Lithium-Sulfur Cell Chemistry Unlocked by 3D Graphene for Next-Generation Energy Storage

22nd Advanced Automotive Battery Conference

John Duke
Chief Business Officer
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LYTEN

NAATBatt INTERNATIONAL

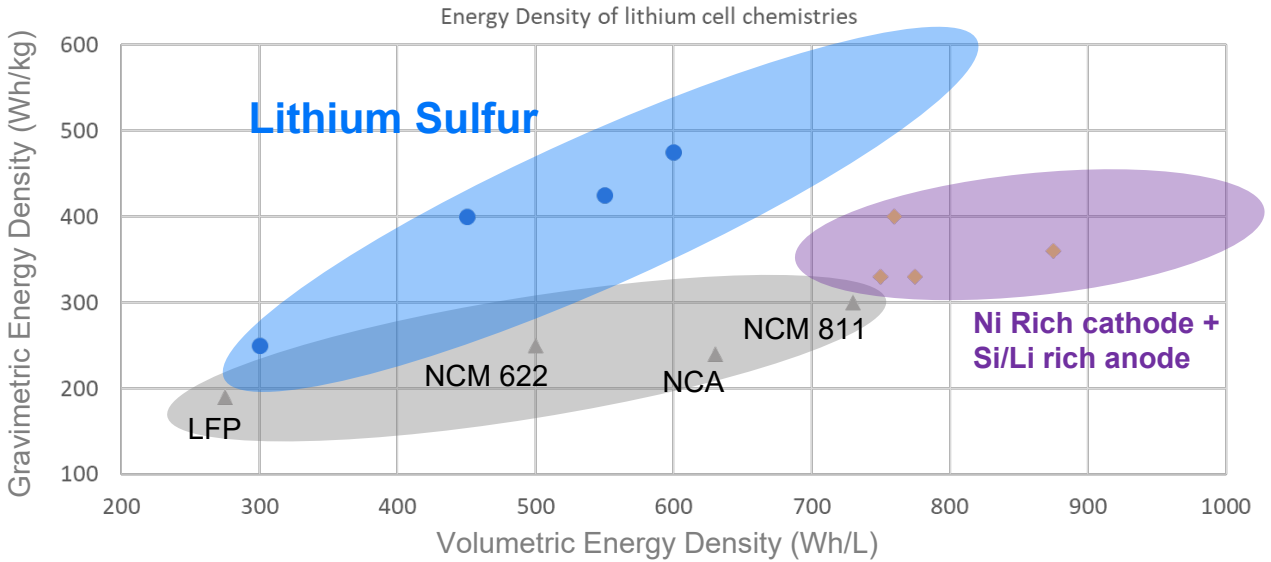
LYTEN OVERVIEW

- Founded 2015 – Inventor of Lyten 3D Graphene™
- Global leader in 3D Graphene IP (PatSnap)
  - >300 Patents granted or pending
  - Material and product patents
- HQ in San Jose, CA – New 55,000 ft^2 facility
  - 3D Graphene™ fab
  - Pilot cell production line in dry-room
  - > 230 Employees and growing
- History of US Government engagements

THE ATTRACTIVENESS OF LITHIUM SULFUR CELL CHEMISTRY

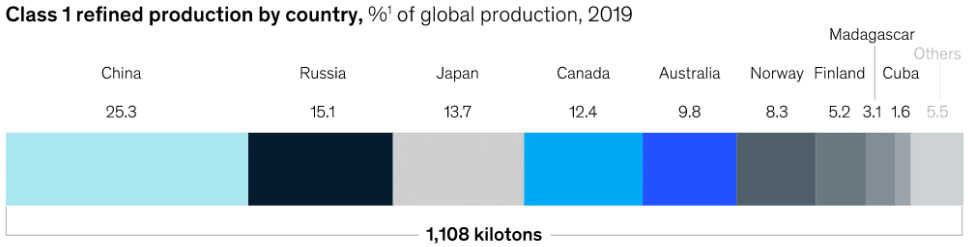
Key Advantages of Lithium Sulfur

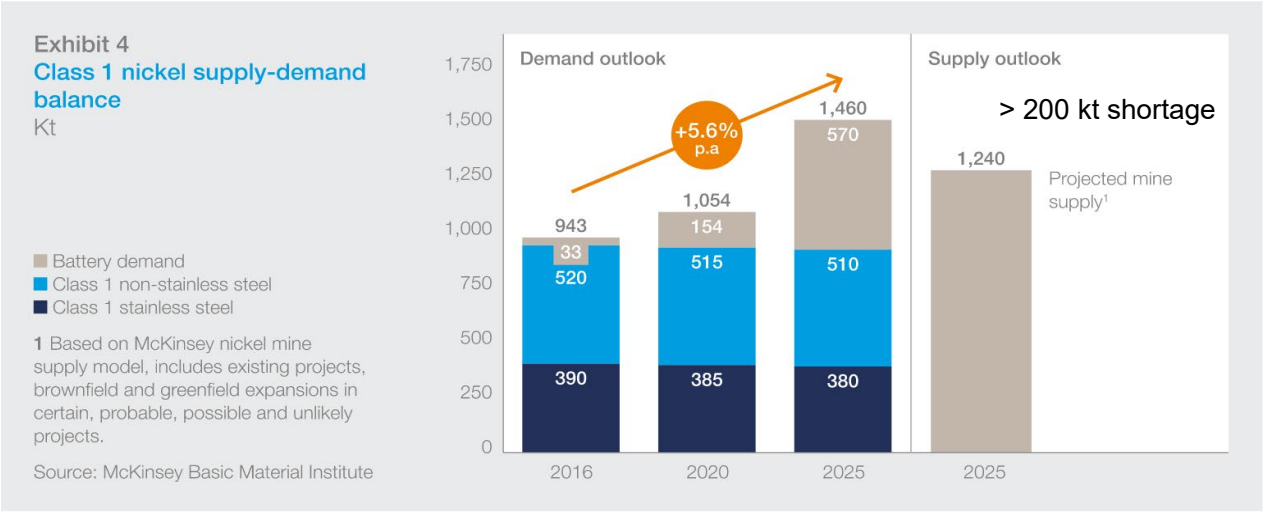
- Nickel/cobalt/graphite - free → fully domestic supply chain
- Abundant, low-cost materials: sulfur, carbon, solvents
- Inherently safer due to unique conversion chemistry
- At maturity, 600 Wh/kg and 800 Wh/L possible



Key Challenges for Traditional LIBs

- Predominantly foreign-sourced active materials
- Cell performance reaching its fundamental limits
- Nickel shortfall in coming years





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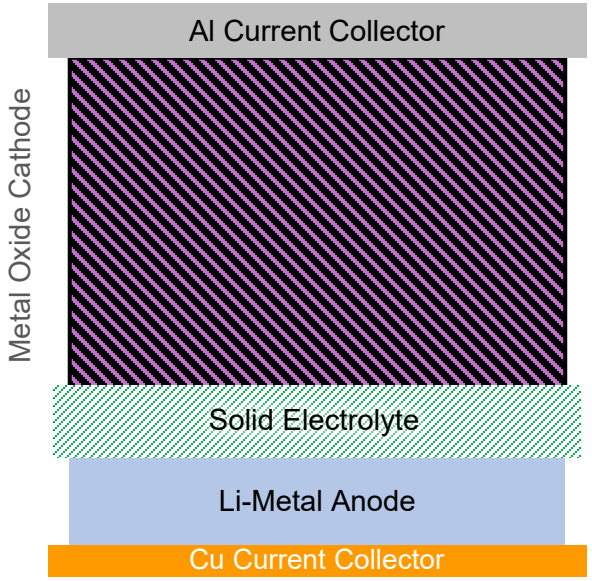
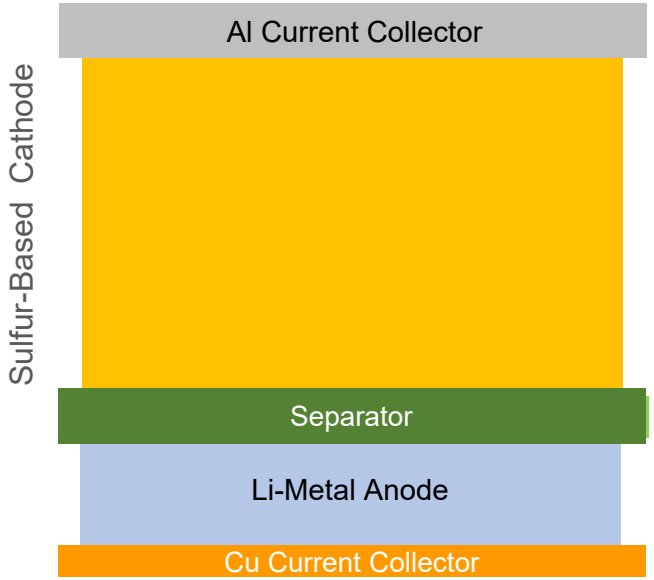
LI-S CELLS : DISTINCTIVE ATTRIBUTES AND HISTORIC CHALLENGES

TRADITIONAL LIB

SOLID STATE



LITHIUM-SULFUR



Key attributes

- 1675 mAh/g theoretical sulfur cathode capacity
- Conversion chemistry cathode: $S_8 \rightarrow 8Li_2S$
- Li metal anode is stripped and plated

Historic challenges

- Polysulfide shuttle → Less than 100 cycles (typical)
- Sulfur is an insulator → Slow charge/discharge rates (C/10)
- Li metal degradation → Less than 100 cycles (typical)

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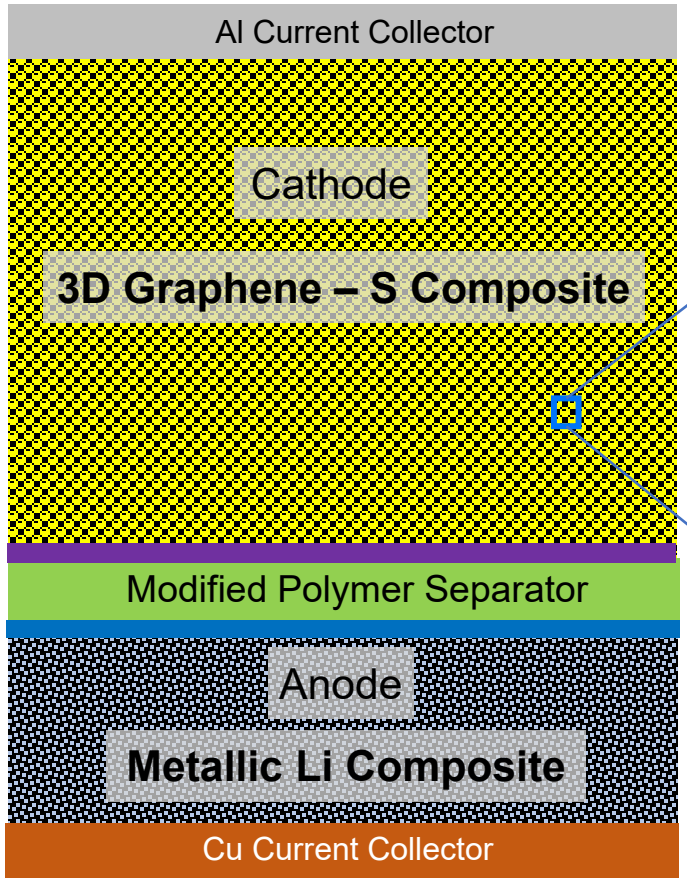
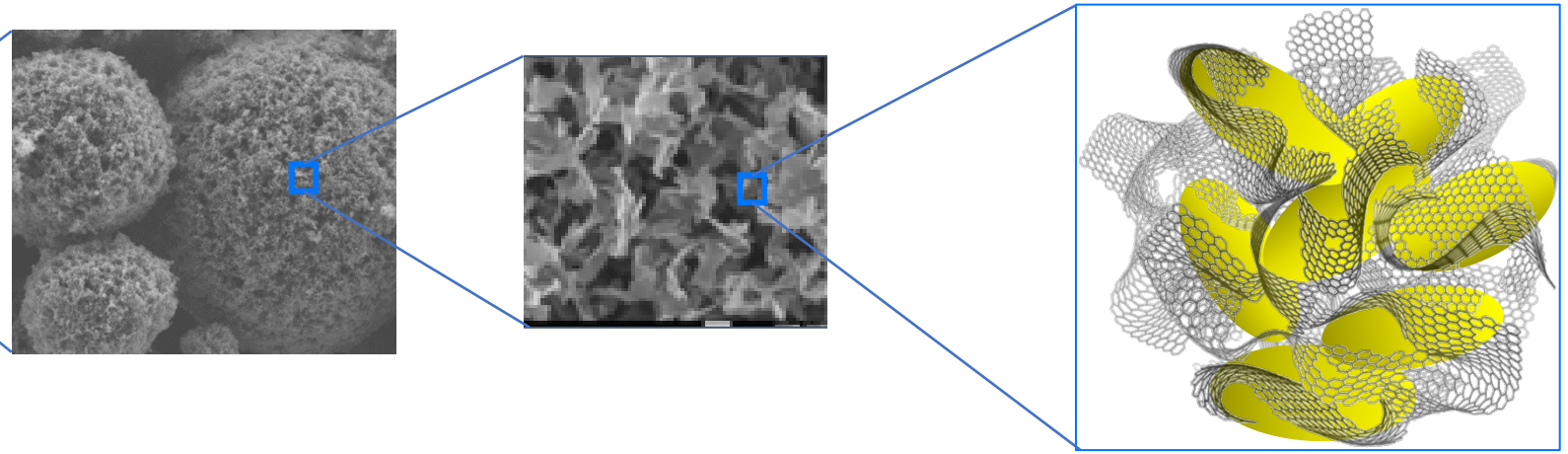
CUSTOM 3D-GRAPHENE™ IS ADDRESSING HISTORIC LI-S CHALLENGES

LYTEN LI-S Cell Architecture



- Nanostructured and functionalized 3D graphene™ mitigate polysulfide shuttle
- High conductivity of 3D Graphene™ enables higher charge/discharge rates

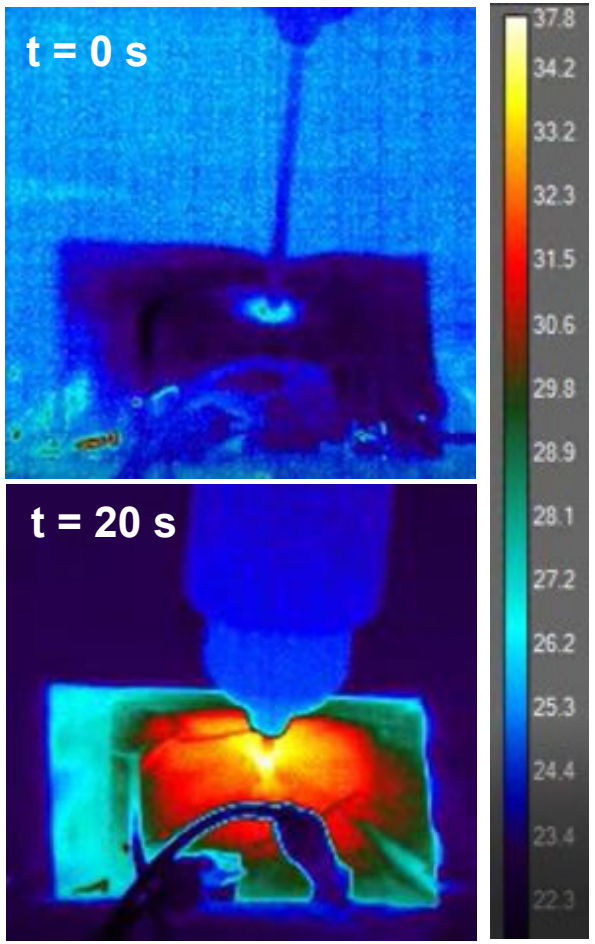


- Composite anode with protective coating mitigates anode degradation

TESTS AT INDEPENDENT LAB SHOW SUPERIOR SAFETY OF LYTEN CELLS

Nail Penetration Test

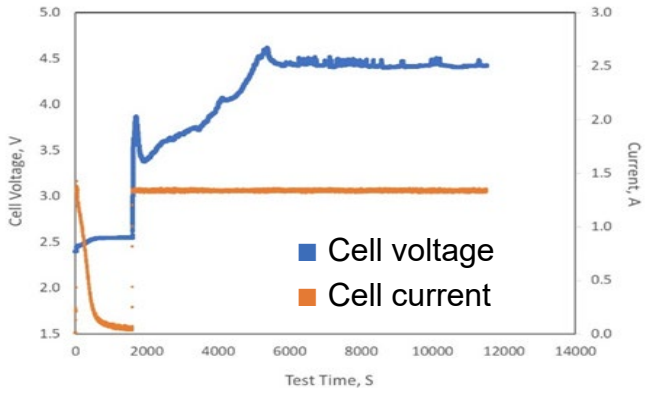
IR camera images

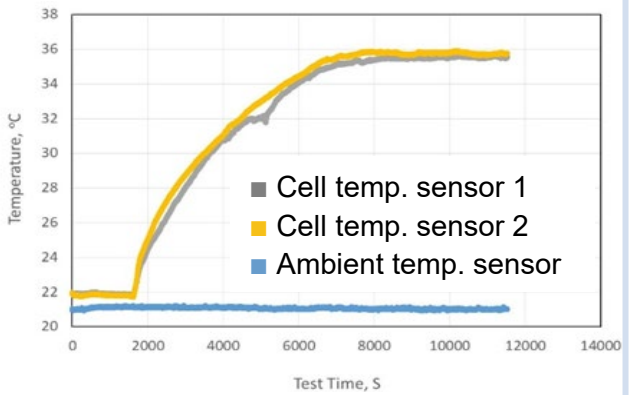


Category	Test	Condition	Form Factor	Capacity	Test result
Electrical	External Short	Rapid drop to 0V	pouch	1.90 Ah	No damage/fire, T_{max} = 26 °C
			18650	1.03 Ah	No damage/fire, T_{max} = 37 °C
	Over charge	1C Charge until > 200% SoC	pouch	1.87 Ah	No damage/fire, T_{max} = 32 °C
			18650	1.36 Ah	No damage/fire, T_{max} = 93 °C
	Over discharge	1C Discharge	pouch	1.85 Ah	No damage/fire, T_{max} = 26 °C
			18650	1.24 Ah	No damage/fire, T_{max} = 37 °C
Mechanical	Nail Penetration	3 mm Nail puncture at 10 mm s^{-1}	pouch	1.86 Ah	No damage/fire, T_{max} = 35 °C
			18650	1.43 Ah	No damage/fire, T_{max} = 62 °C
	Ball Crush	51 mm Sphere at 2 mm s^{-1}	pouch	1.75 Ah	No damage/fire, T_{max} = 27 °C

Overcharge Test

Cell voltage, current and temp. vs. time





Lyten is performing additional safety tests on various cell formats with latest formulations

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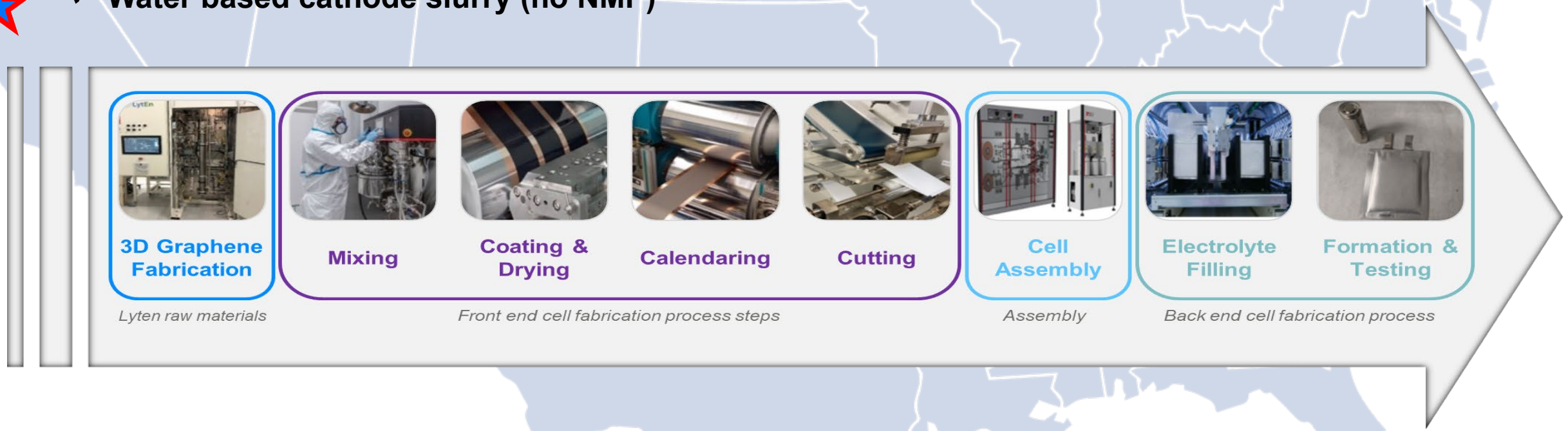
LYTEN ONLY USES STANDARD LIB PRODUCTION EQUIPMENT

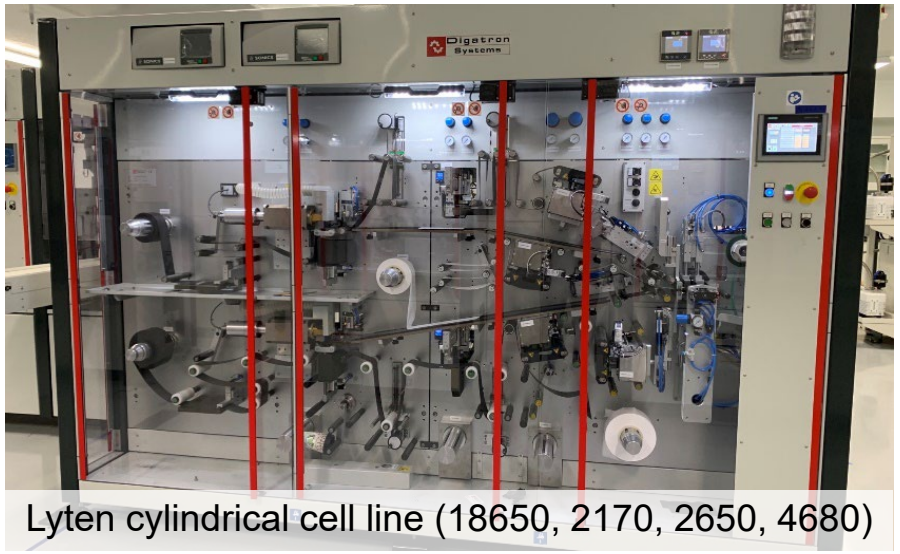
- ✓ **Semi-automated cell pilot line in dry-room (2MW capable)**
- ✓ **No custom cell assembly equipment**
- ✓ **Water based cathode slurry (no NMP)**



Lyten's Li-S manufacturing process can readily overlay on existing LIB lines

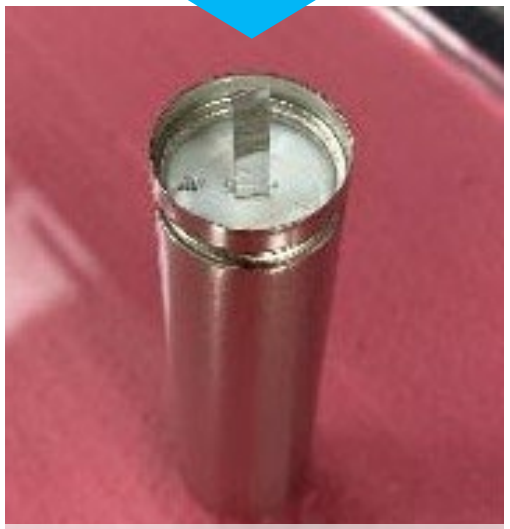
PILOT LINE SUPPORTS POUCH AND CYLINDRICAL CELL ENGINEERING

Lyten pouch cell line

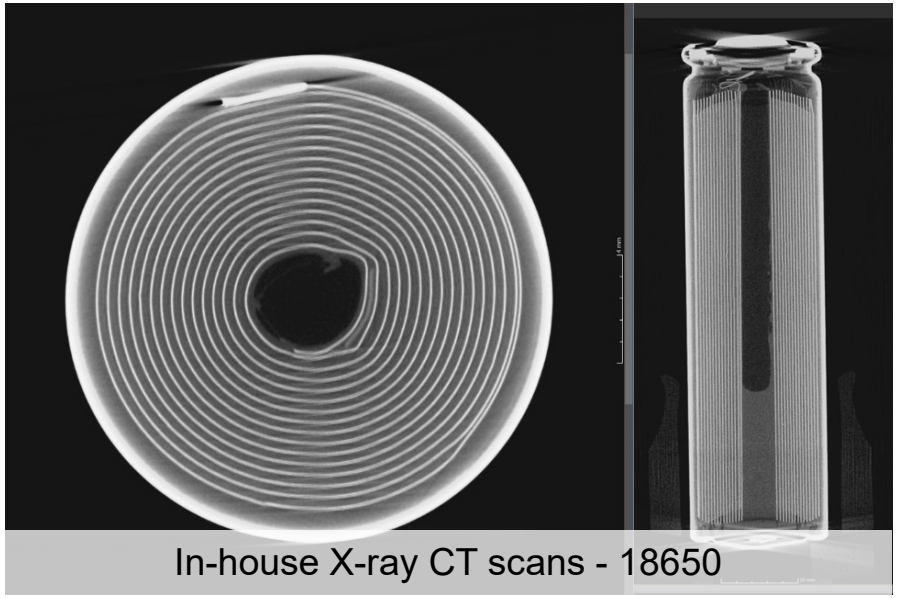


Lyten cylindrical cell line (18650, 2170, 2650, 4680)

Lyten Li-S jelly roll



Lyten Li-S 18650 assembly



In-house X-ray CT scans - 18650

UNITED STATES SPACE FORCE

DEFENSE INNOVATION UNIT

LYTEN

SUMMARY OF VALUE PROPOSITIONS

LYTEN'S UNIQUE LI-S WILL CREATE A DISTINCTIVE VALUE FOR AN ARRAY OF APPLICATIONS

Lowest $/Wh	**Replacing Ni-based cathodes with Sulfur lowers raw material cost**
High Specific Energy (Wh/kg)	**>2x Practical specific energy** compared to existing technologies
Abundant and Accessible Raw Materials	**Sulfur is abundant in high quantities as a byproduct of minerals and petrochemical production**
Reliable North America Raw Material Supply	**Target 100% sourced and manufactured in NA:** Lyten could help OEMs meet 2025 USMCA mandates
Sustainable Supply Chain	**60%+ Lower cell material emissions – eliminate conventional cathode active material production, eliminate conventional graphite processing**
Minimal Technology Switching Costs	**Lower greenfield capex and minimal incremental brownfield conversion capex** due to a simpler manufacturing process and Li-ion B facility compatibility