Liquefied Gas Electrolytes
for Next-Generation Lithium Batteries

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Advancing a Clean Energy Future

SOUTH 8 TECHNOLOGIES

Founded in 2016 | San Diego, CA

Spin out from UC San Diego where the Liquefied Gas Electrolyte (*LiGas*) chemistry was first developed

Team

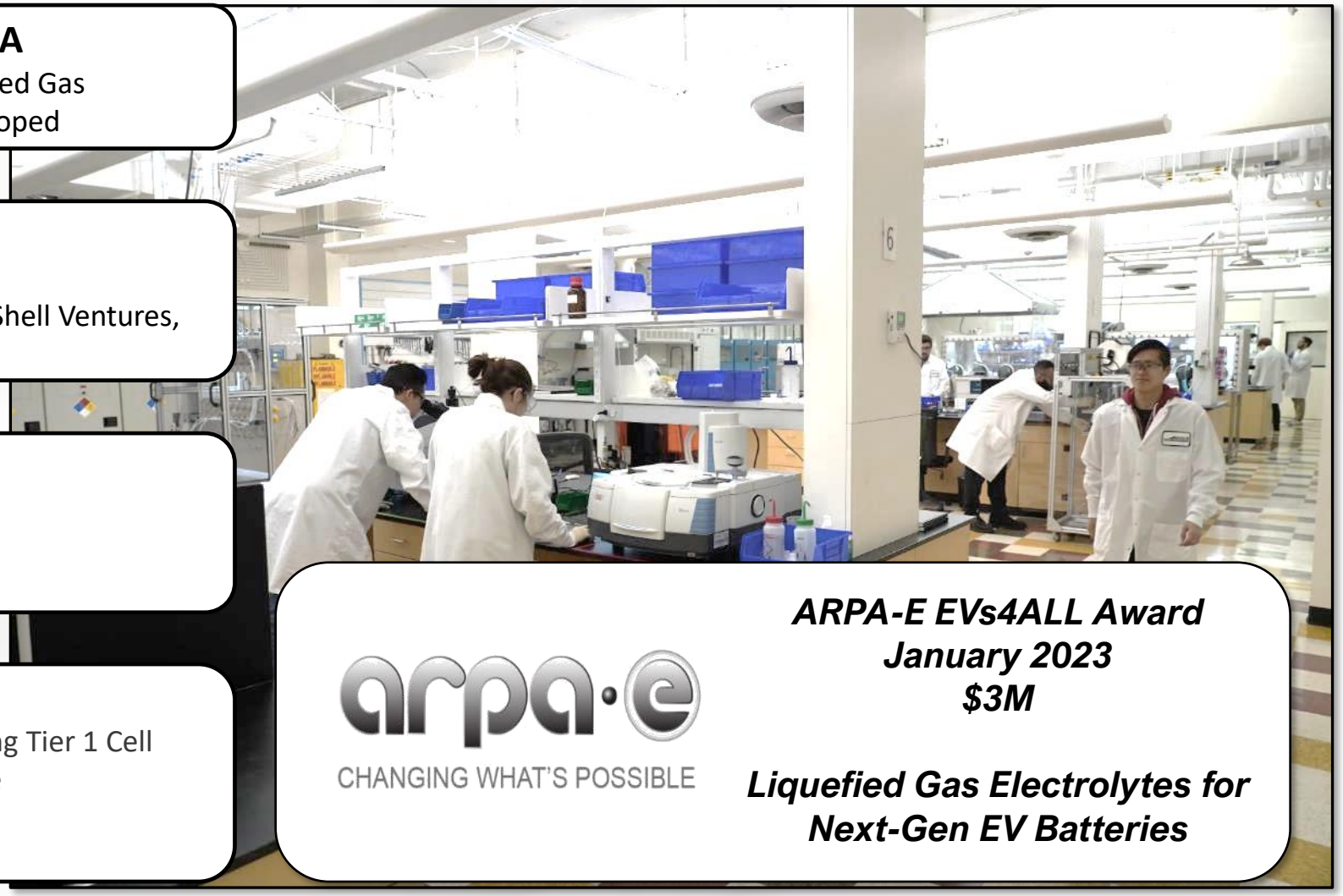
- 24 Full-Time Employees
- Prominent Series-A Investors Including LG Ventures, Shell Ventures, Anzu Partners, Foothill Ventures, Taiyo Nippon Sanso

IP Portfolio

- 7 Separate Patent Families Issued in U.S.
- Several International Patents Issued
- Continual IP Generation

Traction

- Technology Validated by 3rd Party Validated by Leading Tier 1 Cell and Automotive Manufacturers and Dept. of Defense
- Several Purchase Orders Across Industry Segments
- Ongoing Joint Development Projects



arpa·e
CHANGING WHAT'S POSSIBLE

ARPA-E EVs4ALL Award
January 2023
$3M

Liquefied Gas Electrolytes for Next-Gen EV Batteries

LiGas Electrolytes for Any Cell

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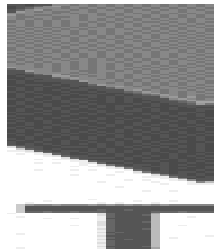
South 8 is focused on electrolyte development and electrolyte filling
Maintaining compatibility with all Li-ion jelly rolls

Materials Supplier	Dry-Cell Manufacturing	Cell Production	Product Integrator
BASF We create chemistry	LG Energy Solution	SOUTH 8 TECHNOLOGIES *Electrolyte Fill*	TESLA
TODA AMERICA	EnerSys		HYUNDAI
TAIYO NIPPON SANSO	Panasonic		BOEING
	SAMSUNG		Mercedes-Benz
CELGARD	SAFT, SONY, BYD	*Manufacturing Partners*	Ford, CAT, BYD

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Liquefied Gas Solvent Electrolytes

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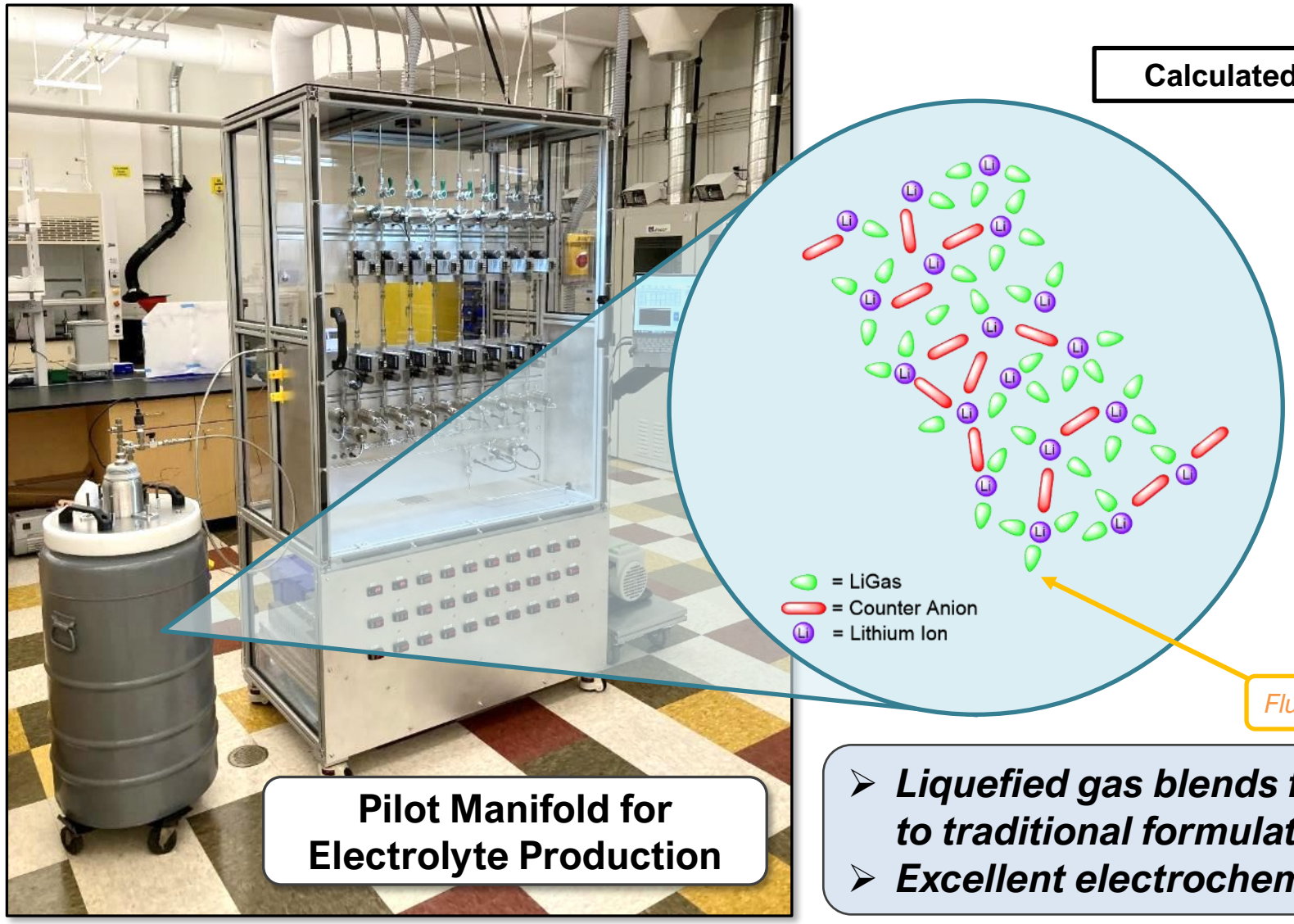
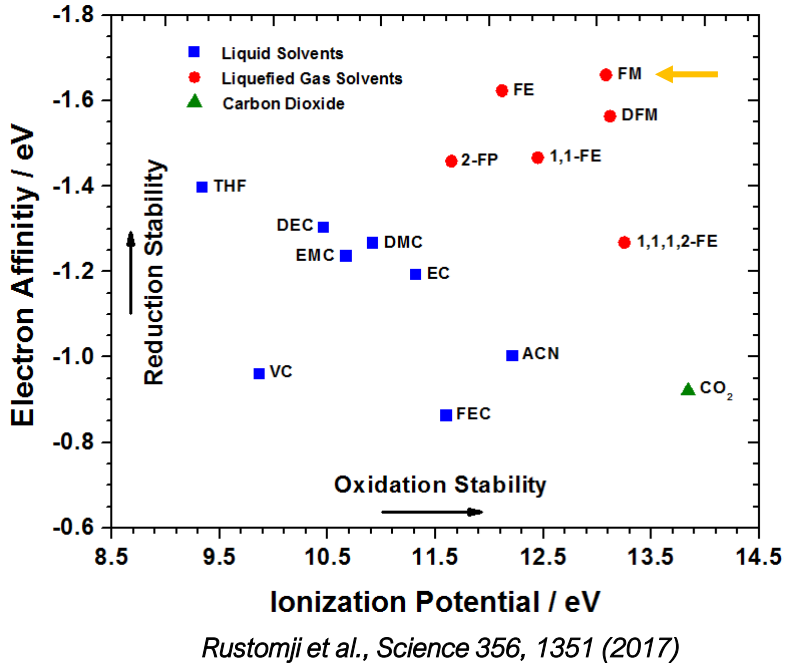


Calculated via DFT at B3LYP/6-31+g(d,p) level of theory.



Rustomji et al., Science 356, 1351 (2017)

Fluoromethane: the only publicly disclosed LiGas component

- ***Liquefied gas blends form electrolyte solutions analogous to traditional formulations***
- ***Excellent electrochemical stability windows predicted***

LiGas: Desirable Properties

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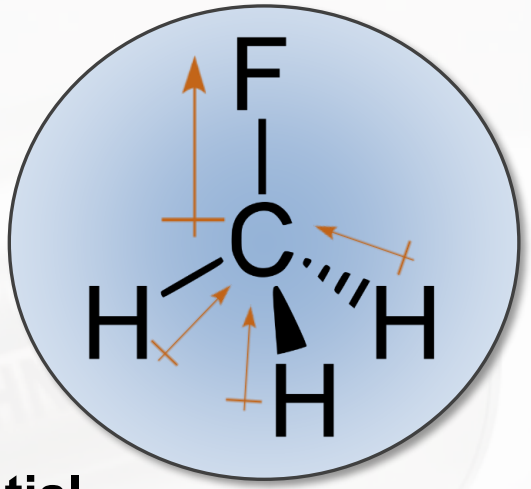
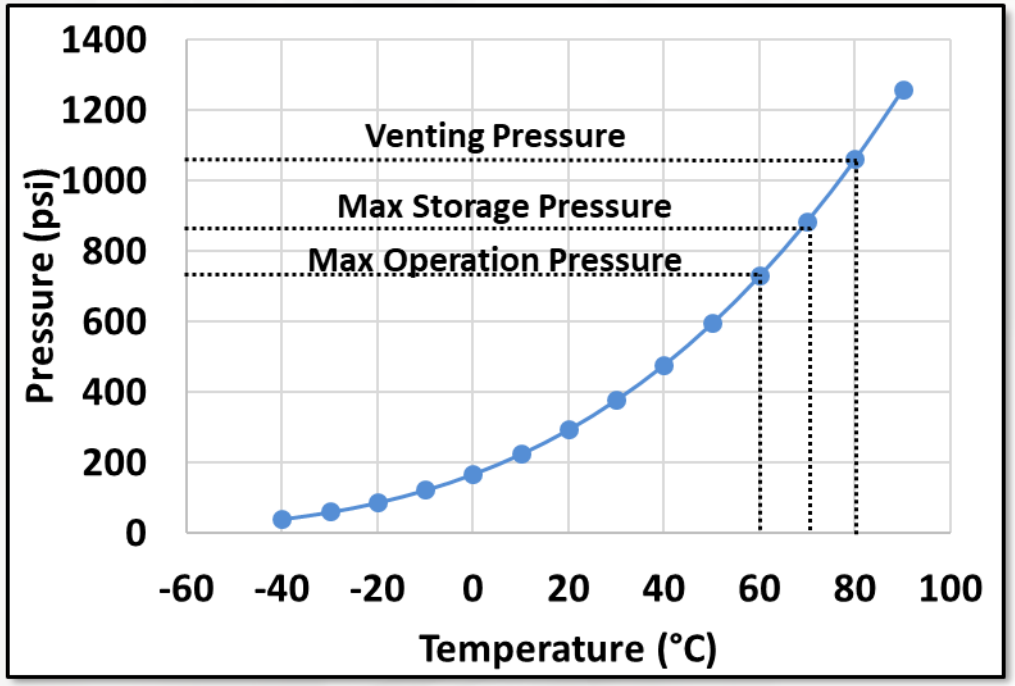
Fluoromethane is used in combination with other proprietary gaseous solvents to create high performance *LiGas* electrolytes



- Cost-Effective
- Low Viscosity
- Low Melting Points
- Non-Toxic, Non-Corrosive
- Non-Ozone-Depleting
- Low Global Warming Potential
- Excellent Electrochemical Stability
- Commercially Available in High Purity
- Compatible With All Common Battery Materials

Typical Vapor Pressure Curve for *LiGas* Cell



Always working towards lower vapor pressure electrolytes

Implementing LiGas: Cylindrical Packaging

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Pre-A Cells: Higher TRL Sample Cells

- Standard form-factor
- Low impedance: high power capable
- Laser welded for hermetic sealing
- High temperature capable
- Easier manufacturing



Prototype Cells: Chemistry Demonstration

- Non-standard cap form-factor
- High impedance positive pin
- Electrolyte leakage at high temperature
- Difficult manufacturing

➢ ***Supplier COTS cans can handle LiGas pressure***

LiGas Advantages: Safety

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Crush Test – 3 Cells



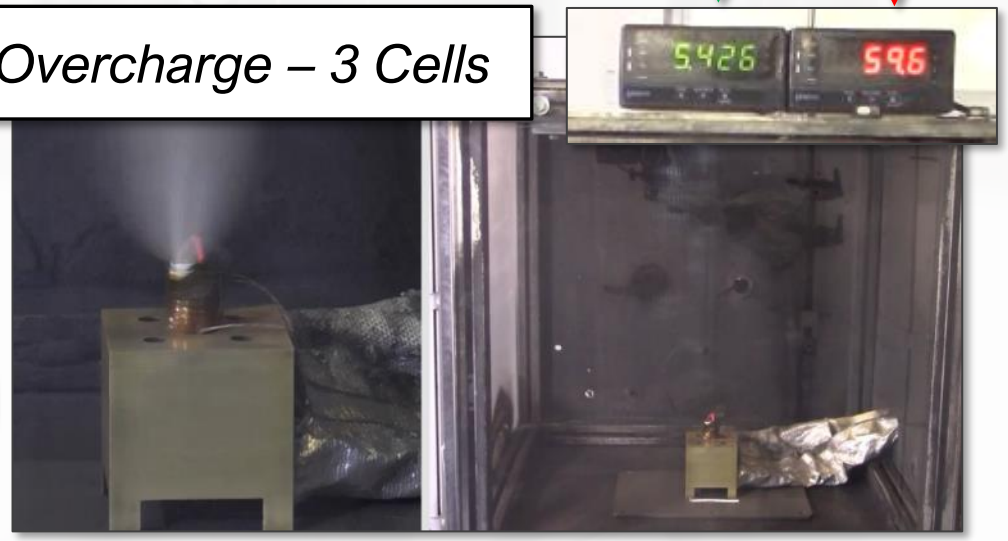
***LiGas* Cells Fail Safely**

Destructive testing at
Sandia National Laboratory

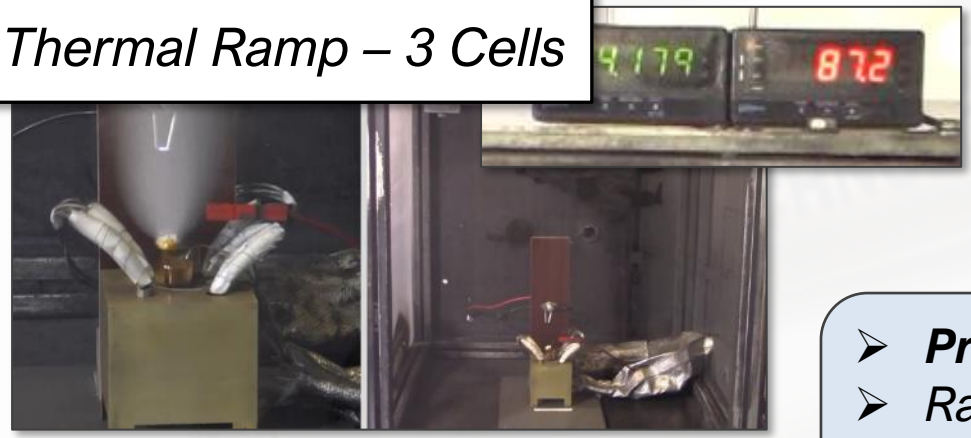
2 Ah Graphite-NMC622
18650 Cells

Voltage **Temperature**

Overcharge – 3 Cells



Thermal Ramp – 3 Cells



- ***Pressure can be a safety advantage***
- *Rapid venting of LiGas solvents and evaporative cooling of the cell*
- *Vented LiGas appears sparingly or non-flammable: spark igniters in vent path had no effect*

Venting Electrolyte Reduces Fuel

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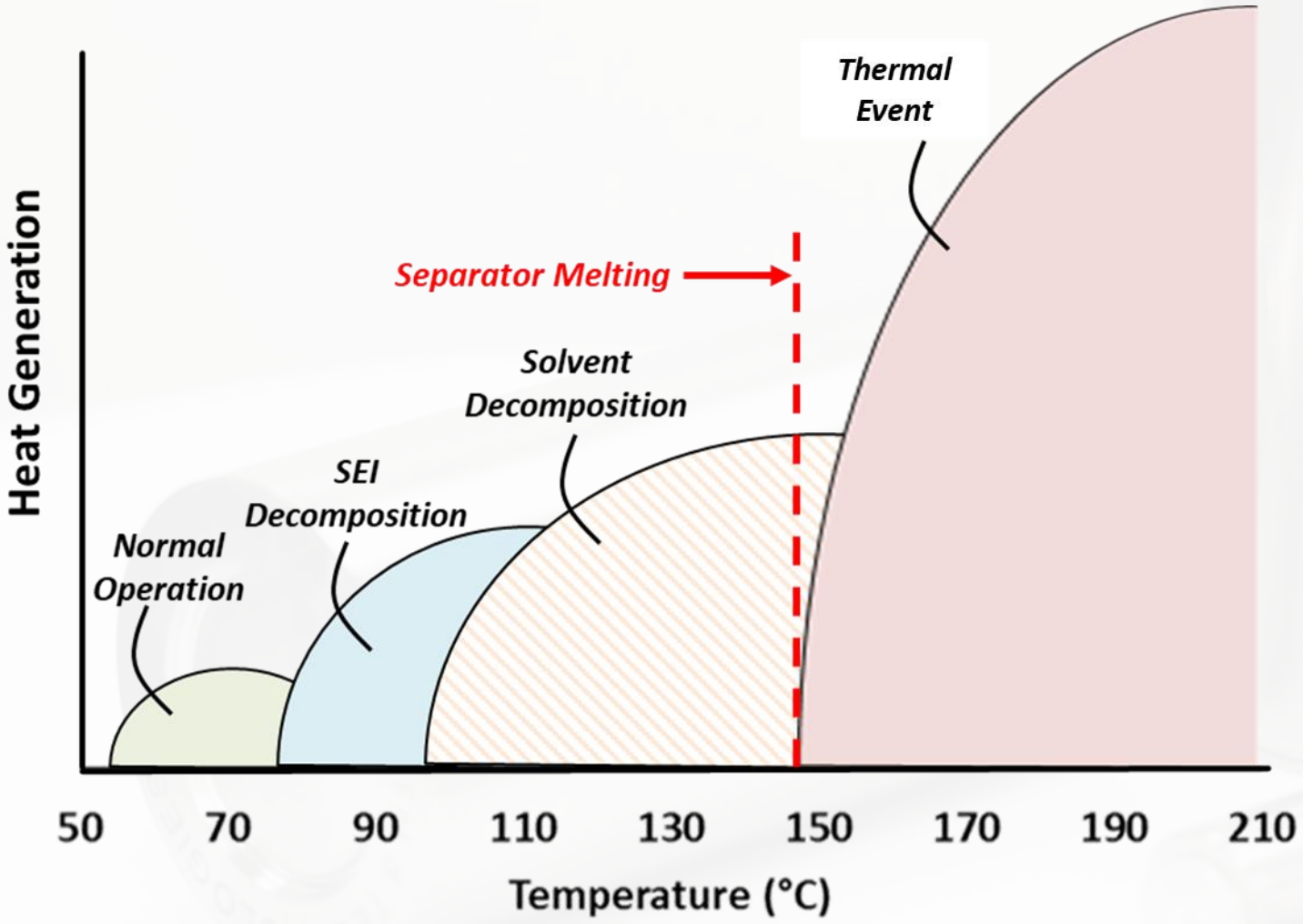
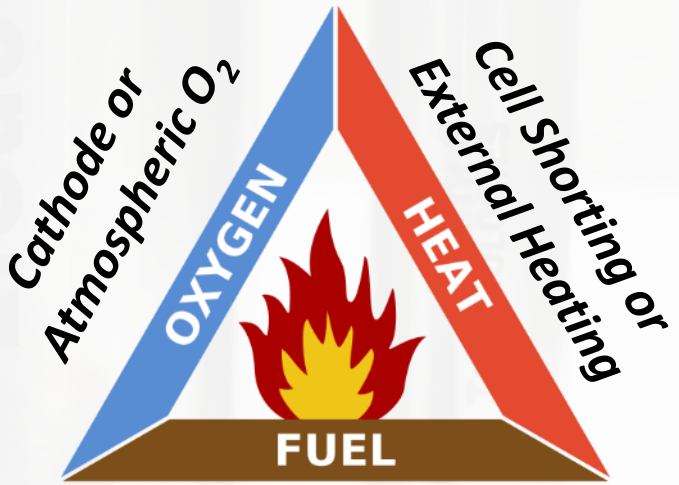


As soon as the can is breached, liquefied gasses immediately vaporize and vacate the cell



Graphite

~~Electrolyte~~

Less Fuel = Safer Cell

LiGas Electrolytes: Fully Functional

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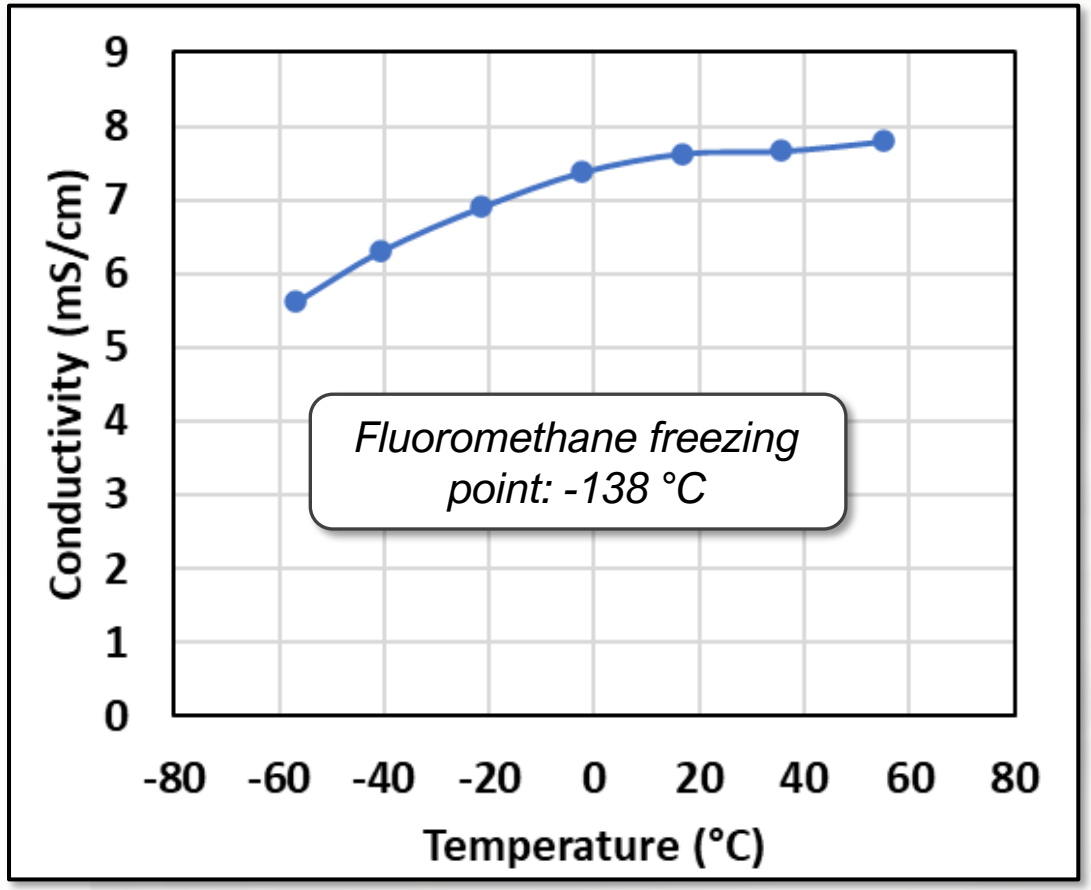
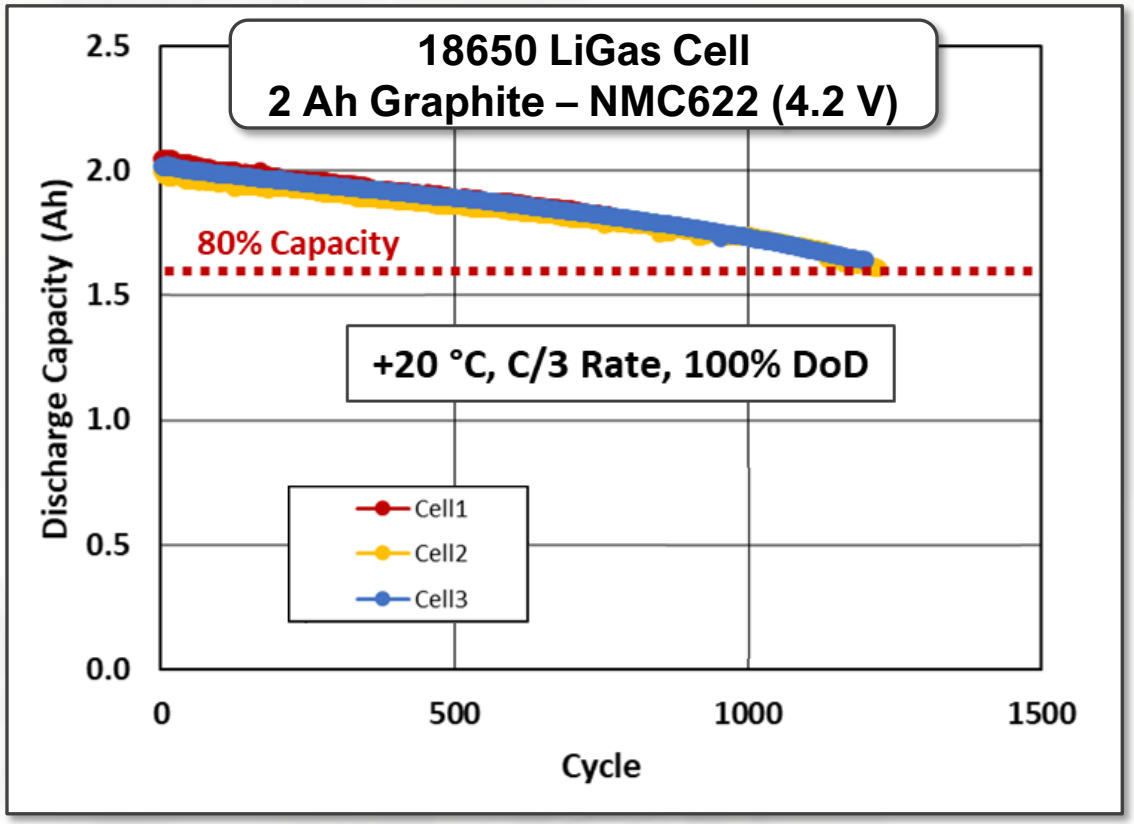


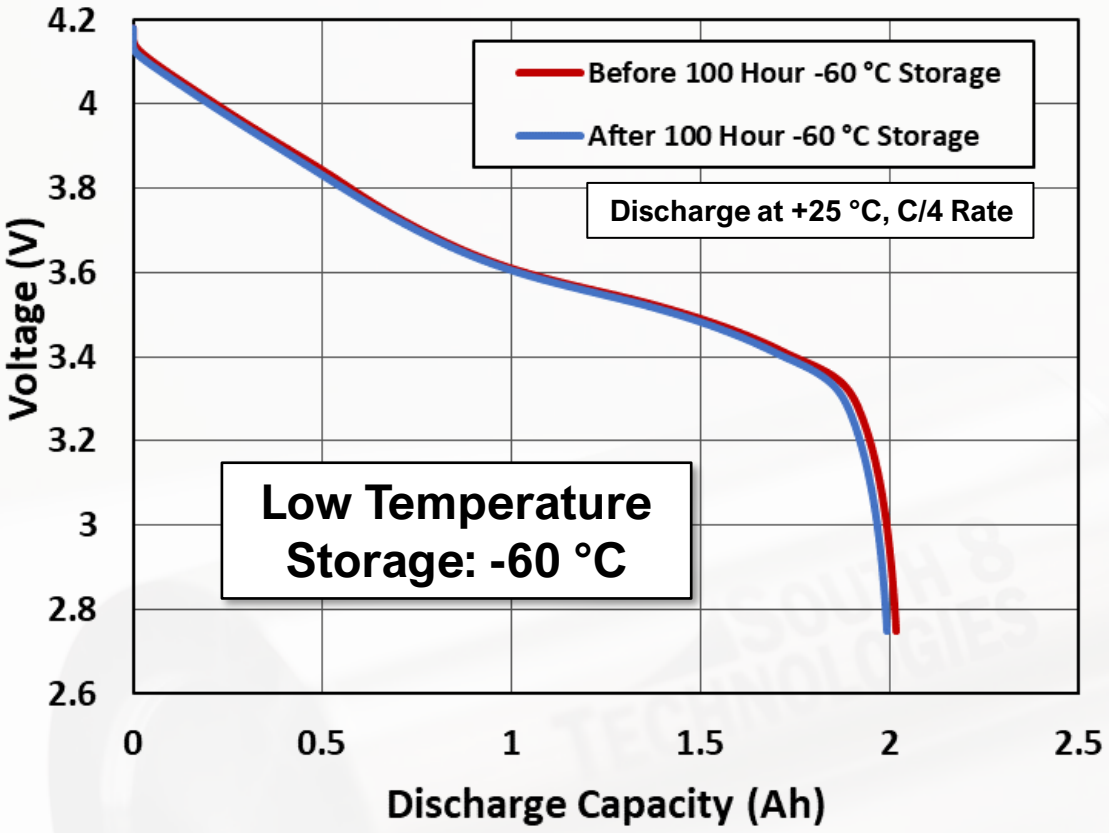
Excellent electrolyte conductivity across a wide temperature range.

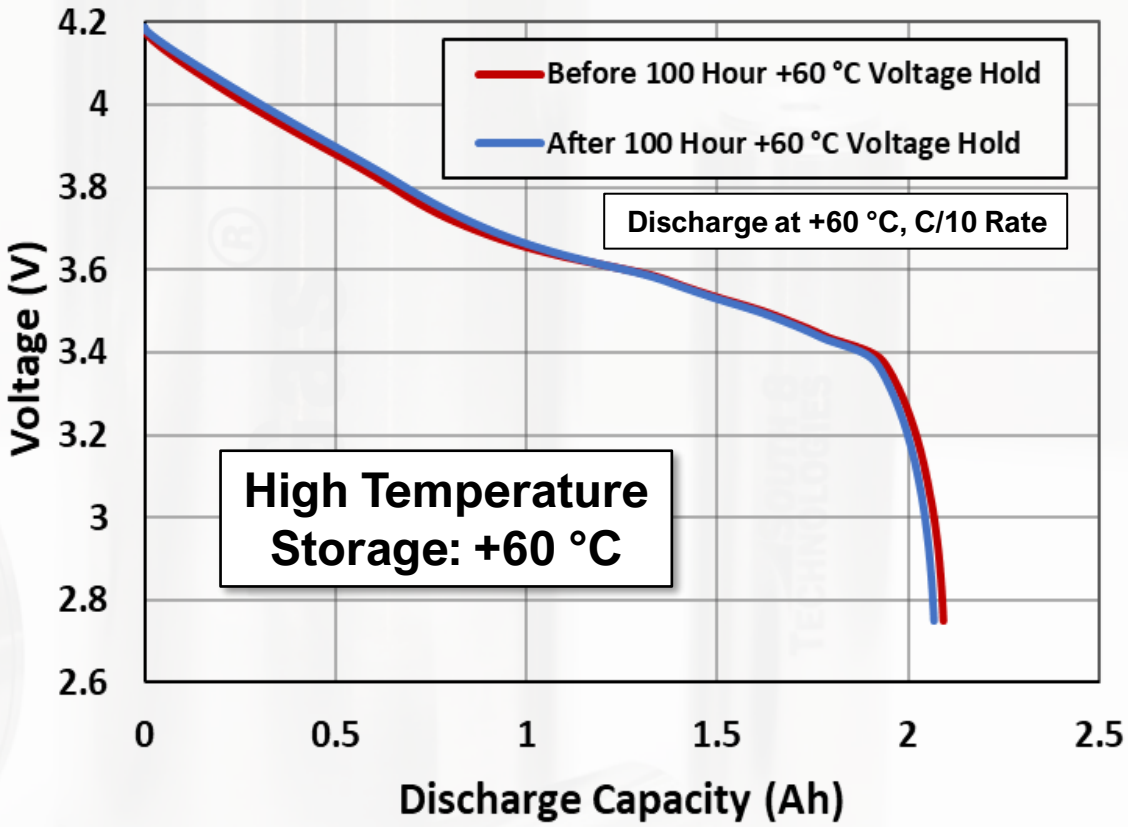


18650 prototypes demonstrate excellent cycle life.

- *Stable SEI on graphite anode*
- *First cycle coulombic efficiency ~ 90%*
- *Compatible with all traditional electrodes and binders*

18650 Temperature Storage





South 8 LiGas Electrolyte
2.2 Ah 18650: NMC622/graphite
4.2 V float charge, 100 h

18650 at Low Temperature: LiGas vs. Liquid

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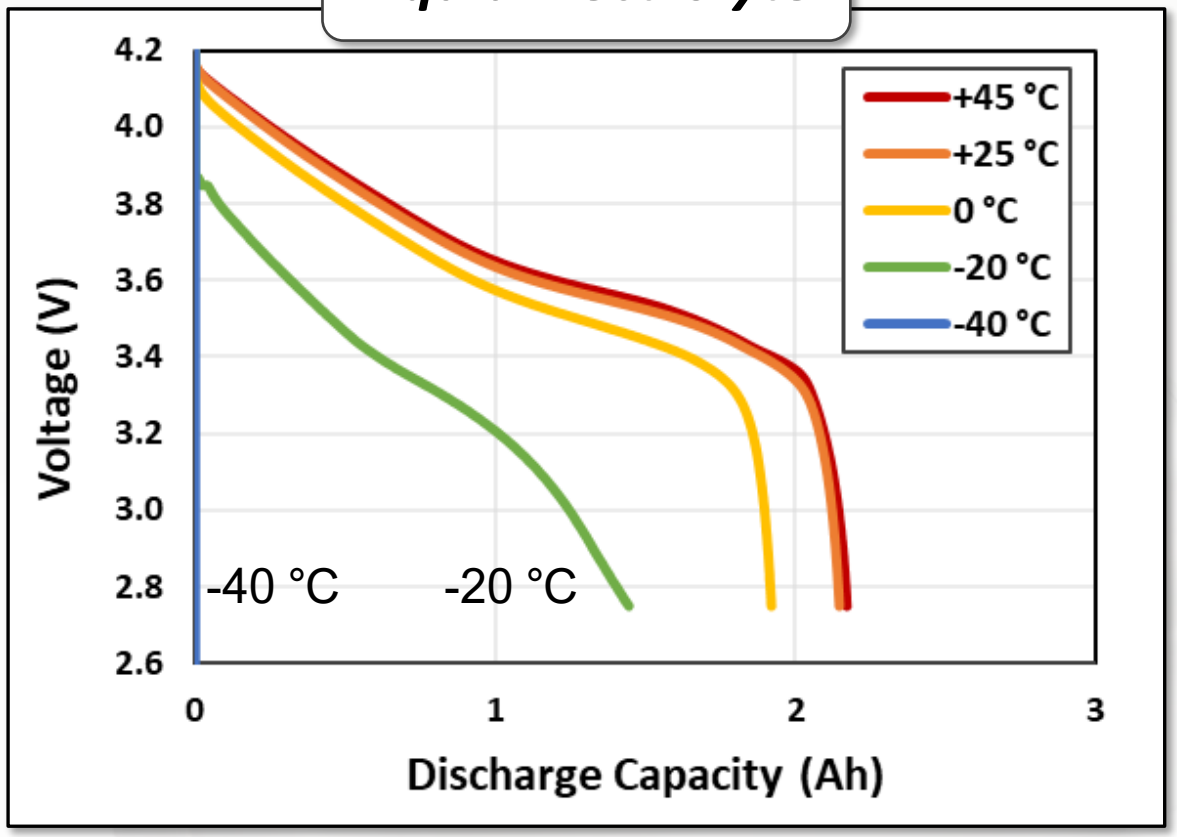
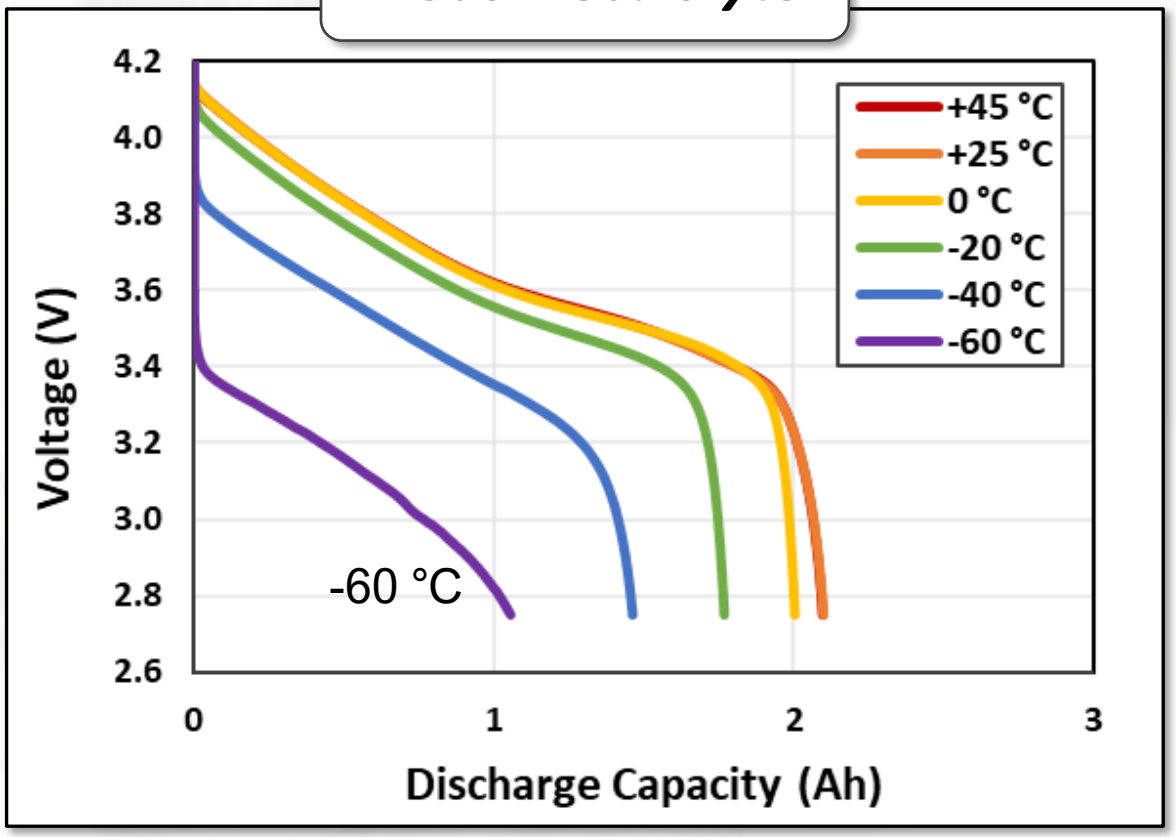
Liquid Electrolyte

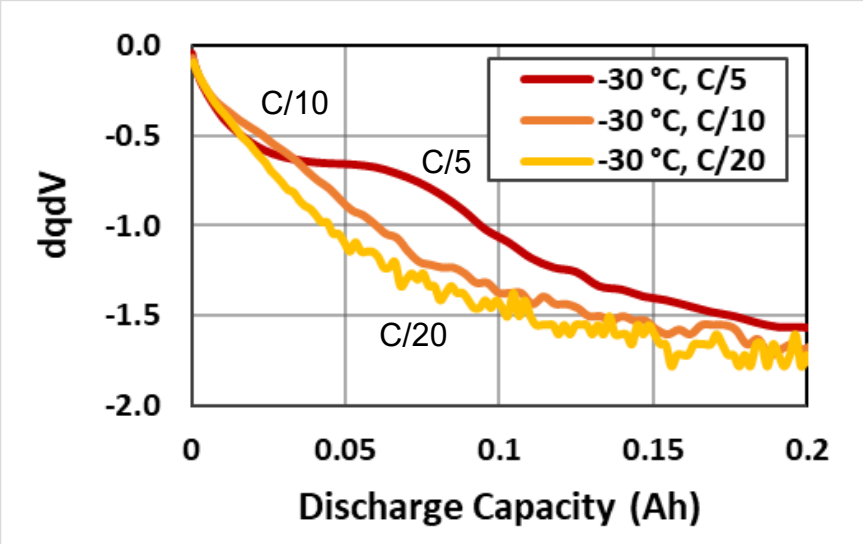


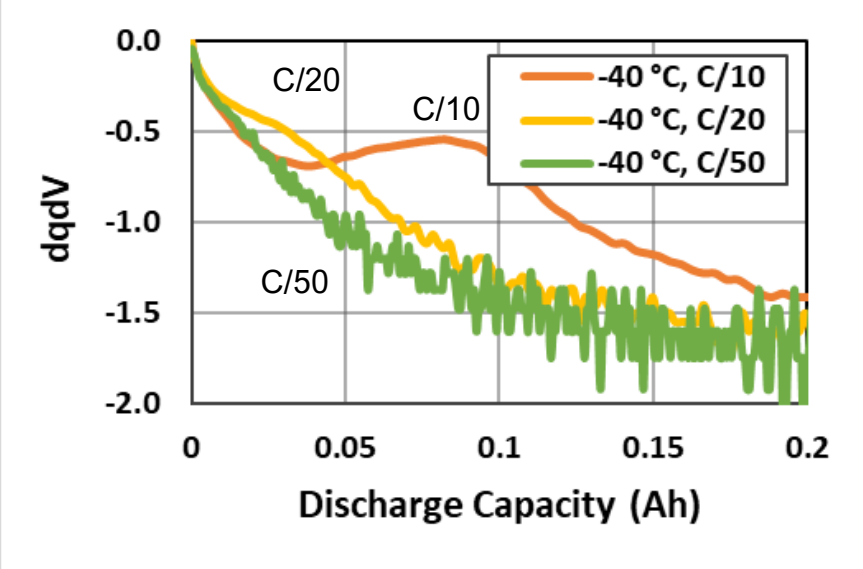
LiGas Electrolyte



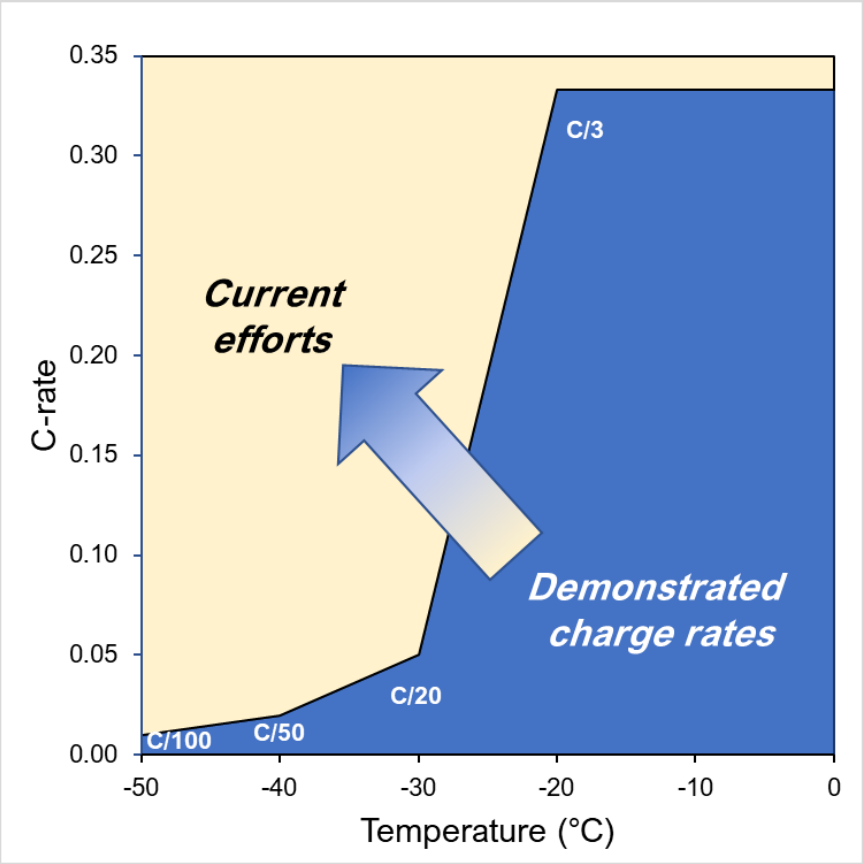
Charged at +25 ℃
C/4 Discharge Rate with Identical 18650 Jelly Rolls
2.2 Ah NMC622/Graphite

18650 Low-Temperature Charging





Demonstrated low-temperature charging without Li plating:



18650 Discharge Power & Fast Charge

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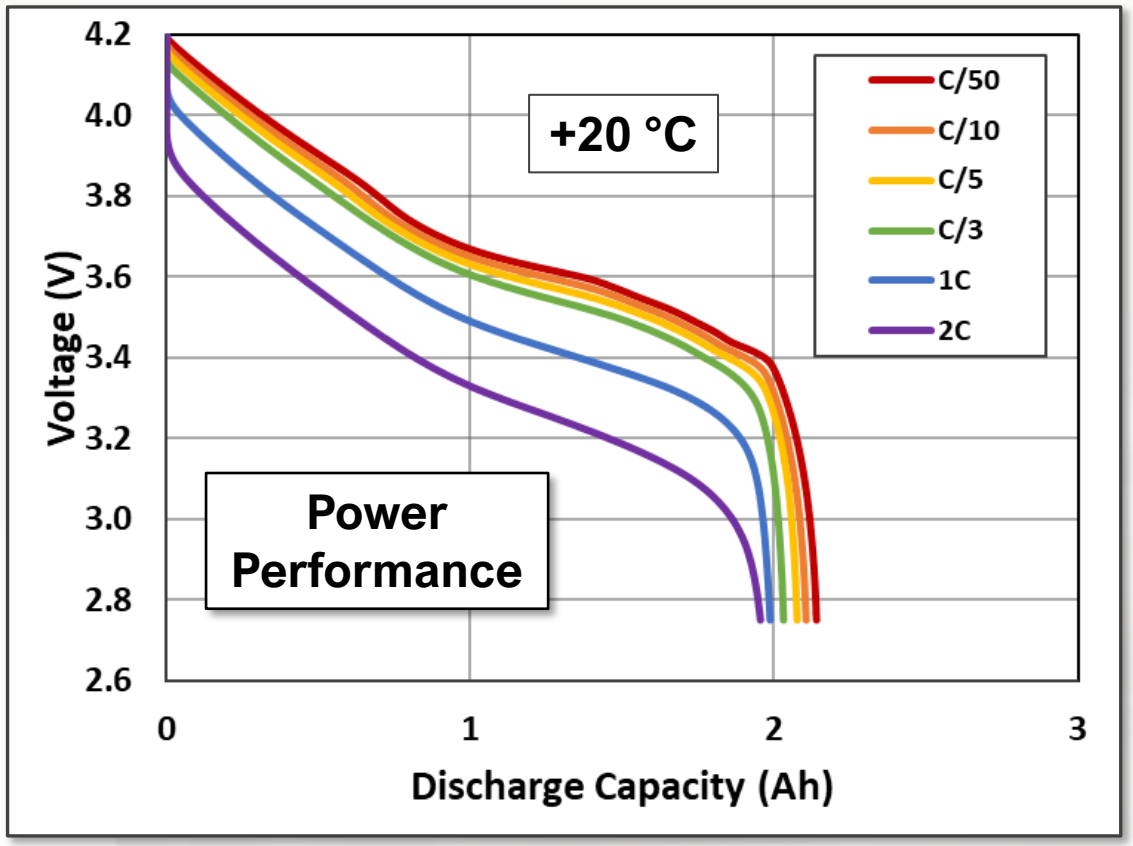

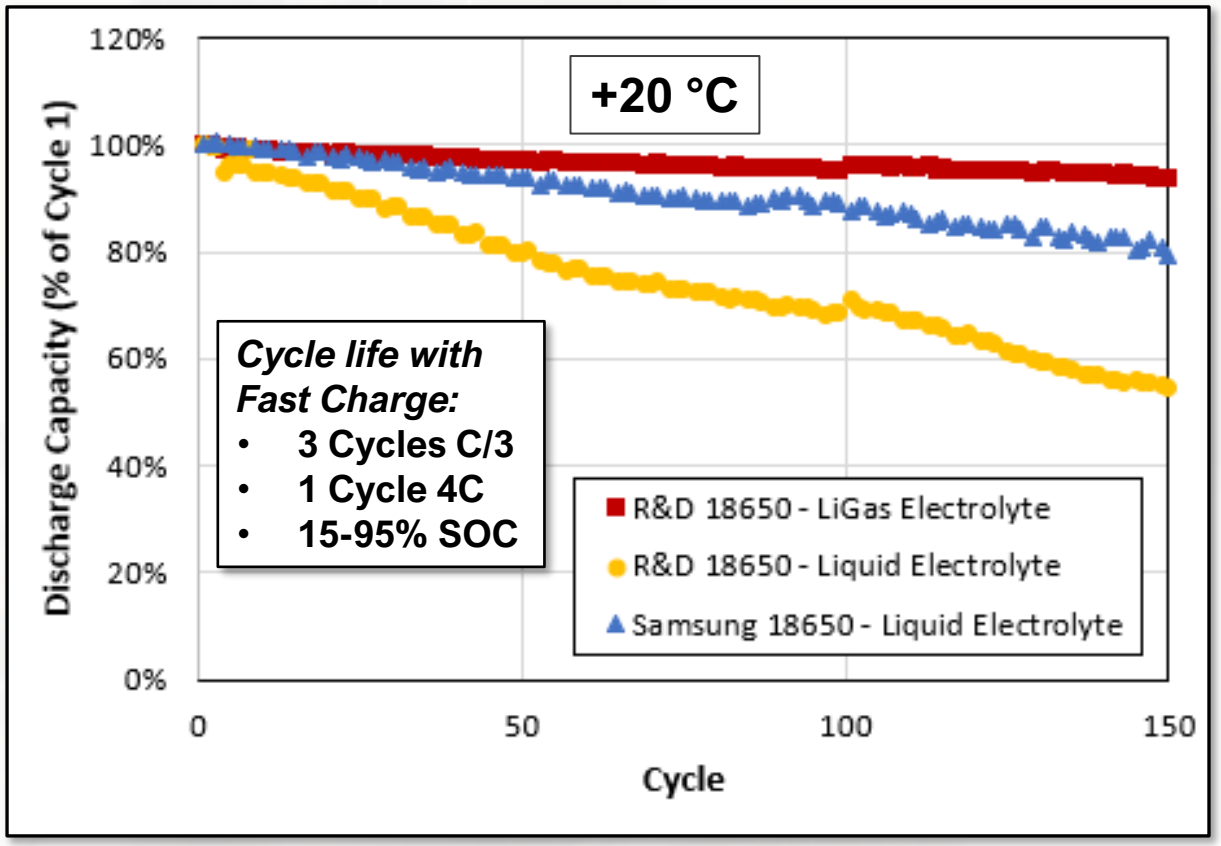

LiGas electrolyte has high conductivity and produces favorable SEI

18650 LiGas Low-Temperature Rate Performance

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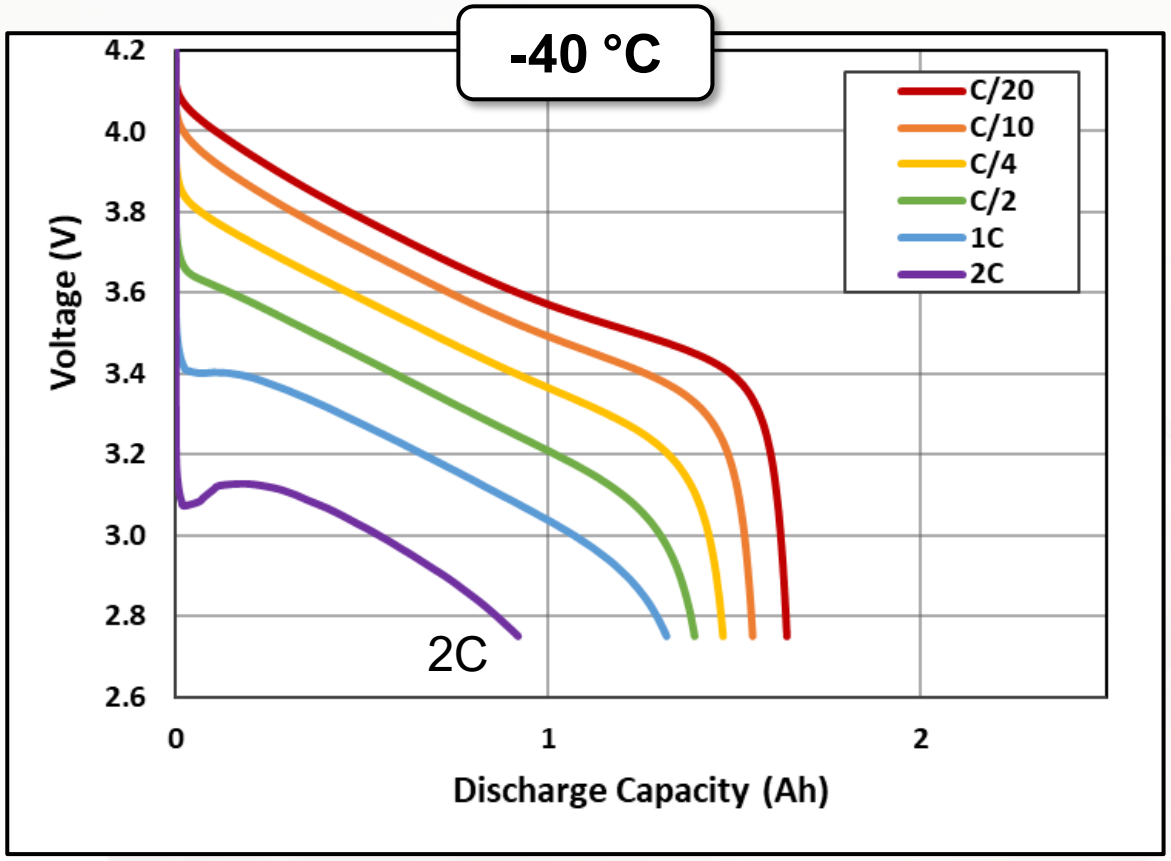

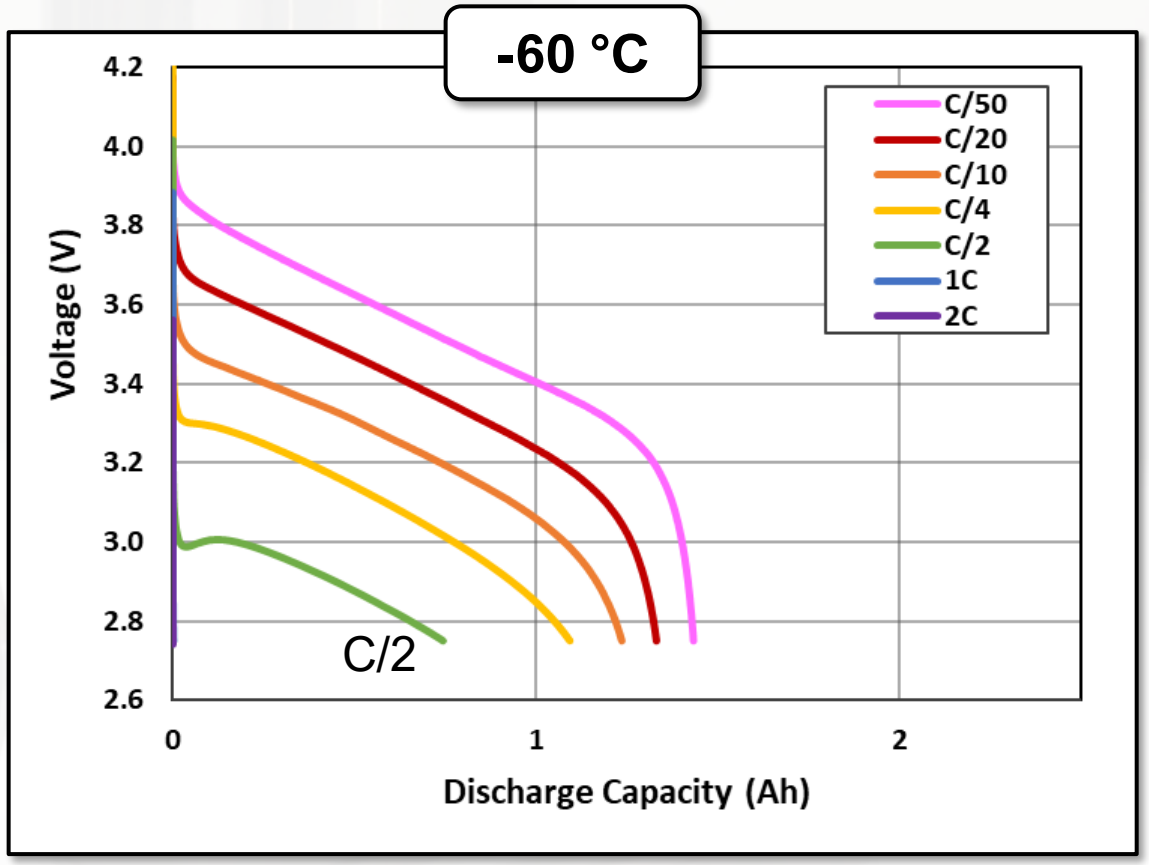

South 8 LiGas Electrolyte
2.2 Ah 18650: NMC622/graphite
Each discharge followed a C/4 CC-CV charge at +25 °C

Enabling Thick Electrodes Increases Energy

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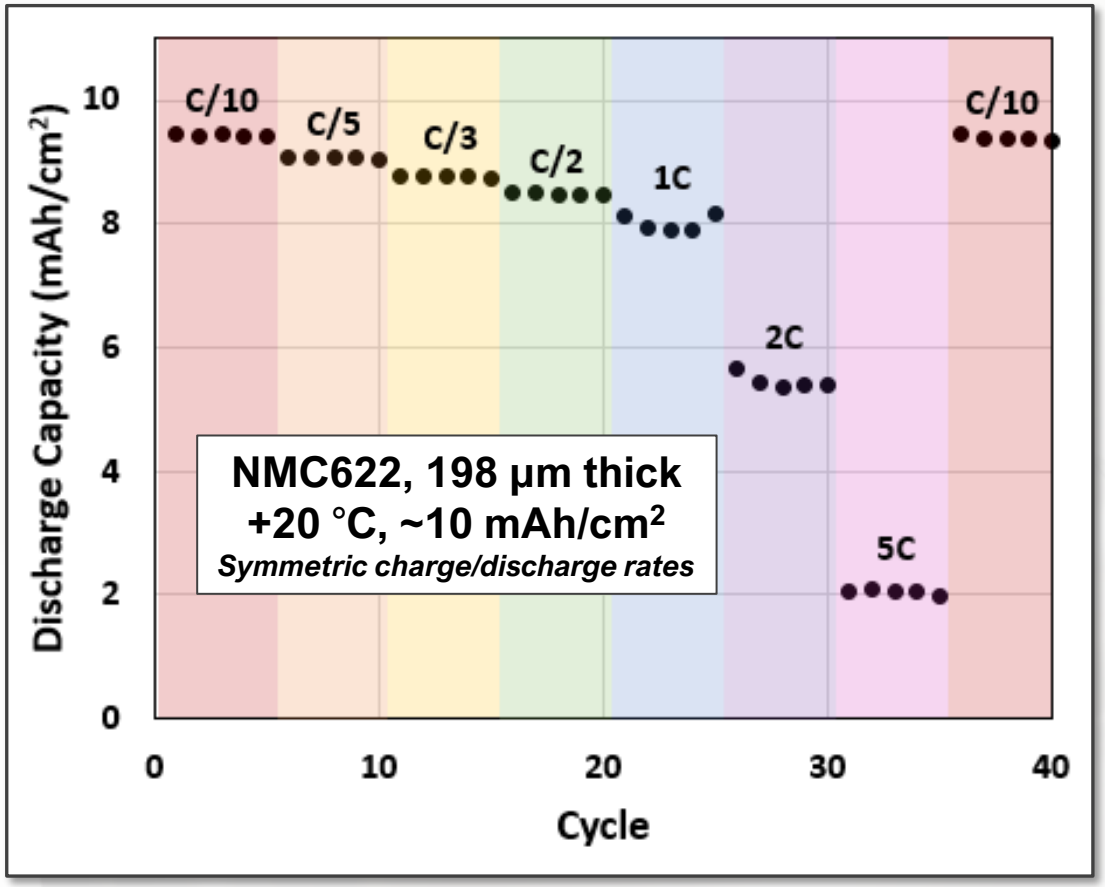

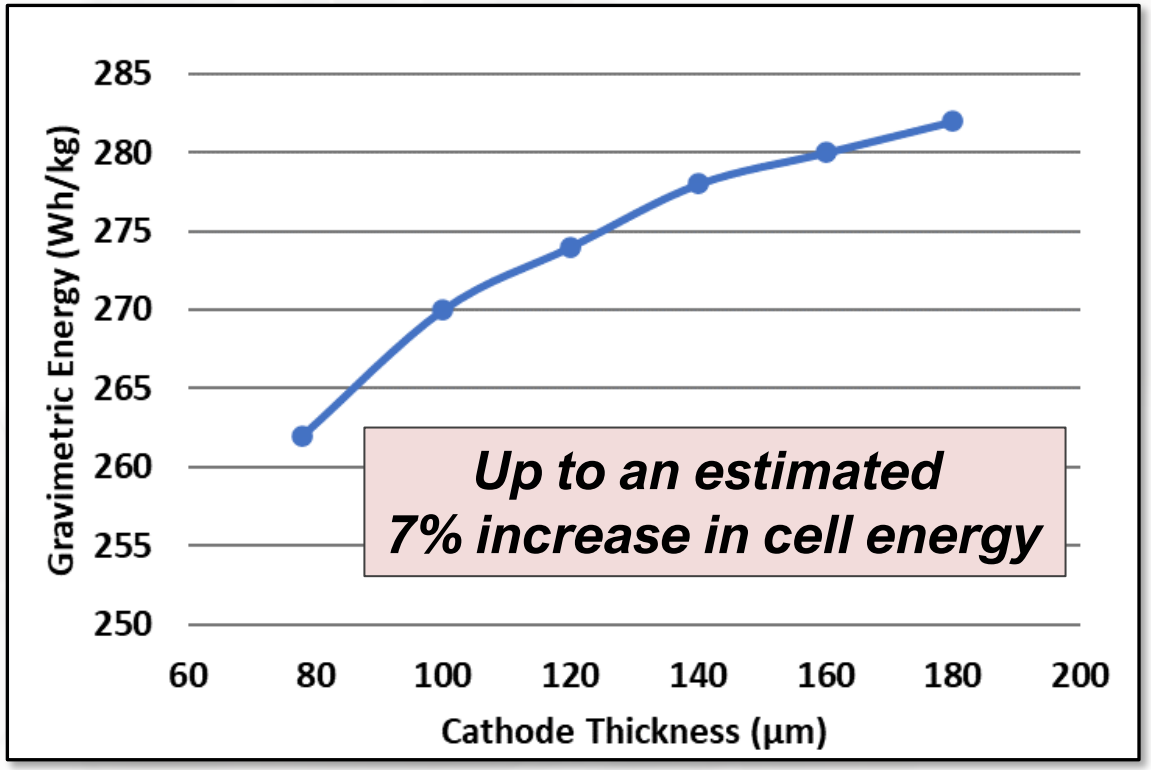

LiGas **electrolyte's pressure results in rapid and efficient wetting, even with very thick electrodes**

High Voltage: High-Ni and Co-free Cathodes

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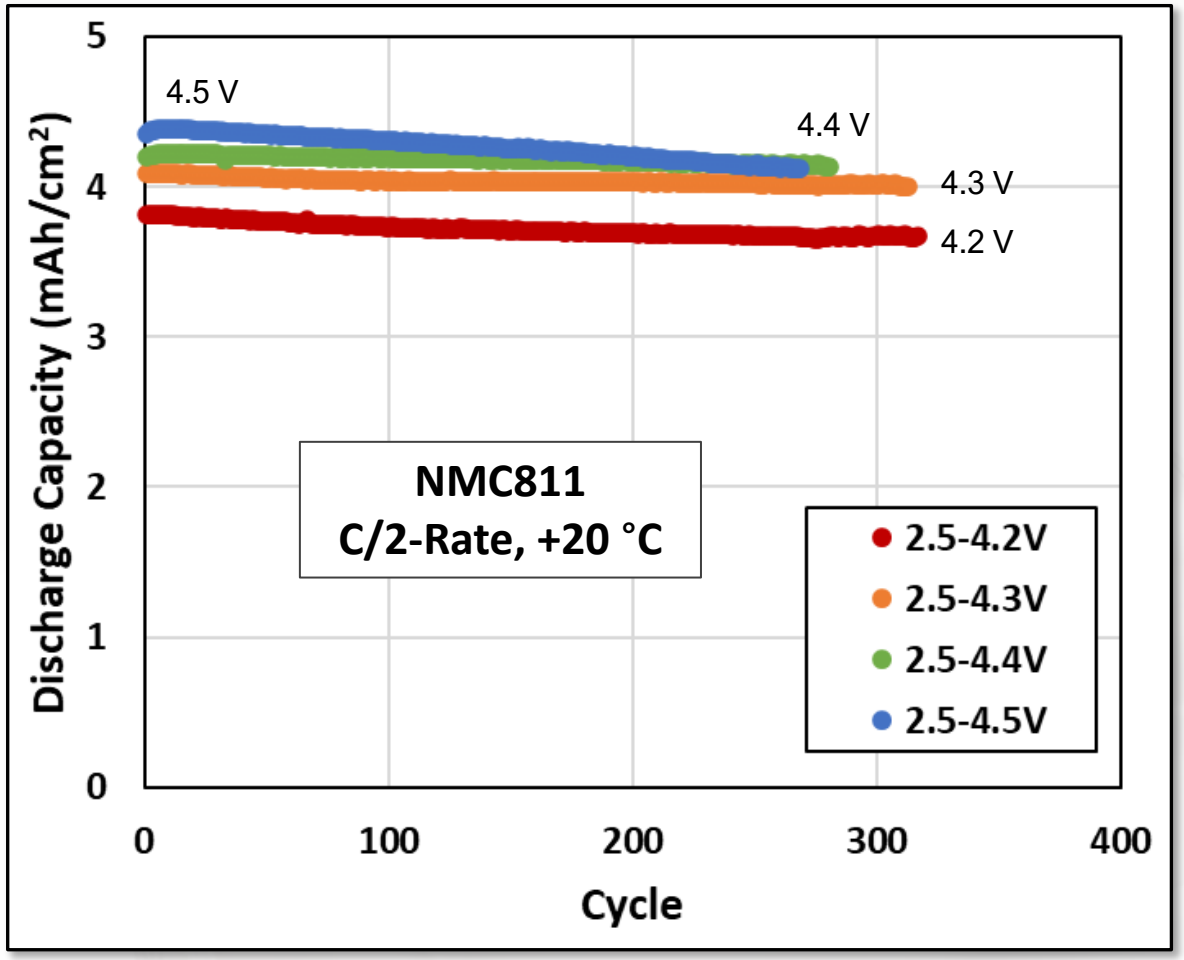

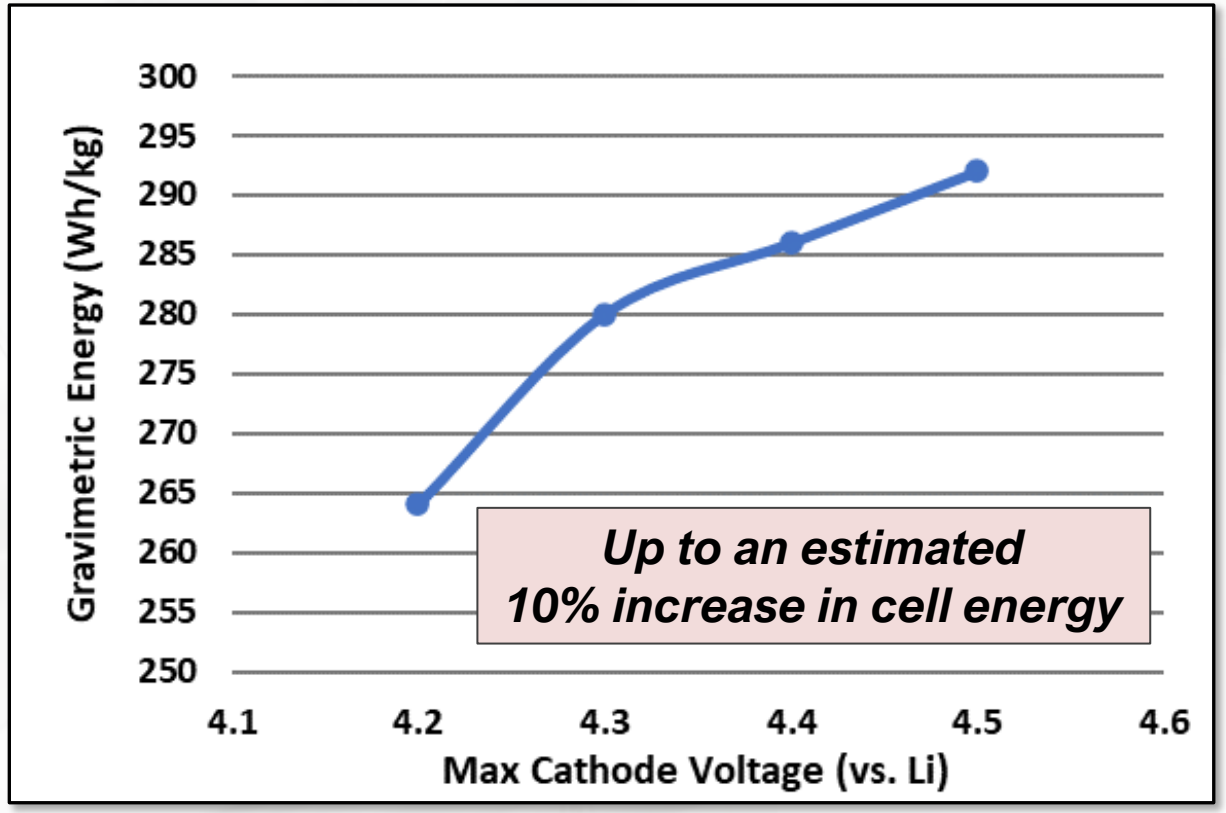

LiGas electrolyte forms an effective CEI and AI passivation layer

High Voltage: High-Ni and Co-free Cathodes

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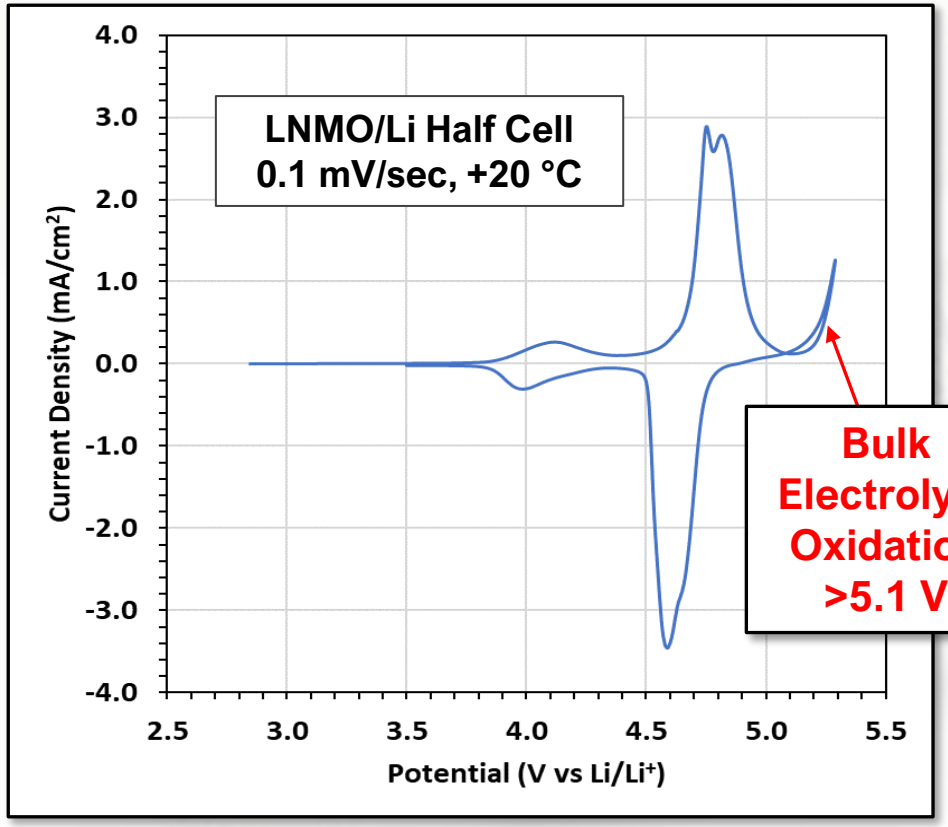
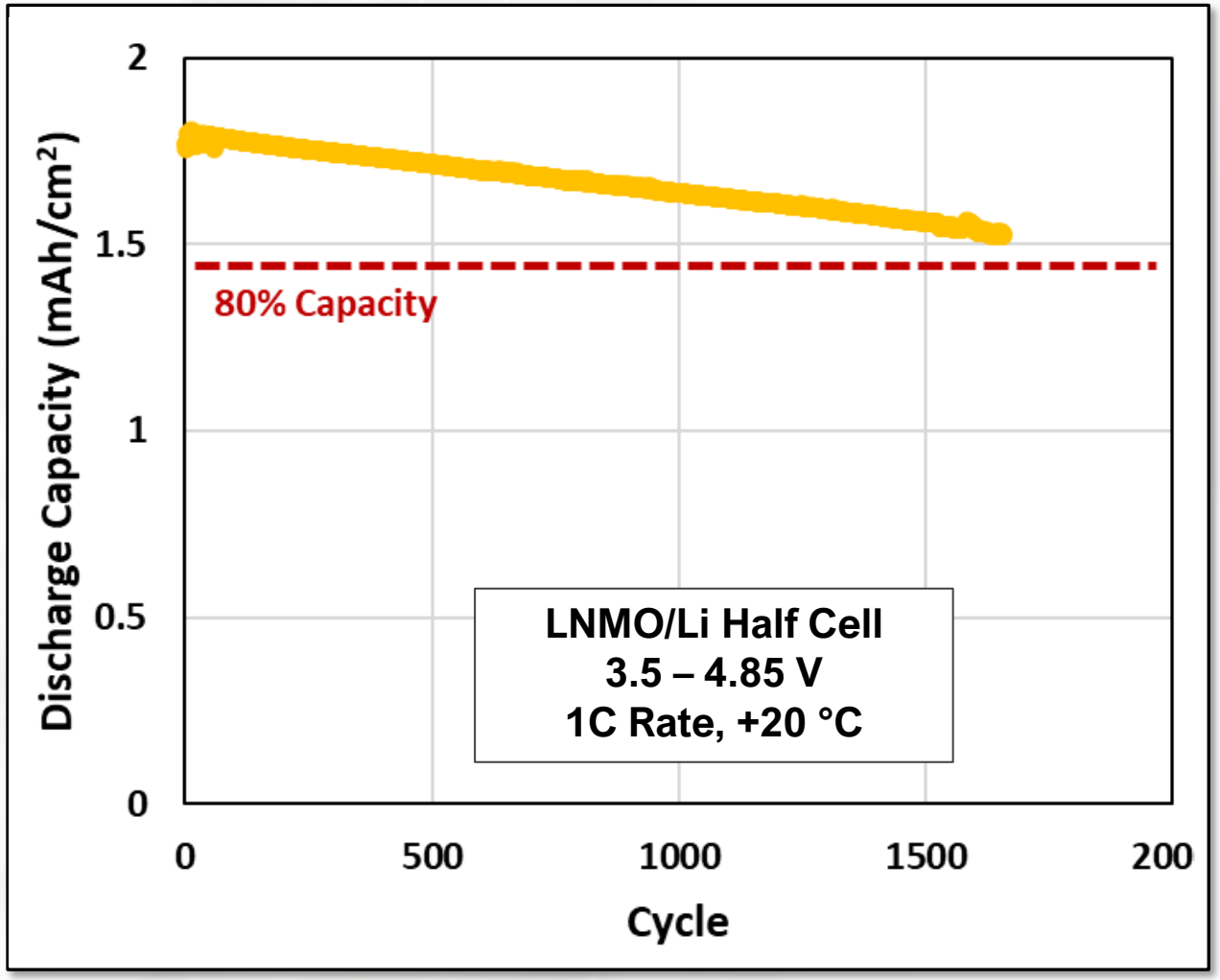
Estimated 10~15% $/kWh Reduction
Cobalt-Free LNMO Cathode





Excellent cycling stability with 4.85 V cathode

LiGas Advantages

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Improved Safety
Non-flammable, non-toxic *LiGas* electrolytes

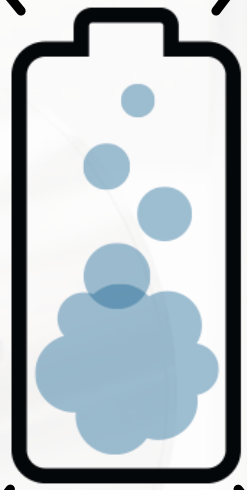
Cost-Effective
Faster manufacturing, high voltage, thick electrodes, safer cells.

Fast Charge
High electrolyte conductivity & ideal SEI enables <15 min fast-charge

All-Weather Resilience
-60 to +60 °C Operation

Material Compatibility
Fully compatible with all common cell electrodes, separators, cans

Increased Energy
Thicker electrodes, more efficient battery system integration



Improved Recyclability
Safer handling of dry cells, no longer need hazardous shipping

Faster Manufacturing
Electrolyte injection & wetting times reduced from hours to minutes.

Liquefied Gas Electrolytes

for Next-Generation Lithium Batteries



Thank you!!

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