



Nov. 17th, 2025

*3D Lithium–Sulfurized Carbon Pouch
Cells: Enabling EV-Level Performance
and Durability*

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Chief Science Officer

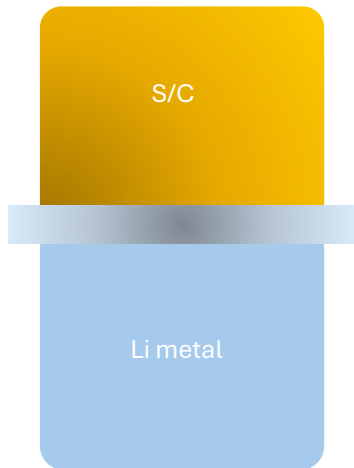
12th Lithium-Sulfur
Workshop at
Fraunhofer IWS
Nov 17-18, 2025



- 45+ people - company based in Houston-TX
- R&D team > 70% R&D level + industry experts
- R&D HQ starts operation in 2022
- *Series A* completed in early 2023 – \$23 mm
- *Series B* (2024-2025), pilot plant in Houston – **on-going!**
- 1 JDA agreement, funded, with Stellantis (2024-2026)
- 2 government projects from DOE (2023 – 2027), total 10\$ mm
 - *ARPA-E JOULES with *Argonne National Lab.*
 - *EERE-VTO-2024 with *OEM2*

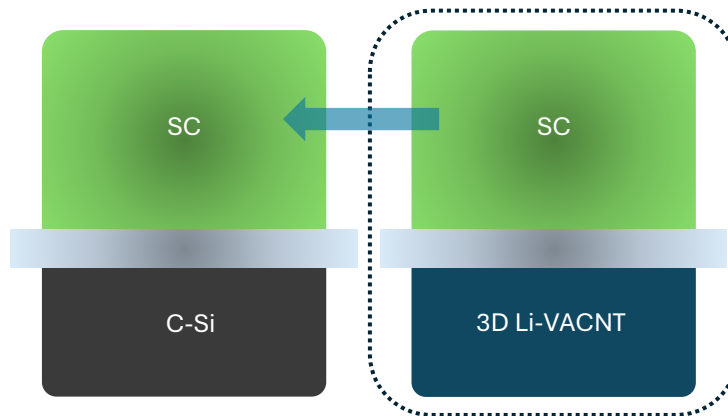
Zeta Energy 3D Li-SC technology

Traditional Lithium-sulfur



- Elemental sulfur ($0 \text{ kg}_{\text{metals}} / \text{kWh}$)
- Shuttle effect $\rightarrow$ fast degradation
- Lithium dendrite formation
- Excessive use of materials in cells
- $> 500 \text{ Wh kg}^{-1}$ (unsafe, unpredictable performance)

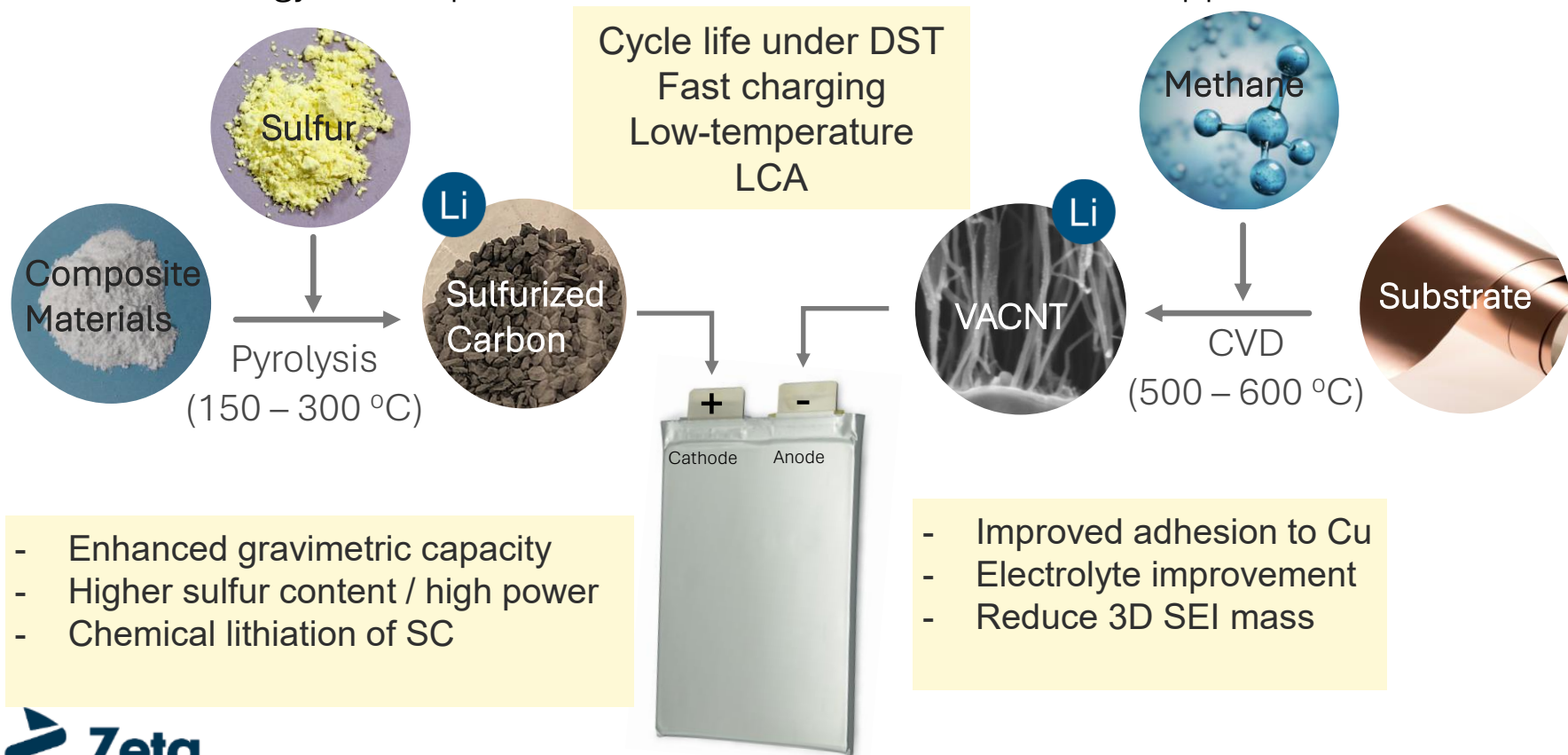
ZETA 3D Li + Sulfurized Carbon



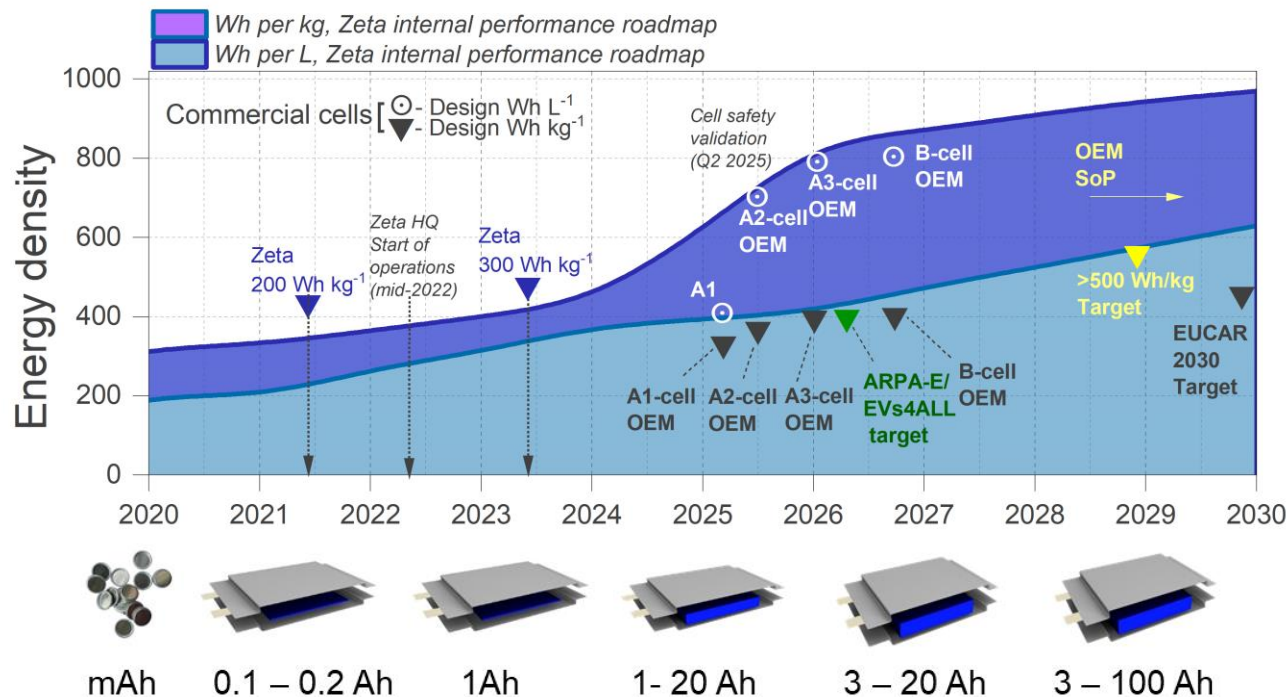
- Shuttle-free SC cathode – stable across electrolytes
- Dendrite-free 3D Li metal anodes
- Supportive lithiation method
- Efficient use of Li and electrolyte amount in cells
- SC | Li-VACNT raw materials – all domestic
- $> 500 \text{ Wh kg}^{-1}$ (safe, predictable performance)
- **Raw materials – all U.S. based sources**

Zeta Energy 3D Li-SC technology

Cell technology can be produced from full domestic and local supplies.



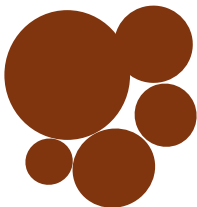
Technology roadmap



Electrode densification

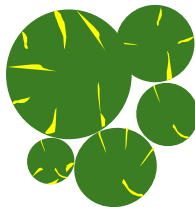
Reduced Li excess, electrolyte and cycle life

SPAN-type cathode

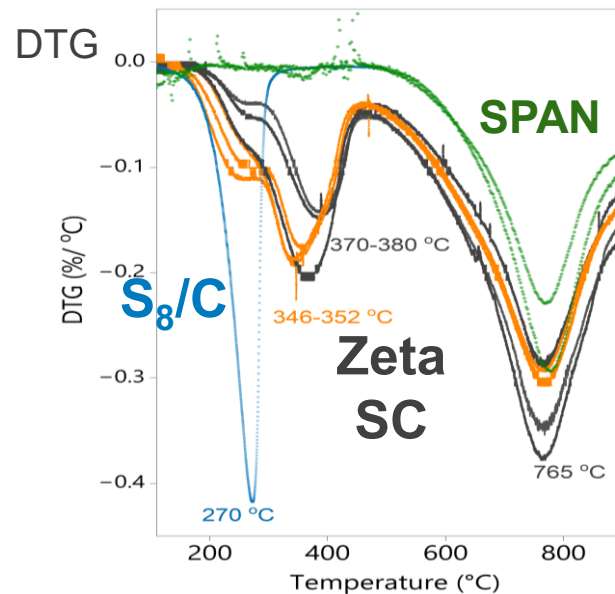


- **PAN**
- Sulfur content limited to ~30-40% (bonded state)
- One-plateau discharge
- No diffusion of Li polysulfides
- High electrochemical stability
- Limited electrolyte flexibility
- Particle/electrode expansion buffered by C

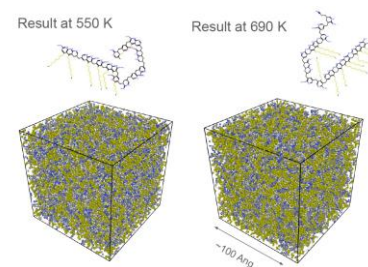
Zeta Sulfurized Carbon



- **PAN derivatives & composites**
- Sulfur content expanded to 40 to > 70%
- No diffusion of Li polysulfides
- High electrochemical stability
- Electrolyte flexibility
- Low-resistance
- Particle/electrode expansion buffered by C and particle PSD/shape optimization (~6%)



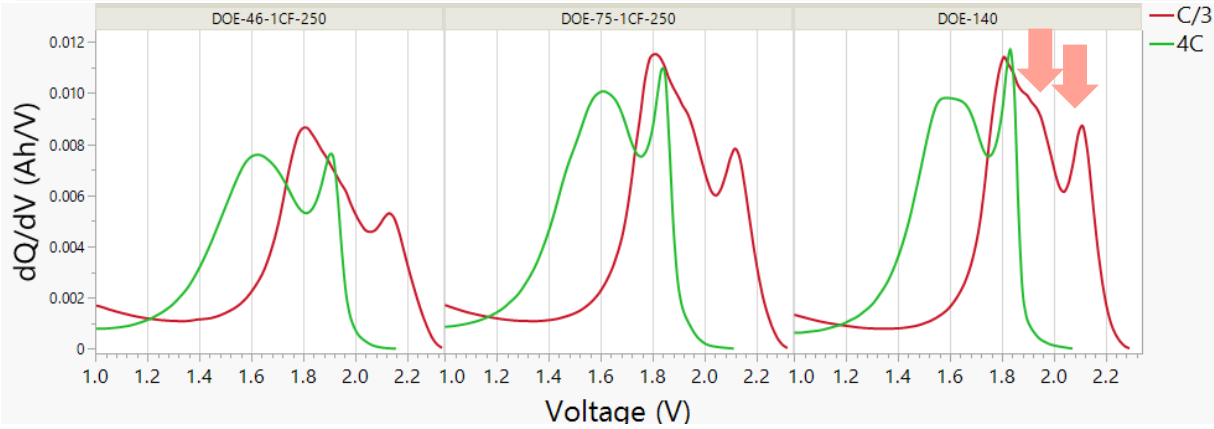
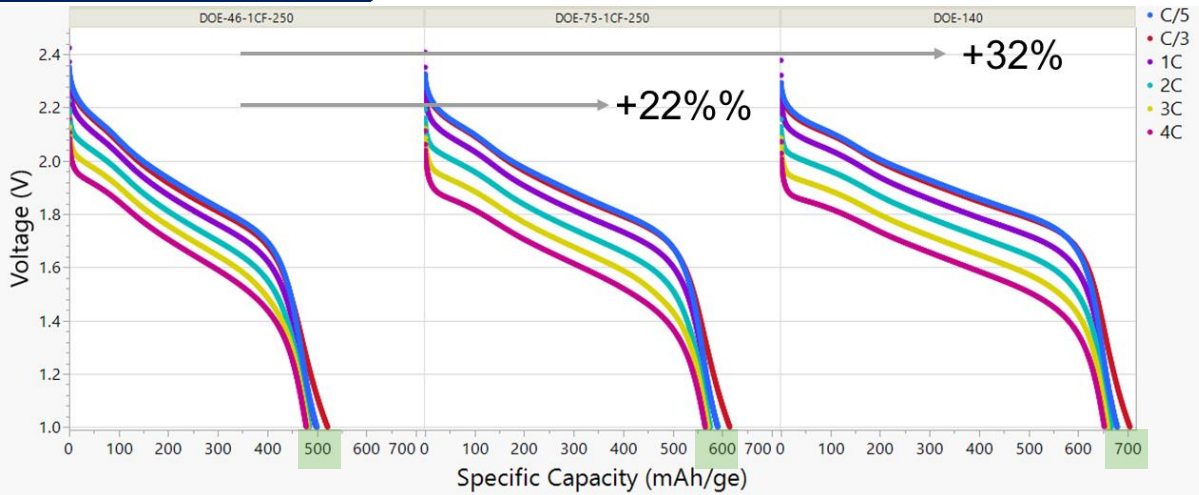
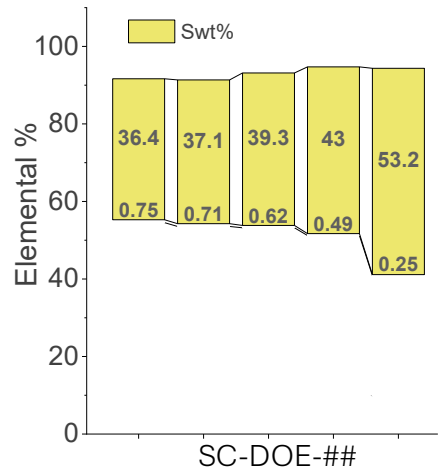
DFT/MD



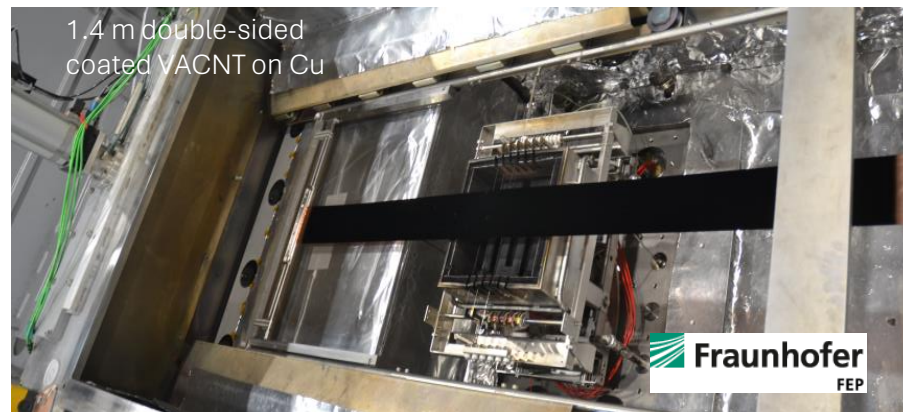
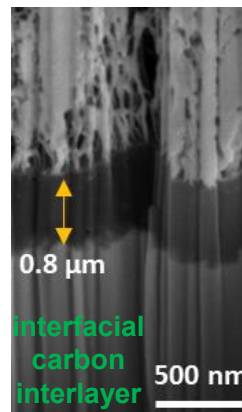
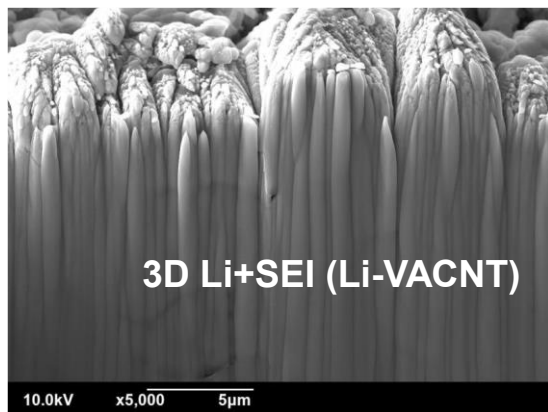
Gravimetric capacity gains through SC engineering

Engineered porosity in carbon structures trap sulfur physically, while covalent bonding stabilizes it chemically—allowing high sulfur content without performance trade-offs

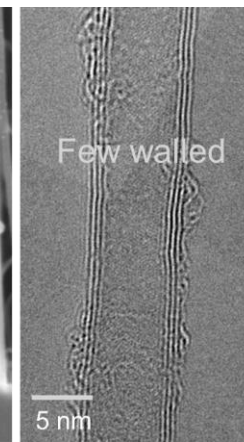
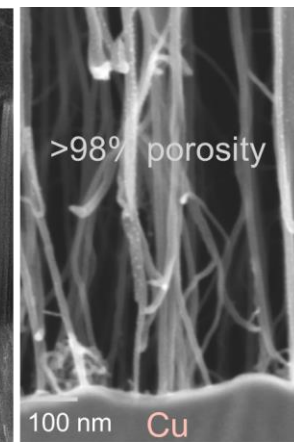
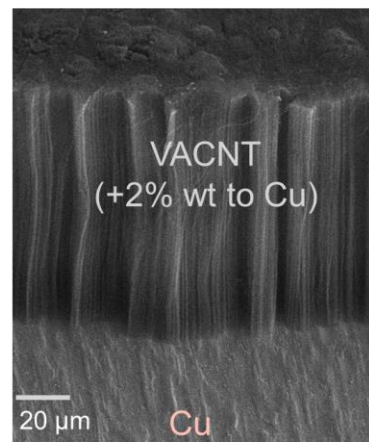
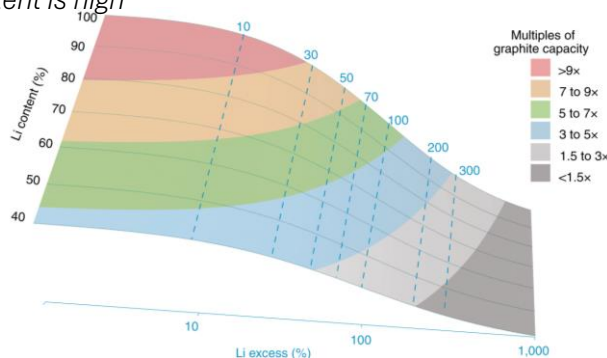
Elemental composition%



Zeta 3D Li anode on VACNT

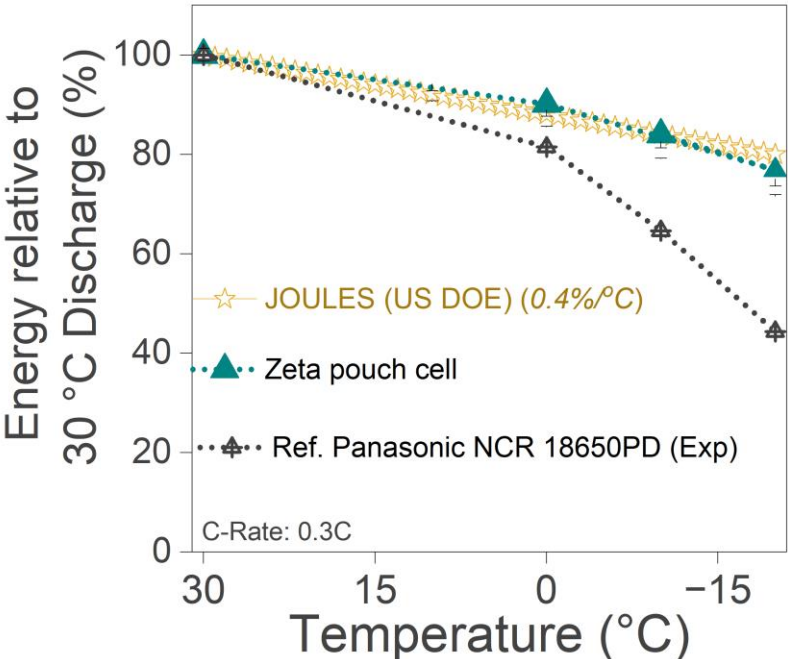


- >9x higher capacity than graphite
- ... if low NP* ratio is used
- ... if Li content is high

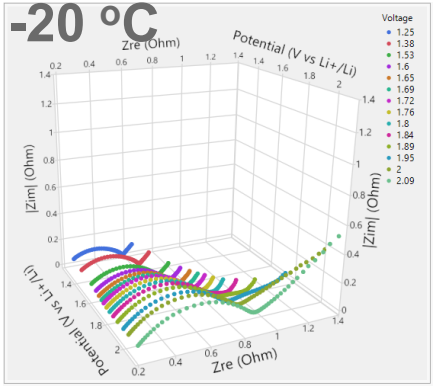
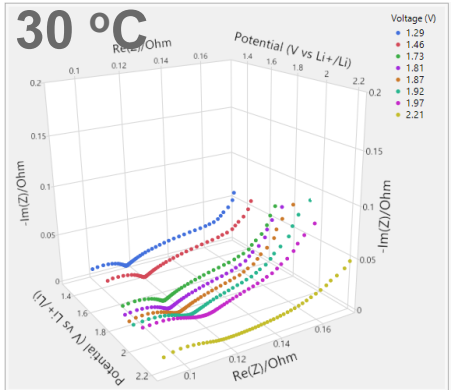
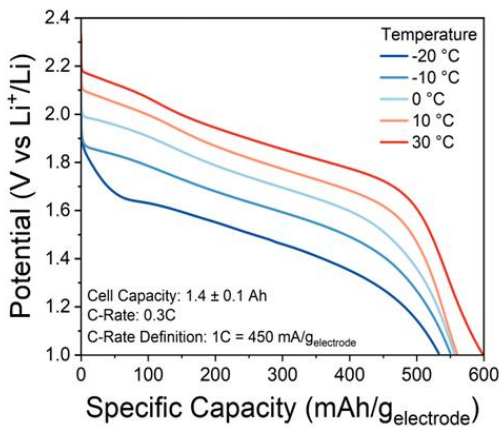


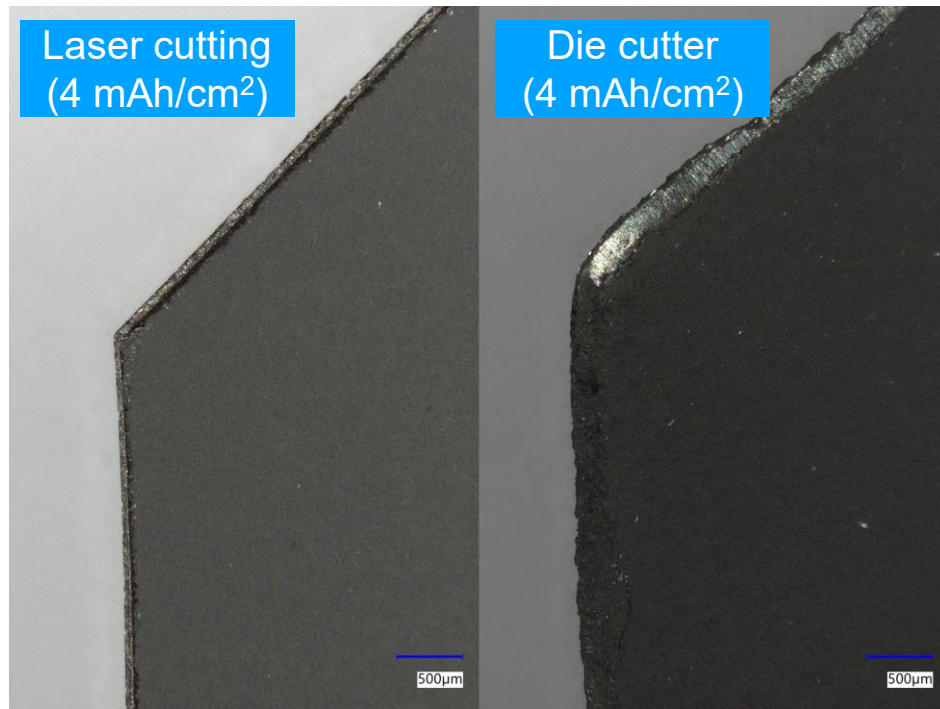
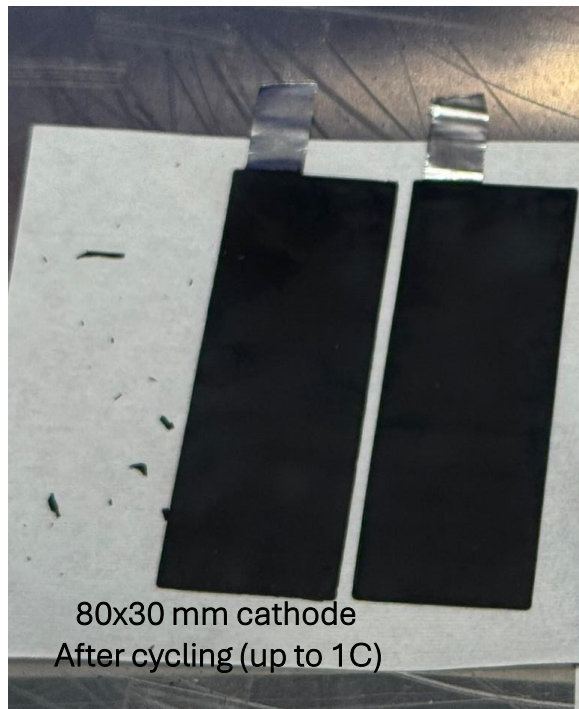
Cell - Performance at low temperatures

SC | Li-VACNT Pouch cells can retain high energy at -20 °C



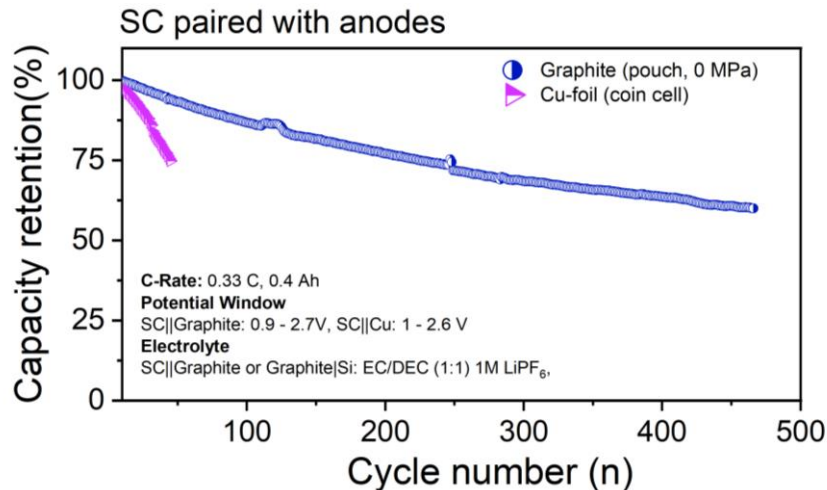
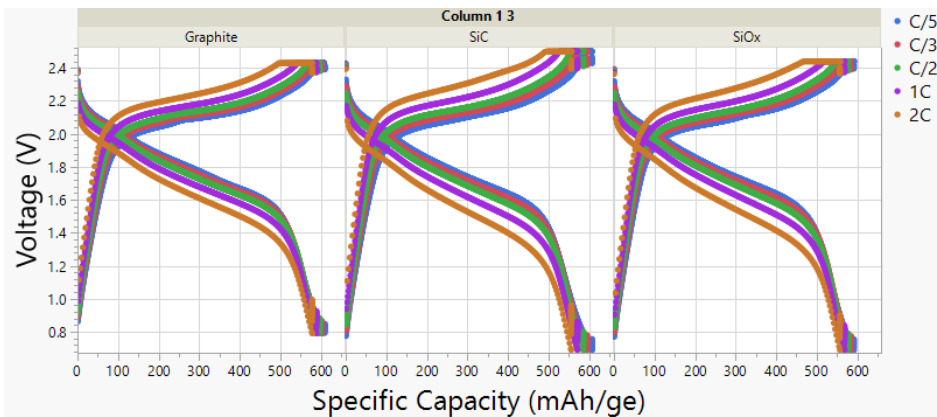
~ 78%
energy
retention
at -20 °C





SC with traditional anodes (graphite-Si)

- Lithiated sulfurized carbon (Li-SC) can deliver lithium to a range of commercial anode architectures—including graphite, Si/graphite (Si-C), and SiO_x - Estimated energy density for *iteration 1* - ~ 200 Wh/kg



*Li-SC | graphite-SiO_x cells in development as part of
US DOE EERE-VTO (250 Wh/kg, 1000 cycles) with OEM2*



Thank you!

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1

Dendrite-free
Li anode

2

Low-expansion
electrodes

3

Stable sulfur
cathode

4

Competitive
Cell Performance

5

Low cost
solutions
