



High Energy Density Lithium-Ion Cells with  
Silicon Nanowire Anode Technology

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## AMPRIUS TECHNOLOGIES, INC.

# Leader in Silicon Anode Technology Highest Performance Li-Ion Cells in the Industry

### ENABLING TECHNOLOGY

Pioneers and established leaders in silicon anode materials and high energy density lithium ion batteries

- 2008 Company founded at Stanford
- 2009 Operations Started
- 2018 First Commercial Product

### COMPREHENSIVE PLATFORM

Technology platform includes entire ecosystem for optimal performance:

- Silicon nanowire anode manufacturing
- Electrochemistry
- High energy cell designs

### BEST PERFORMANCE

Highest energy density lithium-ion cells

1200  
Wh/liter

450  
Wh/kg

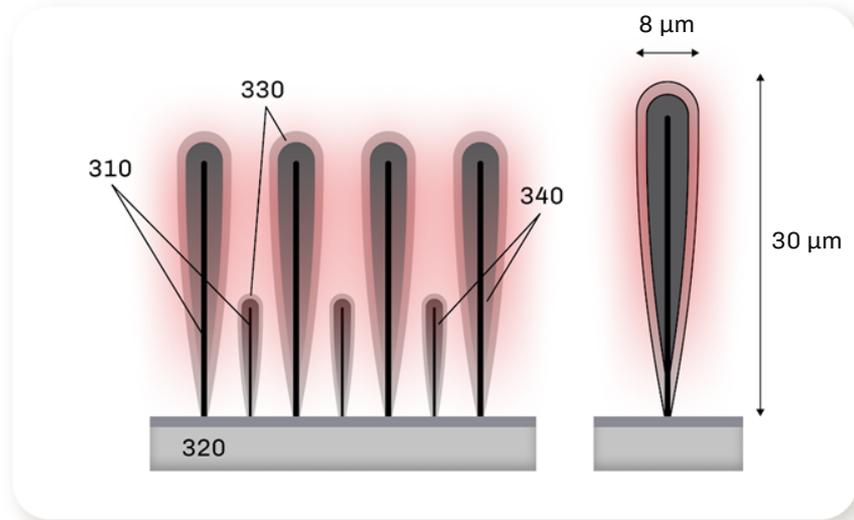
100%  
Silicon nanowire  
anode

50+  
Independent patent filings  
on nanowire technology  
and lithium ion cells

“Silicon Is Awesome and Inexpensive” - Tesla Battery Day 2020

## PATENTED SILICON NANOWIRE ANODE CONSTRUCTION

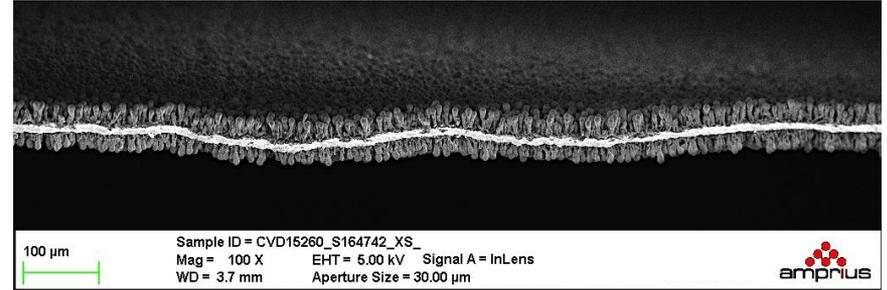
### A New Structure for 100% Silicon Based on Nanowires



310 - Conductive filament grown from substrate

340 - Bulk coating of low density, porous amorphous silicon

330 - Thin layer of high-density amorphous silicon



#### KEY BENEFITS

- Micro & Macro porosity- prevents cracking and interference between nanowires
- Tolerates Expansion, Nanowire Rooted- mechanically and electrically connected to substrate
- Stable Solid Electrolyte Interphase (SEI)- stabilized interaction with electrolytes

## MANUFACTURING: ROLL-TO-ROLL FOR SILICON NANOWIRE ANODE PRODUCTION

Pilot Scale Manufacturing – demonstrated scalability with Pilot Tool

*Bare Foil In and Finished Anode Out*



### Replaces:

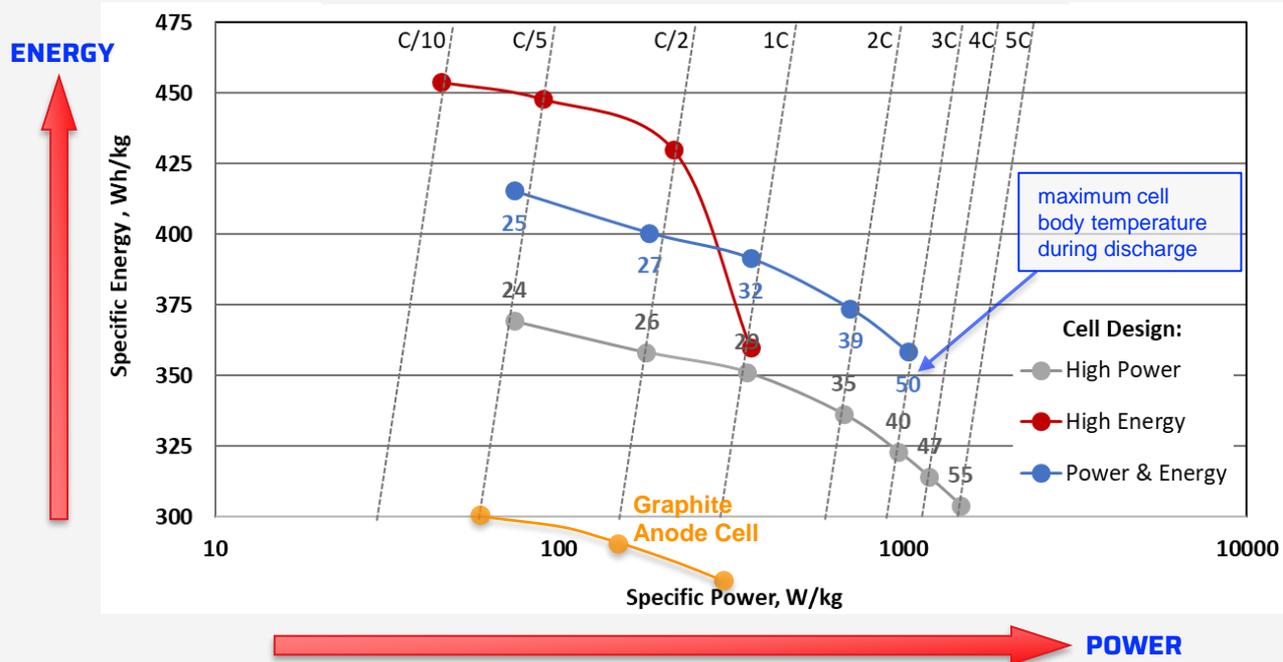
- powder mixing
- slurry preparation
- roll coating (2X)
- drying
- calendaring

# Products and Applications

## HIGH ENERGY AND POWER CAPABILITY

Amprius' cells enable the highest energy and power

Silicon Nanowire//LCO Ragone Plot



## PRODUCTS

High Power capability with highest energy density and specific energy

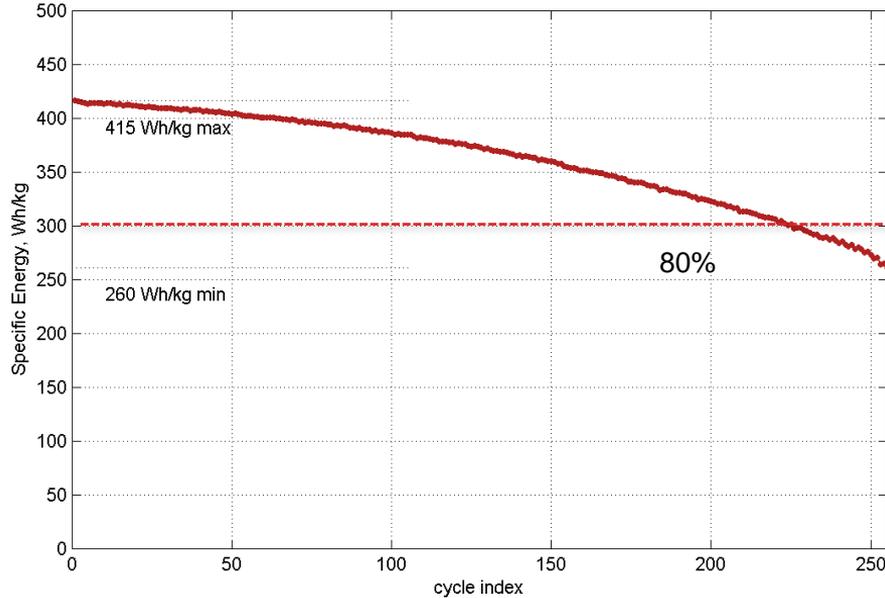
| Application                   | Dimensions<br>(T x W x H)<br>mm | Mass<br>g | Capacity<br>Ah                 | Energy<br>Wh | Wh/L | Wh/kg      | Capacity<br>Ah               | Energy<br>Wh | Wh/L | Wh/kg      |
|-------------------------------|---------------------------------|-----------|--------------------------------|--------------|------|------------|------------------------------|--------------|------|------------|
|                               |                                 |           | Charge-Discharge Rate: C/5-C/5 |              |      |            | Charge-Discharge Rate: 1C-3C |              |      |            |
| <b>HAPS</b>                   | 4.5 x 50 x 55                   | 33.1      | 3.8                            | 13.9         | 1125 | <b>420</b> |                              |              |      |            |
| <b>Drones, High Power</b>     | 4.2 x 50 x 55                   | 27.8      | 2.8                            | 10.1         | 875  | <b>365</b> | 2.65                         | 9.0          | 780  | <b>325</b> |
| <b>Drones, Long Endurance</b> | 4.6 x 50 x 55                   | 31.7      | 3.6                            | 13.2         | 1040 | <b>416</b> | 3.4                          | 11.5         | 870  | <b>360</b> |
| <b>High-Capacity Cells</b>    | 4.5 x 50 x 105                  | 68.1      | 8.1                            | 29.3         | 1240 | <b>430</b> |                              |              |      |            |
| <b>Army Wearable Pack</b>     | 5.4 x 54 x 64                   | 49.5      | 5.4                            | 21           | 1125 | <b>425</b> |                              |              |      |            |

Operating temperature range: -20°C to 55°C. Cycle life 150-300 cycles, depending on operating conditions

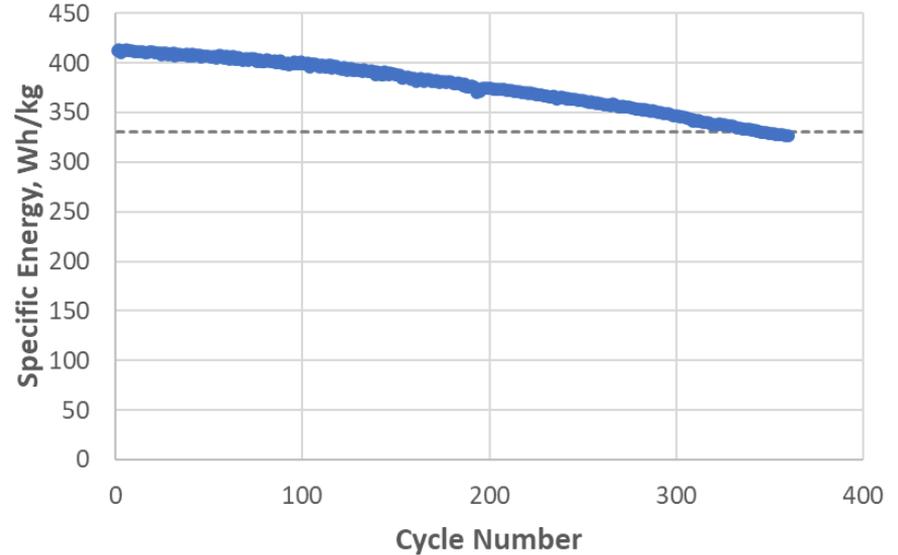
## CHEMISTRIES WITH LONG CYCLE LIFE

### Long Endurance Batteries

#### Si/LCO



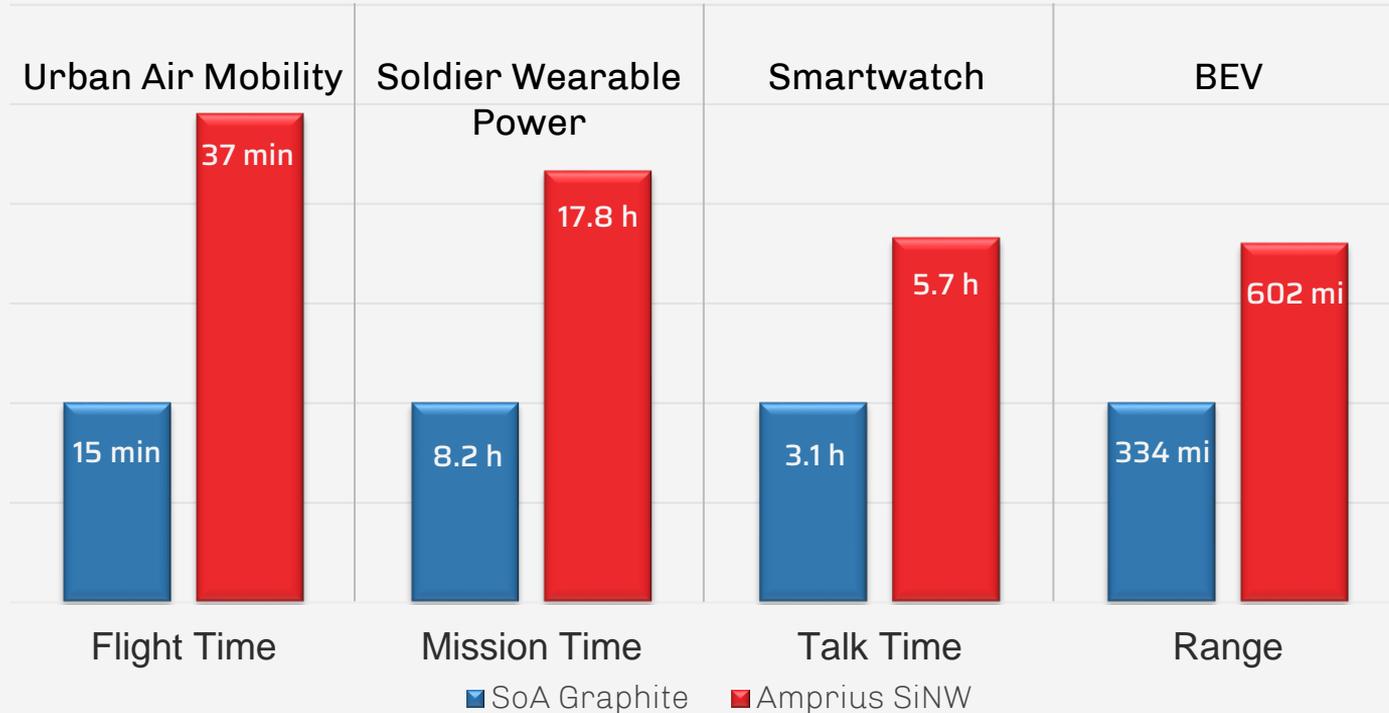
#### Si/NMC811



Cycling at C/5 for Long Endurance UAV applications

## SILICON NANOWIRE ANODE ENABLES MUCH GREATER IMPROVEMENT

### Game-Changing Advantages in Advanced Applications



**Notes:**

UAM - estimated flight time based on customer models

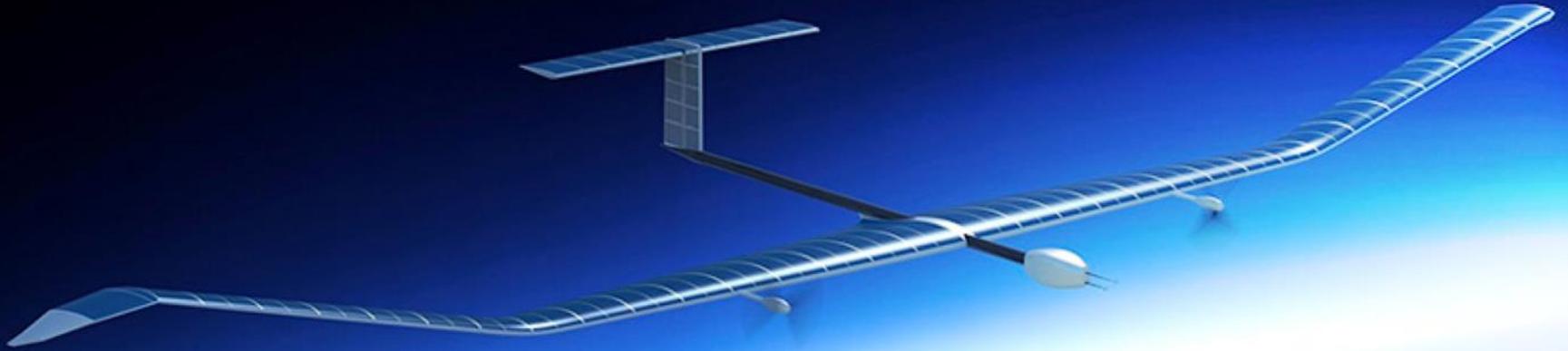
Soldier Power - real data based on Conformal Wearable Battery developed for US Army

Smartwatch - customer reported data

BEV - estimated relative to Tesla Model 3 long range battery specifications

## USE CASES

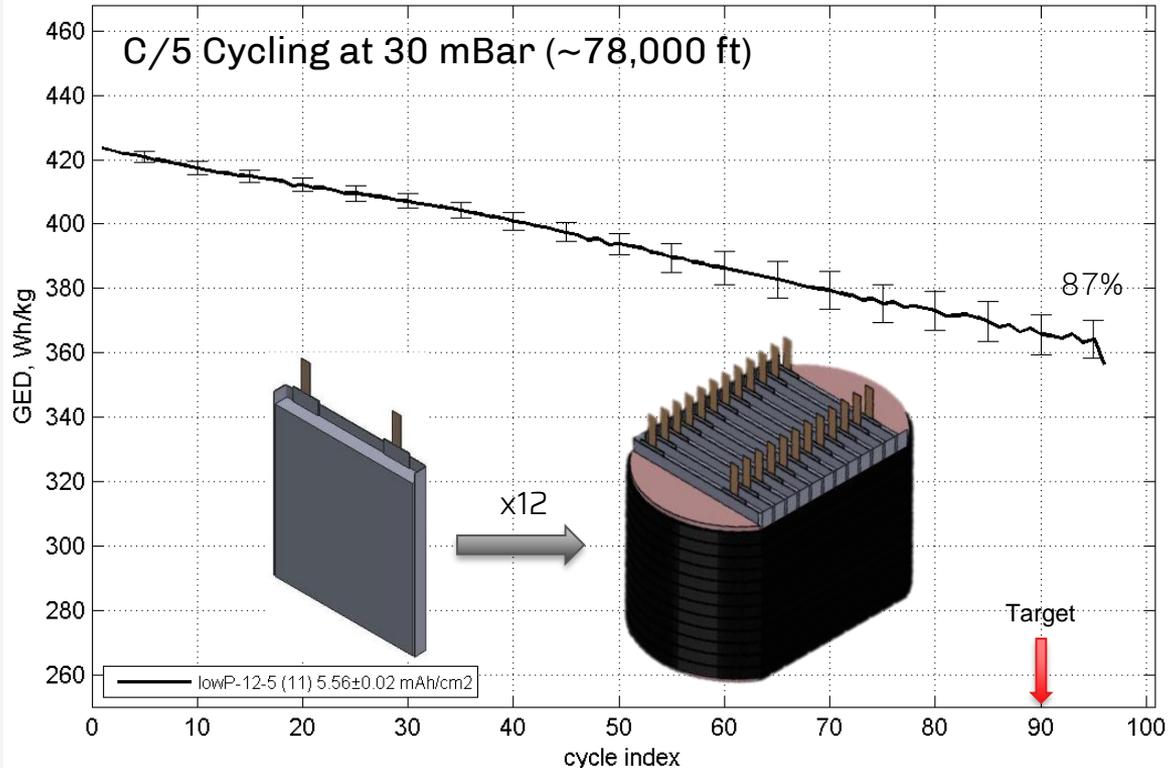
# Energy Cells for High Altitude Drones Enable Longest Endurance



"The aircraft has achieved an altitude of 74,000 ft in Arizona and, critically, has remained above 50,000ft at dawn, after a night's flying with no sun to charge its batteries."

## USE CASES

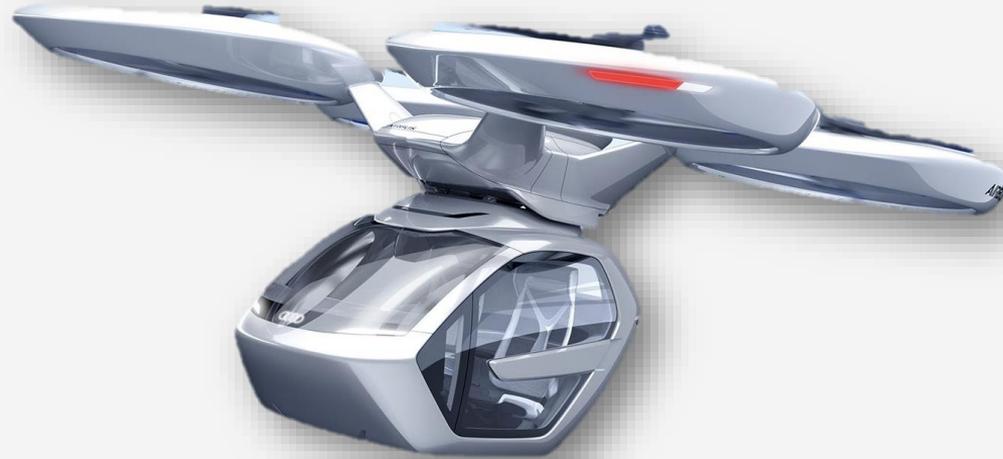
### Lightweight battery pack for Stratosphere



- 406 Wh/kg battery pack
- Replaced incumbent Li/S
- Reduced battery size over 50%
- Light-weight, compliant compression system for stratosphere

## USE CASES

# Power Cells for Urban Air Mobility – Long Endurance



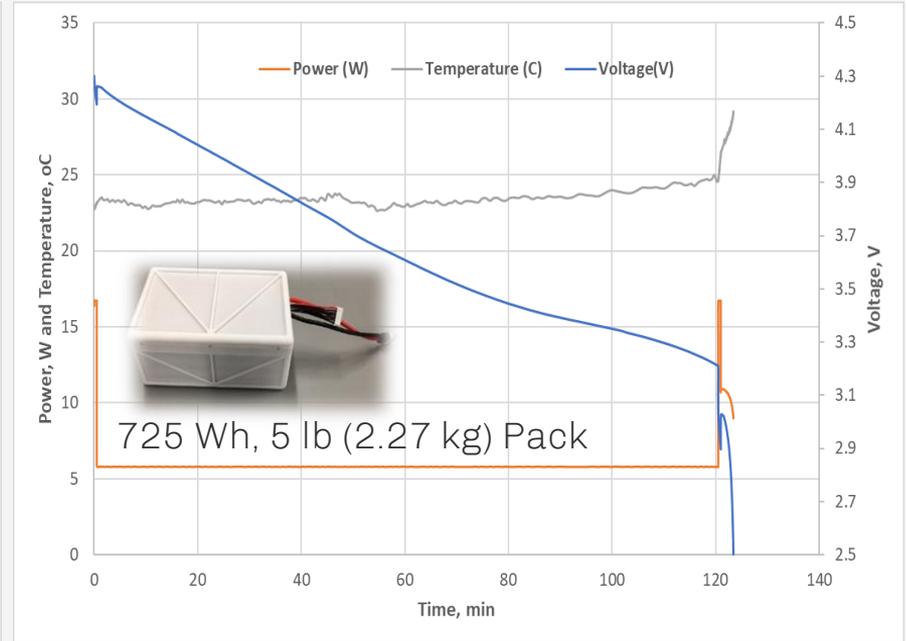
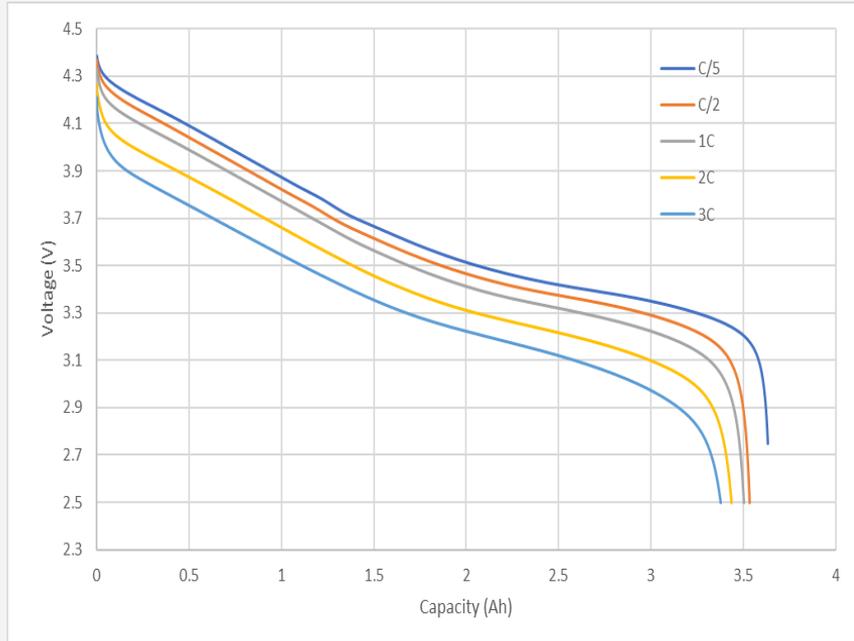
## USE CASES

Endurance Record for Multi-Rotor Drone with Amprius Power Cells



## USE CASES

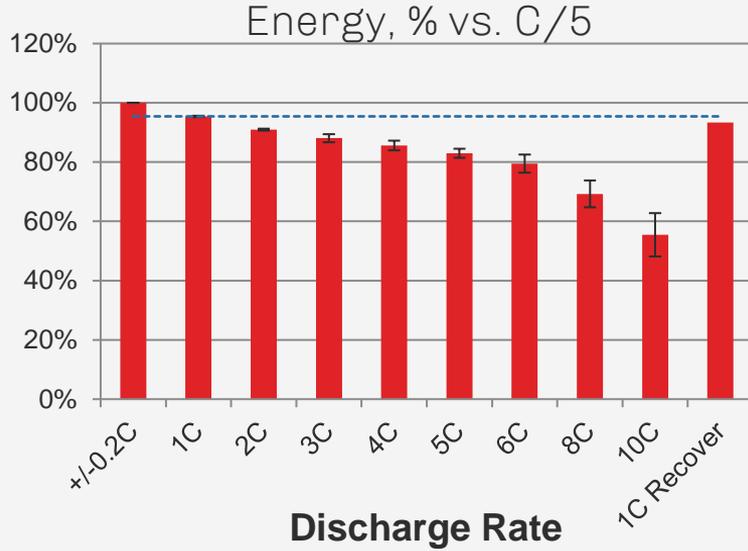
# Long Endurance Power Batteries



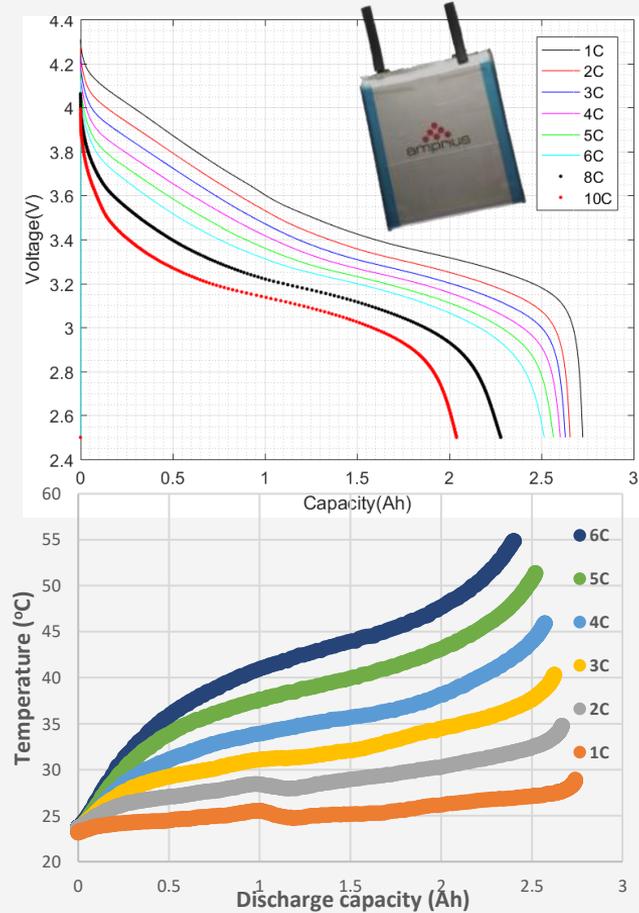
- 415 Wh/kg at C/5, 370 Wh/kg at 2C → doubles endurance
- Designed for eVTOL and multirotor drones

## HIGH POWER CELLS

Small, long endurance power drones



- >80% relative energy to 6C rate
- Small temperature increase and within operating limits to 10C rate



## PORTABLE POWER APPLICATION

# Conformal-Wearable Battery – 2X Energy Content



## CONFORMAL-WEARABLE BATTERY

2X Energy Content

| Specification         | CWB-150 (Fielded Model)   | Amprius   |
|-----------------------|---|---|
| "Flexible" battery    |  |  |
| Energy (Pack)         | 148 Wh  | <b>320 Wh</b>   |
| Weight                | 2.6 lb  | <b>2.6 lb</b>   |
| Dimensions            | 8.7" x 7.65" x 0.7"   | <b>8.7" x 7.65" x 0.7"</b>  |
| Cells specific energy | 201 Wh/kg   | <b>395 Wh/ kg</b>   |

UN38.3 certified in 2020, confirmed performance in field test

## USE CASES

### EV – Future Market



## EV CELLS

### Exceed 2025 Goals

- Si/NCM811
- ISO form factor VIFB-/99/300

Model based on results to date:

- Capacity: 60 Ah at C/3 rate (30°C)
- Energy: 450 Wh/kg and 1200 Wh/L
- Peak Power: 1000 W/kg and 2650 W/L
- 80% capacity charged in 15 minutes

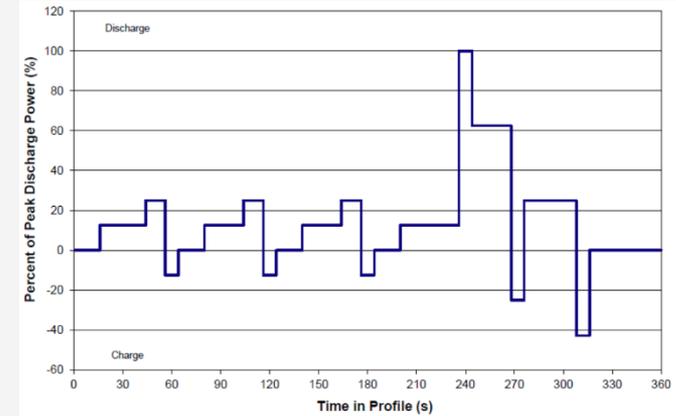
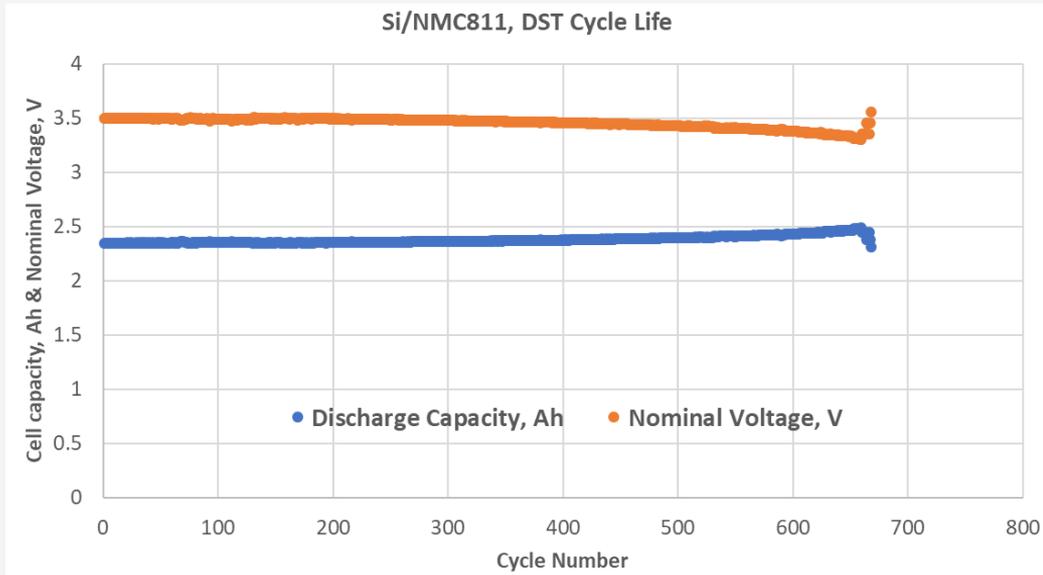
**50% higher specific energy than best EV cells**



## EV PERFORMANCE TESTS

### Cycle Life – Dynamic Stress Test (DST)

>650 cycles, ongoing improvement to 1000



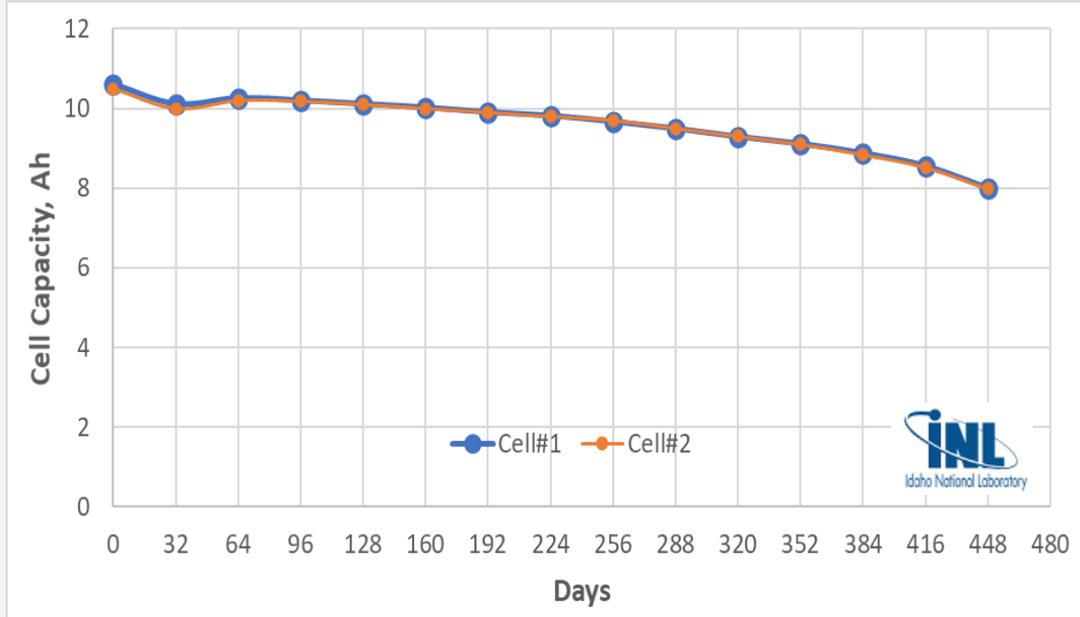
- DST pulse profile
- Constant energy discharged every cycle

>100,000 miles with 200-mile range battery

## EV PERFORMANCE TESTS

# Calendar Life – 50°C at Full Charge

Equivalent to about 8 years, ongoing improvement to 10 years

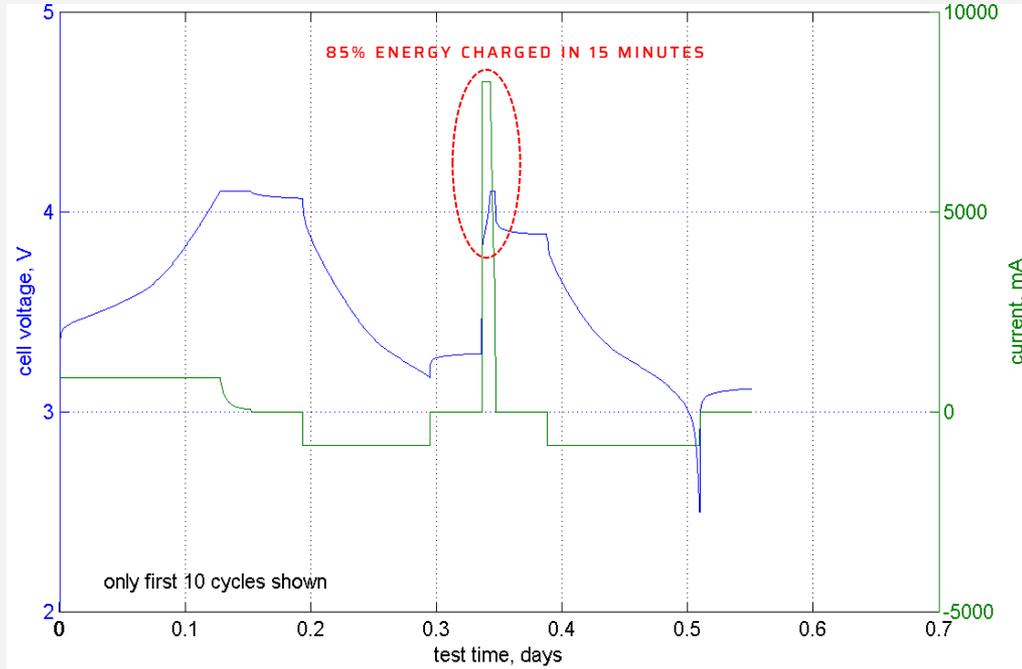


- Reference Performance Test verification every 32 days
- Calendar Life at 50°C equivalent to about 4x Calendar Life at 30°C

## EV PERFORMANCE TESTS

# High Rate Charge

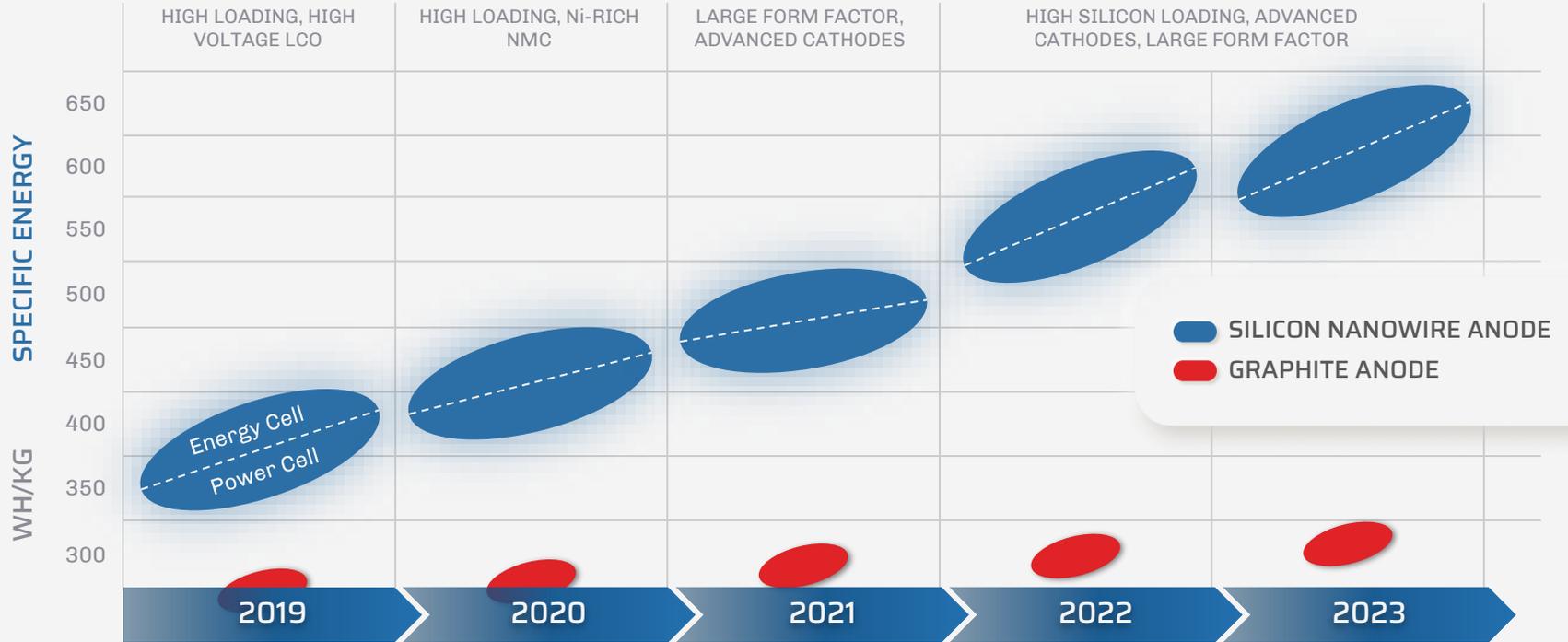
Silicon nanowire anode is best for fast charging due to lower thickness



- Charge for 15 minutes at 3.2C rate
- 85% energy restored in 15 minutes
- 99.5% energy restored in subsequent normal full cycle

# ROAD MAP: SPECIFIC ENERGY

## ACTIVE MATERIALS IMPROVEMENT AND ACTIVE/INACTIVE RATIO INCREASE



# Thank You

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