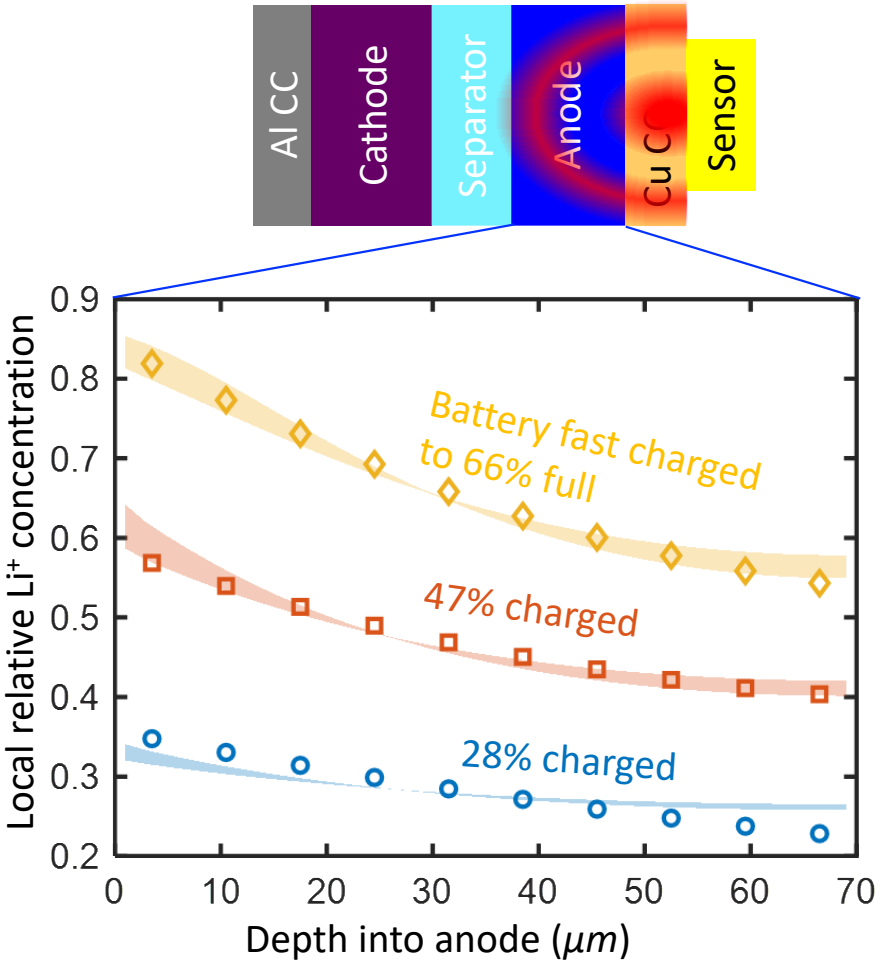
Thermal Wave Sensors (TWS) can map battery subsurface transport properties



Cross Section View

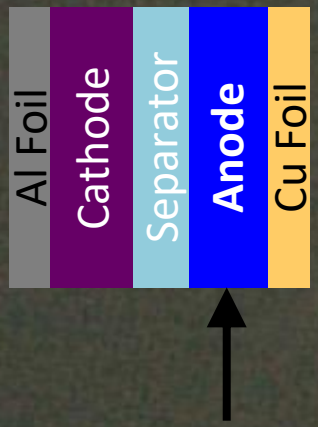


TWS Can Measure Lithium Gradients Within Batteries



Anode Cross Section

(optical microscope image)



(Separator would go here)

Anode

Cu Foil

Gold color = high lithiation

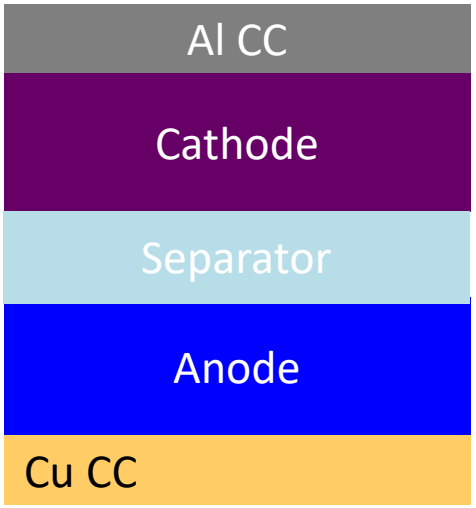
Low lithiation

70 µm

Trade-Off Between Energy Density and Power Density

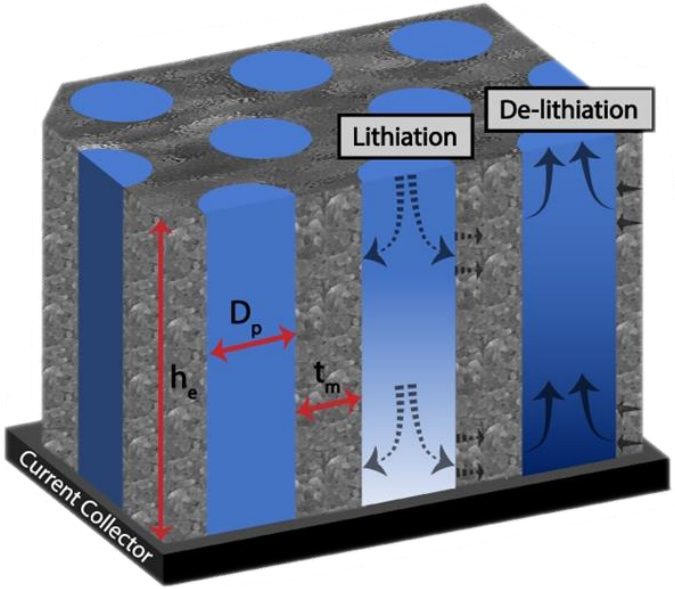
$$Energy\ Density = \frac{Energy\ (J)}{Mass\ (kg)}$$

$$Power\ Density = \frac{Power\ (W)}{Mass\ (kg)}$$



$$M_{total} = \underbrace{m_{cathode} + m_{anode}}_{\text{Active Material}} + \underbrace{m_{separator} + m_{cc}}_{\text{Inactive Material}}$$

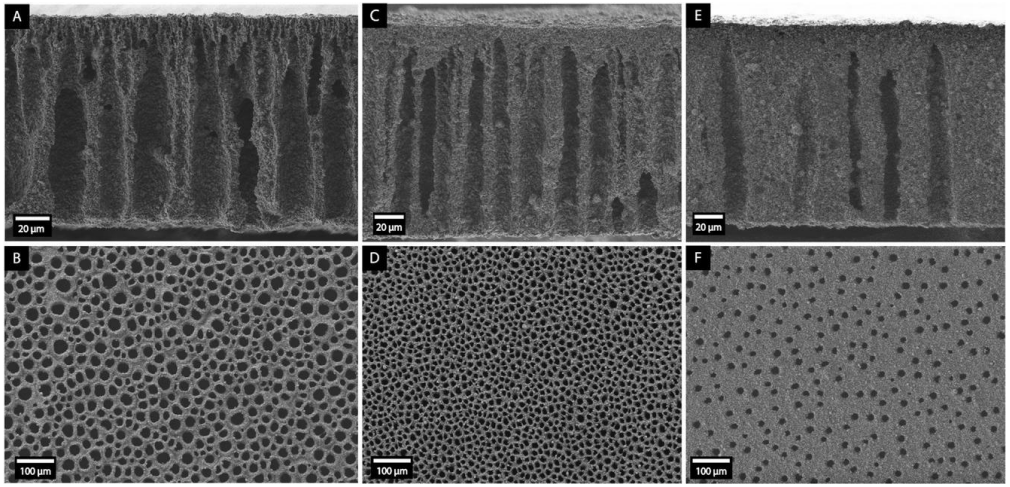
TWS Can Validate Decoupling of Energy Density and Power Density



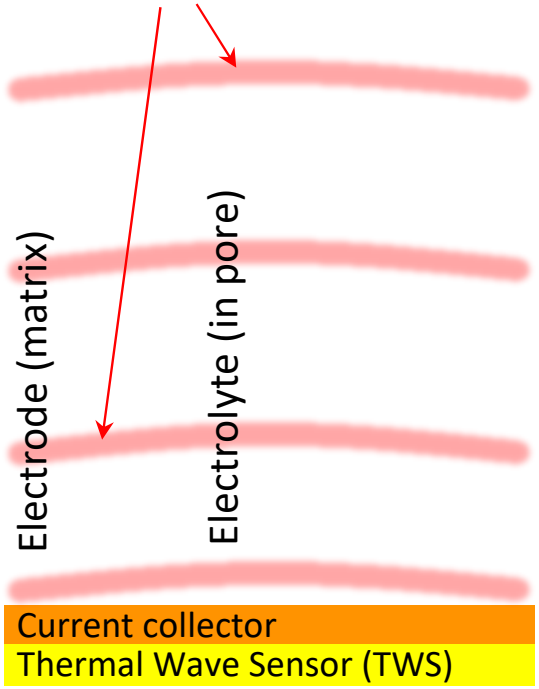
Structural parameters
- Electrode thickness (h_e)
- Primary Pore size (D_p)
- Matrix thickness (t_m)
- Matrix porosity and composition

Determines energy density (scales with electrode thickness)

Determines power density (electrode thickness invariant)

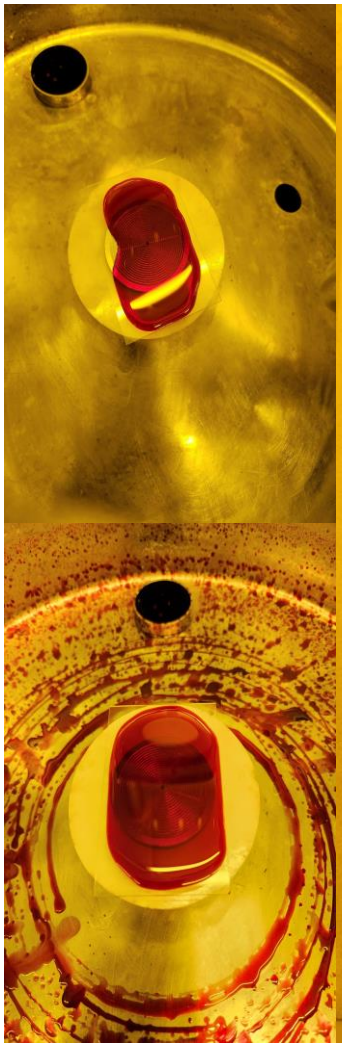


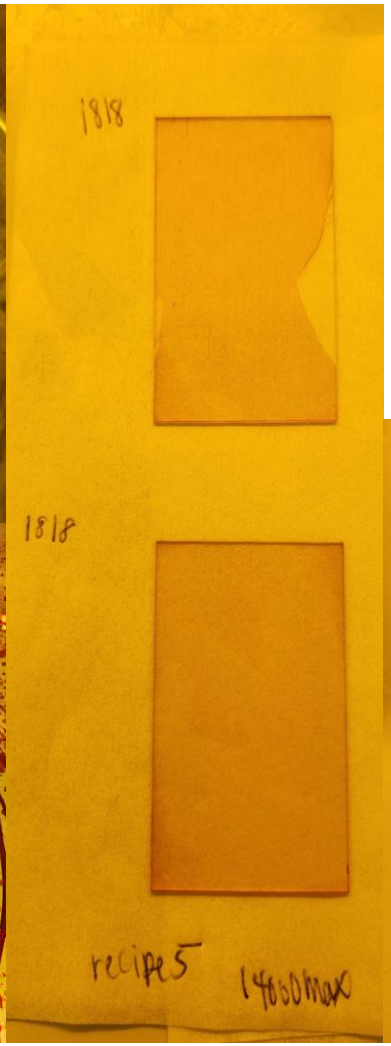
Thermal waves non-invasively map subsurface Li^+ distributions in AE

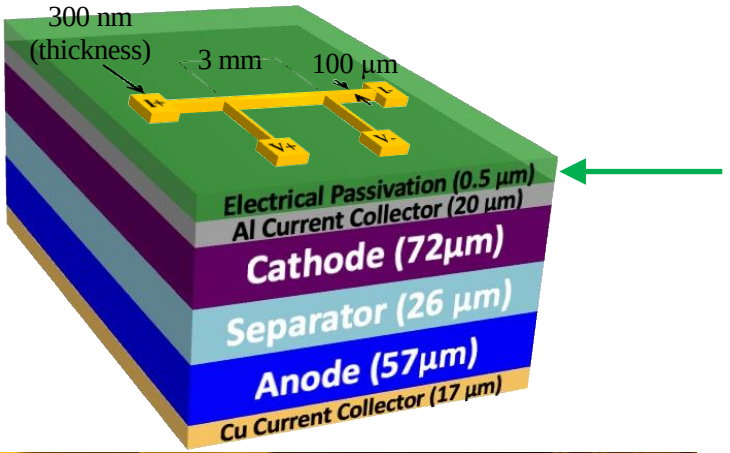


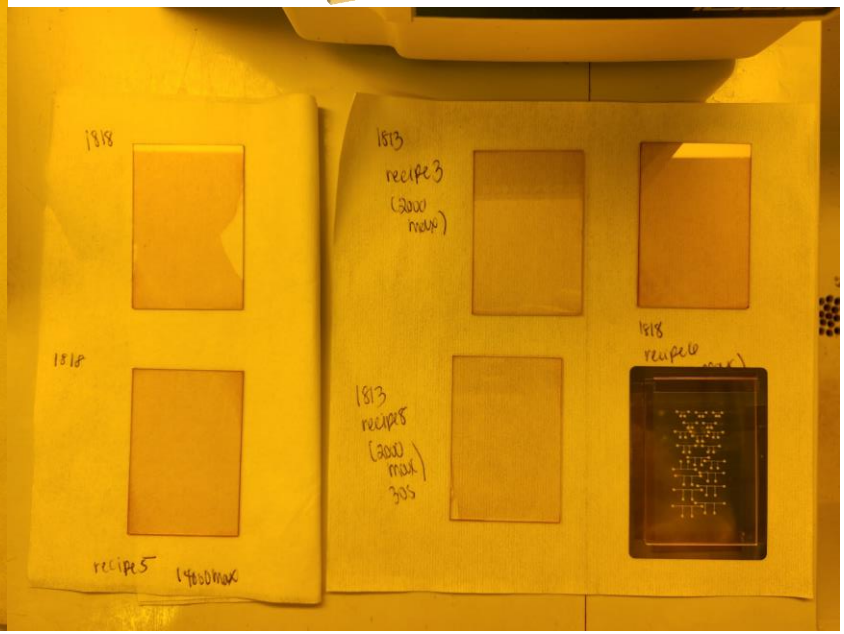
Thermal Wave Sensor Fabrication

Fabrication: Photoresist Spinning

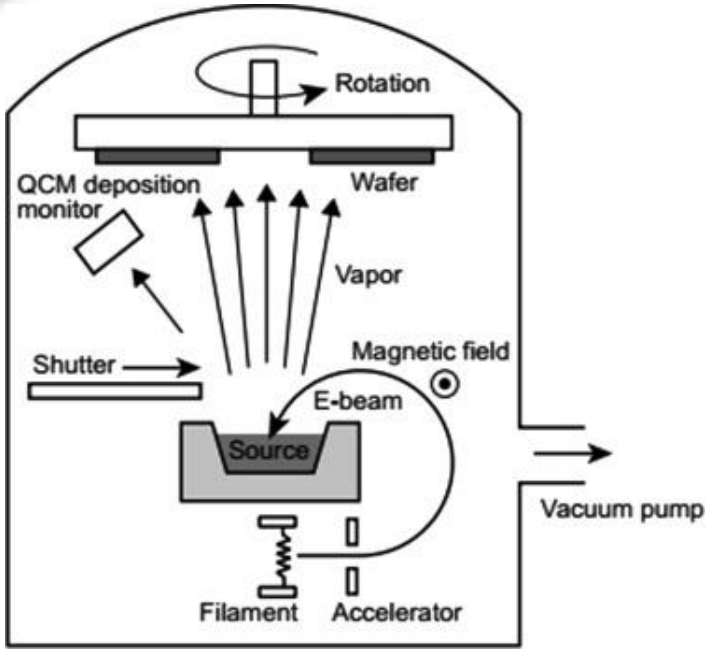


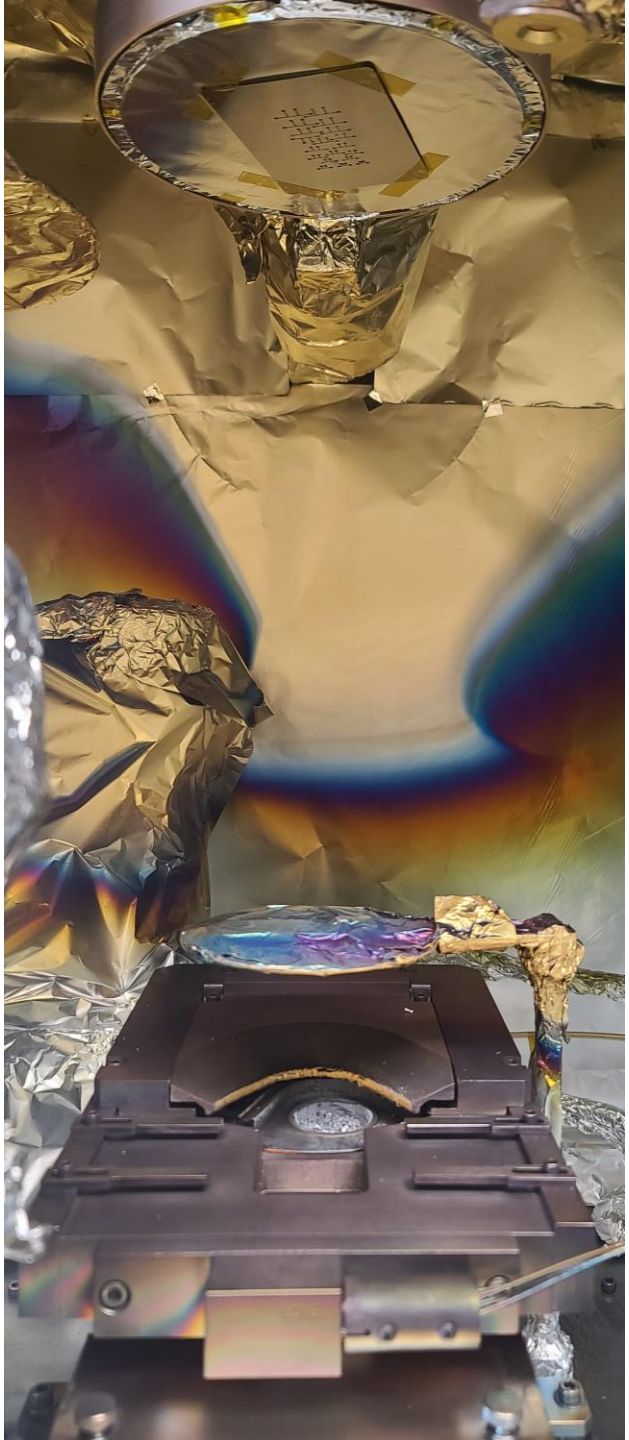




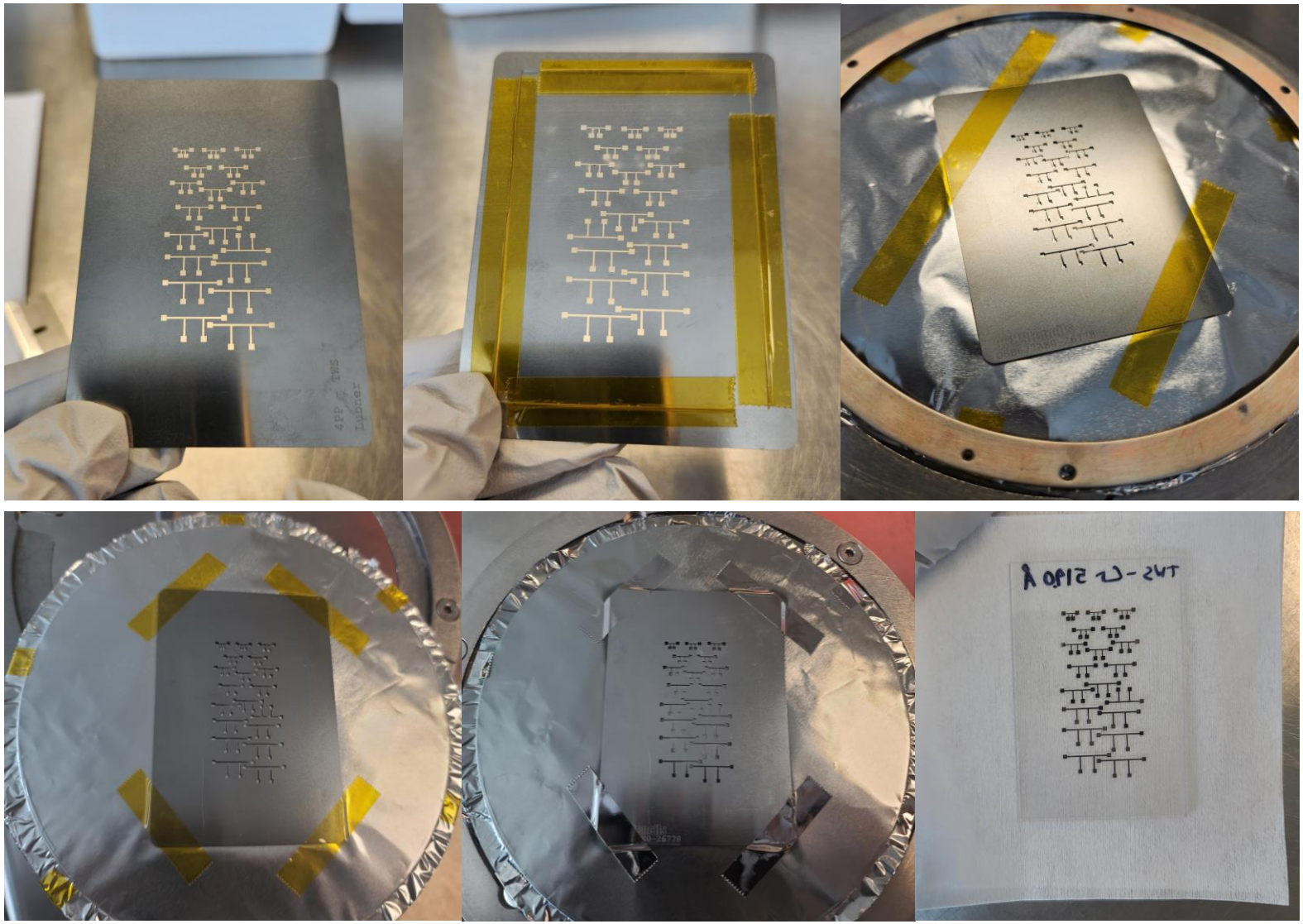


Fabrication: Electron beam metal deposition

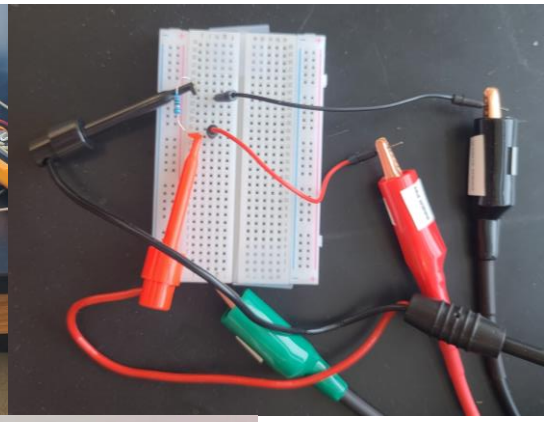


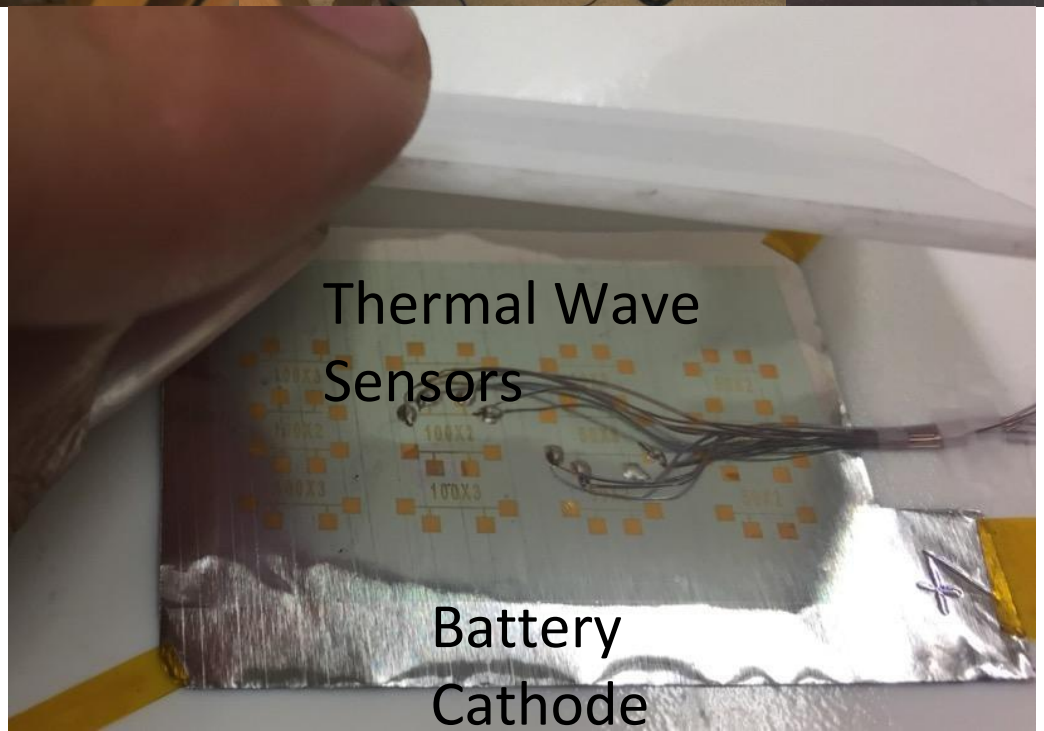


Fabrication: Shadowmask



Also building the electronics to power TWS





TWS: Further Applications

Fuel cells (structurally very similar to batteries), interface morphology evolution with cycling

Carbon capture adsorbent materials (CO_2 concentration gradients, when to replace, how well is it charging/discharging)

High Temperature Thermal Energy Storage: Generation and evolution of microcracks and sintering.

Thank You