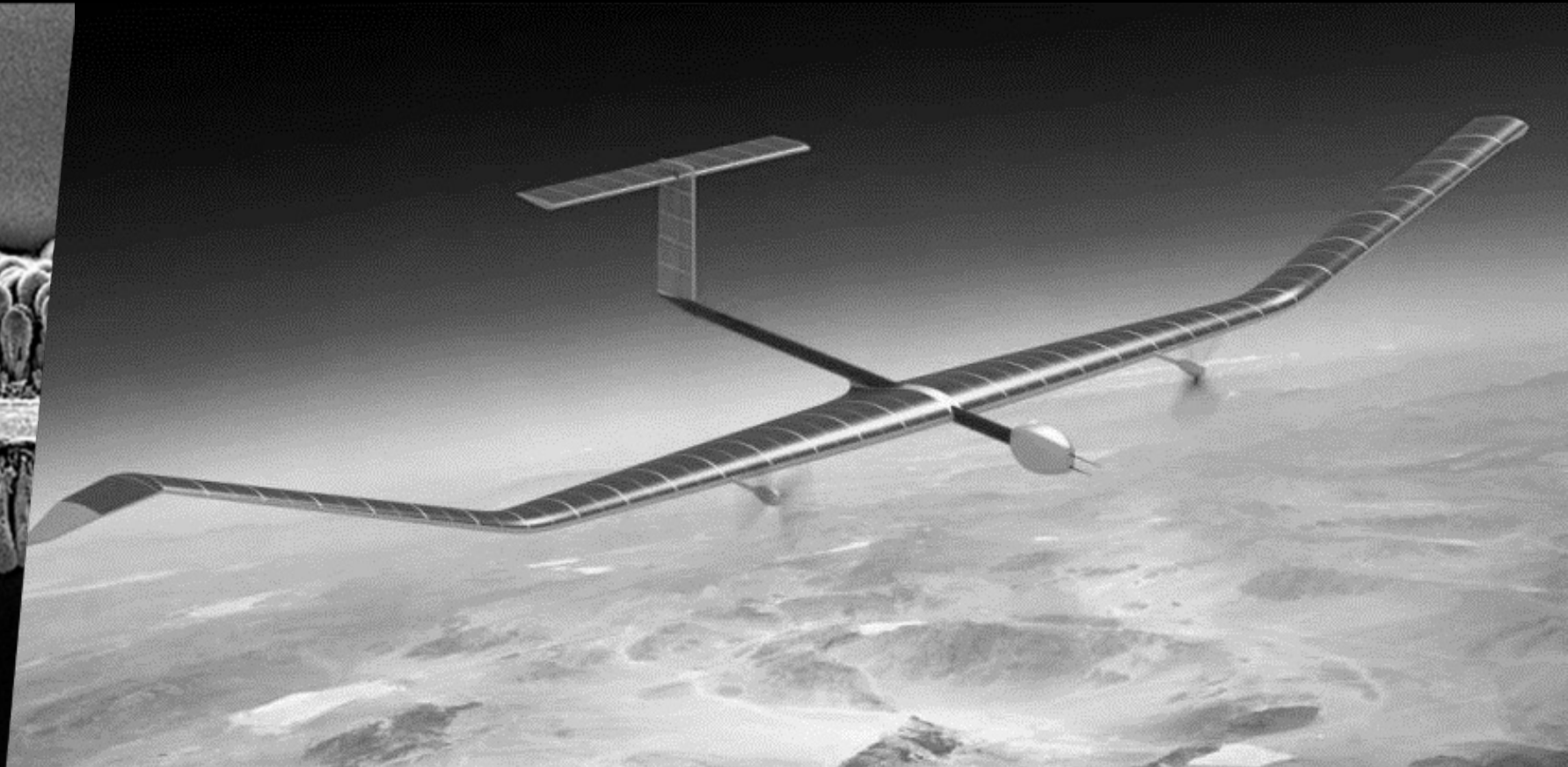
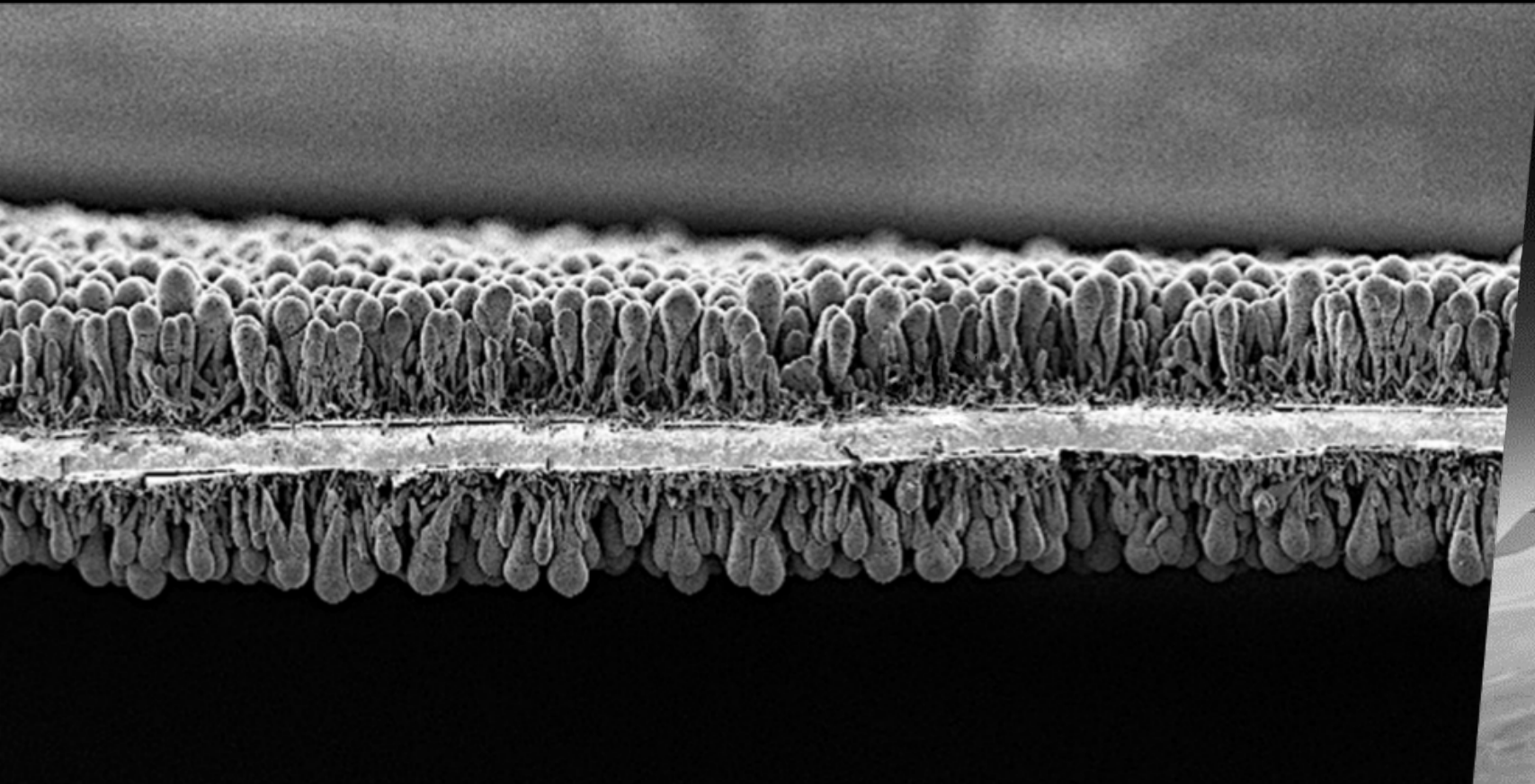


Transforming Electric Mobility



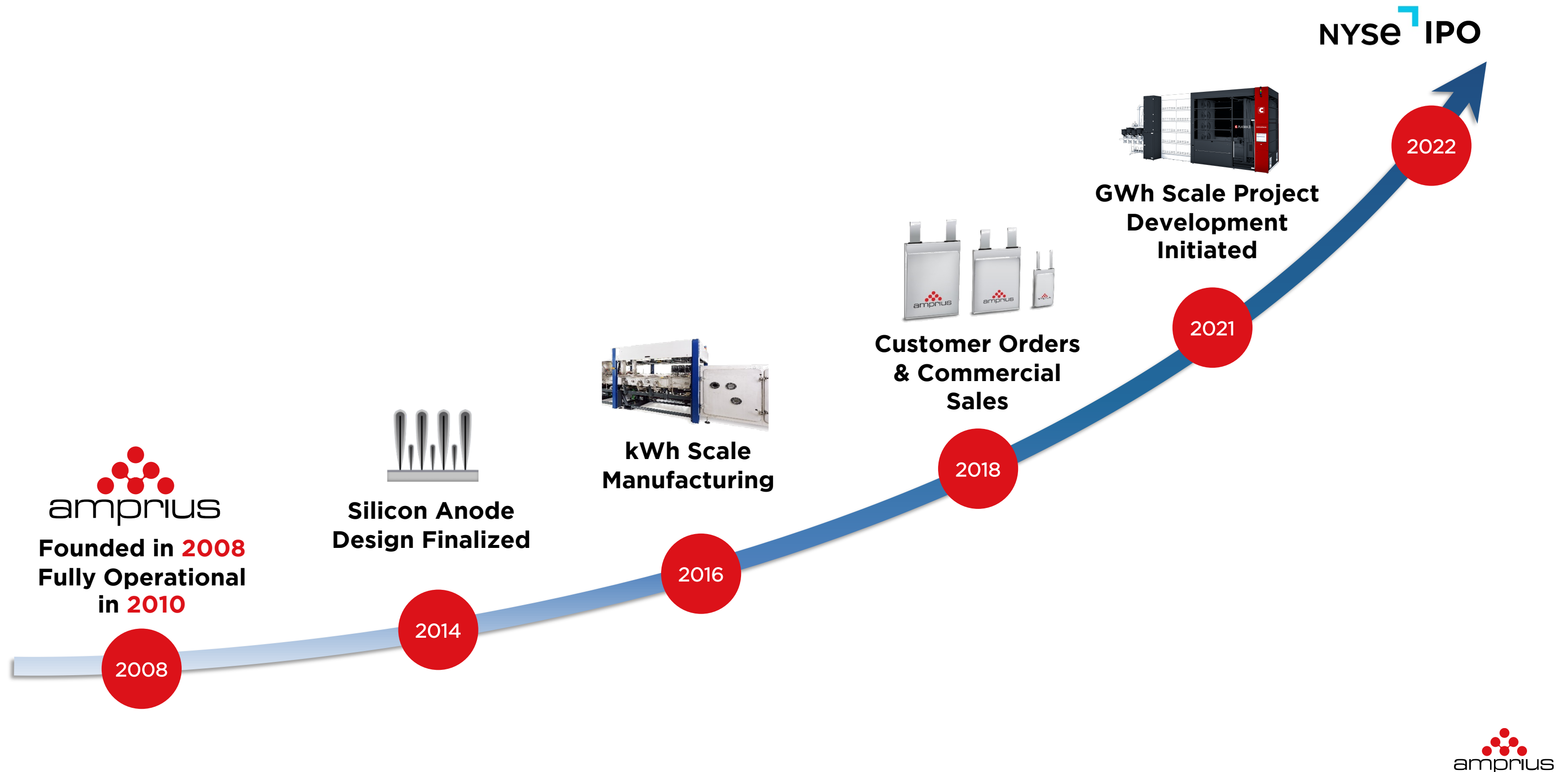
Ionel Stefan
CTO, Amprius Technologies, Inc.
1180 Page Ave., Fremont, CA

The eVTOL Show

October 2023

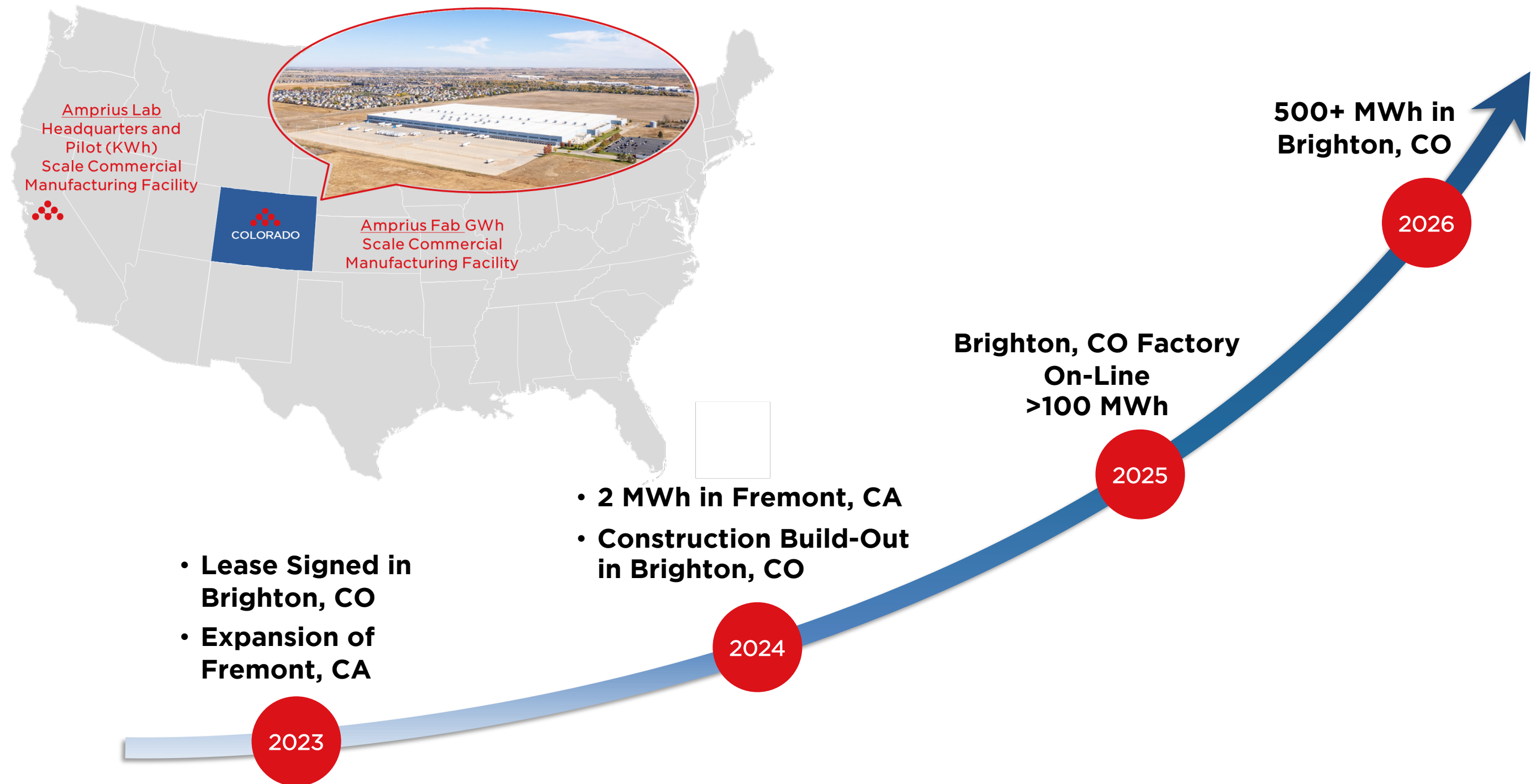
COMPANY DEVELOPMENT

A history of innovation and achievements



COMPANY DEVELOPMENT

Scale Up Roadmap

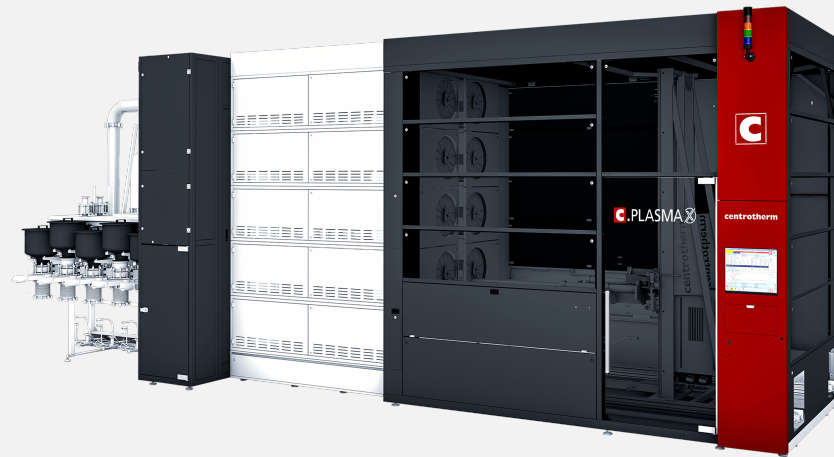


MANUFACTURING PROCESS

Amprius uses standard commercial manufacturing processes

- Cathode and Assembly Processes are Unchanged
- The Only Change is to the Anode Manufacturing Line

SILICON ANODE



SILICON ANODE
MANUFACTURING LINE

STANDARD BATTERY
MANUFACTURING LINE

STANDARD BATTERY ASSEMBLY



Slitting



Stacking



Formation

STANDARD BATTERY CATHODE



Mixing



Coating

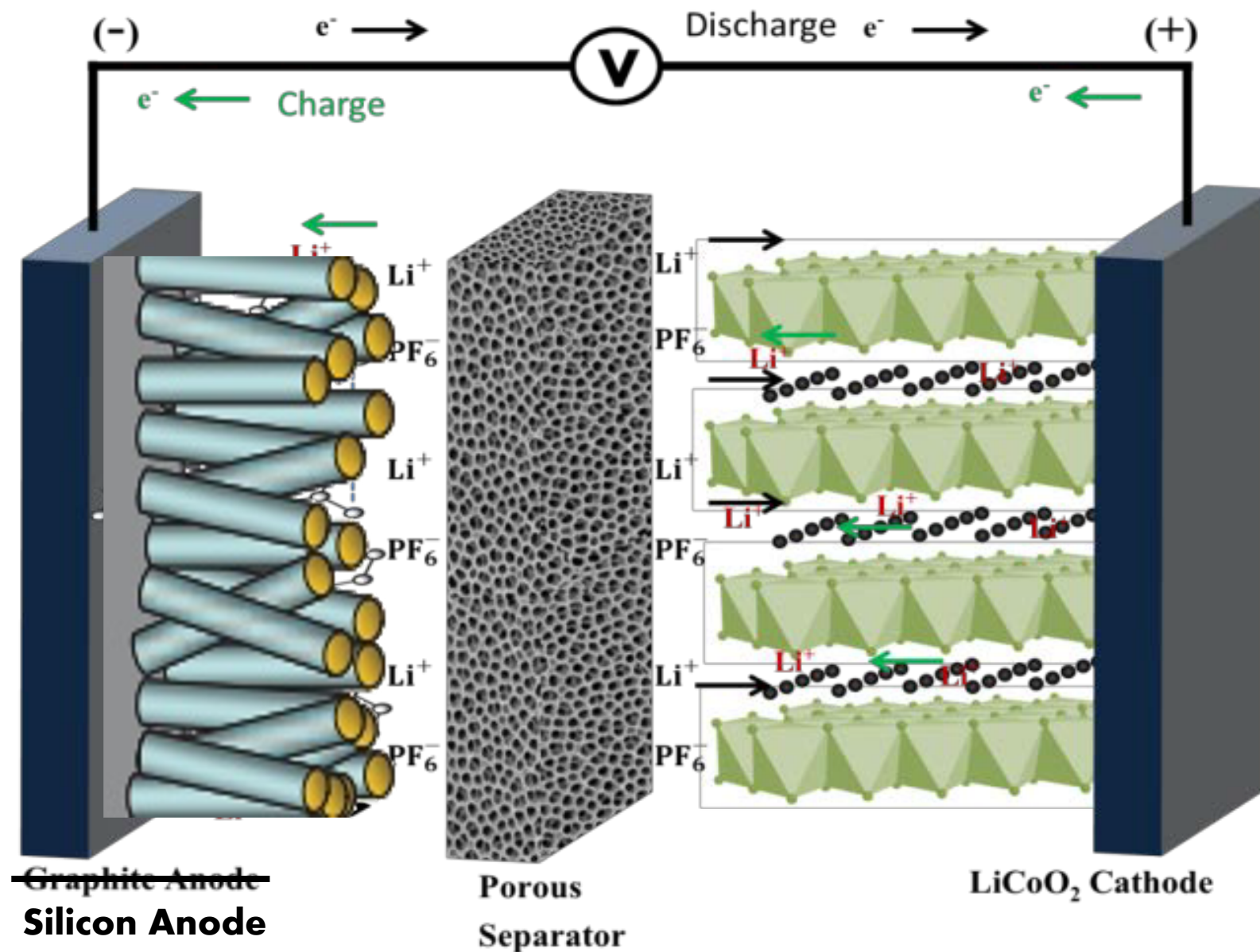


Calendaring



AMPRIUS REPLACES GRAPHITE ANODE WITH SILICON

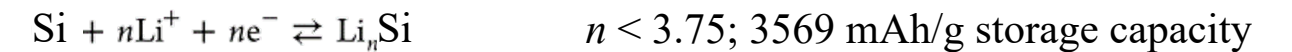
100% Silicon anode



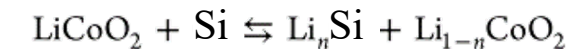
Cathode:



Anode:



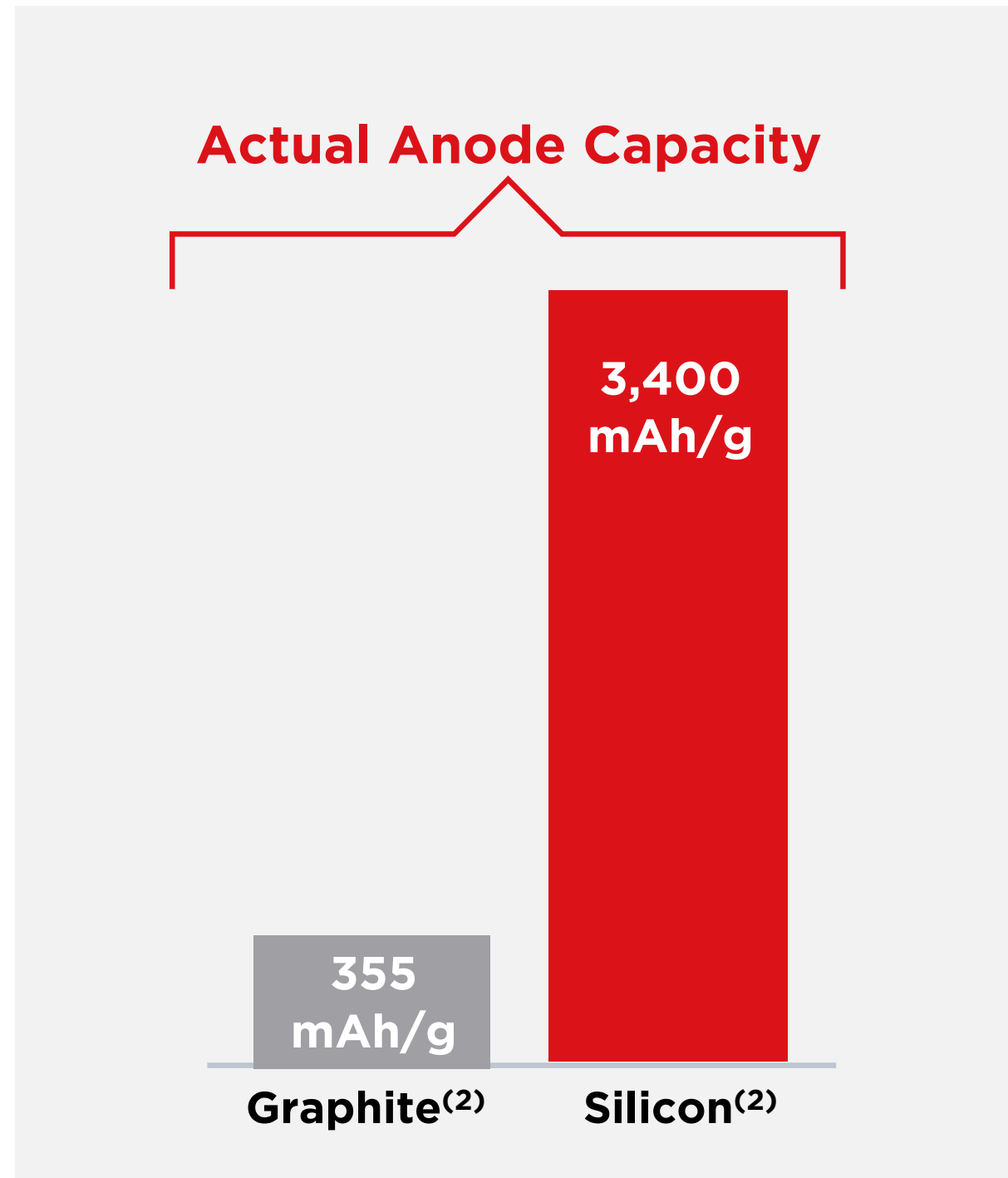
Cell reaction:



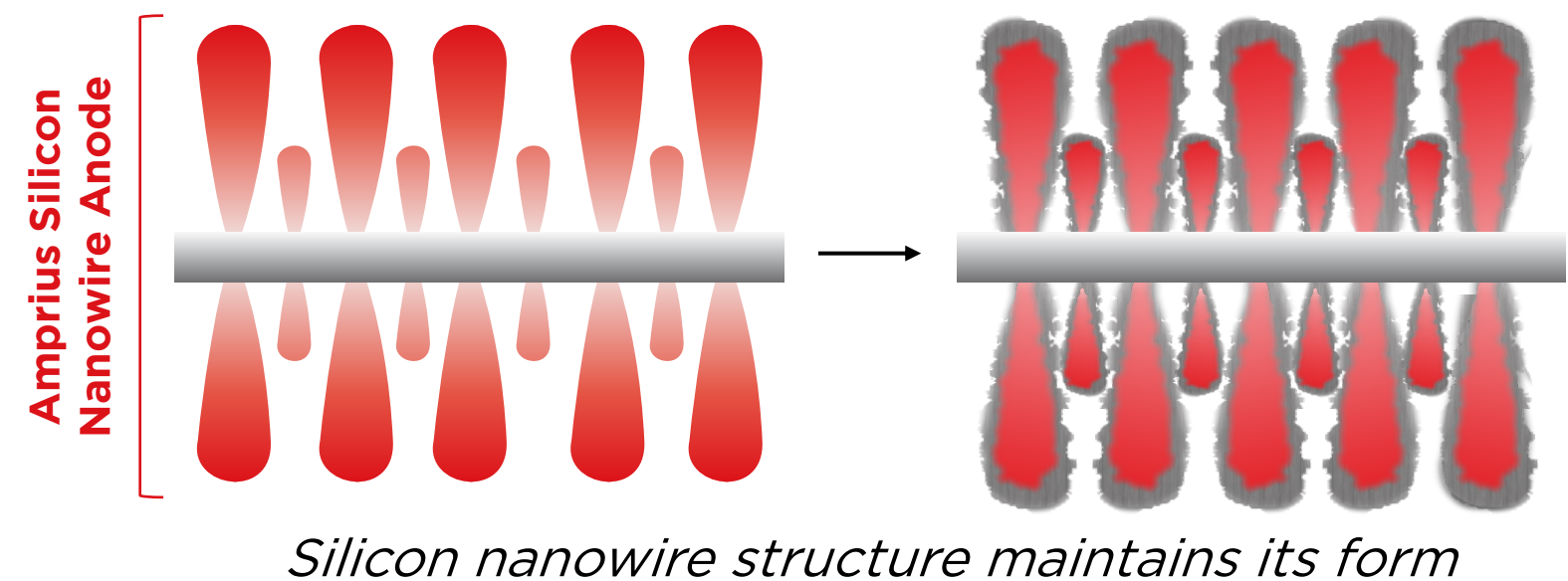
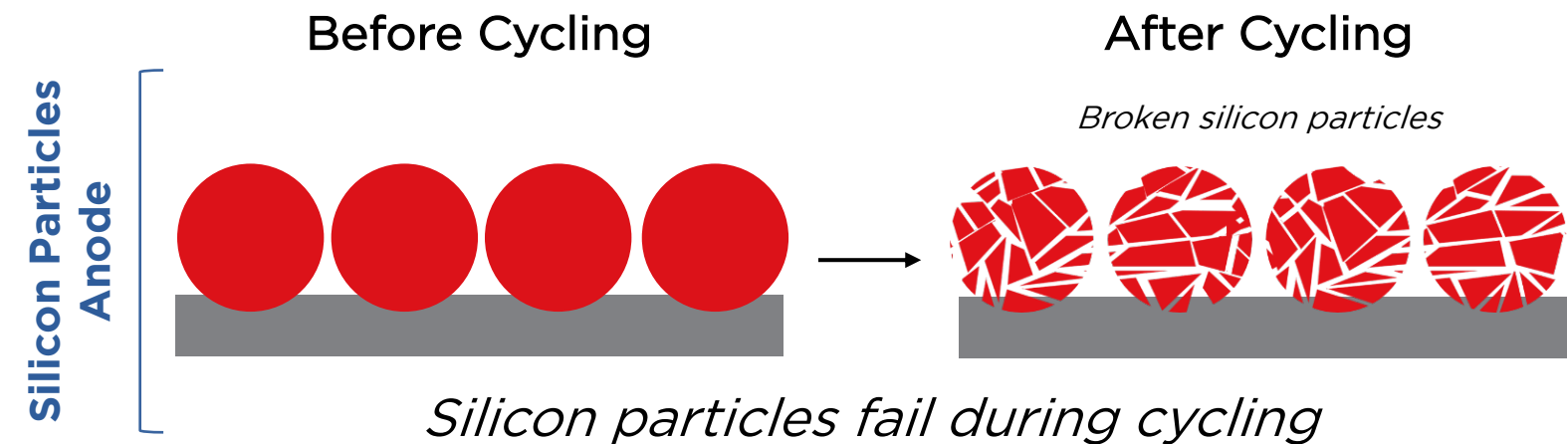
(www.electrochem.org)

State of the art: intercalation active materials (graphite and metal oxides), liquid electrolytes and porous polymer separators

Why Silicon? 100% Silicon Anode⁽¹⁾ Has ~10x Capacity vs. Graphite



Silicon anode can swell up to ~300% causing battery damage after a few cycles



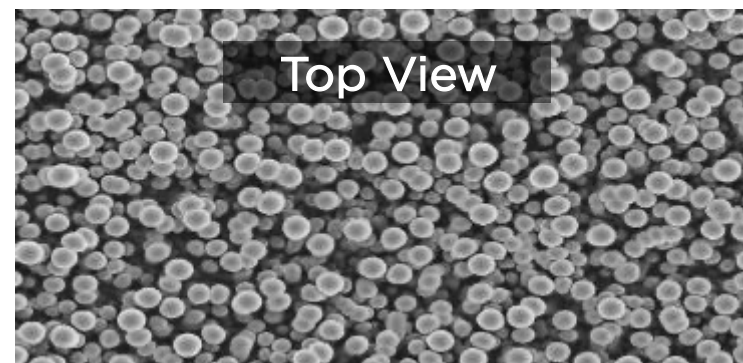
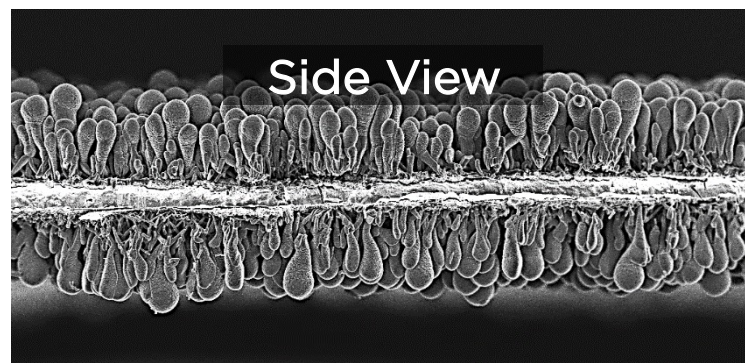
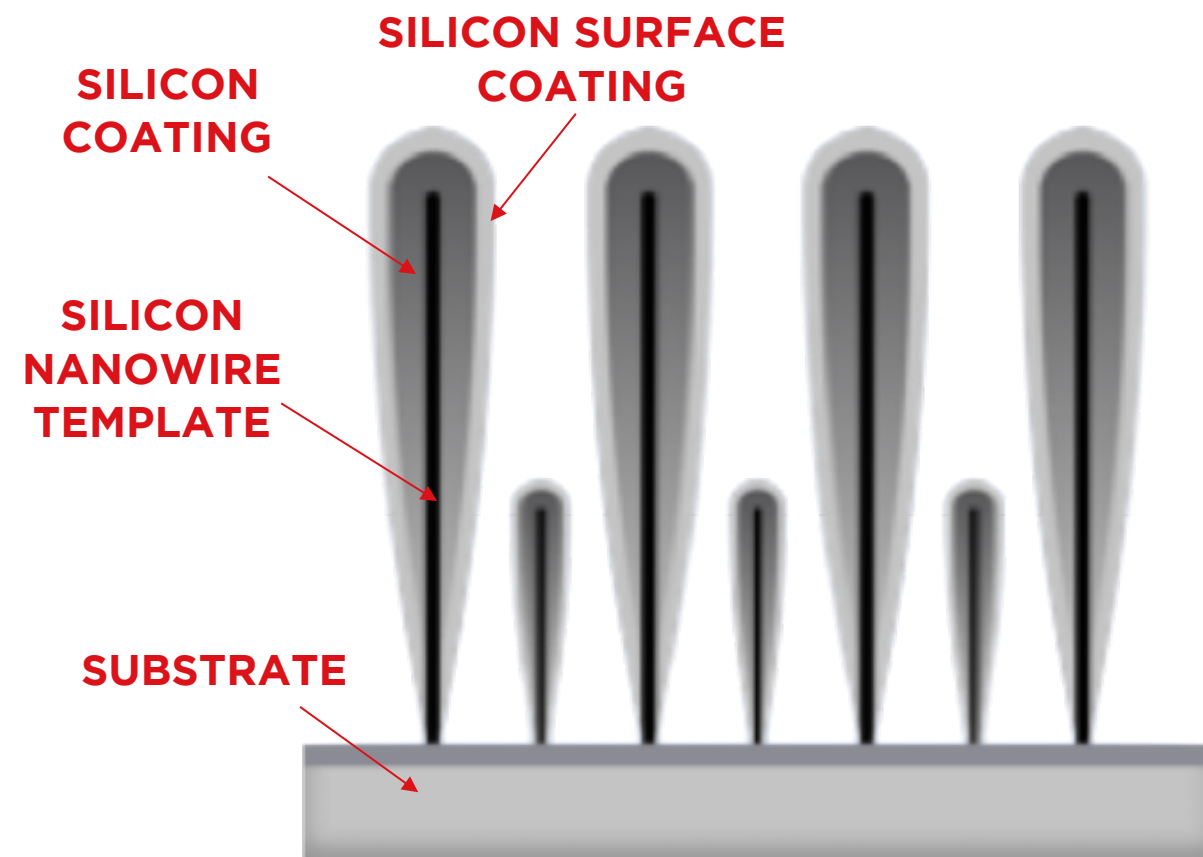
(1) Actual percentage of silicon is 99.5-99.9% which is within the range of acceptable purity levels for materials that are considered 100%.

(2) Based on Amprius measurements in half cells.

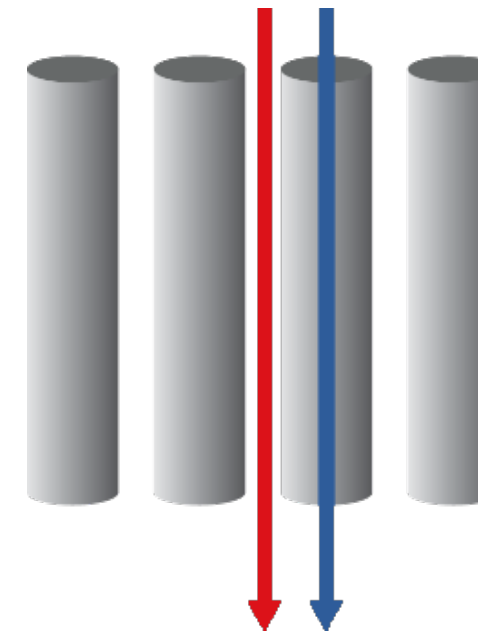
UNIQUE SILICON ANODE STRUCTURE

The Amprius Solution to Silicon Anode Expansion

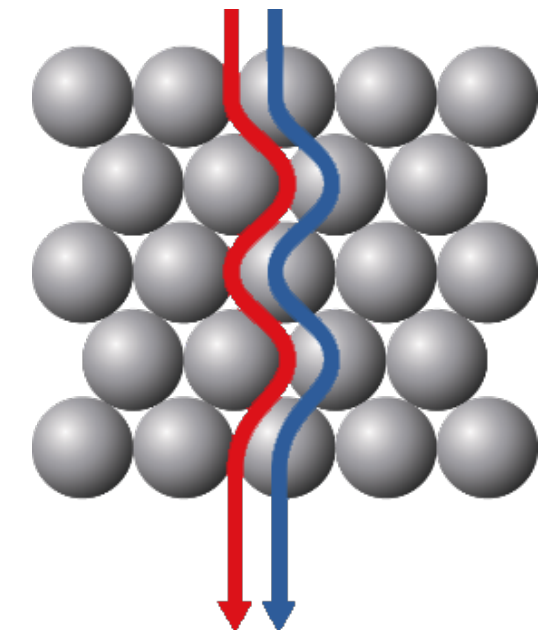
100% Silicon Nanowires Allow Volume Expansion without Binders, Graphite or any Inactive Materials



Silicon Nanowires



Conventional Graphite (and/or Silicon) Particles



- Spacing between nanowires and silicon porosity **accommodate silicon volume expansion**
- Ions and electrons travel straight paths
- Most conductive path for ions and electrons results in **high power capability and fast charge rate**

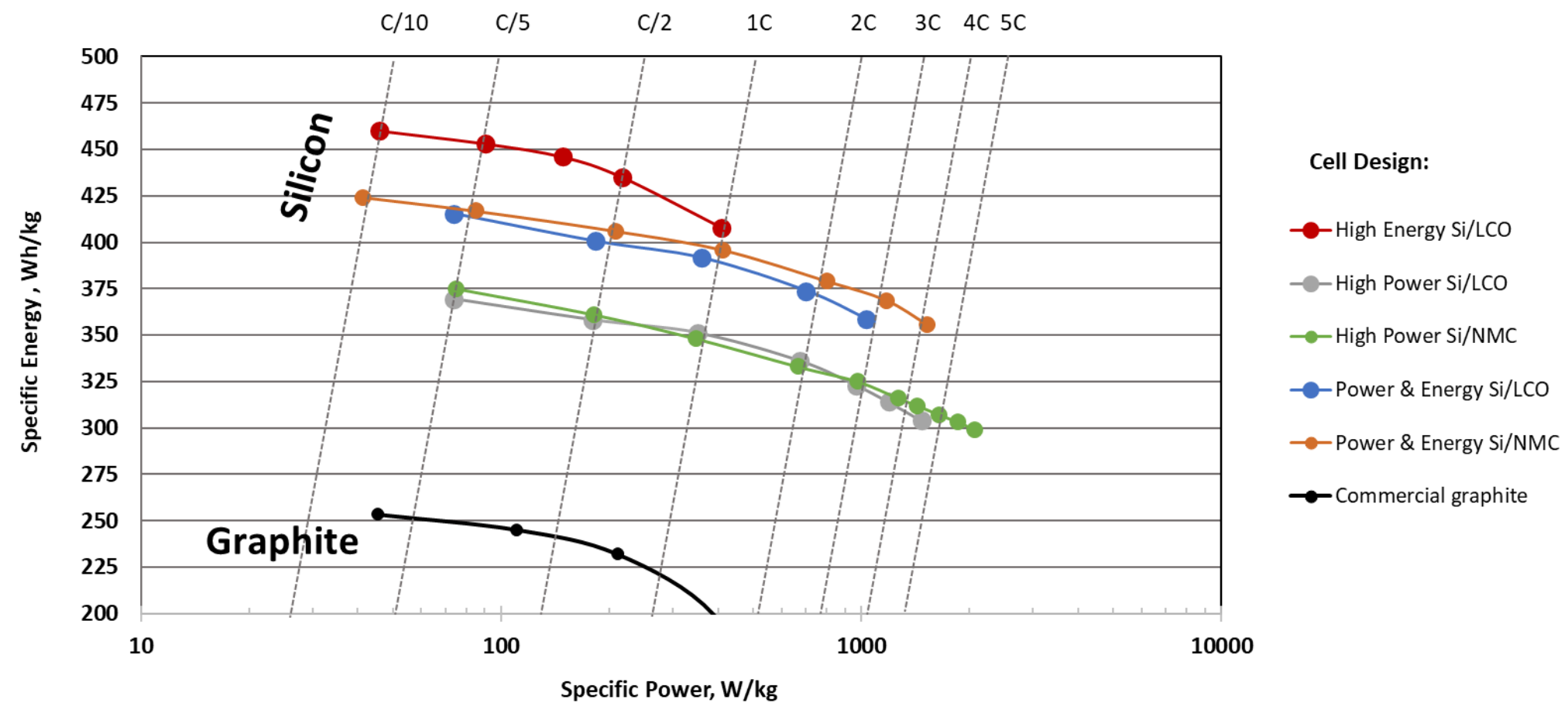
Products and Applications

HIGH ENERGY AND POWER DENSITIES

Minimal trade off between specific energy and specific

Silicon Nanowire Power & Energy platforms

ENERGY



POWER

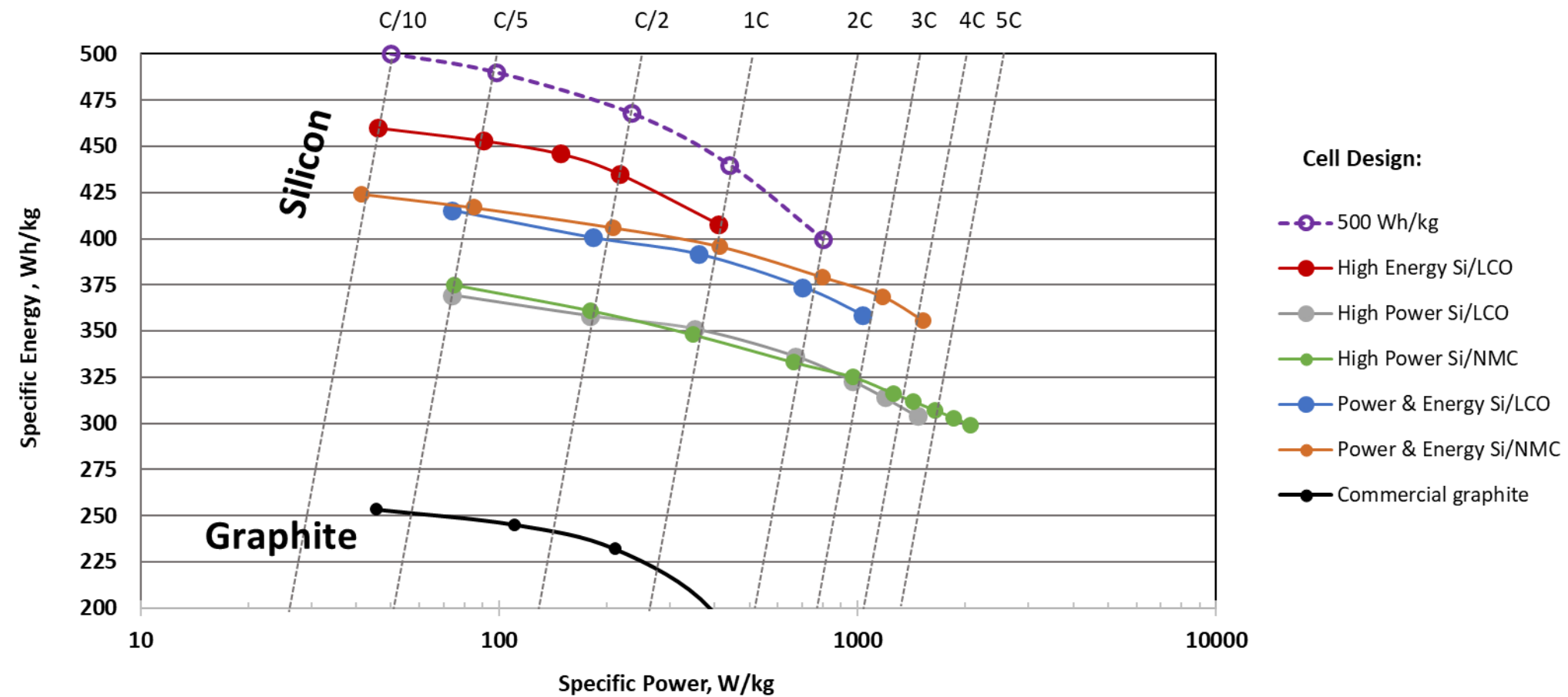


HIGH ENERGY AND POWER DENSITIES

New energy cell design: 500 Wh/kg cells

Silicon Nanowire Power & Energy platforms

ENERGY



POWER

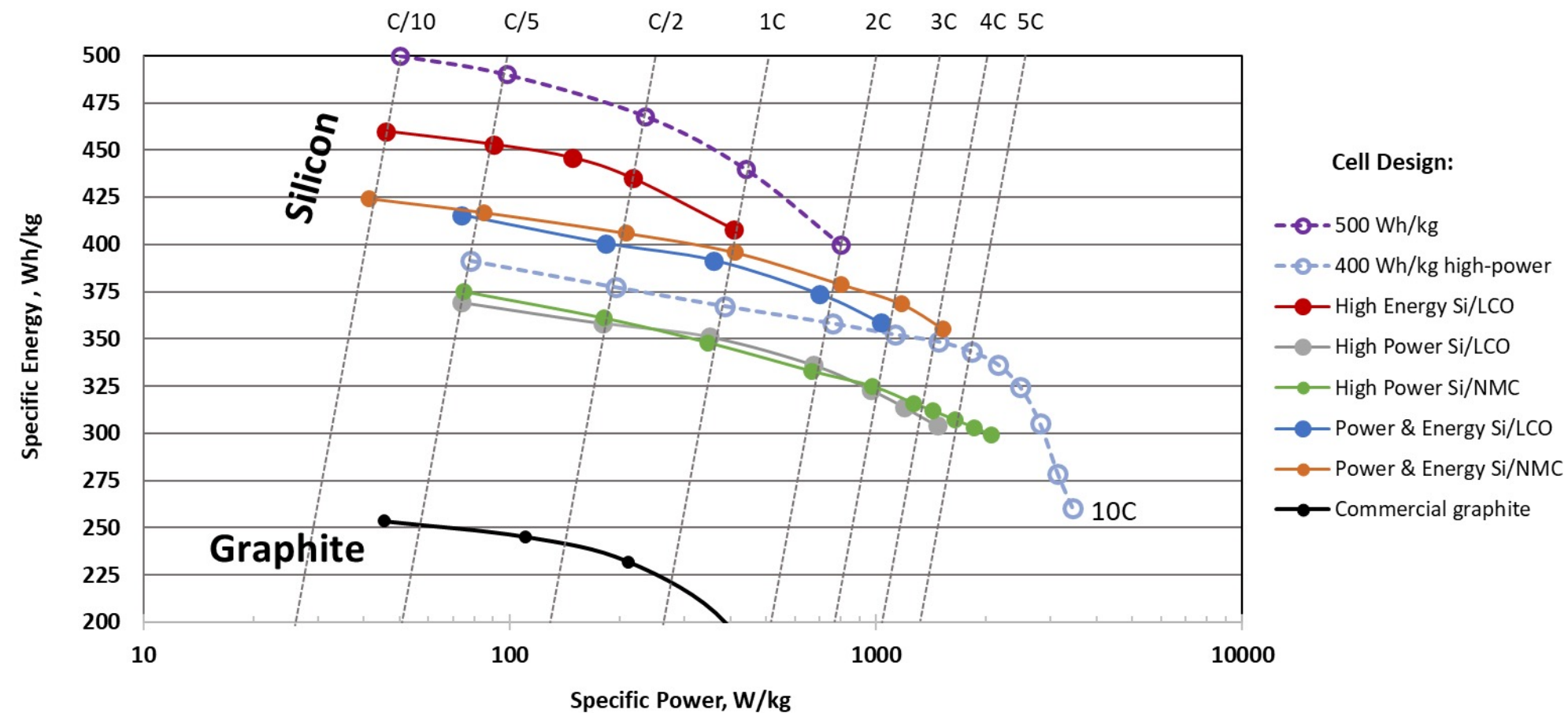


HIGH ENERGY AND POWER DENSITIES

New power cell design: 400 Wh/kg with 4000 W/kg power density

Silicon Nanowire Power & Energy platforms

ENERGY

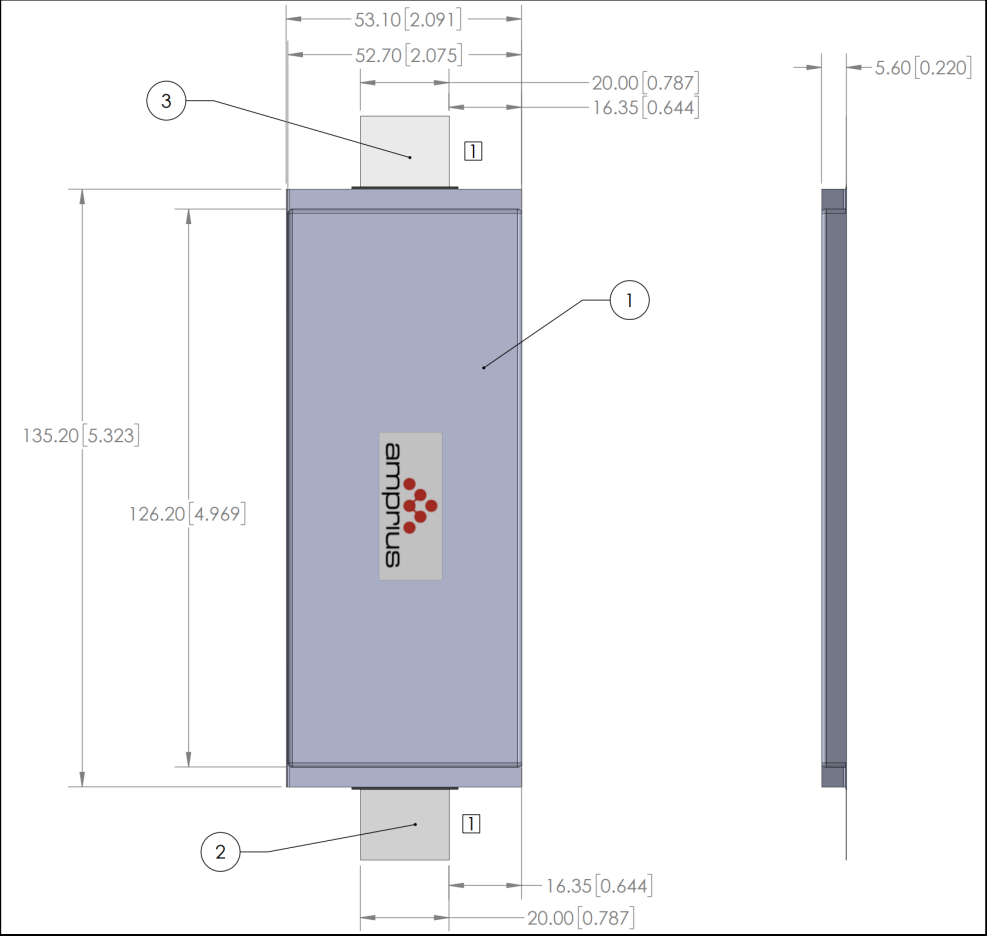


POWER



EXAMPLE AMPRIUS PRODUCTS

High Power capability with high energy density and specific energy

Applications	HAPS, portable power, CE	Long Endurance Drones, eVTOL, UAM	High power drones	HAPS, portable power	EV, Electric Flight	High power drones, eVTOL
Dimensions (T x W x H) mm						
	High Energy 0.5C max rate					
	4.5 x 50 x 55					
	420 Wh/kg 1125 Wh/L					
5.4 x 54 x 65	450 Wh/kg 1150 Wh/L					
5.5 x 54 x 135						
				Si/NMC Platforms		
				High Energy 1C max rate	Power-Energy 4C max rate	High Power 8C max rate
				450 Wh/kg 1100 Wh/L	410 Wh/kg 950 Wh/L	370 Wh/kg 820 Wh/L
				455 Wh/kg 1100 Wh/L	415 Wh/kg 975 Wh/L	
				460 Wh/kg 1150 Wh/L	420 Wh/kg 1020 Wh/L	

Operating temperature range: -30°C to 55°C. Cycle life 200-1200 cycles, depending on operating conditions



EXAMPLE AMPRIUS PRODUCTS

High Power capability with high energy density and specific energy

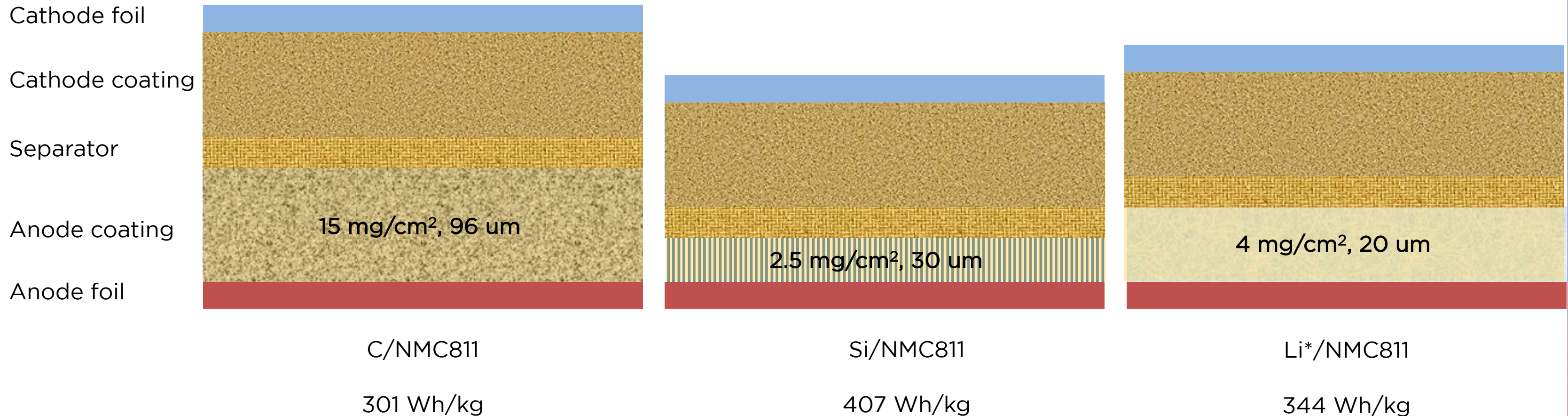
Applications	HAPS, portable power, CE	Long Endurance Drones, eVTOL, UAM	High power drones	HAPS, portable power	EV, Electric Flight	High power drones, eVTOL
Dimensions (T x W x H) mm	Si/LCO Platforms				Si/NMC Platforms	
	High Energy 0.5C max rate	Power-Energy 3C max rate	High Power 5C max rate	High Energy 1C max rate	Power-Energy 4C max rate	High Power 8C max rate
4.5 x 50 x 55	420 Wh/kg 1125 Wh/L	415 Wh/kg 1040 Wh/L	370 Wh/kg 920 Wh/L	450 Wh/kg 1100 Wh/L	410 Wh/kg 950 Wh/L	370 Wh/kg 820 Wh/L
5.4 x 54 x 65	450 Wh/kg 1150 Wh/L	420 Wh/kg 1050 Wh/L		455 Wh/kg 1100 Wh/L	415 Wh/kg 975 Wh/L	
5.5 x 54 x 135				460 Wh/kg 1150 Wh/L	420 Wh/kg 1020 Wh/L	

Operating temperature range: -30°C to 55°C. Cycle life 200-1200 cycles, depending on operating conditions

SILICON ADVANTAGE IN CELL DESIGN

Pure silicon anode mass is lower than alternatives

Example for 5 mAh/cm²



2.5 mg/cm² Si has a reversible capacity of 9mAh/cm²

Lithium metal electrode has to be thinner than 5μm to be equivalent in mass

Solid-state electrolytes further increase cell mass

First to reach 500 Wh/kg with commercial cathodes

*20μm thin-film Li/Cu

500 Wh/kg WITH AMPRIUS SILICON

External validation of early prototypes by Mobile Power Solutions



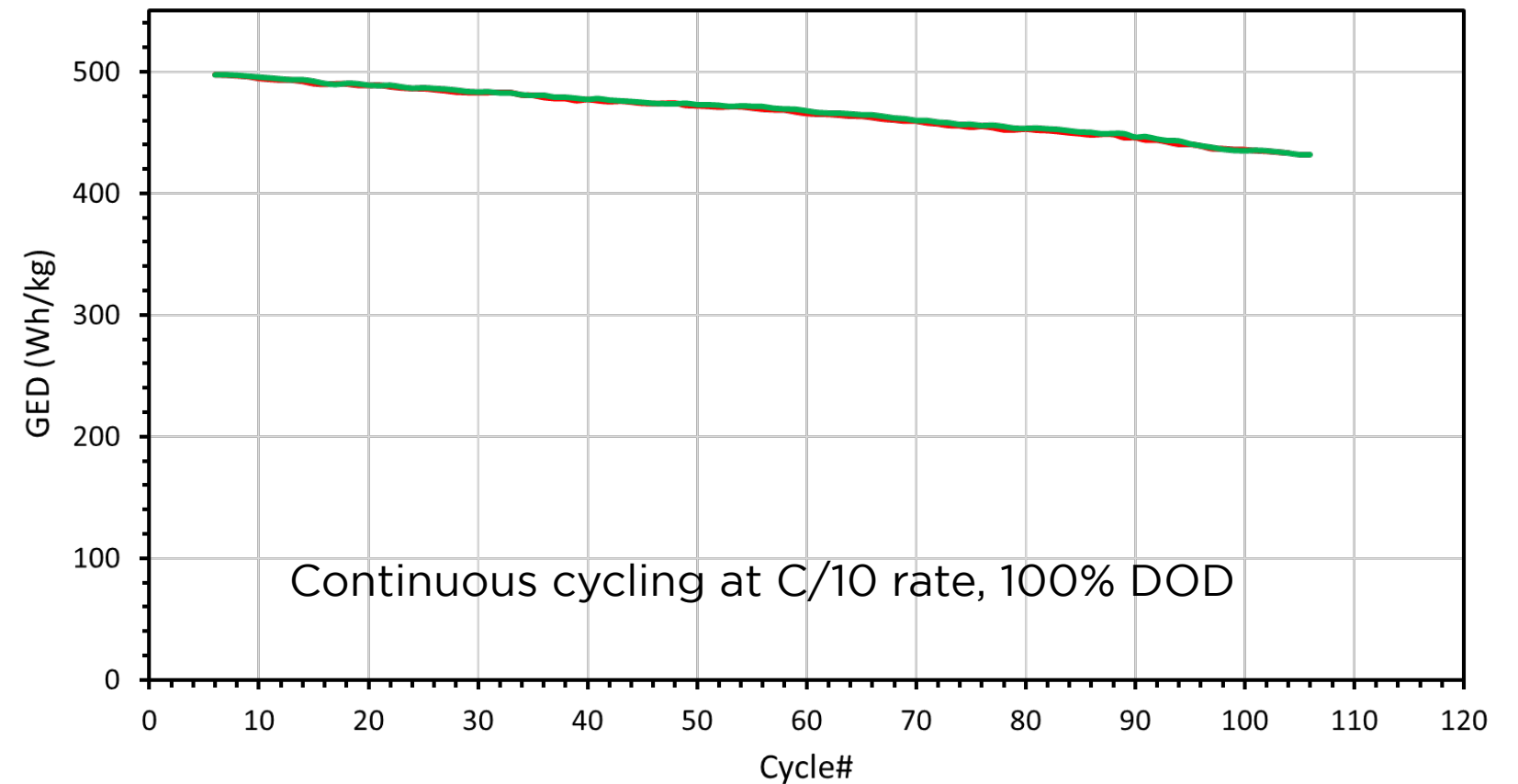
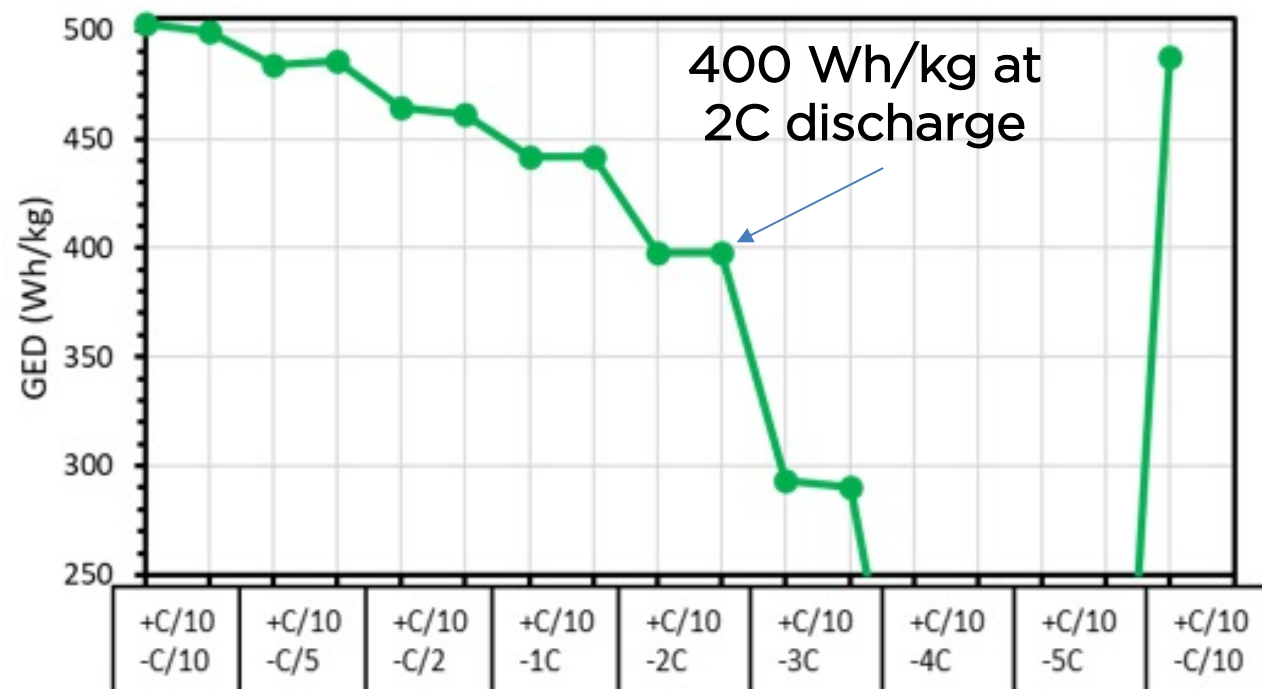
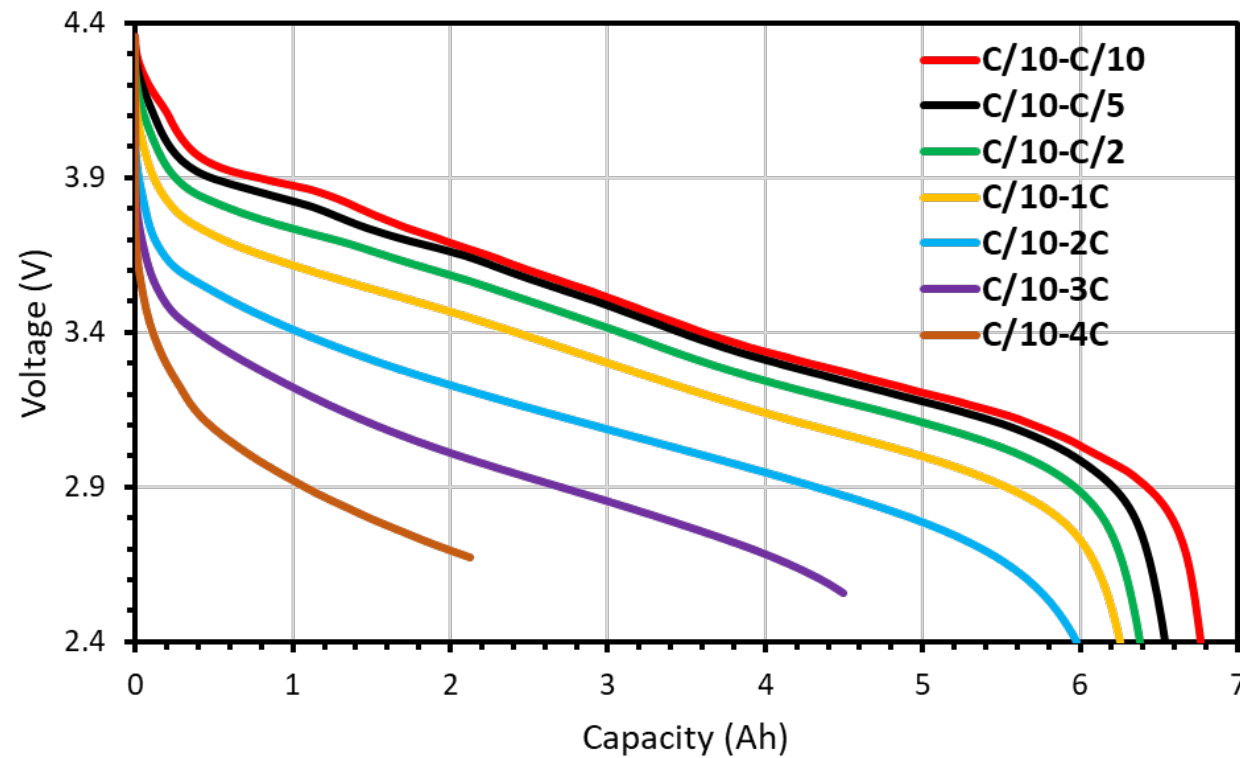
MPS SN:	Cell SN	1st cycle		2nd cycle	
		Capacity (Ah)	Energy (Wh)	Capacity (Ah)	Energy (Wh)
AK-1823-CP-1	40546	6.8552	23.657	6.8482	23.632
AK-1823-CP-2	40544	6.8766	23.648	6.8636	23.602
AK-1823-CP-3	40574	6.8529	23.424	6.8432	23.389

MPS SN:	Cell SN	Weight (g)	L (mm)	W (mm)	T (600g plate) (mm)	Gravimetric Energy Density (Wh/kg)	Volumetric Energy Density (Wh/l)
AK-1823-CP-1	40546	46.3604	59.72	52.31	5.667	509.7	1335
AK-1823-CP-2	40544	46.3627	59.81	52.37	5.693	509.1	1324
AK-1823-CP-3	40574	46.3638	59.76	52.32	5.662	504.5	1321

~ the same weight as an 18650 cell but double capacity

500 Wh/kg WITH AMPRIUS SILICON

Products under development

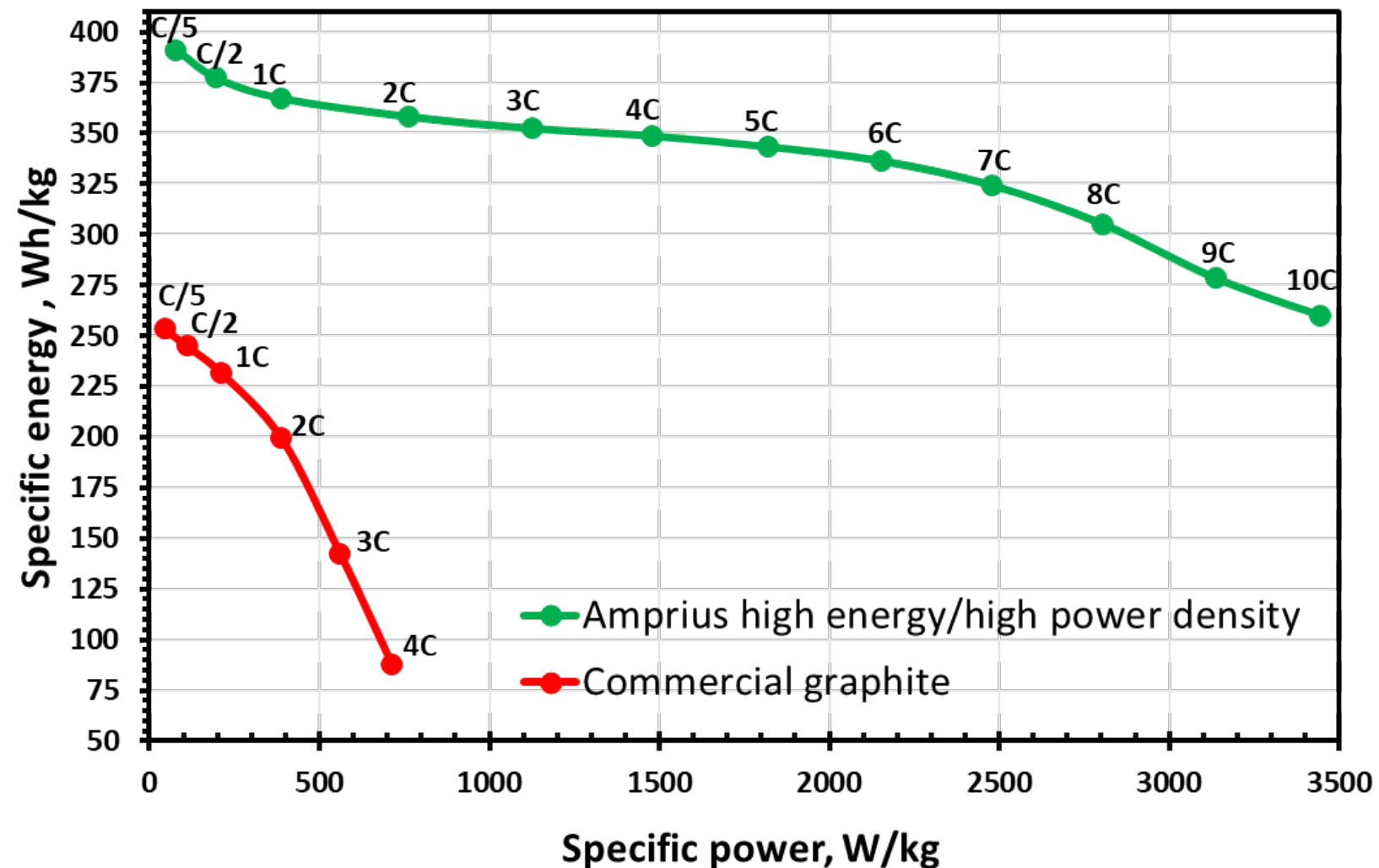


- Optimization of electrolyte formulation and amount, full electrical and safety evaluation underway for future product release

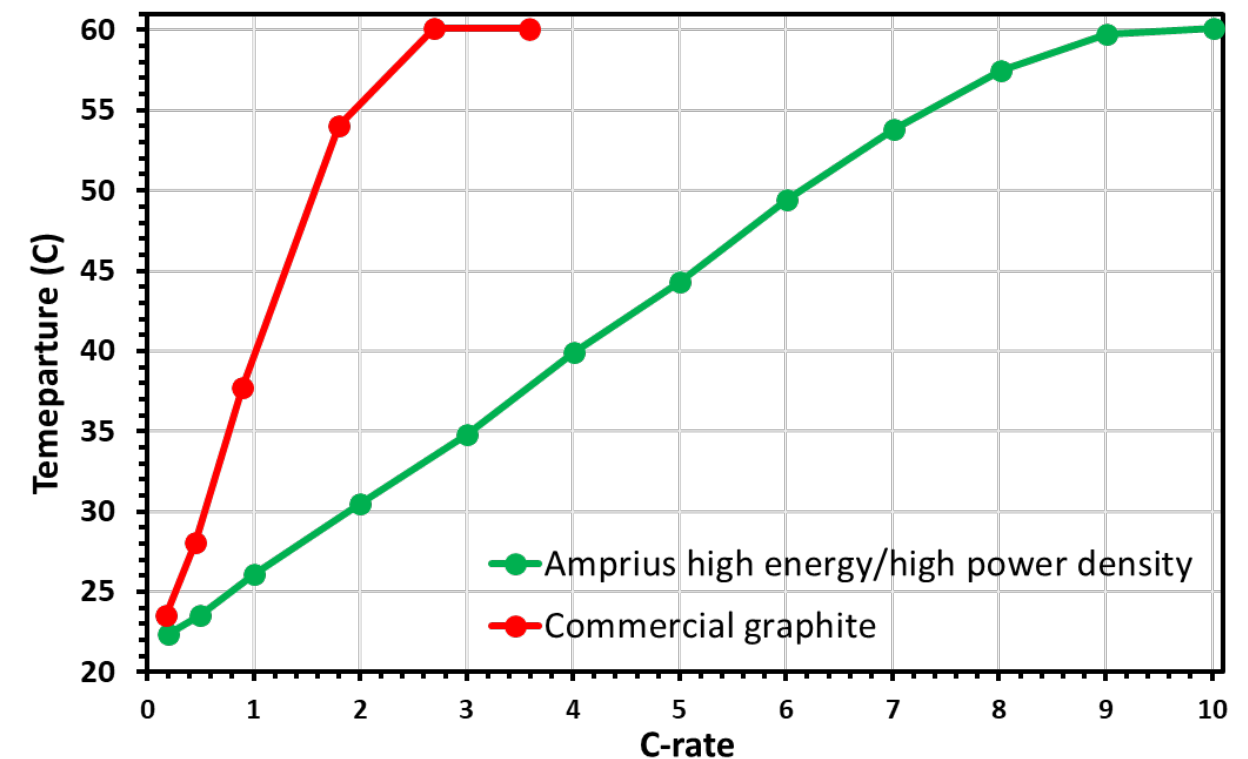
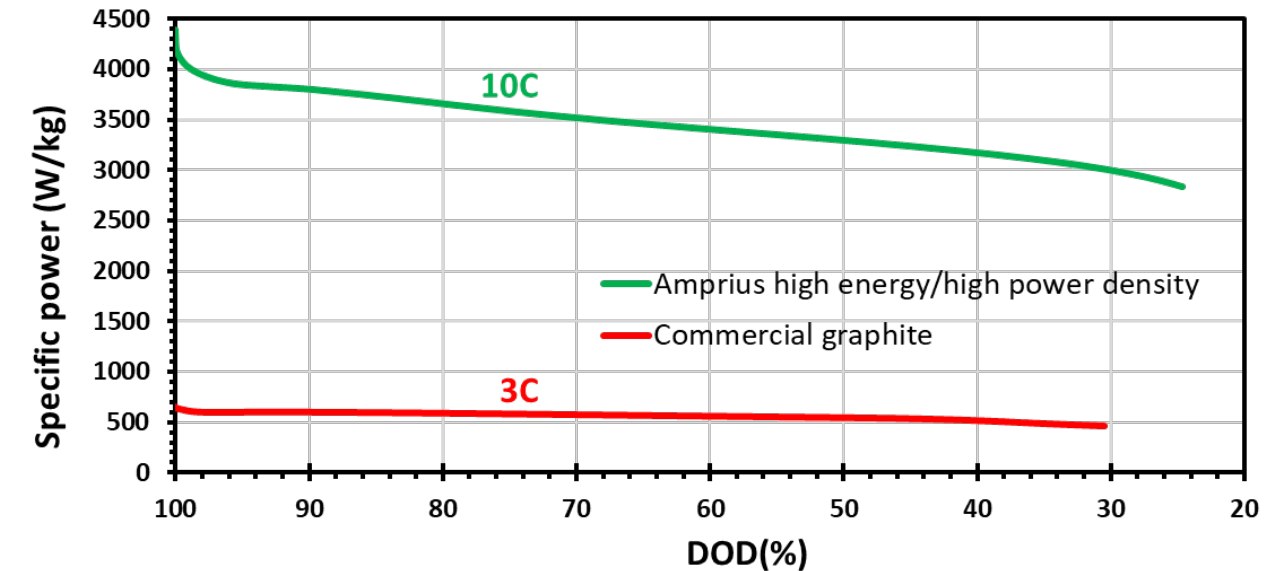
AMPRIUS CELLS - ULTRA HIGH POWER, XFC CAPABLE

New chemistry, 400 Wh/kg and 3000 W/kg

4.8Ah cell, 400Wh/kg, 1020Wh/L



eVTOL and supercar applications



EXAMPLE AMPRIUS PRODUCTS

Pouch cells customized to application requirements

Certified designs



5x50x56mm
3700mAh
HAPS drone



6x54x65mm
5400mAh
CWB

Nano-UAS cell
in development



7x15x32mm
725mAh
nano-UAS

Prototypes



3x7x53mm
190mAh
Wearable



6x28x29mm
1200mAh
Smart watch

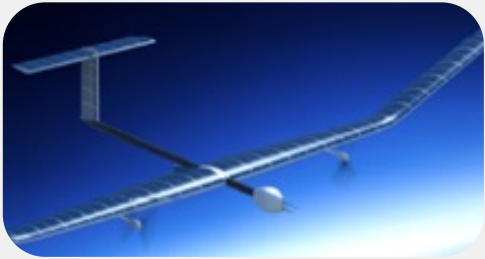


5x99x300mm
45 Ah
BEV

Capacities from 200 mAh to 80 Ah

TARGET MARKETS

Electric Flight Applications Enabled by Amprius' Batteries

	Unmanned Aerial Systems (Drones)	High Altitude Pseudo Satellites	Air Transportation
Product			
Application	Recon Drone	Stratospheric Satellite	eVTOL ⁽¹⁾
Amprius Product	Balanced Energy/Power	High Energy	High Power
Performance Specification	1.4 Ah, 390 Wh/kg at C/5	5.8 Ah, 450 Wh/kg at C/10	15+ Ah, 380+ Wh/kg at C/5 with 6C long pulse
End User Benefit	Very long endurance and increased capacity with no increase in weight or volume	Ultra long sustained flight at high altitude with max payload	eVTOL with extreme-fast charge and greatly extended service radius

(1) Actively sampling with OEMs and continuing to pursue joint development agreements.

A large solar plane with a long, thin wing and a small fuselage is flying over a city at sunset. The city lights are visible in the foreground, and the sky is a mix of orange and blue. The plane is silhouetted against the bright sunset sky.

Thank you!

Contact Us

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