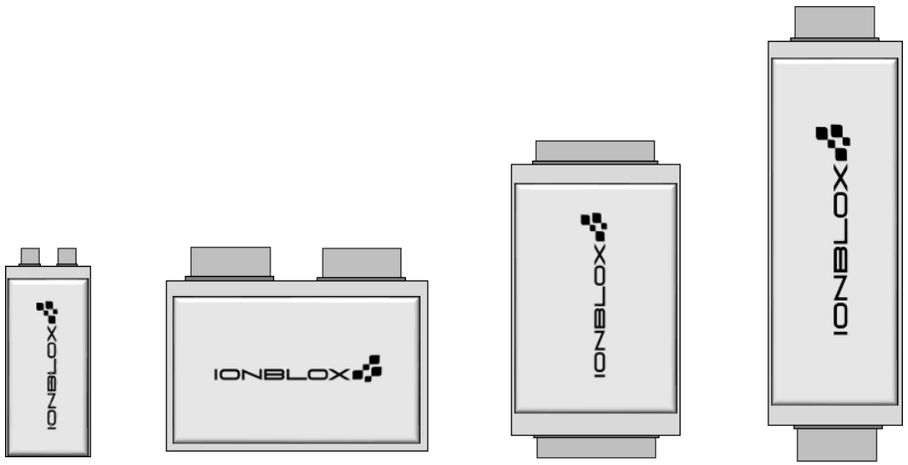


IONBLOX

Accelerating the Future of Electric Mobility

High-Energy & High-Power Silicon Anode Lithium-ion Batteries Enabling Advanced Military Applications

Dr. Herman Lopez,
CTO & co-founder, **Ionblox, Inc.**

June 4-6, 2024

Email: herman@ionblox.com
Website: www.ionblox.com
Ionblox, Inc., Fremont, CA

Company Overview

- Ionblox founded in Silicon Valley in 2017, has developed “all-in-one” Lithium-ion cells that can simultaneously deliver High-Energy, High-Power, Fast-Charging, and Long Life
- Ionblox’s “all-in-one” Lithium-ion cells are enabled by a proprietary Pre-lithiated Silicon-based anode. Cell performance has been validated by industry leaders:
  - ✓ EV cell performance validated by US National Labs in the USABC program
  - ✓ eVTOL cell performance validated by Lilium, a leading eVTOL player & investor
- Ionblox has solved the poor durability issues associated with Silicon-based anodes and has the industry-first silicon anode battery that meets the cycle life and calendar life for EVs
- Raised $32M Series B round from Lilium, Applied Ventures, Temasek, and Catalus
- 50+ issued US patents & several pending applications. IP protection includes foundational patents for pre-lithiation of all types of silicon-based anodes

USABC Awards to Commercialize EV Cells

- Demonstrated 1,000 cycles with silicon anode in first $7.7M USABC award in 2017.
- Awarded second $4.8M USABC contract in 2019 for “low-cost rapid charging cell.”
- Ongoing third $3.5M USABC contract in 2022 to further advance our technology and cost reduction.

Multiple funded test programs with leading auto OEMs.

- Cell performance accepted by the automakers
- Working on Cell cost reduction

Proprietary Pre-Lithiated Silicon Anode Technology

Proprietary **Silicon-Powerblox** technology addresses every element of the LIB technology stack to solve the silicon swelling and cycling problems:

Silicon Monoxide (SiO_x) Anode

- 100% active material
- Low cost
- Low swelling
- Easy to scale

Pre-Lithiation

- Offsets irreversible capacity loss
- Increases cycle life and calendar life
- Implementing manufacturable process

Electrode Architecture

- Porous electrode
- High strength binder
- Carbon nanotube network

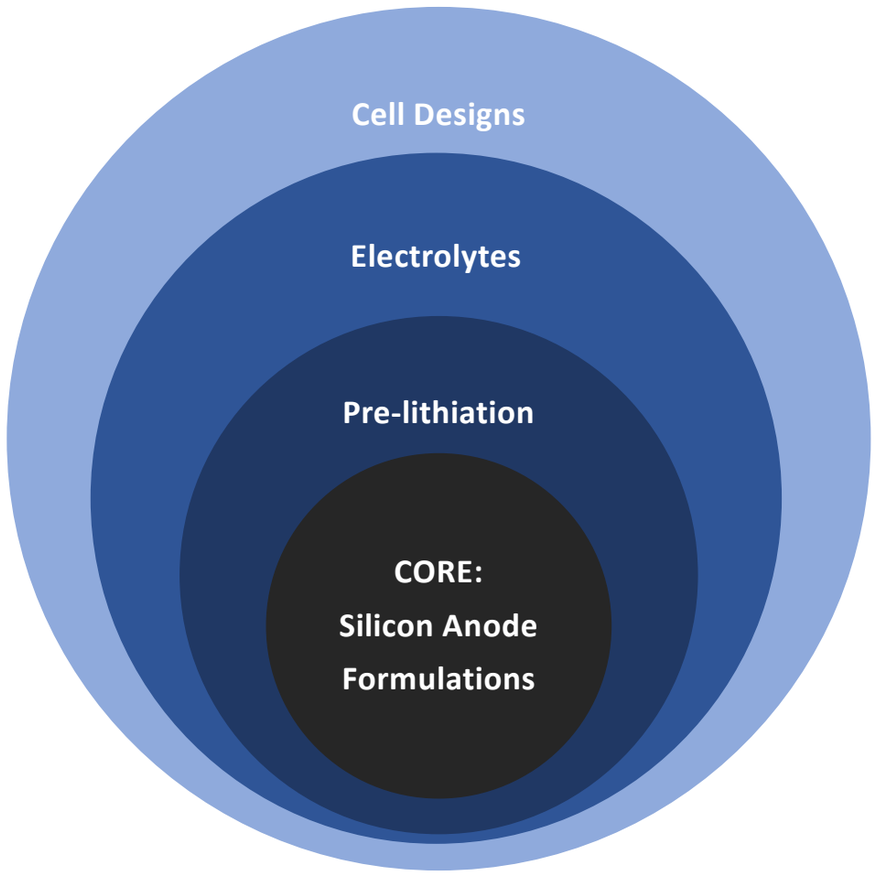
Cell Design & Integration

- Robust Solid Electrolyte Interphase (SEI)
- Formation protocol
- Designs leading up to 400 Wh/kg

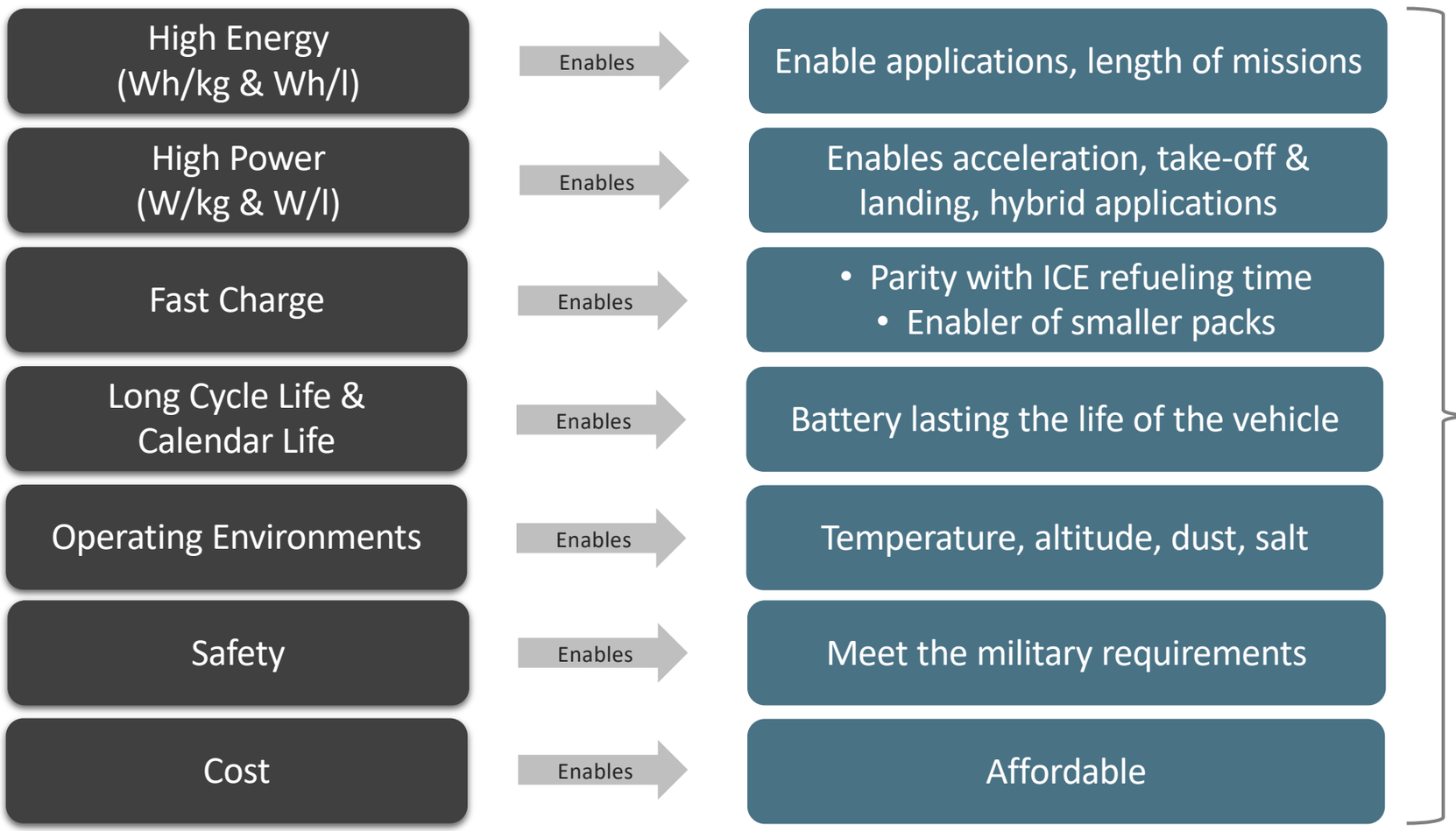
All areas are Patent protected.

Patent-Protected Pre-lithiated Silicon Anode

- Awarded over 50+ patents.
- Own foundational patents for **pre-lithiation for <u>all</u> types of silicon-based anodes.**
  - Covers specific range of lithiation required for highest performance.
  - Provides the only path for silicon cells to achieve industry-leading performance.
- Prosecuting new patents pairing our silicon anode with next generation cathode chemistries



Battery Requirements for Military Applications

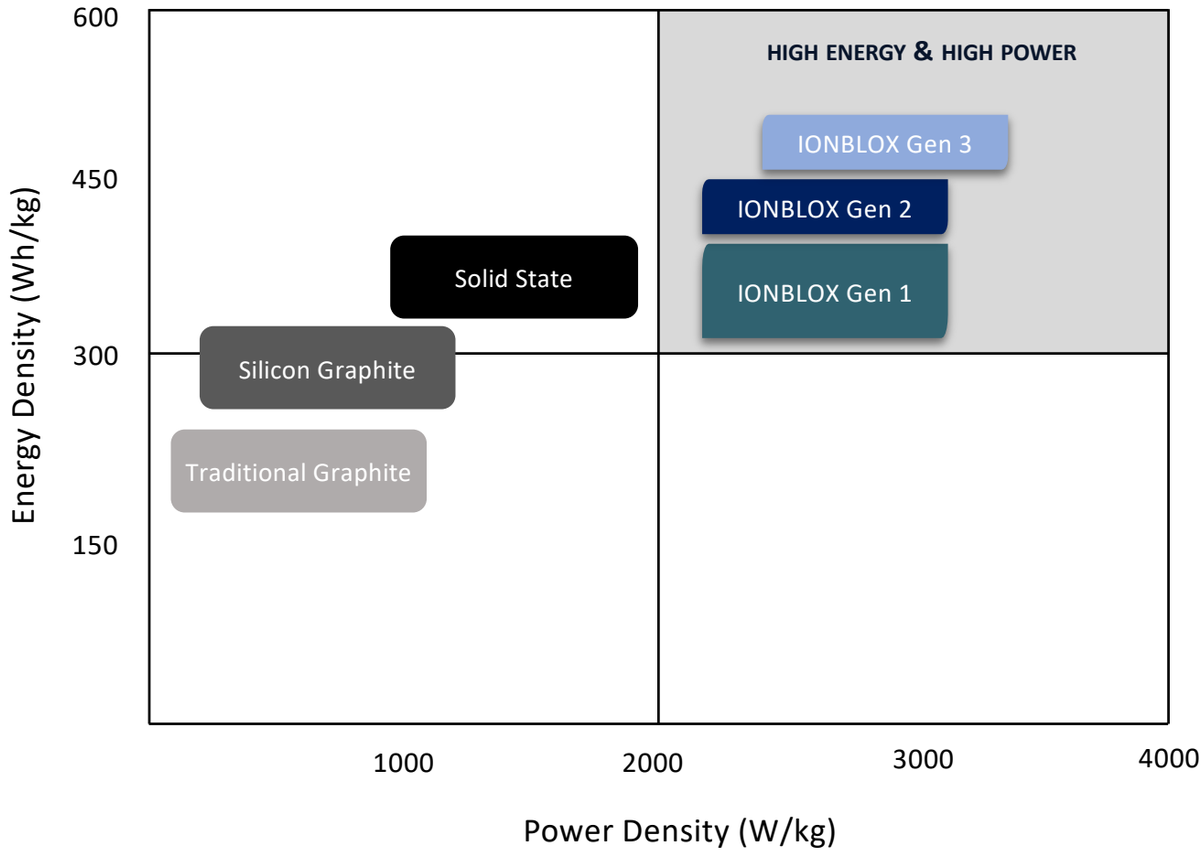


Electrification of Military applications require batteries to deliver all performance metrics

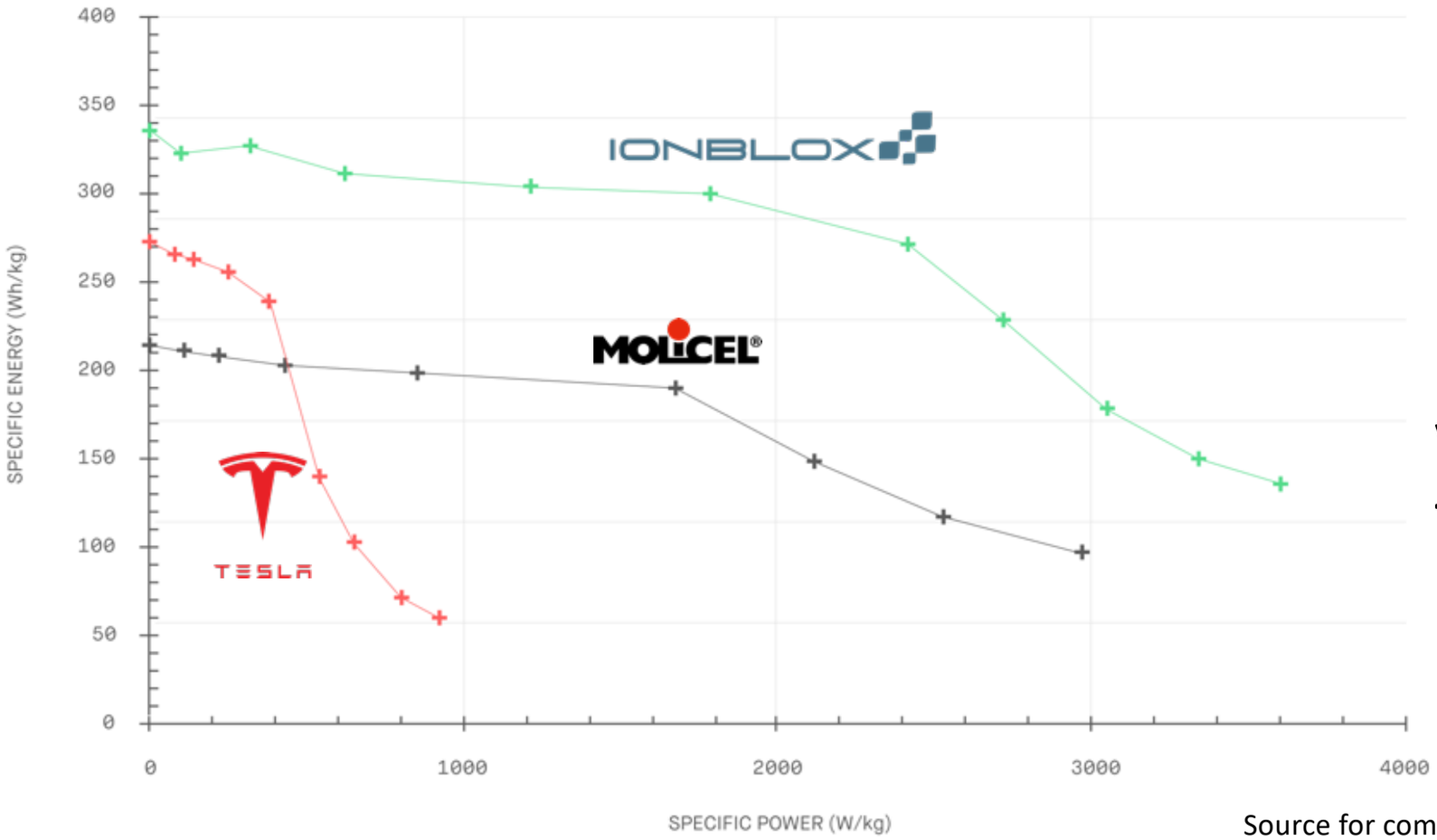
The Solution: LIBs with Pre-lithiated Silicon Anode

Ionblox has created the only LIB that can simultaneously deliver all cell performance attributes critical for mass electrification and continue to push the boundaries of traditional battery storage technology:

- ✓High Energy: (**Gen 1**) **350 Wh/Kg**
- ✓Extreme Fast Charge: **5 min charge**
- ✓High Power: **> 3000 W/Kg**
- ✓Battery Life: **> 1000 Cycles**
- ✓Battery Cost: **< $100/kWh**



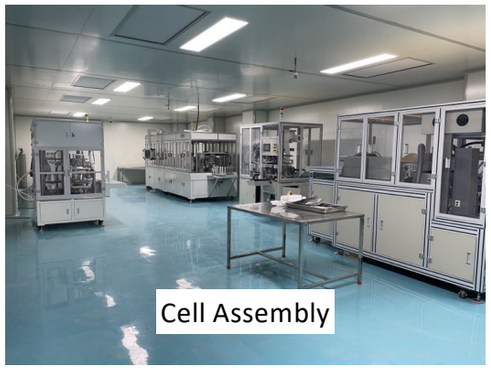
Ionblox Cell vs State of Art Cells



Ionblox cells, show higher available Power *and* Energy versus state-of-the-art cells

Source for commercial cell data: *Batemo*

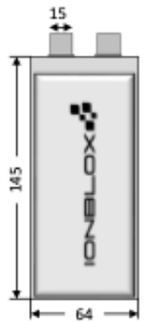
Available Cell Formats



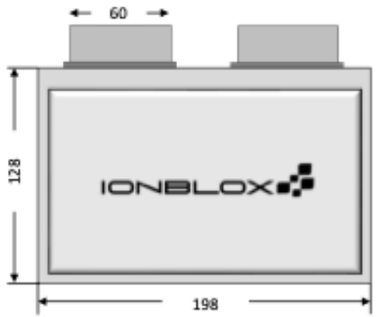
Ionblox Pilot Facility details:

- Floor size: ~40,000 ft^2
- 2 semi-automated pouch cell lines
- 5 MWh capacity

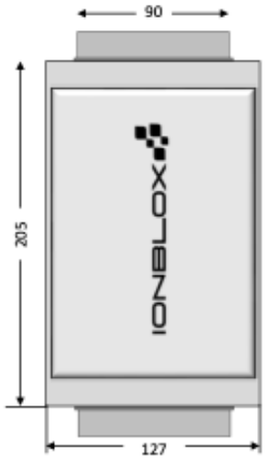
1) 8-12 Ah



2) 15-50 Ah



3) 15-50 Ah



4) 30 Ah 4695 cell
(*Under development)

- 4695 Cylindrical Cell development is in progress. Available in Q3, 2024
- Additional ~100 MWh capacity is available with strategic cell manufacturing partners in Europe and Asia

Target Markets

- **Advanced Air Mobility (AAM)**: Our cells have been designed into Lilium's eVTOL aircraft and cell production is ongoing. Qualify cells with other leading eVTOL & eCTOL OEMs.
- **Electric Vehicle (EV)**: Qualifying technology with major USA and European EV companies.
- **Electric Trucking:** Qualifying cells with major USA and European truck companies.
- **Military Applications:** Ground and air vehicles, wearables, surveillance, others.

6T - Standardized Military Battery
(used in 95% of military vehicles)

U.S.ARMY

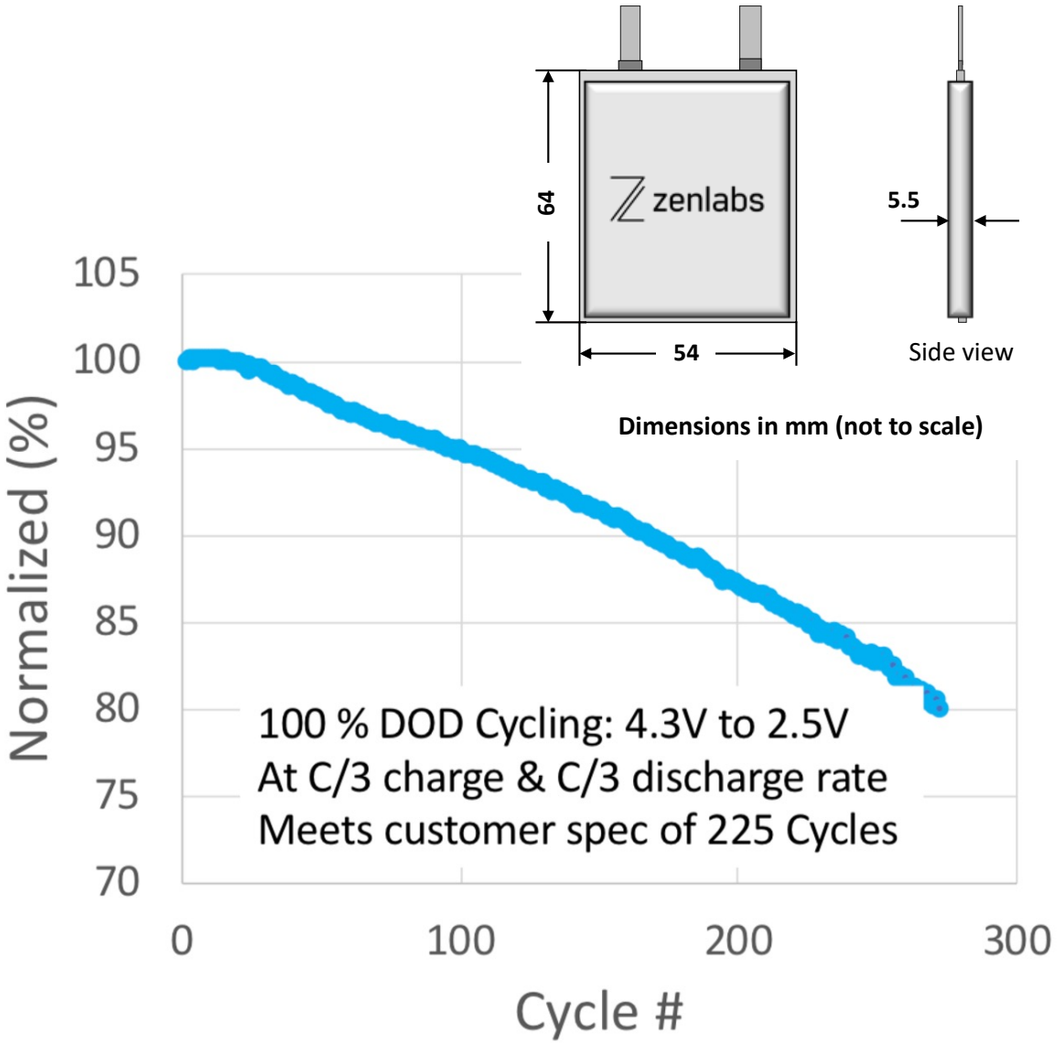
DEVCOM GROUND VEHICLE SYSTEMS CENTER

DEVCOM C5ISR CENTER

Military Applications (400 Wh/Kg)

Military Application – Conformal Wearable Battery (CWB)

- Ionblox was working with C5ISR, Bren-Tronics & GTS to developed 400 Wh/Kg specific energy cells for high gravimetric energy military applications.
- 3x – 4 Ah capacity pouch cells (54 mm x 64 mm) would replace 3x - 18650 cells in the CWB
- High energy pouch cells have shown 250 cycles meeting the cycling specification



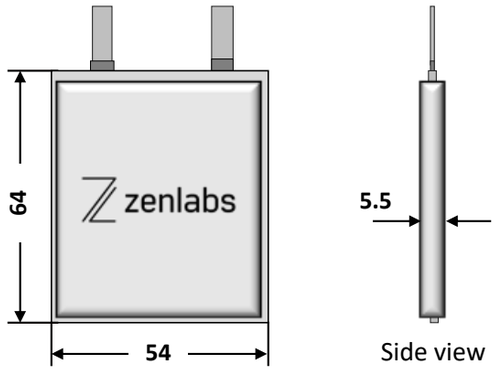
370 Wh/Kg Cells Have Passed UN38.3 Testing

MOBILE POWER SOLUTIONS

6260 SW Arctic Drive
Beaverton, OR 97005
503-645-6789
www.mobilepowersolutions.com
info@mobilepowersolutions.com

ANAB ANSI National Accreditation Board ACCREDITED ISO/IEC 17025 TESTING LABORATORY

Certificate Number: AT-2630



Dimensions in mm (not to scale)

Certificate of Compliance

Certificate/test data report number: Z3-1615 Issue date: August 13, 2020

4 Ah, 370 Wh/Kg pouch cells

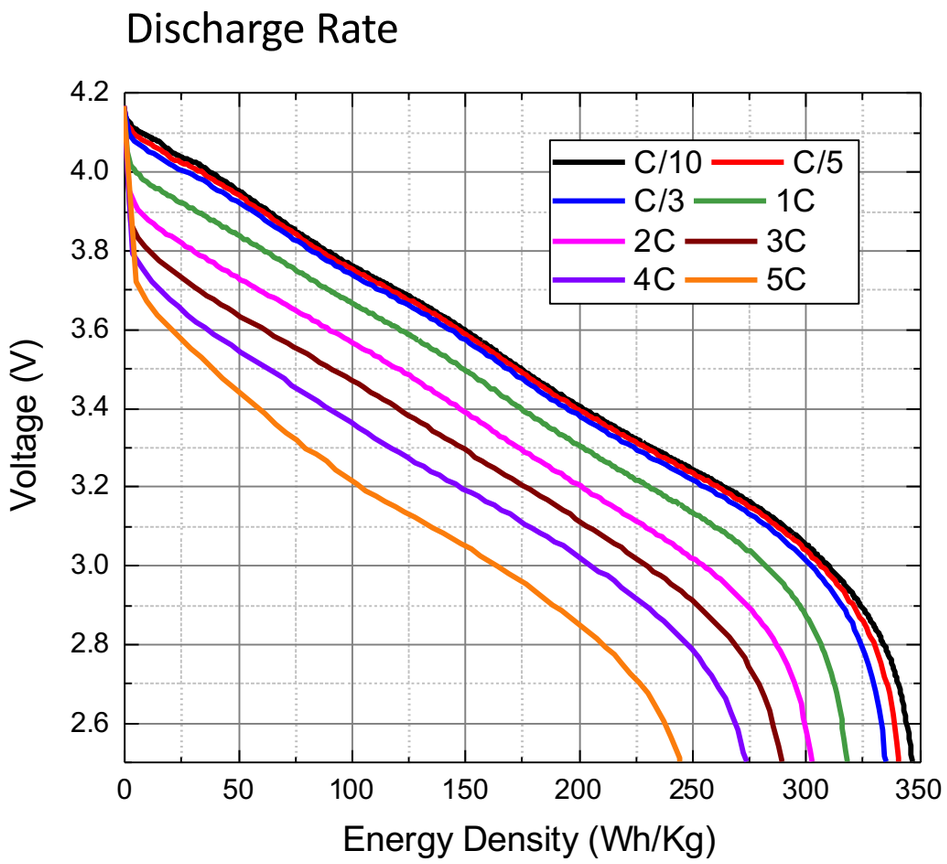
PASS UN38.3 Testing

Tests Conducted / Results

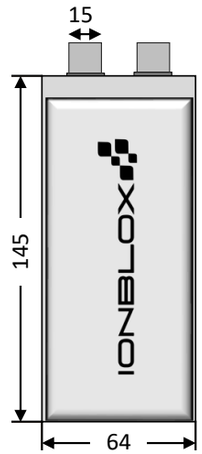
		P/F			P/F
X	T1 Altitude simulation	Pass	X	T5 External short circuit	Pass
X	T2 Thermal test	Pass	X	T6 Impact / Crush *(cells only)*	Pass
X	T3 Vibration	Pass		T7 Overcharge *(rechargeable batteries only)*	N/A
X	T4 Shock	Pass	X	T8 Forced discharge *(cells only)*	Pass

High-Energy & High-Power Results
NCM811 cathode & SiOx dominant anode

Discharge Rate Performance

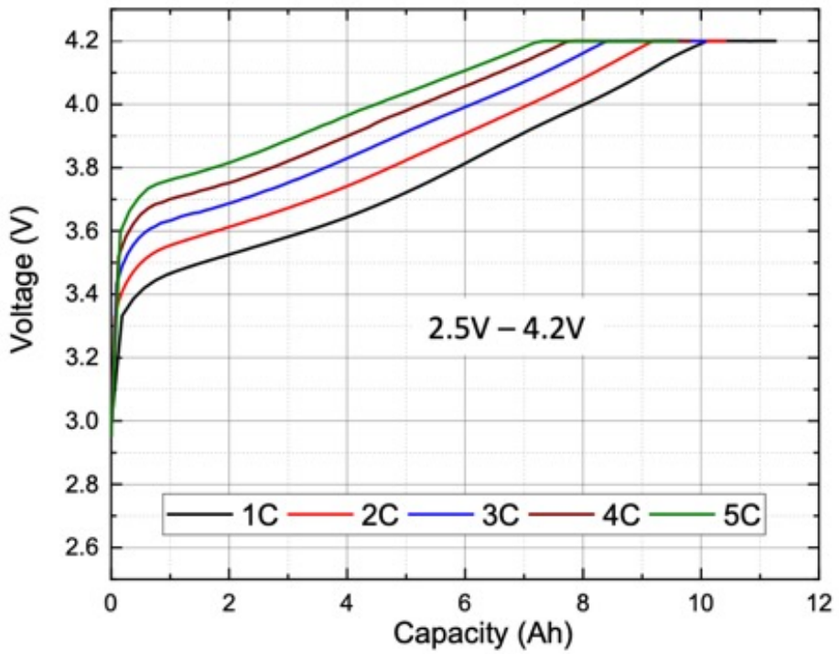


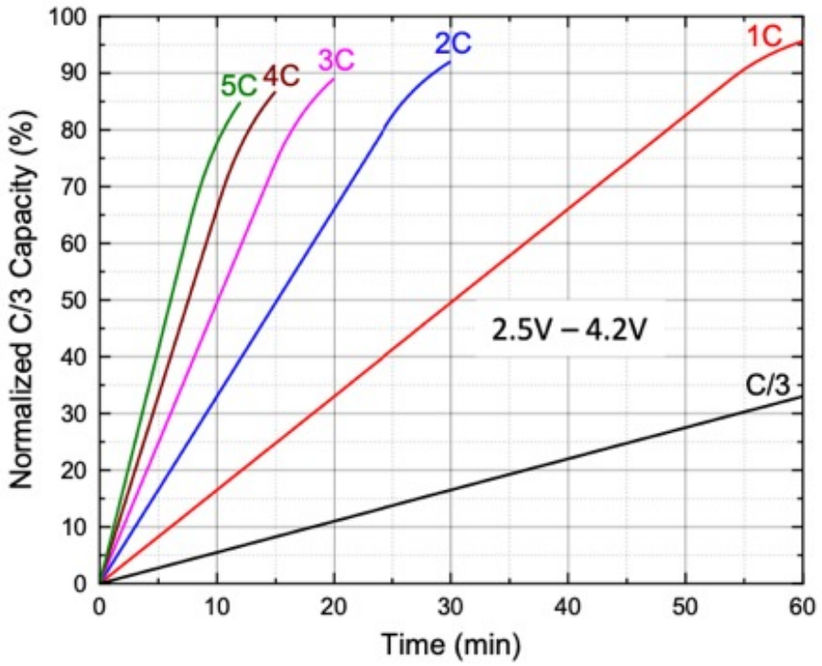
- **11.2 Ah capacity & 335 Wh/Kg** (at C/3 rate) EV cells can be **continuously discharged to 5C rates**
- Discharge rate tested from C/10 to 5C rate
- Voltage window of 4.2 V to 2.5 V tested at 30 ˚C

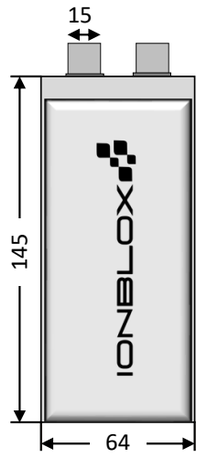


Charge Rate Performance

Charge Rate

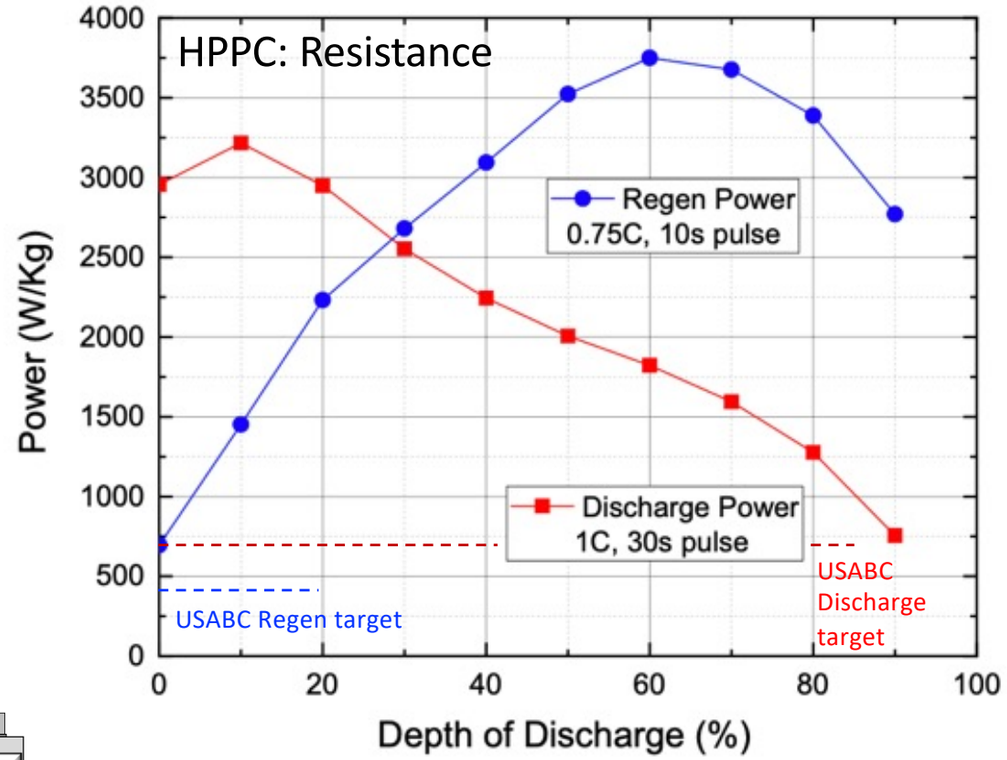


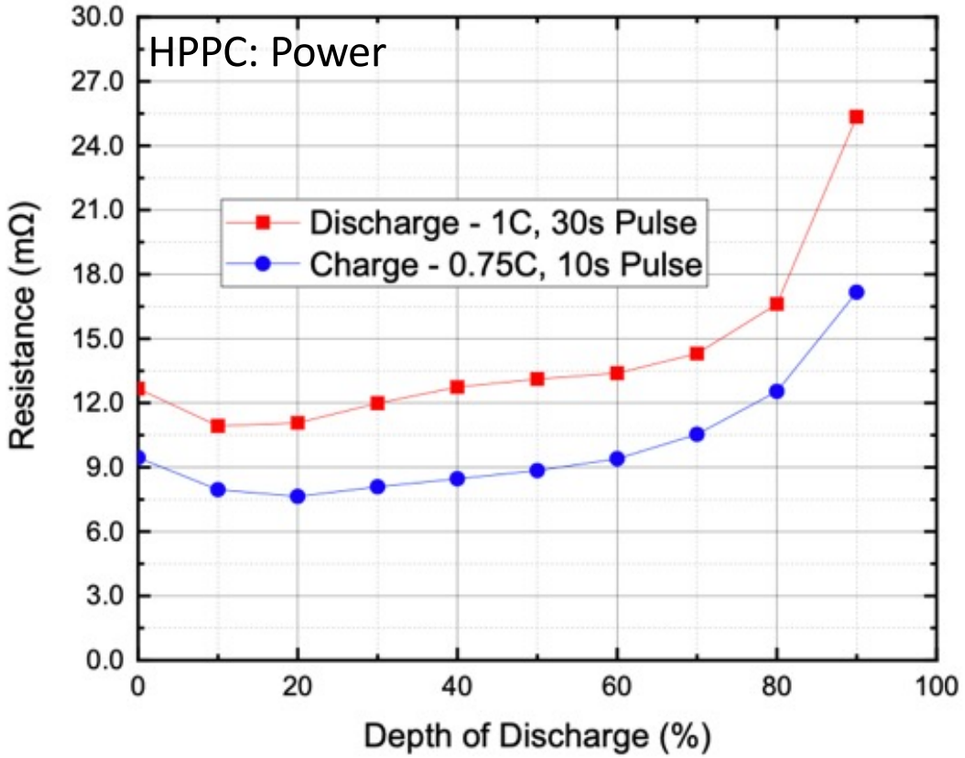


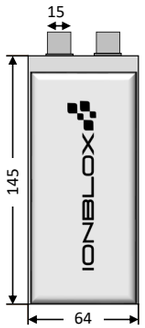


- **11.2 Ah capacity & 335 Wh/Kg** (at C/3 rate) EV cells
- Cells can recover ~80% of their capacity in **10 min charge**

Power Performance



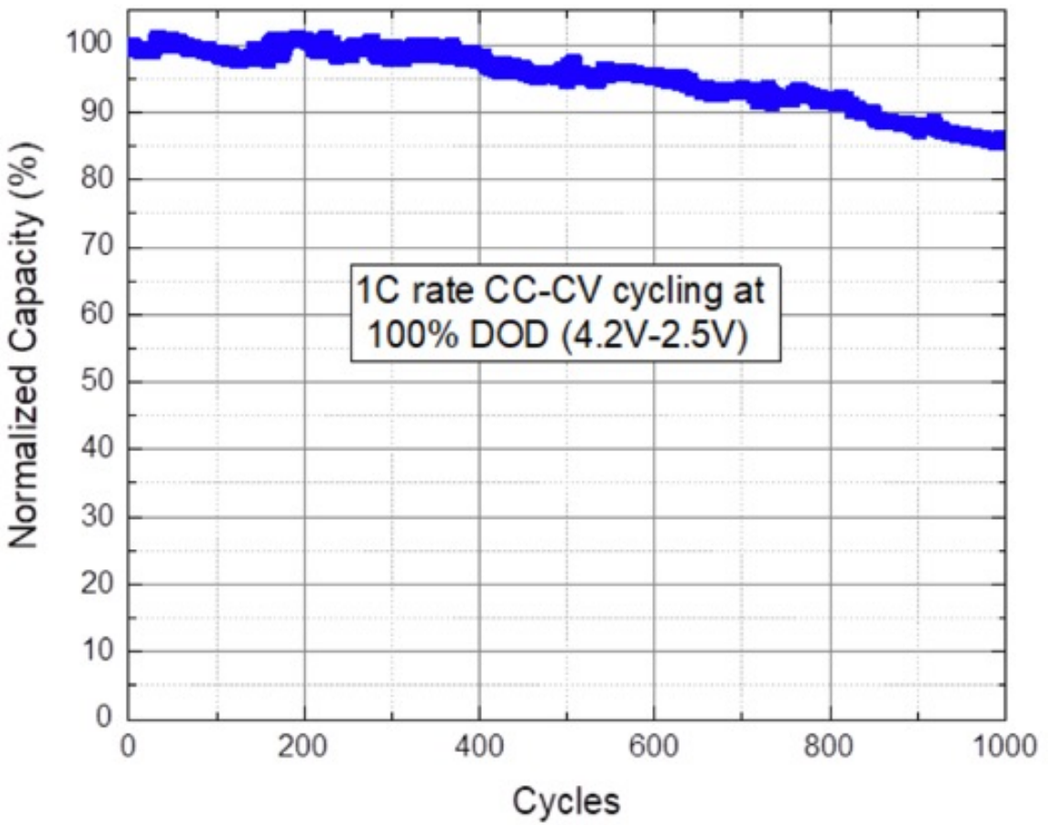




- **11.2 Ah capacity & 335 Wh/Kg** (at C/3 rate) EV cells **exceed the USABC Discharge (700 W/kg) and Regen (300 W/kg) power requirements** at BOL
- Voltage window of 4.2 V to 2.5 V tested at 30˚C

Cycling Performance (100% DoD)

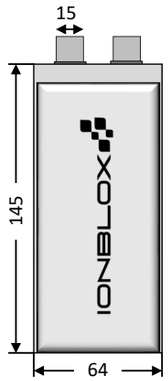
1C/1C rate cycling at 30˚C



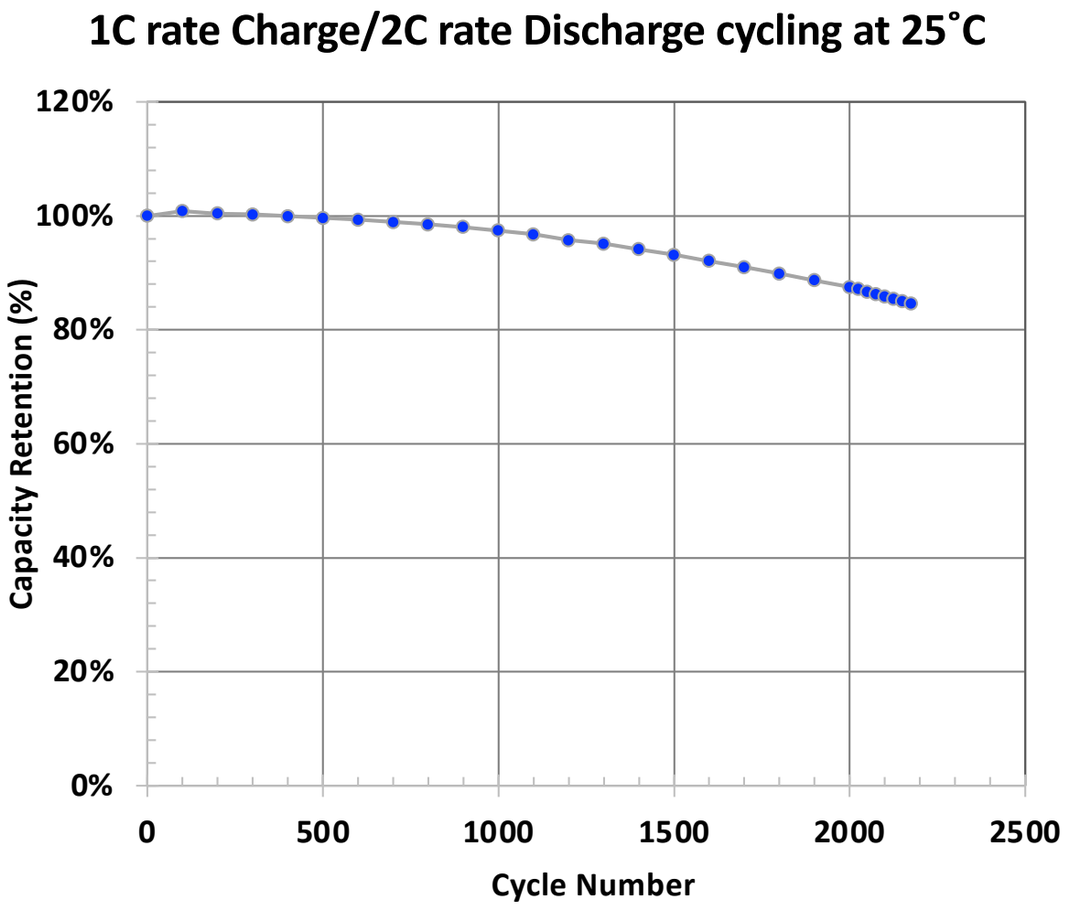
Cycled 1000 cycles at 1C/1C rate, 30˚C

Cells cycled at full 100% DOD from 4.2V to 2.5V

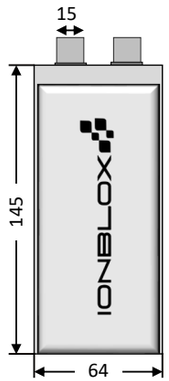
Cycling results validated by National Labs



Cycling Performance (80% DoD)

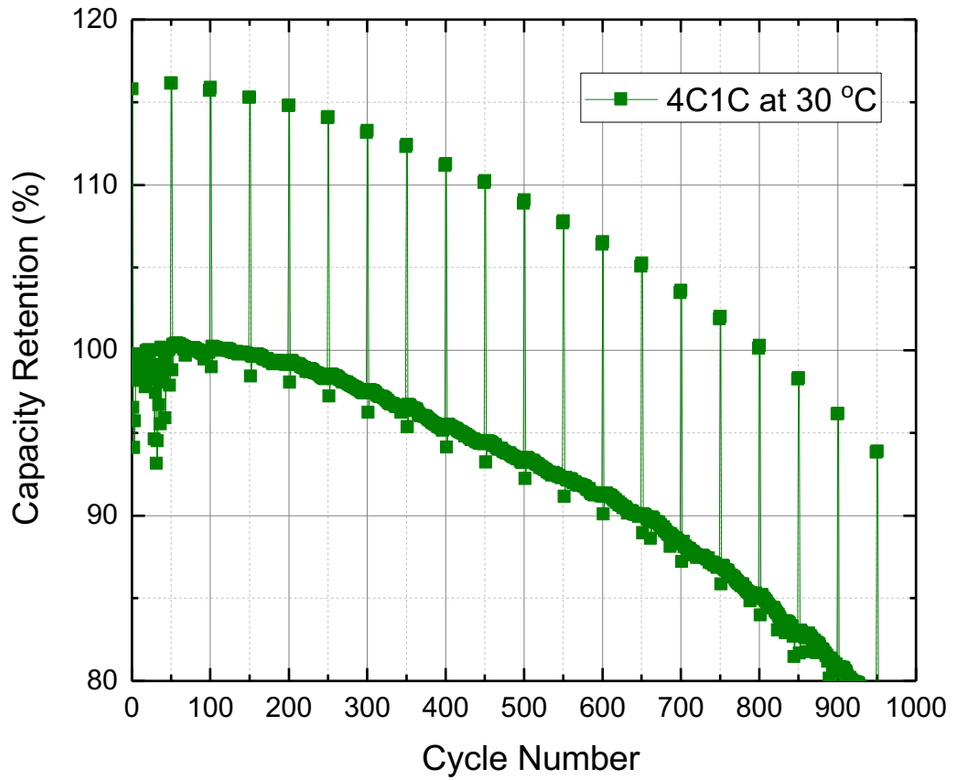


- 11 Ah pouch cells have completed ~2200 cycles and continue to cycle.
- **Projecting ~2400 cycles to 80% capacity retention** enabling long endurance applications.
- Cell cycling at 80% DoD from 100% to 20% SOC or 270 Wh/Kg from full 340 Wh/Kg cell specific energy.
- Capacity checks are performed at a C/3 rate, 25˚C, and every 100 cycles.

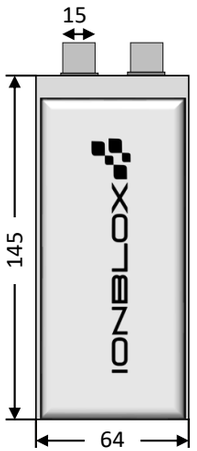


15-min Fast Charge Cycling Performance (100% DoD)

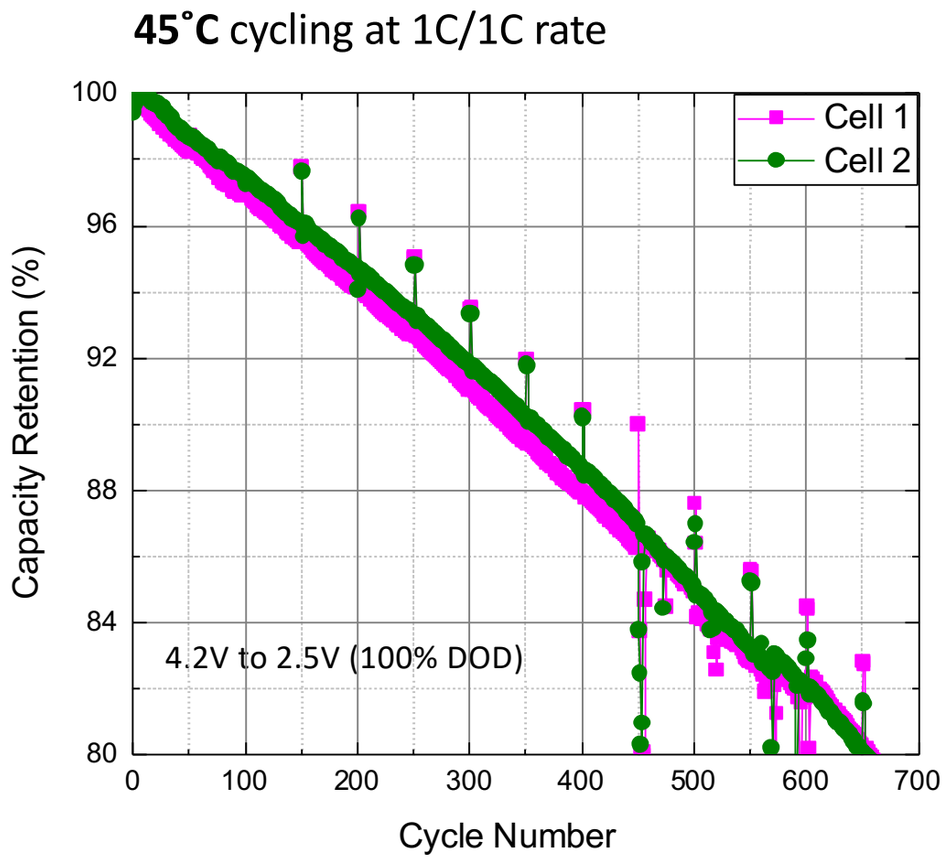
4C/1C rate cycling at 30˚C (15-minute charge)



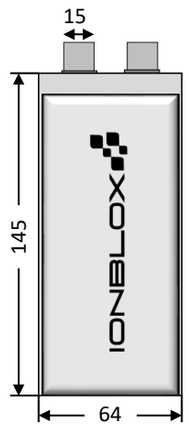
- **Cycled 900 cycles under a 15 min fast charge** conditions while maintaining 80% capacity retention
- Cells cycled at full 100% DOD from 4.2V to 2.5V



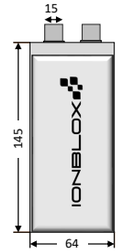
High Temperature Cycling Performance (100% DoD)

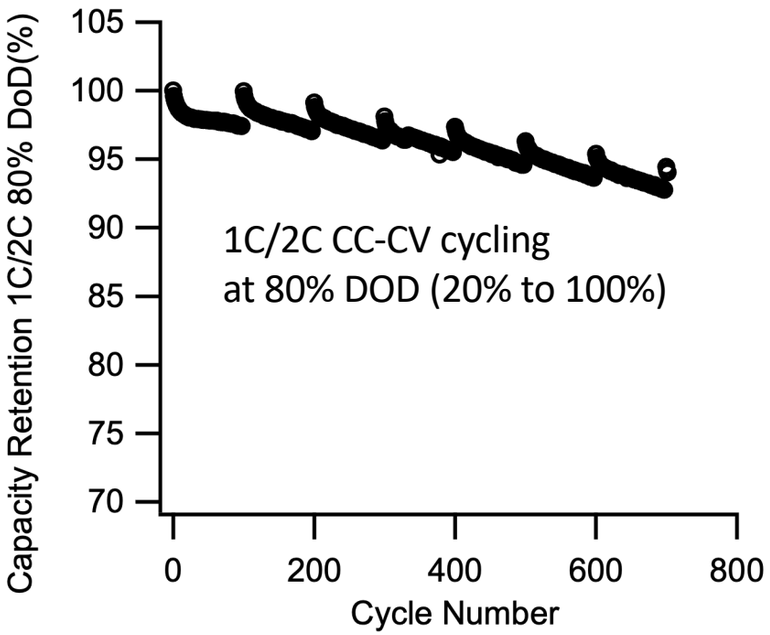


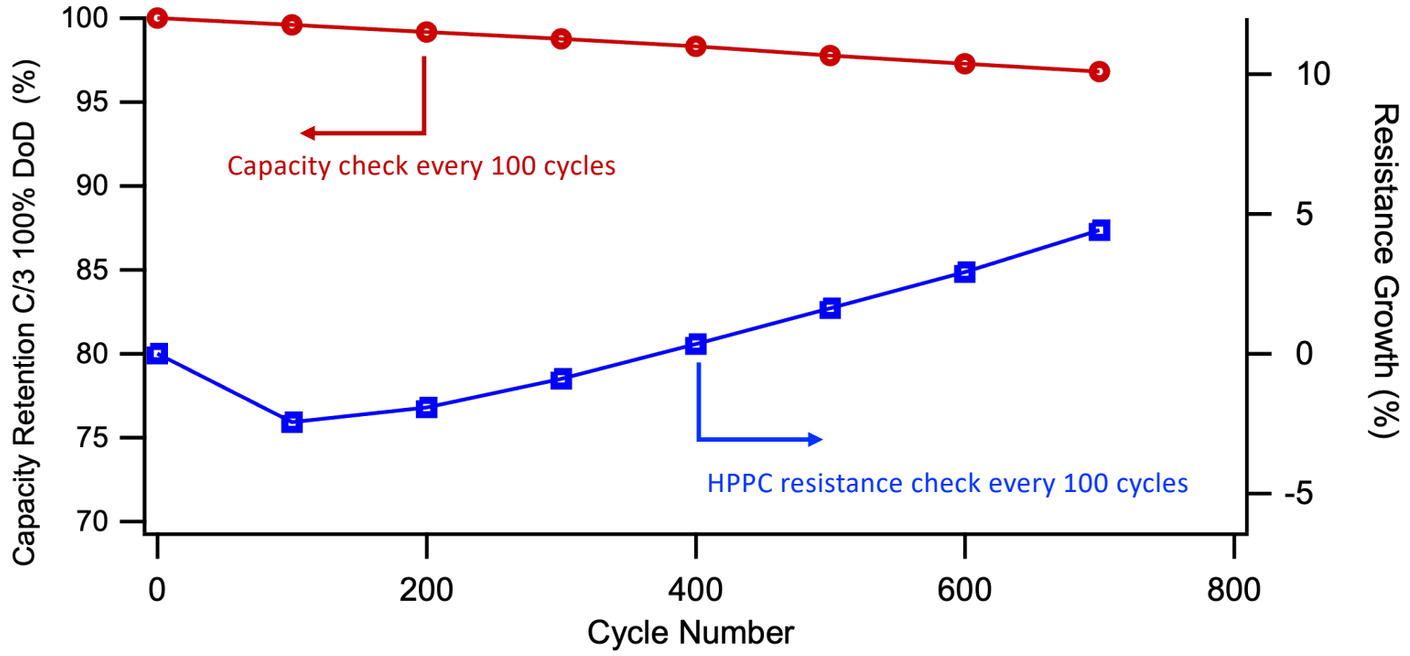
- NCM811–SiO EV Cell
- **Cycled 650 cycles at 45˚C** at a 1C/1C rate
- Cells cycled at full 100% DOD from 4.2V to 2.5V
- Cells **can also be cycled at 65˚C** (1C - Ch/Disch rate)



Resistance Growth vs Cycling (80% DoD)

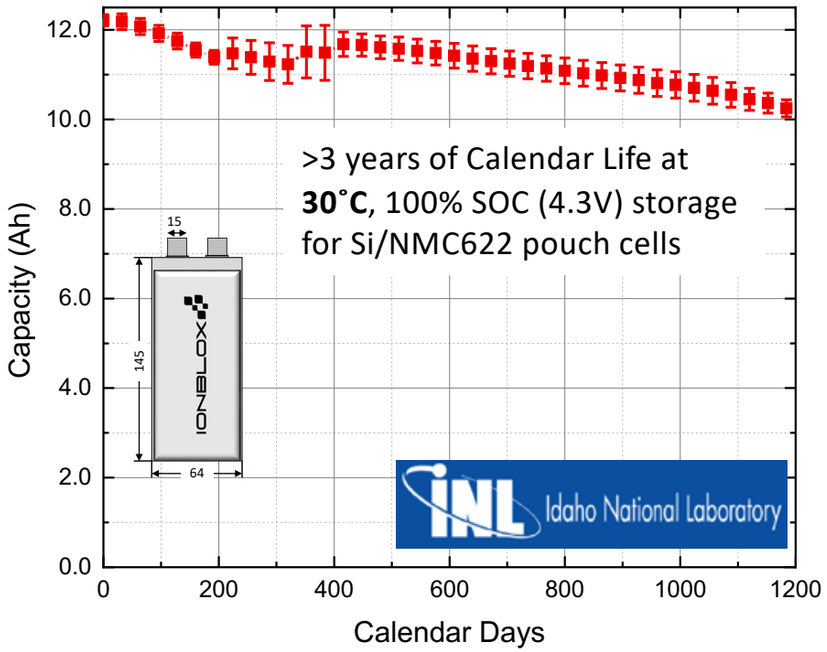




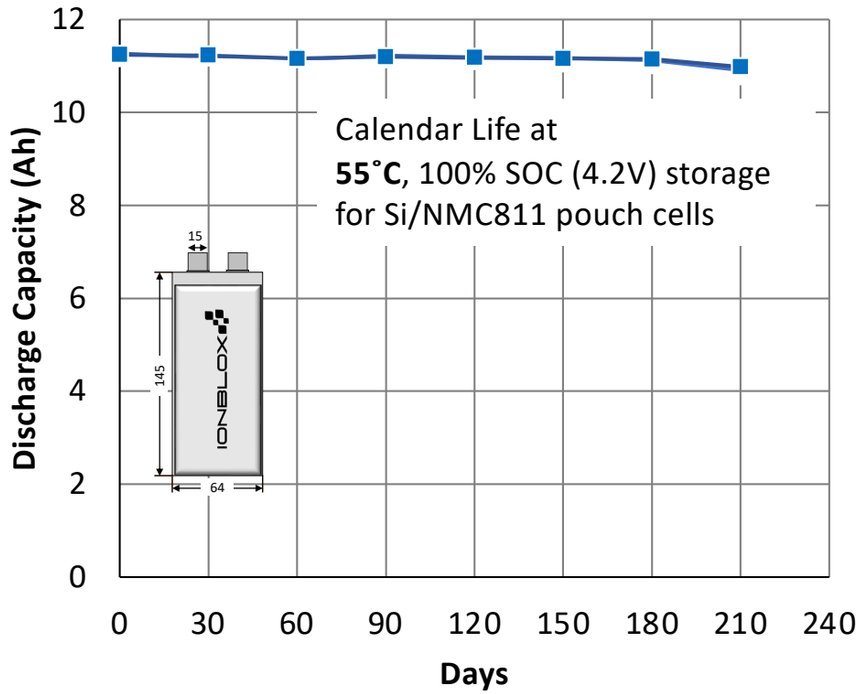


- **Resistance growth is <5% and 95% capacity retention after 700 cycles**
- HPPC testing at every 100 cycles with 30 sec, 1C pulse

Calendar Life of Si-dominant Cells

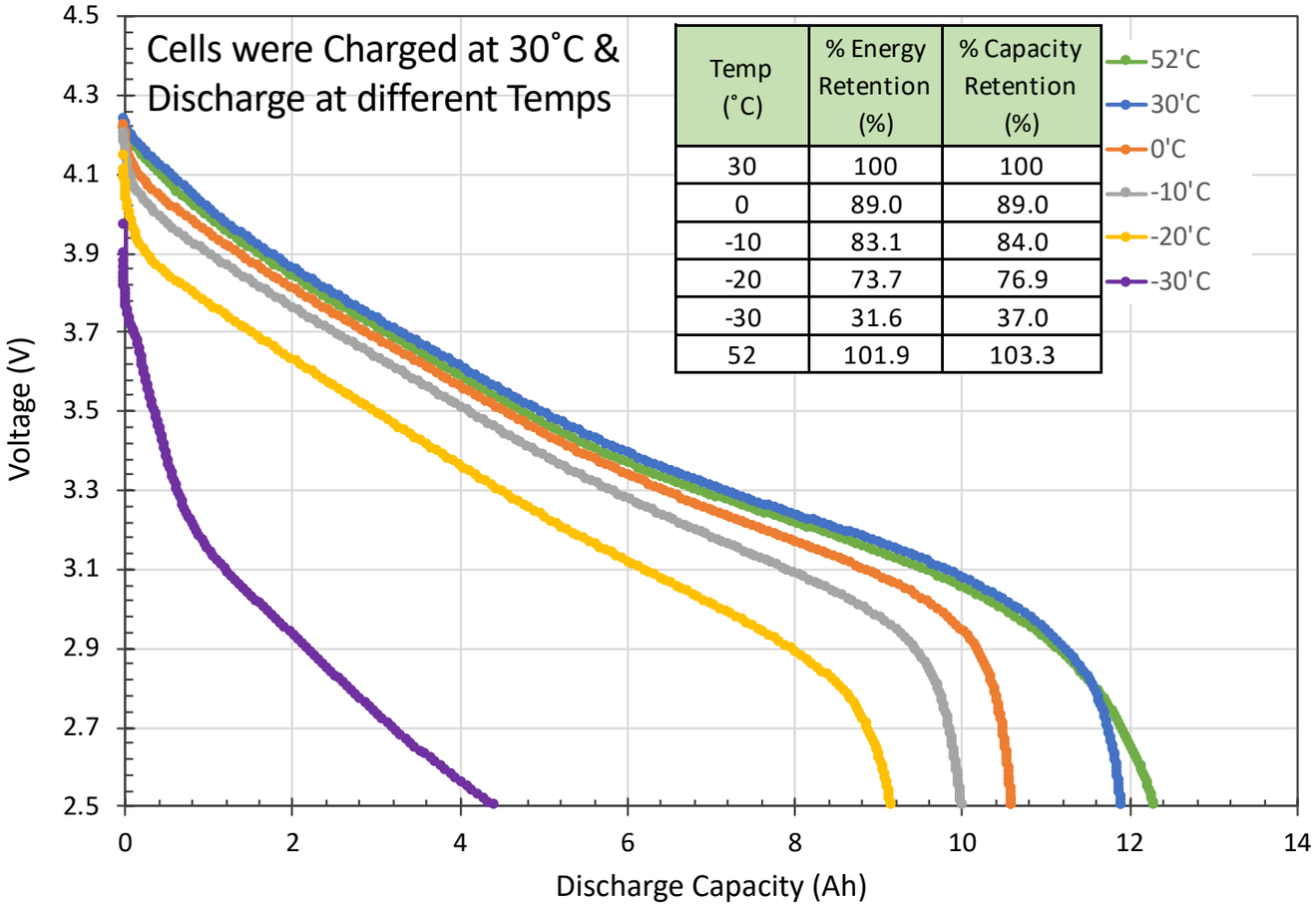


- **>3 years of calendar life** at 30˚C and 100% SOC (with a daily trickle charge)
- 12Ah, 315 Wh/Kg (at C/3 rate), Si/NMC622 pouch cells tested by INL in USABC program (testing started in 2019)

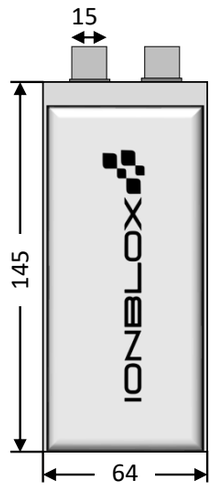


- <5 % capacity drop, over 200 days of storage at high temperature (55˚C) and 100% SOC
- **11.2 Ah, 335 Wh/Kg** (at C/3 rate), Si/NMC811 pouch cells. Testing continues.

Thermal Performance



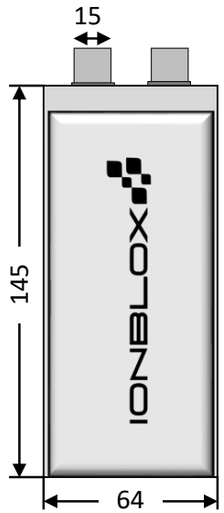
Zenlabs 12Ah EV Cells	
Vmin (zero/pulse)	2.5/2.4 V
Vmax (op/pulse)	4.3/4.4 V
Vnominal at C/3	3.456 V
Rated C/3 capacity	12 Ah
Weight	0.1345 Kg
Volume	0.0605 L
Chemistry	NMC622/SiO_x-C



>70 % of the 30˚C Capacity and Energy obtained at -20˚C

Cell Safety Testing

Passed UN 38.3 testing

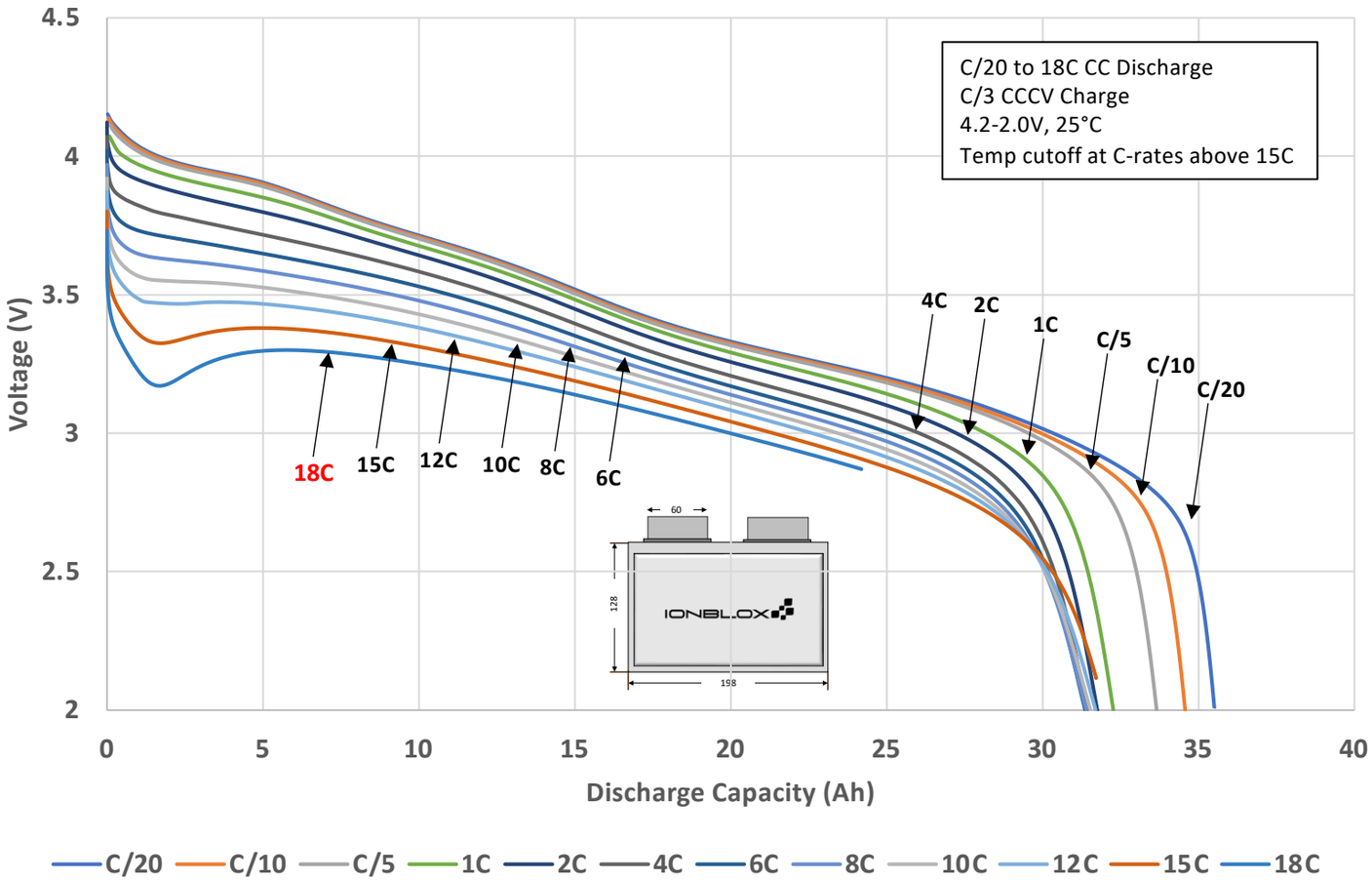


Lithium cell or battery test summary in accordance with sub-section 38.3 of Manual of Tests and Criteria

Manufacturer's identification:		
Name	Ionblox Inc.	
Address	3390 Gateway Blvd Fremont, CA 94538 United States	
Phone number	240-285-1948	
Email	kevin@ionblox.com	
Website	www.ionblox.com	
Testing laboratory:		
Name	UL Solutions Northbrook	
Address	333 Pfingsten Rd., Northbrook, IL 60062 United States	
Phone number	(847) 272-8800	
Email	ULCTech@ul.com	
Website	https://www.ul.com	
Test report number.	4790713181	
Test report date	2022-07-05	
Edition of UN Manual of Tests and Criteria used	ST/SG/AC.10/11/Rev.7+Am. 1	
Description of cell or battery:		
Physical description	Secondary Lithium Ion Polymer Battery Pack	
Chemistry	☐ lithium metal / ☒ lithium ion	
Mass	0.121kg	
Lithium content (for lithium metal)	N/A	
Wh rating (for lithium ion)	N/A	
Cell configuration (X-S/Y-P)	N/A	
Model / type reference	IBX-14640	
Ratings	3.45 Vdc, 11.4 Ah, 39 Wh	
List of tests conducted and results:	(Pass, Fail, or N/A - not applicable)	
T.1: Altitude simulation	Pass	
T.2: Thermal test	Pass	
T.3: Vibration	Pass	
T.4: Shock	Pass	
T.5: External short circuit	Pass	
T.6: Impact / Crush	Pass	
T.7: Overcharge	N/A	
T.8: Forced discharge	Pass	
Remarks	N/A	
Assembled battery testing	N/A	
Test summary date	2023-06-07, 2023-06-08, 2023-06-16, 2023-06-19, 2023-06-20, 2023-06-21, 2023-06-22	
Test summary by (name + title + signature)	Molly Quillin, Project Handler	
Approved by (name + title + signature)	William E. Platts, Reviewer	

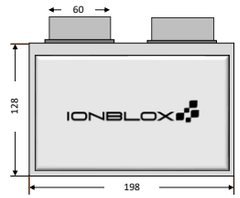
Extreme Fast Charge (XFC)
High-Energy & High-Power Results
NCM811 cathode & 100% SiOx dominant anode

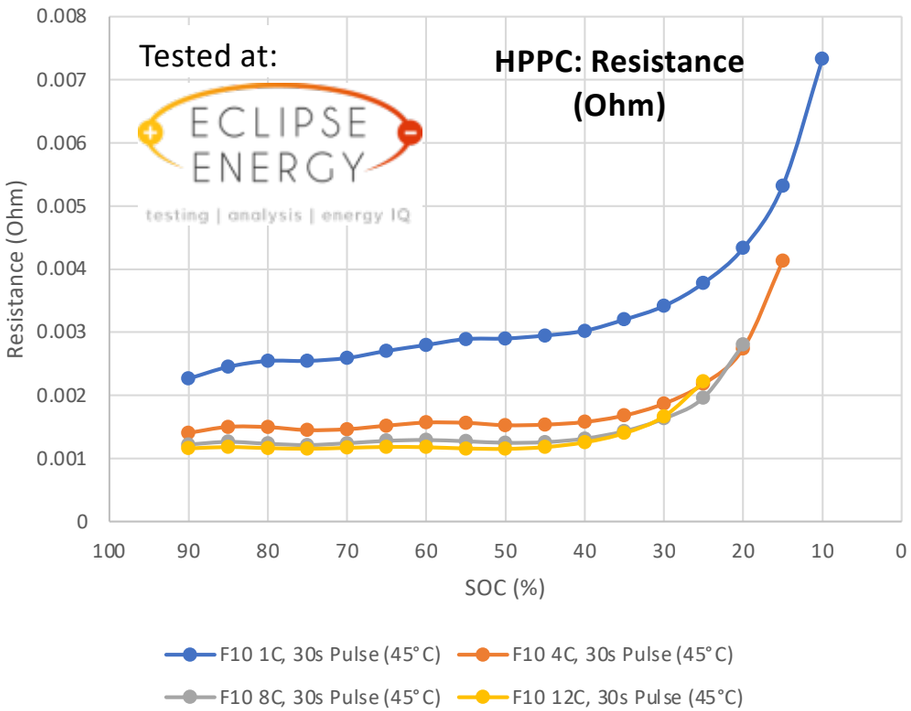
New Extreme Fast Charge (XFC) Cells

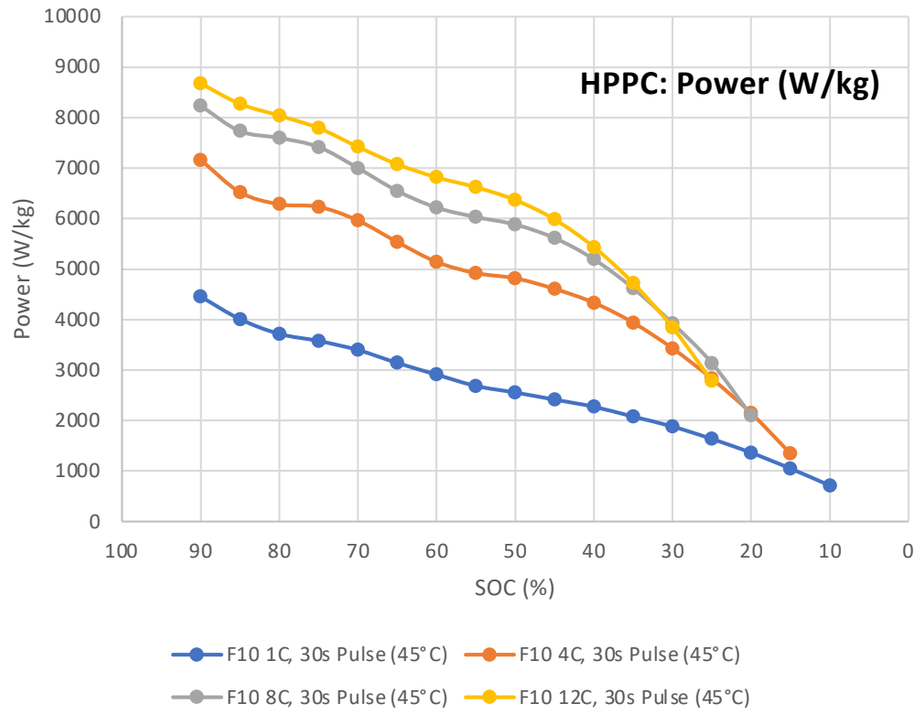


- **Ultra High-power**
- **High Usable Energy**
- Continuous Discharge Rate tested from C/20 to 18 C rate

XFC Cell: Power and Resistance

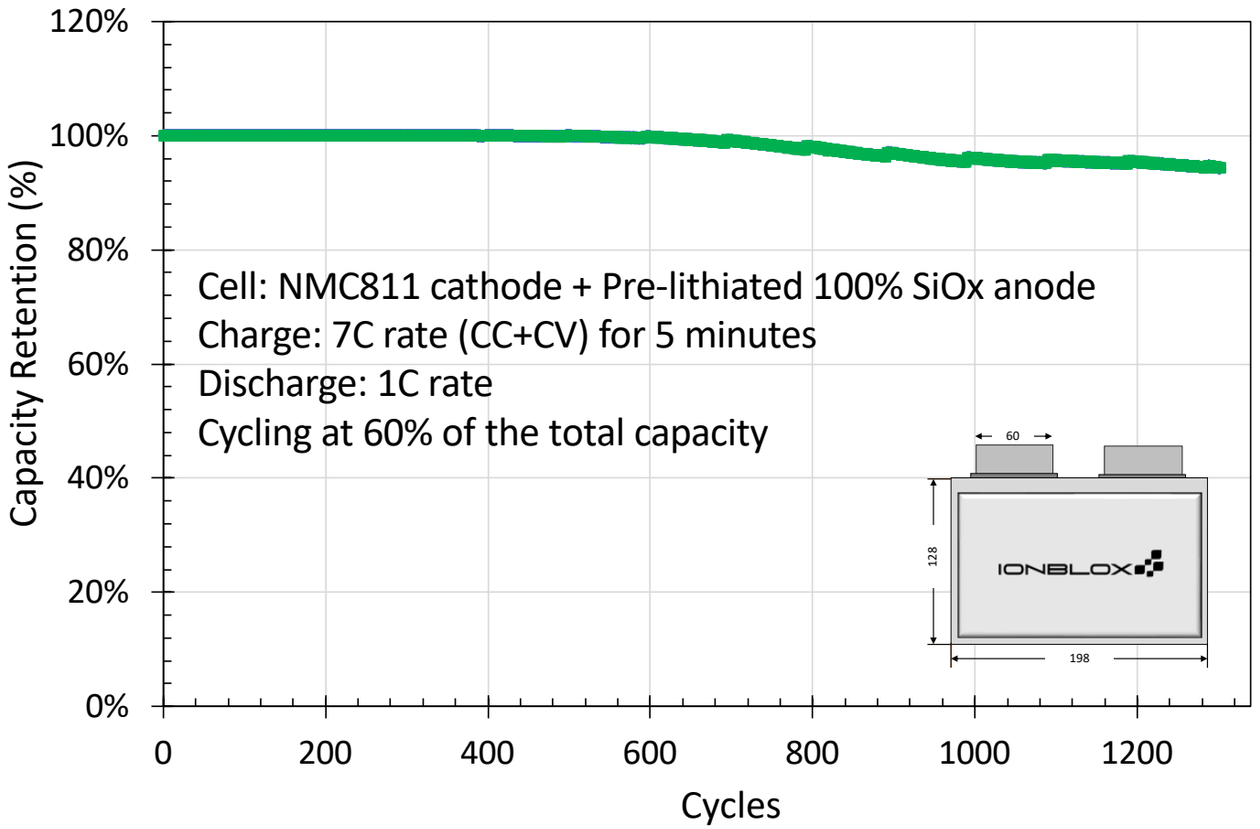






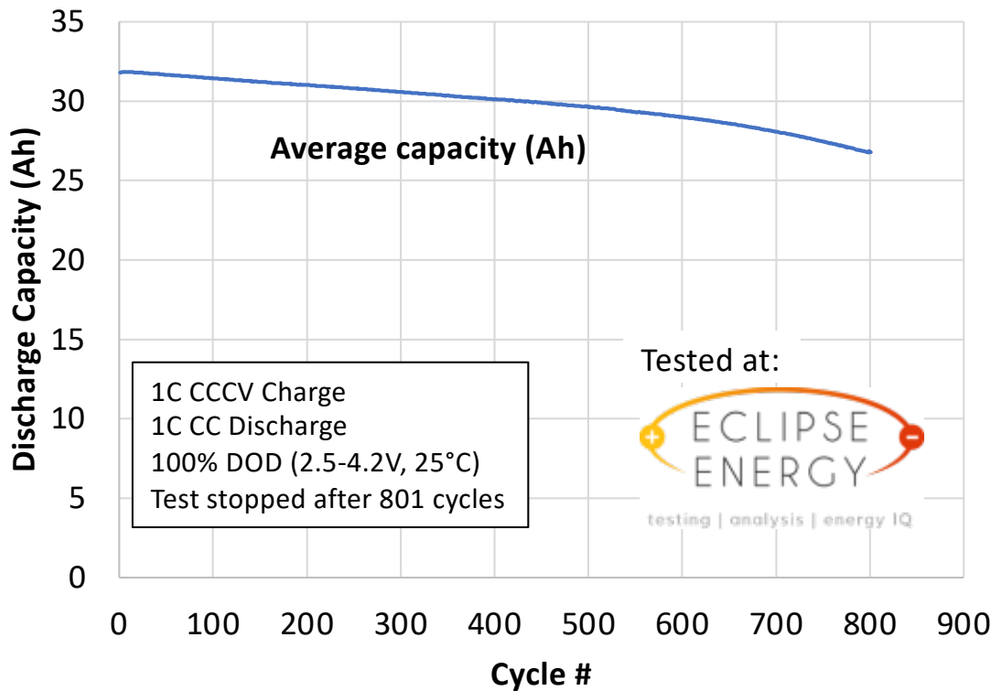
- **32 Ah capacity** showing **Low Resistance and High Power**
- High usable energy under high power requirements
- HPPC tested from 1C to 12C rate – 30 s pulses at 45°C from 4.2V to 2.0V

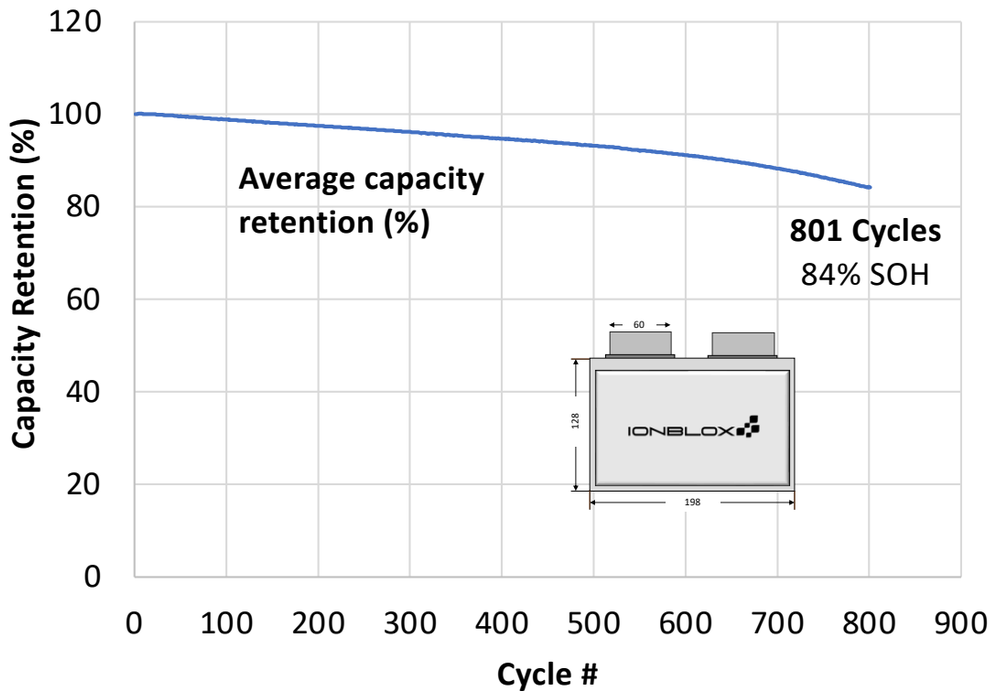
XFC Cell: 5 Min-Extreme Fast Charge Cycling



- **5-min XFC cycling** in voltage window 20% to 80% DoD (~60% of capacity)
- 1300 continuous XFC Cycling with minimal degradation

XFC Cell: 1C /1C Cycle Life (100% DoD)

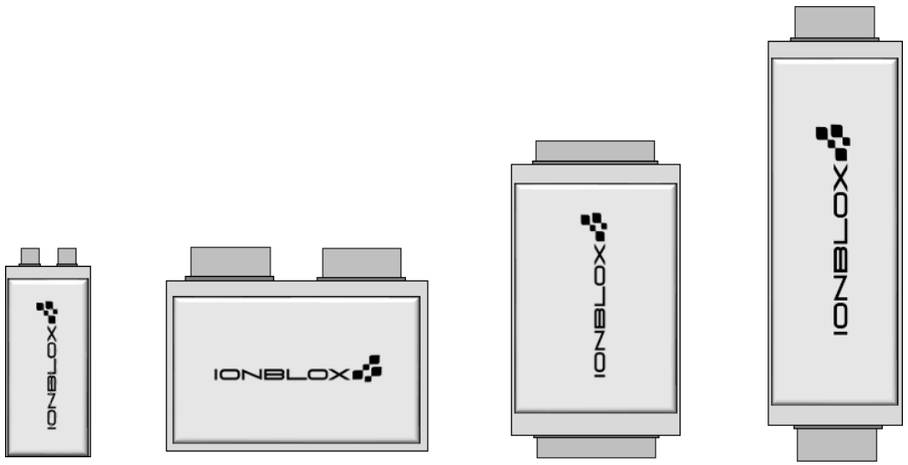




- 84% SOH after 801 cycles at 1C1C CC-CV, 100% DOD (25°C)

Conclusions

- Ionblox has solved the Silicon anode cycling and swelling challenges. Possess strong IP coverage for pre-lithiated Silicon anodes.
- Ionblox simultaneously meets key cell performance attributes, from the all-in-one cell, addressing the **AAM, EV, e-Truck, & Military** markets:
  - ✓ High Specific Energy: >330 Wh/Kg
  - ✓ High Specific Power: >3000 W/kg over wide range of SOCs
  - ✓ Fast-charging: 5 min XFC from 20 % to 80% SOC or >80% SOC in 10 min
  - ✓ Long cycle life: 1000 cycles at 100% DoD, >2000 cycles at 80% DoD, >1300 XFC cycles
  - ✓ Calendar Life: >3 years at 30˚C and 100% SOC, >200 days at 55˚C and 100% SOC (<5% drop)
- Ionblox is scaling up cell production for the different markets with strategic partners and is in the planning stages for USA manufacturing.



IONBLOX

Accelerating the Future of Electric Mobility

High-Energy & High-Power Silicon Anode Lithium-ion Batteries Enabling Advanced Military Applications

Dr. Herman Lopez,
CTO & co-founder, **Ionblox, Inc.**

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Email: herman@ionblox.com
Website: www.ionblox.com
Ionblox, Inc., Fremont, CA