

TYFAST

New Class of High Performance and Highly Safe Li-ion Cell Enabled by Novel Vanadium Oxide Anode

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- Company
- Innovation
- Performance
- Traction
- Summary

COMPANY

Founded in 2021

- Spinout company from UC San Diego
- Prof. Ping Liu, SPEC Center
- Department of NanoEngineering

High Performance Li-ion Cells

- Powered by a new LVO anode
- Domestically sourced raw materials
- Maximized power, safety and durability

R&D and Prototype Cells for Customer Evaluation

- 200 mAh and 2 Ah
- 10 Ah (Q4-24)
- <10 mins charge
- >10,000 cycles
- -40 to +70 °C operation

TYFAST



GRANTS

TYFAST



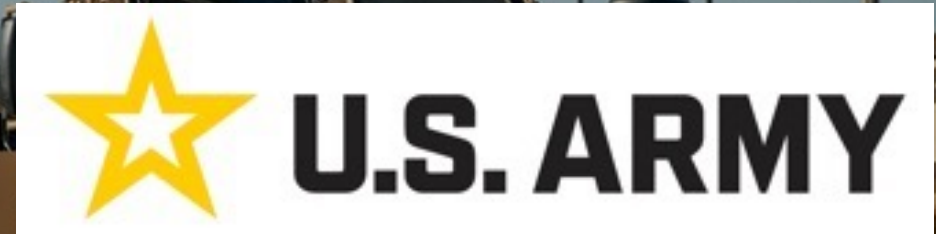
Phase II
Construction Vehicles



Phase II
Next-Gen EVs



Prototype Grant
Heavy Duty Vehicles



Phase I
Tactical Vehicles

Divergence of Military and Commercial Requirements:

Commercial Focus

- Fuel Economy/Hybridized vehicles
- Increased energy – EV applications
- Increased power – HEV applications
- Cost (\$250/kWhr)
- Life (cycle/10-15 year calendar life)
- Safety
- SAE Standards
- Operation from to -20°C to +55°C

Military Requirements:

- ✓Operating Temperatures: -46°C to 71°C
- ✓Storage Temperatures: -54°C to 88°C
- ✓Electromagnetic Interference: MIL-STD-461F
- ✓Ballistic Shock: MIL-STD-810G
- ✓Life Fire: MIL-STD-810G
- ✓Explosive Environment: MIL-STD-810G
- ✓Altitude to 60,000ft: MIL-STD-29595
- ✓Explosive Decompression: MIL-STD-810G
- ✓Salt fog: MIL-STD-810G
- ✓Sand and Dust requirements: MIL-STD-810G

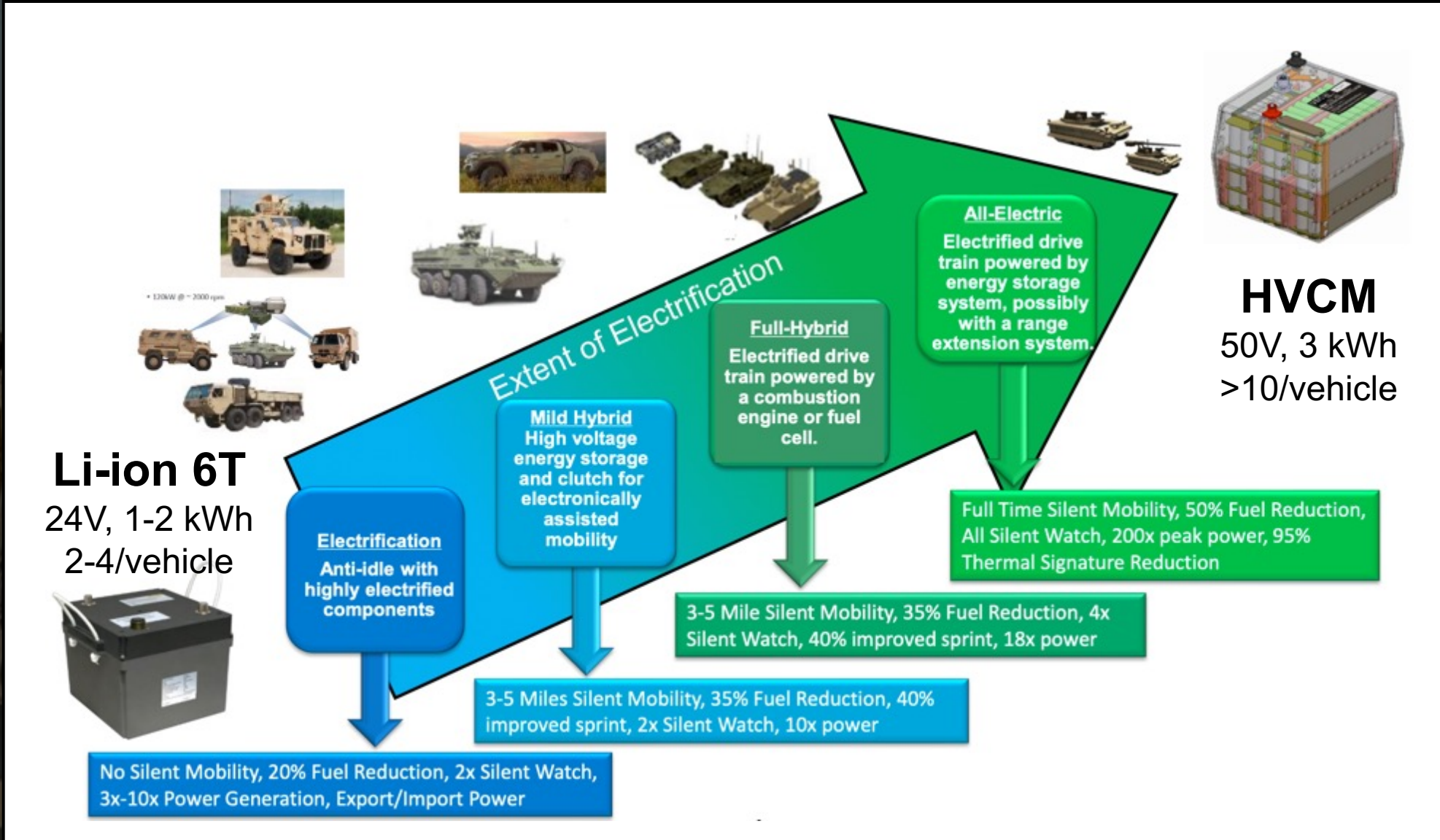
Additional Military Focus:

- ✓NATO Standardized Form Factors (i.e. 6T)
- ✓Maximized Power AND Energy density
- ✓Sustainability and Logistics issues
- ✓Silent Watch/Silent Mobility
- ✓On-board Electric Power

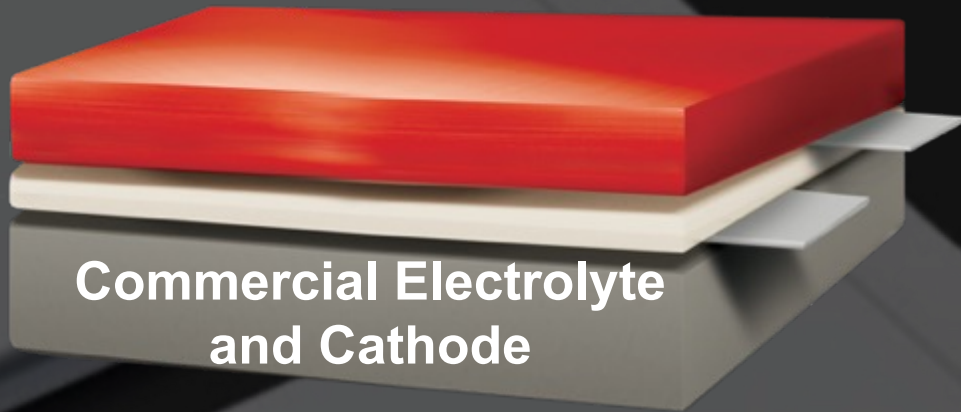
Commercial

Military

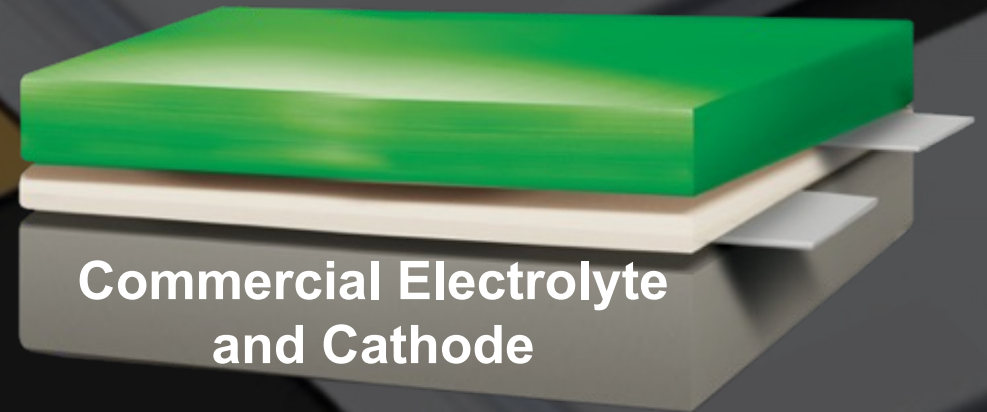




GRAPHITE



TYFAST LVO



Battery Technology	Graphite Anode		LVO Anode Targets
Power	1C Charge / <10C Discharge	Symmetric	>10C Charge / >10C Discharge
Charging time	60 minutes to 80% SOC	>5x faster	<10 minutes to 100% SOC
Cycle Life / Duration	~1,000 cycles	10x longer	~10,000 cycles
Charging Capability	0 °C to +60 °C	Below 0 °C	-40 °C to +70 °C
Energy Density	150 – 250 Wh/kg	Maintain	150 – 200 Wh/kg

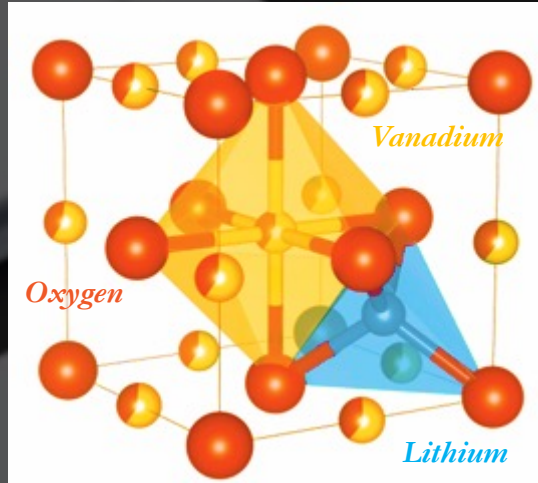
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Lithium Vanadium Oxide

UC San Diego

nature
International journal of science

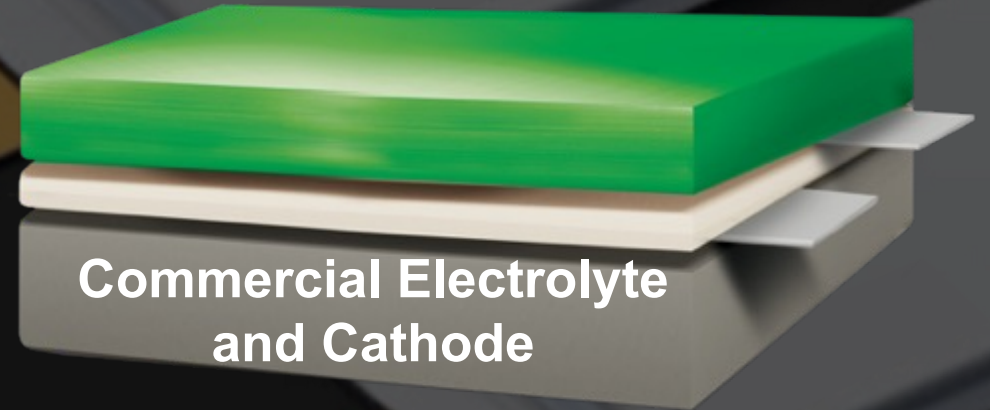
7 Patents
Pending



Cubic Structure



TYFAST LVO



Tyfast LVO	⇒	7 patents pending
10x Faster Li Transport vs. Graphite	⇒	<10-mins charging (>10x Power Target)
5x Lower Volume Expansion vs. Graphite	⇒	>10,000 Cycle Life (>10x Life Target)
Metal Oxide Anode	⇒	Higher Safety, Lower Heat Release

Vanadium Oxide from Industrial Waste

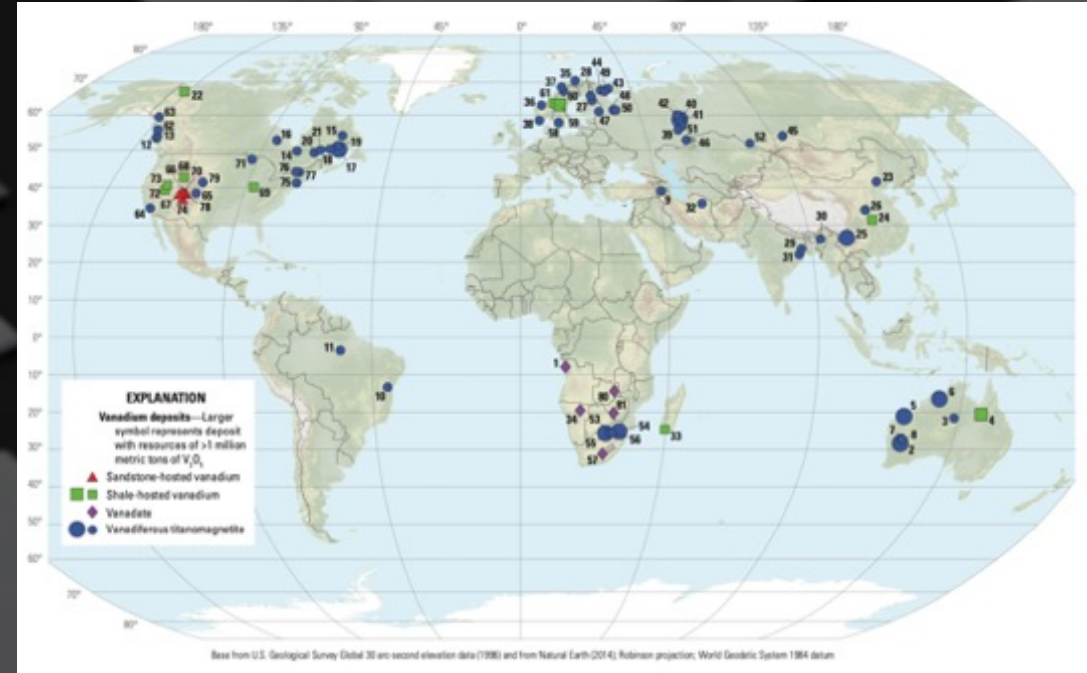


Steel Slag Stockpile



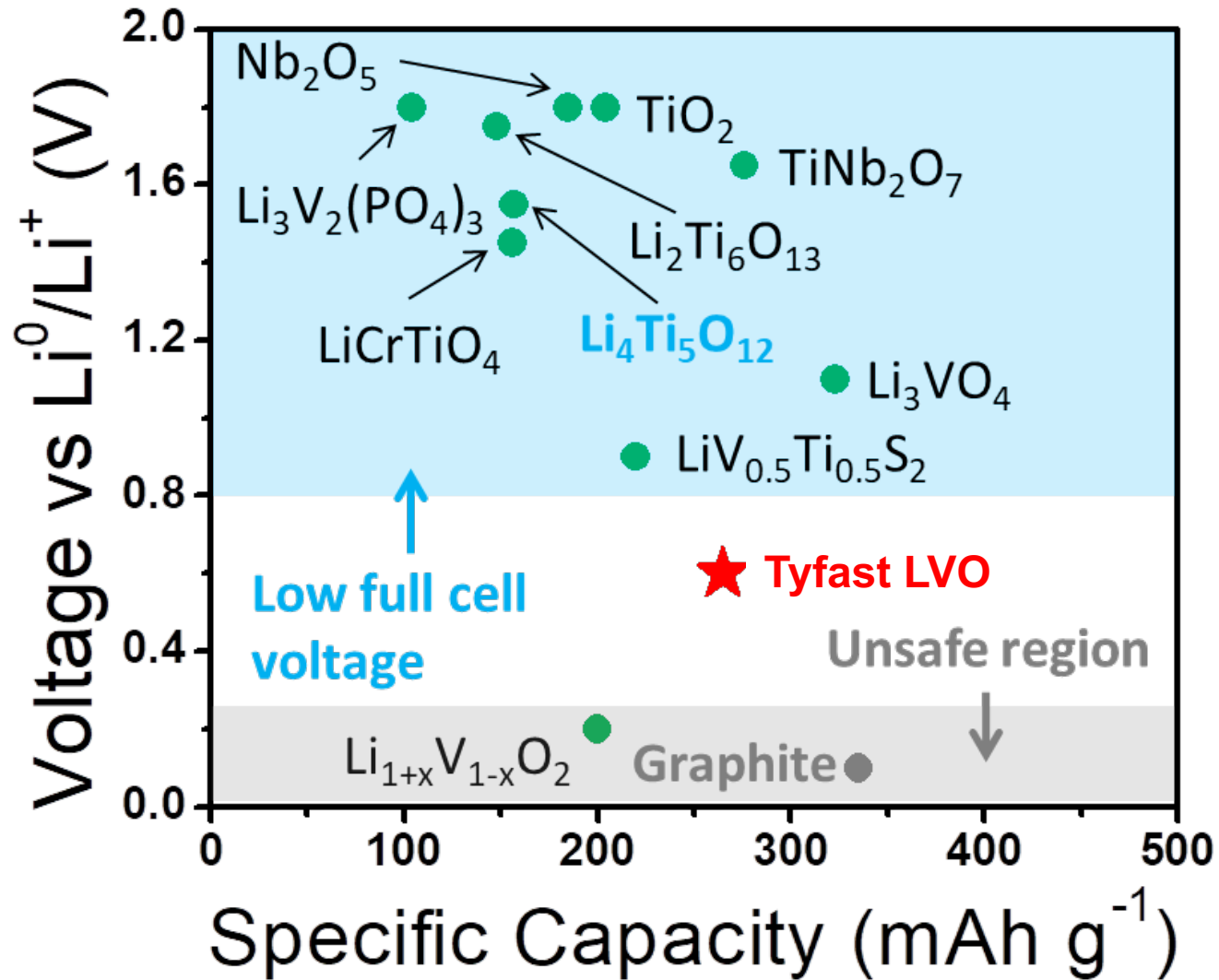
100% US Raw Materials

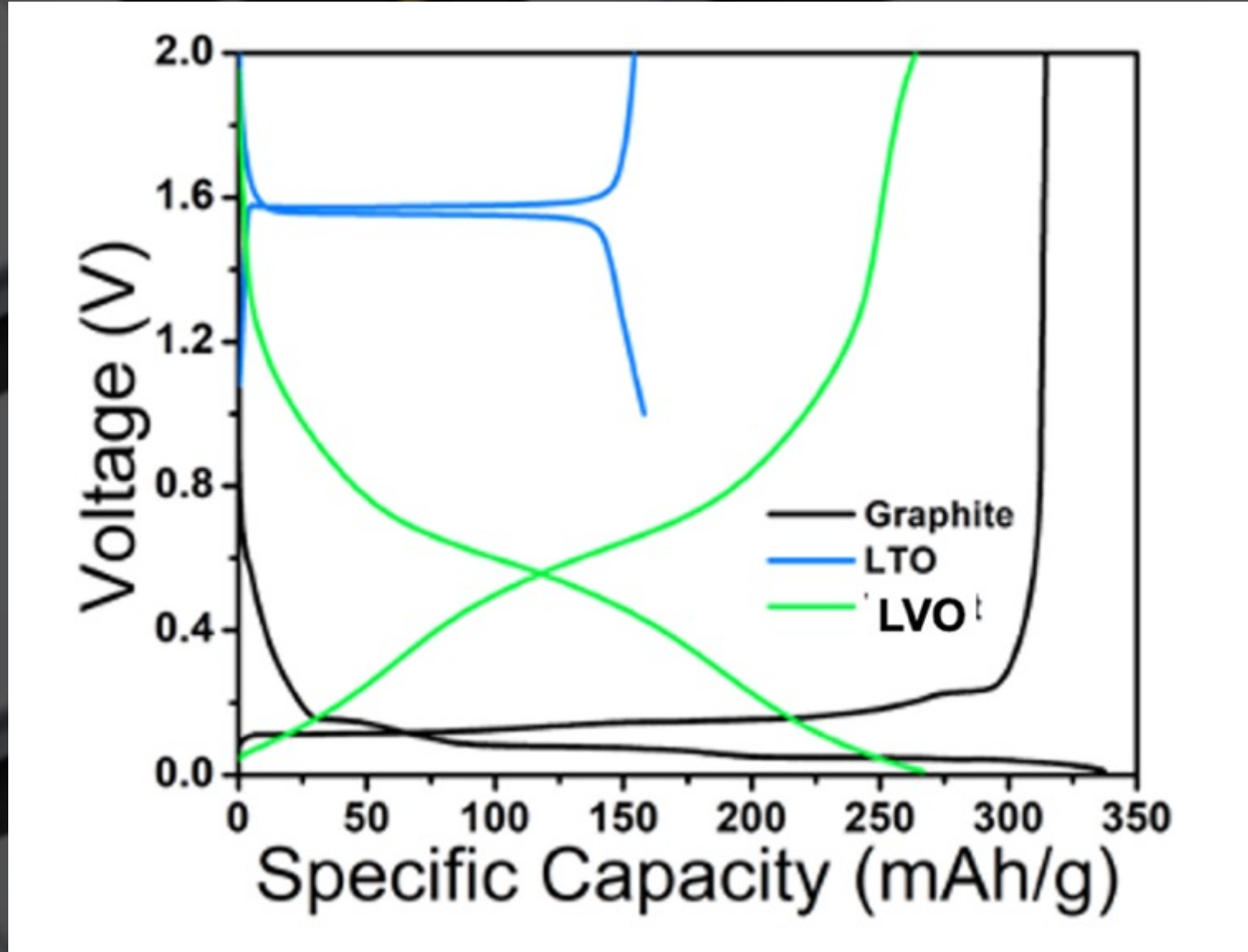
Worldwide Resource (22nd Abundant Element)

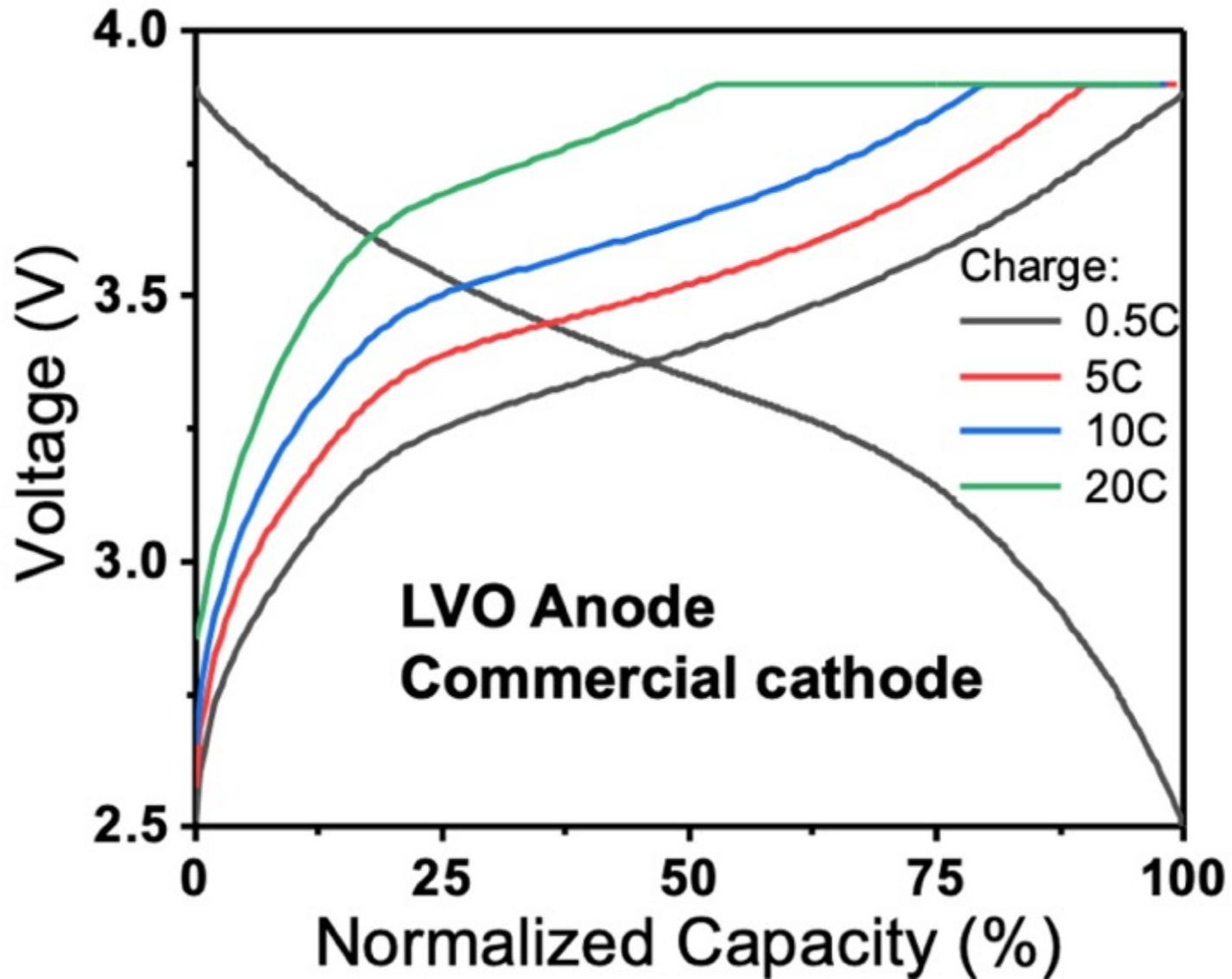


Similar to Zn and more common than Cu, Ni, Co, and Li*

*References: Moskalyk and Alfantazi, 2003; Perron, 2001; USGS Geological Survey Professional Paper 926-B, 1975









R&D cell
200 mAh

Battery Anode*	Rate Capability	Charge <0 °C	Cycle Life	Cell Safety	Energy Density	Cell Cost	Lifetime Cost
TYFAST LVO Targets (3.2V/cell)			10,000		200 Wh/kg	\$150/kWh	\$0.02/kWh cycle
Graphite (3.6V/cell)			1,000		250 Wh/kg	\$100/kWh	\$0.1/kWh cycle
LTO (2.3V/cell)			10,000		100 Wh/kg	>\$400/kWh	\$0.04/kWh cycle

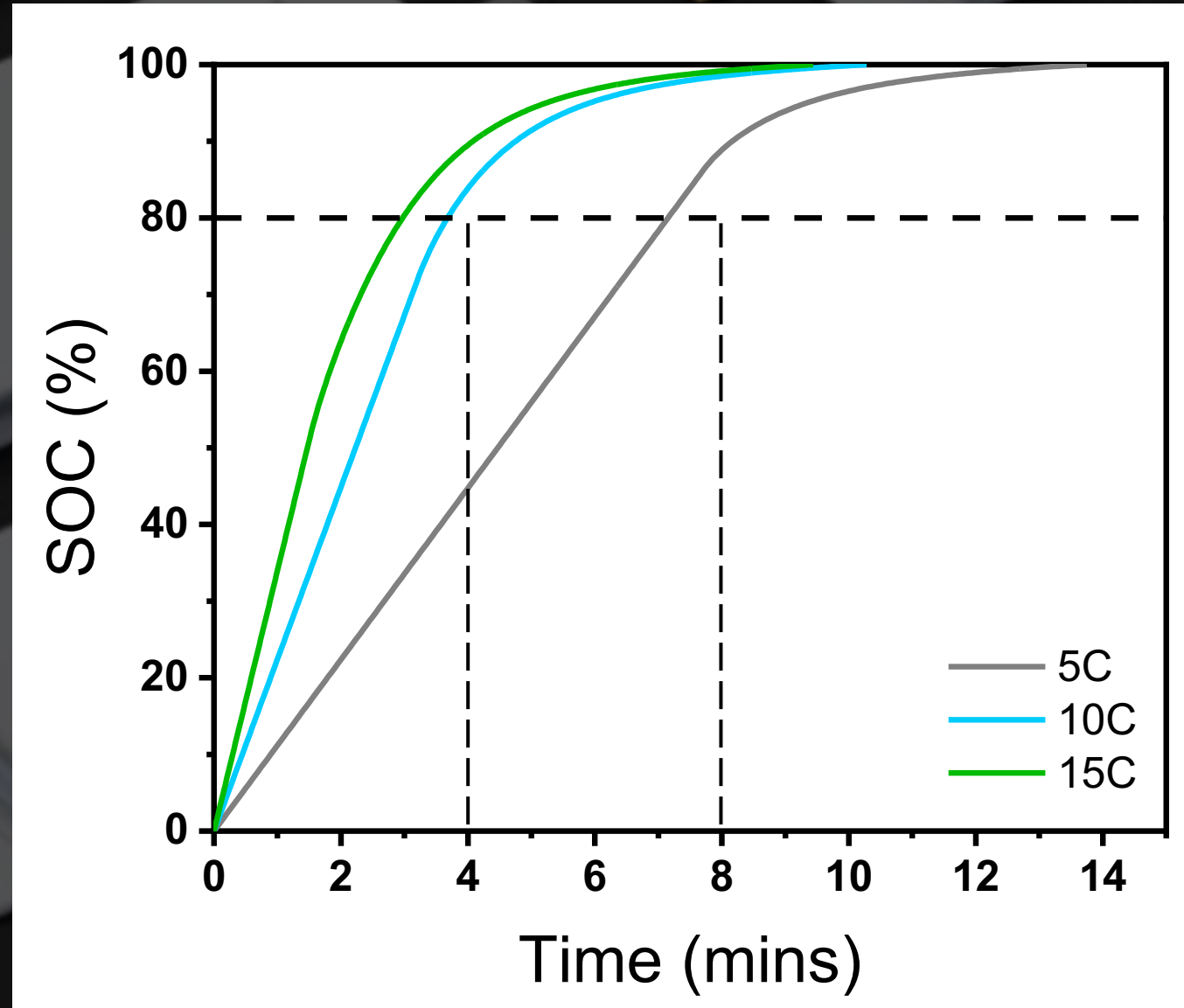
*Paired with NMC Cathode

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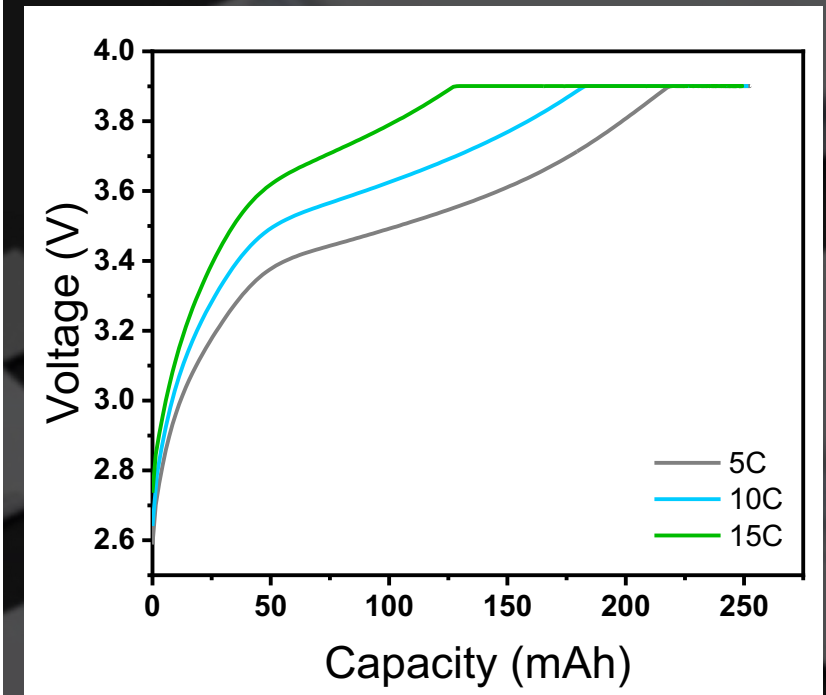
Item	R&D Cell	Prototype Cell
<p>Pouch Cell</p> <ul style="list-style-type: none"> • Anode: LVO • Cathode: Commercial 		
<p>Nominal Capacity</p>	<p>200 – 1000 mAh</p>	<p>2 Ah – 10 Ah</p>
<p>Nominal Voltage</p>	<p>3.2 V</p>	
<p>Max Charging Rate (CC/CV)</p>	<p>10C continuous at RT</p>	
<p>Charging Voltage</p>	<p>3.9 V</p>	
<p>Max Discharging Rate (CC)</p>	<p>10C continuous at RT</p>	
<p>Discharge Voltage</p>	<p>2.5 V</p>	
<p>Dimensions</p>	<p>60 x 70 mm</p>	<p>130 x 160 mm</p>

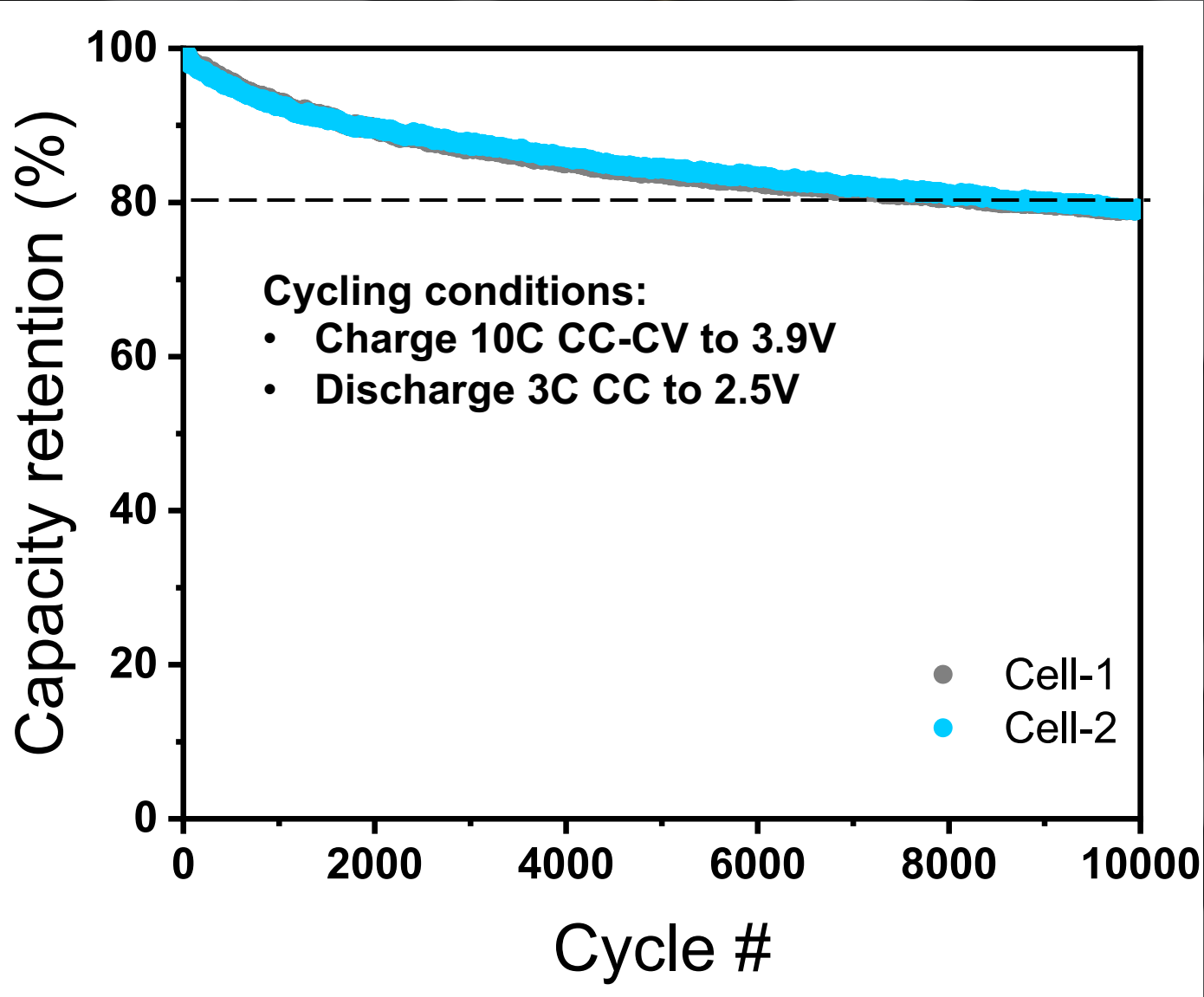
TEMPERATURE: 25 CELSIUS

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R&D cell
200 mAh

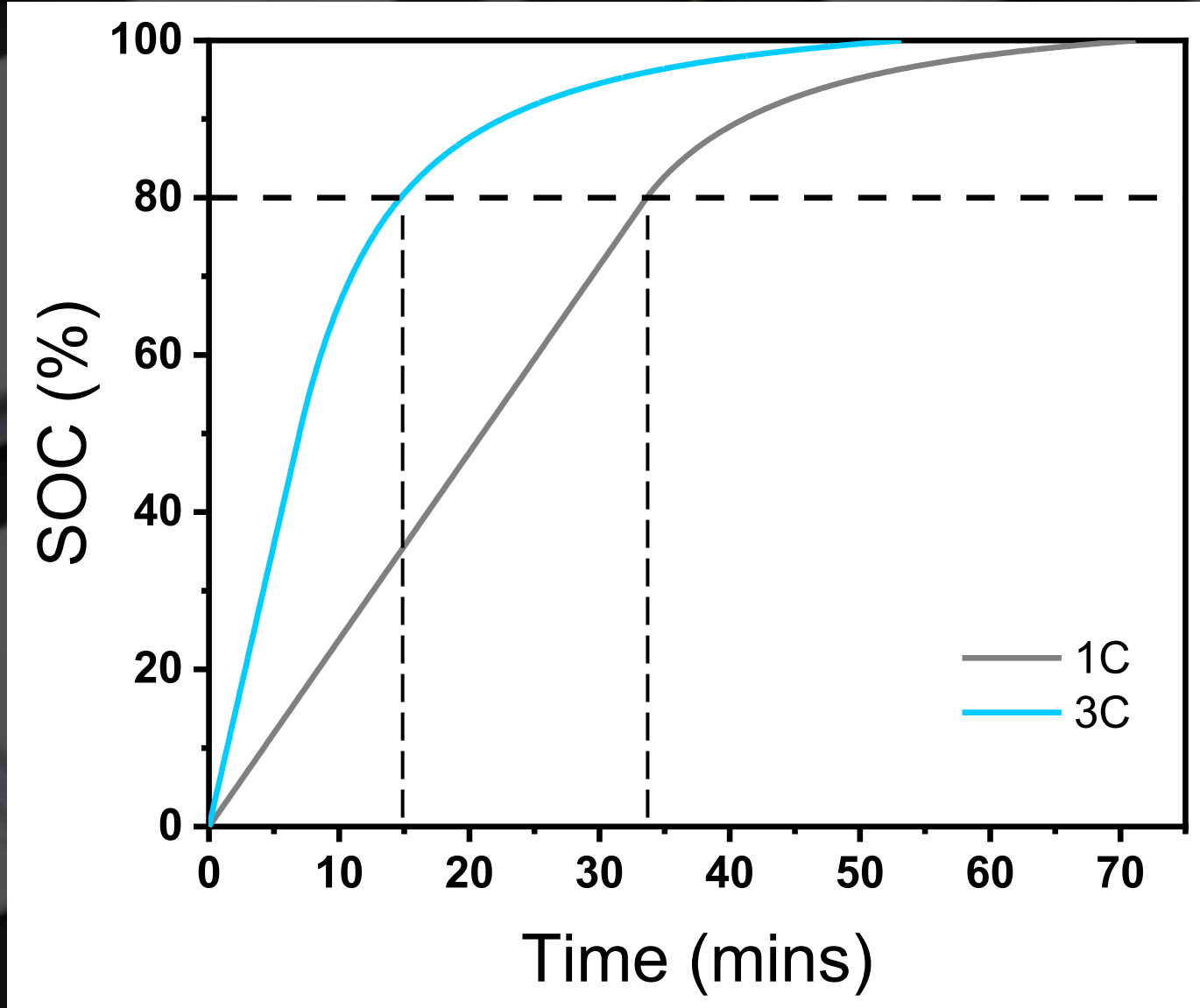




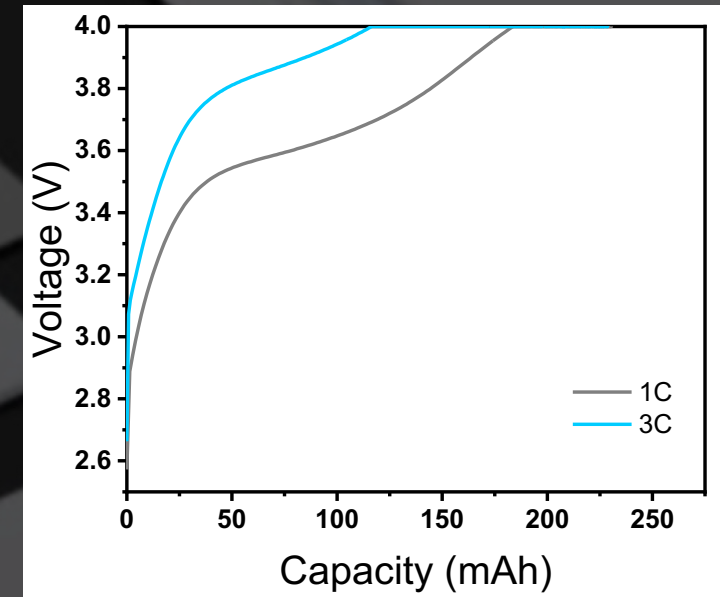
R&D cell
200 mAh

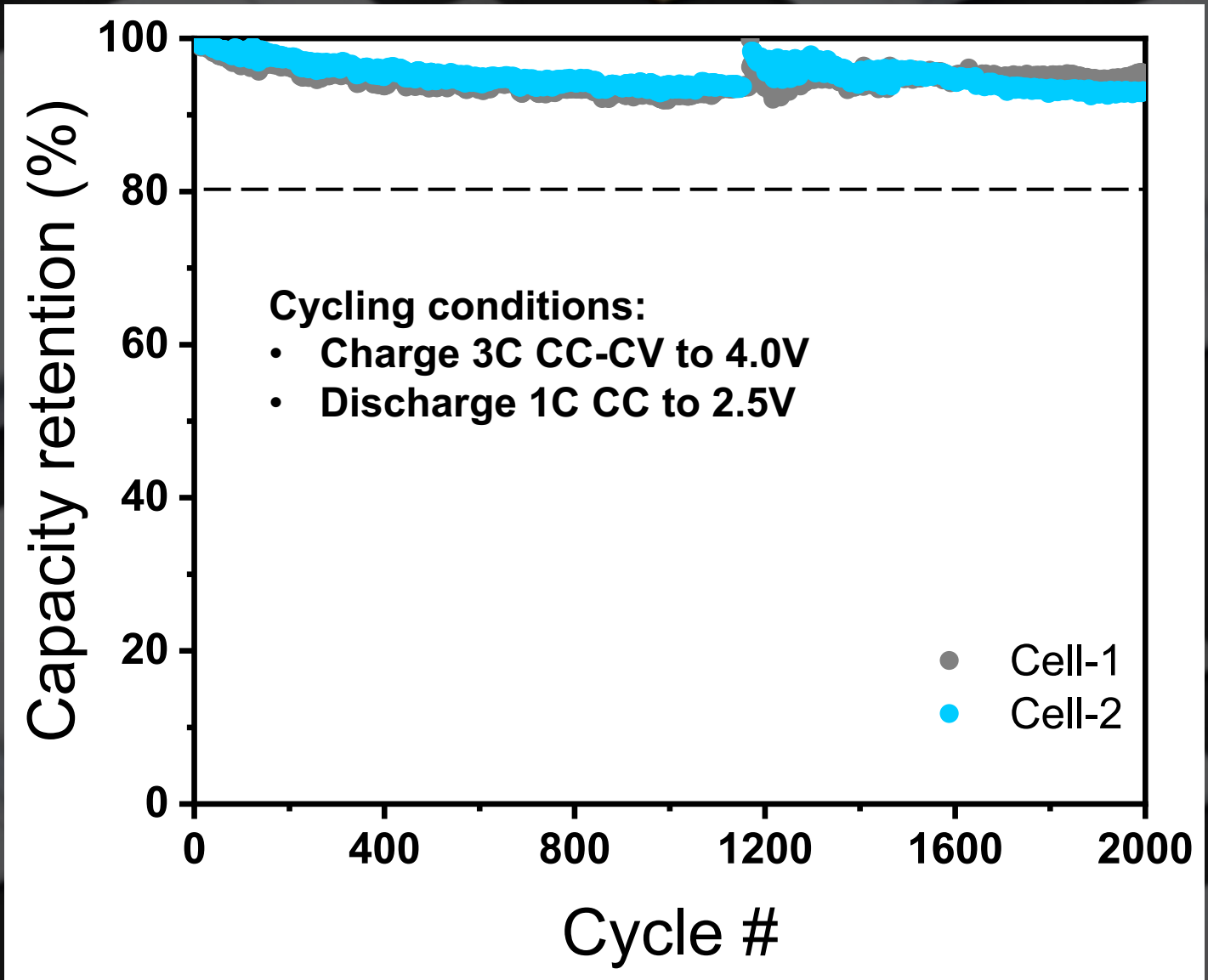
TEMPERATURE: -20 CELSIUS

TYFAST



R&D cell
200 mAh

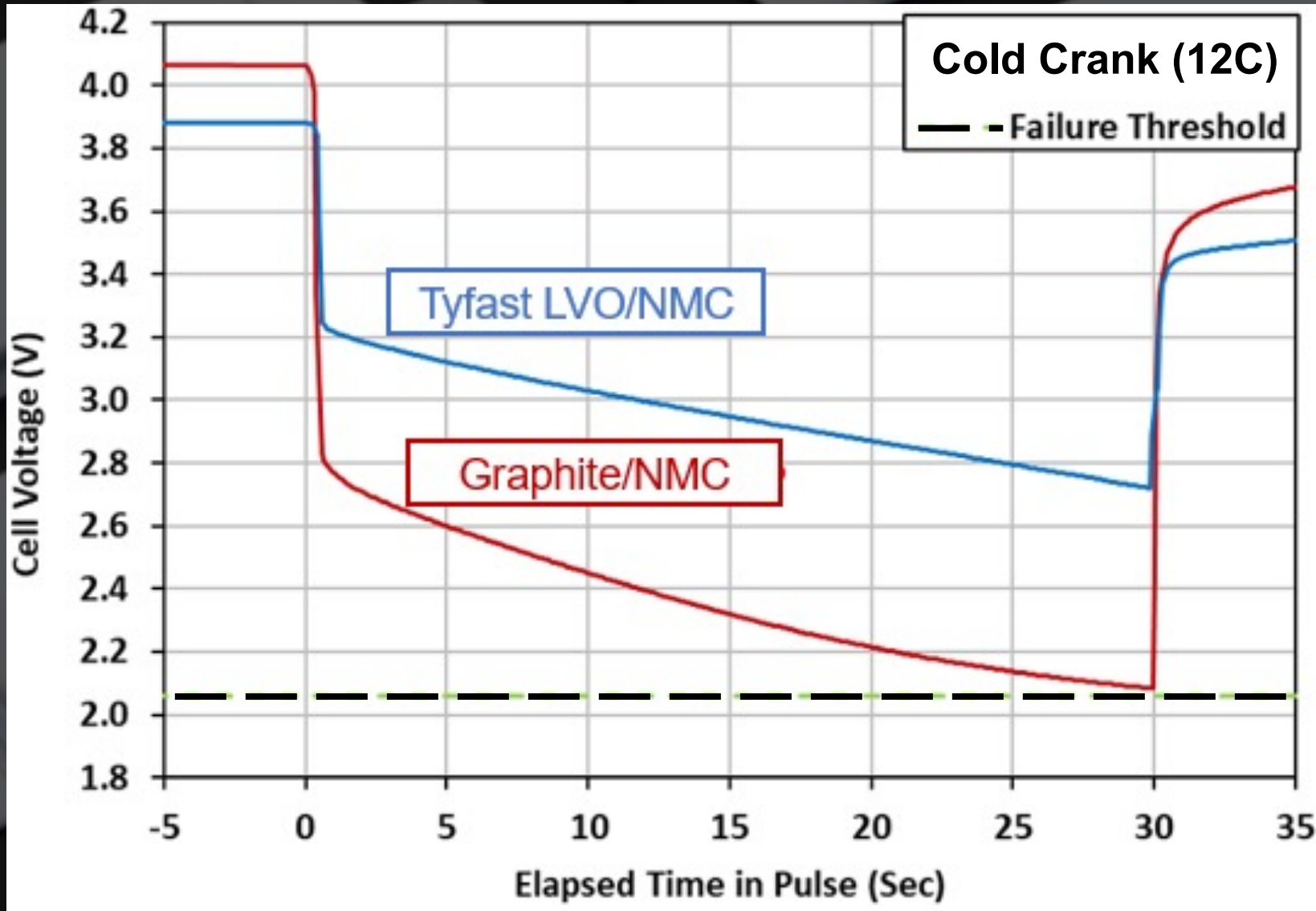




R&D cell
200 mAh

TEMPERATURE: -18 CELSIUS

TYFAST



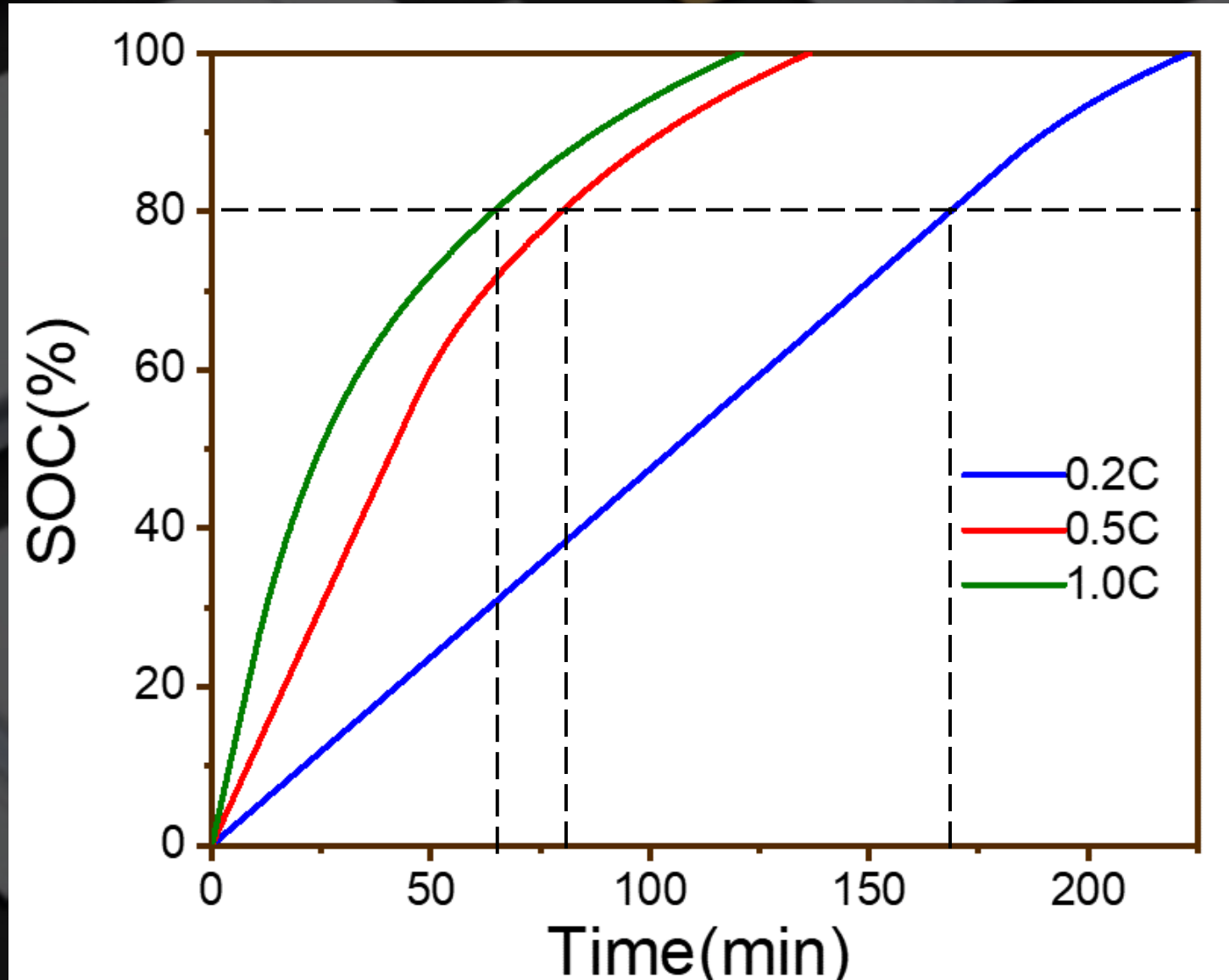
R&D cell
200 mAh

3rd Party Cold Crank Test:

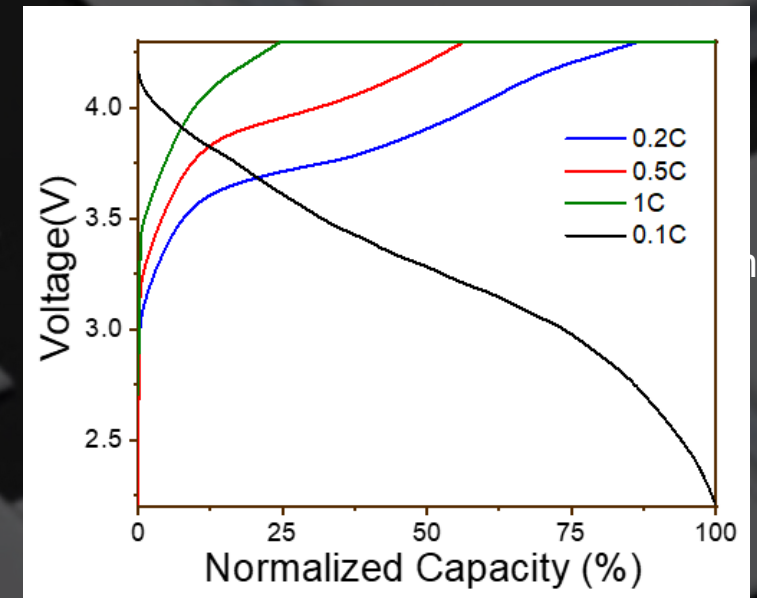
1. Low rate charge at room temperature.
2. Perform 30 sec pulse at temperature.

TEMPERATURE: -40 CELSIUS

TYFAST

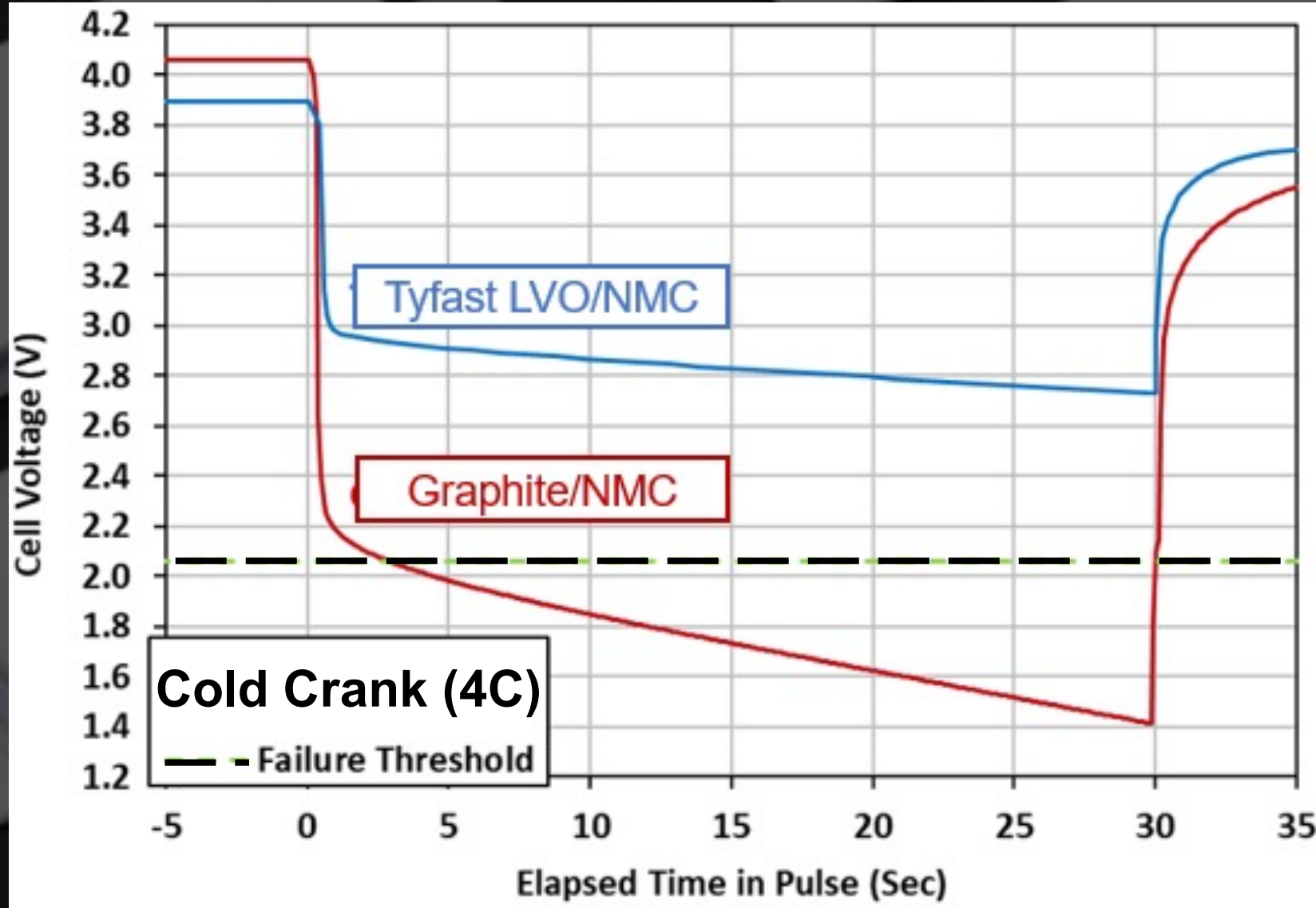


R&D cell
200 mAh



TEMPERATURE: -40 CELSIUS

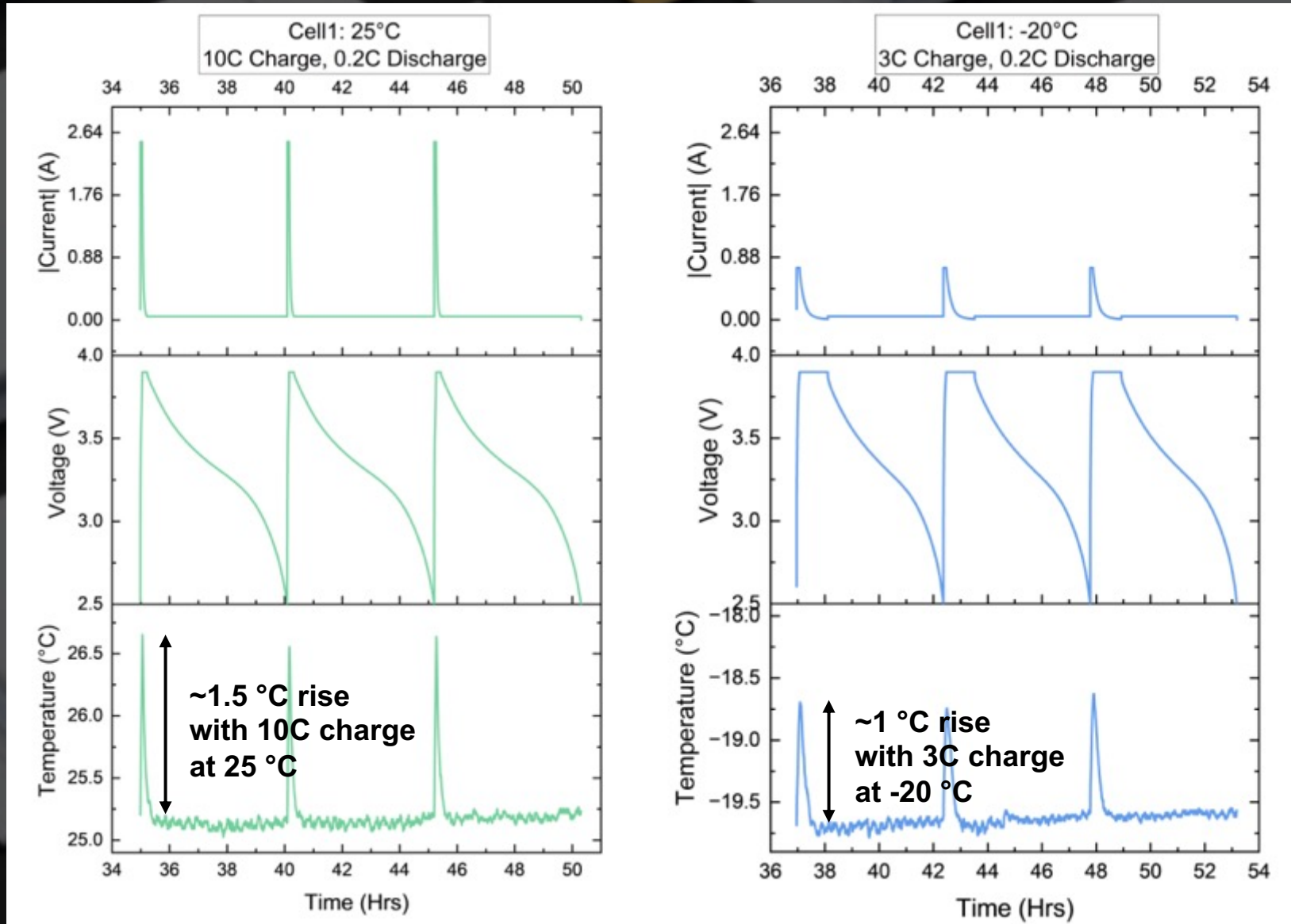
TYFAST



R&D cell
200 mAh

3rd Party Cold Crank Test:

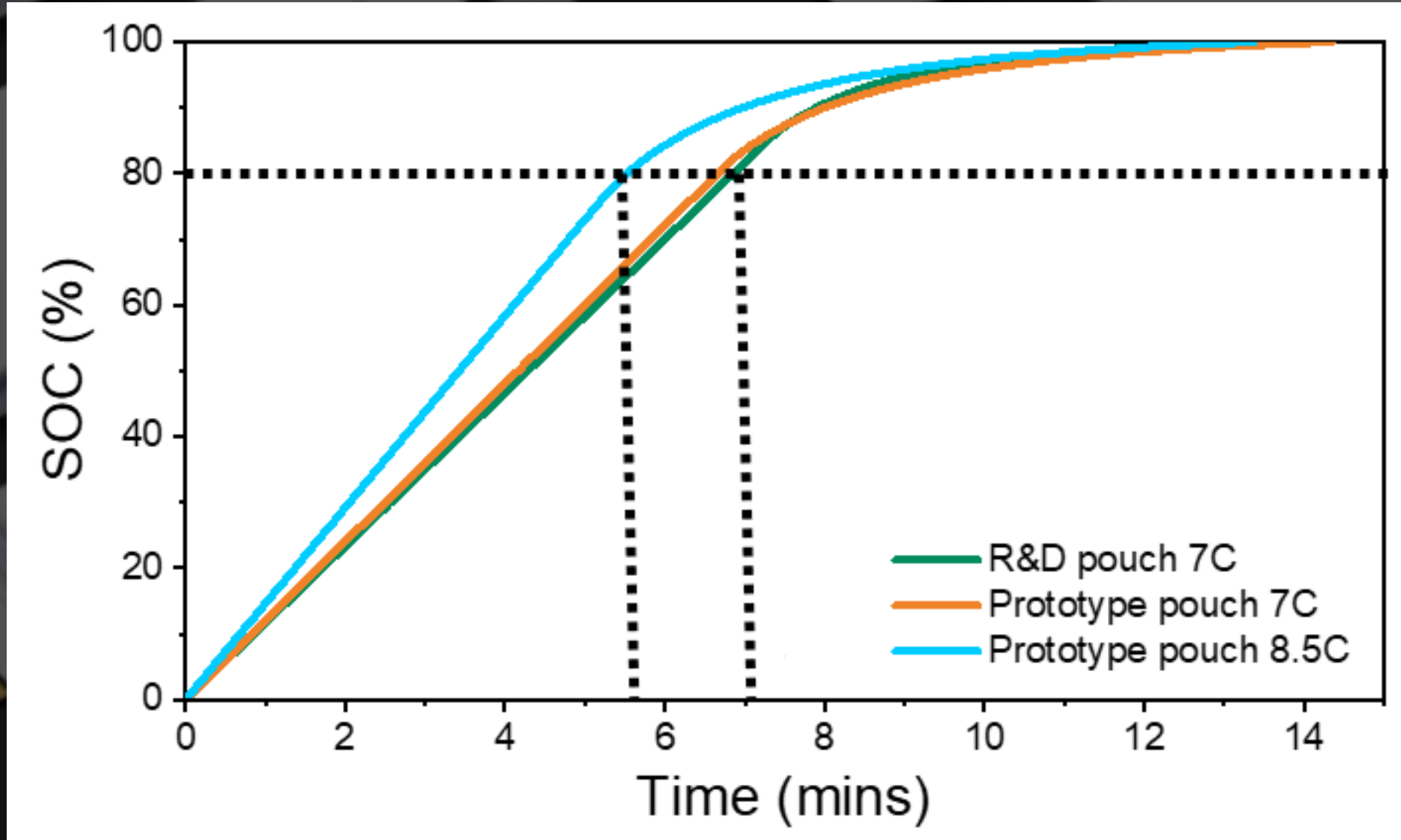
1. Low rate charge at room temperature.
2. Perform 30 sec pulse at temperature.



- 3rd Party Test Measuring Cell Temperature Rise:
1. At 25 °C: 10C charge/ 0.2C discharge
 2. At -20 °C: 3C charge/ 0.2C discharge

PERFORMANCE COMPARISON AT 25 CELSIUS

TYFAST



R&D cell
200 mAh



Prototype cell
2 Ah

PASS = No Fire, Smoke or Explosion

UL1642 Test	Test Result	Test Image/ Description
Overcharge (SAEJ2464)	PASS	<ul style="list-style-type: none"> 150% of Voltage or 200% of Capacity
Short Circuit	PASS	<ul style="list-style-type: none"> 10 mΩ resistance load at 100% SOC <p>Note placement of thermocouple temperature sensor on cell</p>
Impact	PASS	<ul style="list-style-type: none"> 20-lb bar dropped from 2ft, 100% SOC <p>Impact damage clear across all samples</p>

UL1642 Test	Result	Test Image/ Description
Crush	PASS	<ul style="list-style-type: none"> Ram with 3000+224 lbs force applied, 100% SOC <p>Minor deformation observed on back side of cells</p>
Nail Penetration	PASS	<ul style="list-style-type: none"> 8mm nail at 100mm/sec, 100% SOC
Thermal Abuse	PASS	<ul style="list-style-type: none"> Temp hold at 130 °C for 10 mins



R&D cell
200 mAh

- **Company**
- **Innovation**
- **Performance**
- **Benefits**
- **Summary**



6T Battery
24 V, 90 Ah, 2.2 kWh

Tyfast offers:

- Higher Amps capability
- Low temperature performance
- Rapid recharge
- Reduced maintenance

Standard Li-ion	Tyfast 6T Advantage	Tyfast Li-ion
CCA 1,100 A (-18 °C)	2x Higher	CCA 2,200 A (-18 °C)
Continuous 300/180 A	3-5x Higher	Continuous 900/900 A
Charge -46 °C Internal Heater	New Capability	-46 °C No Heater
Rapid Charge 30 mins to 90%	3x Faster	<10 mins to 100%
Cycle Life ~1,000	10x More Cycles	Cycle Life >10,000



Stryker Capability	Tyfast Offers
Silent Watch Duration	No change (2 hours)
Engine-on Duration	10x Shorter (~3 mins)
Silent Watch Instances	10x More (10,000 cycles)
Battery Maintenance	10x Longer (10,000 cycles)



3 Parallel 6T Batteries for Silent Watch* (180A)
 24 V, 90 Ah, 2.2 kWh

*Example from GVSC for 6T options for Stryker

BRADLEY HYBRID ELECTRIC



HVCM
50V, 3 kWh
>10/vehicle

Hybrid Requirements	Tyfast Offers
High Rate/Power	>10C Rate Continuous
Peak and Regen Rate/Power	>20C Rate Pulse
High Durability	10,000 cycles
Safety	Target HSL ≤ 4

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- **Summary**

- New class of high-performance and safe Li-ion
- Enabled by a novel LVO anode
- Domestic V raw material from industrial waste
- Demonstrated rate, life and temperature capability
- Seeking DOD and Defense OEMs for evaluation/partnership

*Contact: G.J. la O', Co-Founder and CEO
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