



# Maximizing High Silicon Anode Performance

*43<sup>rd</sup> Florida International Battery Seminar*

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# Product portfolio in silicon enabling technologies

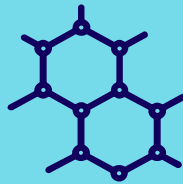
Established  
and growing  
business



## Publicly listed company (ASX:ADO)

- Chemical and materials solutions business in Battery Technology and Life Sciences
- Headquartered in Brisbane, Australia

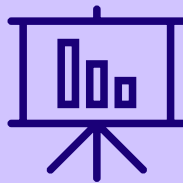
Proprietary  
technology



## Portfolio of Lithium-ion battery (LIB) products

- **Anteo X** – Cross-linker for high silicon anodes
- **Anteo S** – Cross-linker for ceramic coated separators
- **SiMRAX** – Anteo X + SWCNT combined product for silicon anodes
- **Ultranode** – Ultra-high silicon content anode technology (70% - 95% silicon)

Innovating for  
the next  
generation of  
batteries



## Deep expertise in battery chemistry and electrode development

- >20wt% silicon active material anode focus
- Performance optimization of silicon anode designs
- Collaborations with novel cathode active material suppliers
- Anteo X and Anteo S production facility with commercial-scale supply capacity
- SiMRAX GWh production scale-facility, operated by US technology partner

# Leading Cross-linking Technology Products for Electrodes and Ceramic Separator Coatings

NEW

# S

## ANTEO S™

Cross-linker for Ceramic Coated Separators (CCS)

### Safer and Thinner Separators

- Reinforces ceramic coating, reducing potential thermal runaway and fires.
- Improves mechanical strength, puncture strength and thermal shut-down window



## ANTEO X®

Cross-linker for Silicon Anodes

### Improved Performance

- Improved cycle life/capacity retention
- Reduced anode expansion

### Improved Cost Efficiency

- Reduction in CNT content for high silicon anodes
- Reduction in binder content for high binder systems



NEW

## SIMRAX

Anteo X + SWCNT Combination Product

### All-in-one solution for high Si anodes

- The world's only additive combining high quality carbon nanotube products with unique cross-linking agents
- World's most efficient binder strengthening additive. A single 'drop in' product that improves performance and reduces costs

# Leading Cross-linking Technology Product Portfolio for Electrodes and Ceramic Separator Coatings



ANTEO S™

Cross-linker for Ceramic Coated Separators (CCS)

NEW



ANTEO X®

Cross-linker for Silicon Anodes

➤ Improved Performance & Cost Efficiency



SIMRAX

Anteo X + SWCNT Combination Product

NEW

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# Anteo X<sup>®</sup> - Cross-linker for Silicon Anodes

A performance additive reinforcing binder efficacy in silicon anodes



## Performance

- Improved cycle life/capacity retention
- Reduced expansion



## Ease of use

- “Fits” into conventional manufacturing processes
- Broad binder compatibility
- Heat activated between 50 - 120 °C



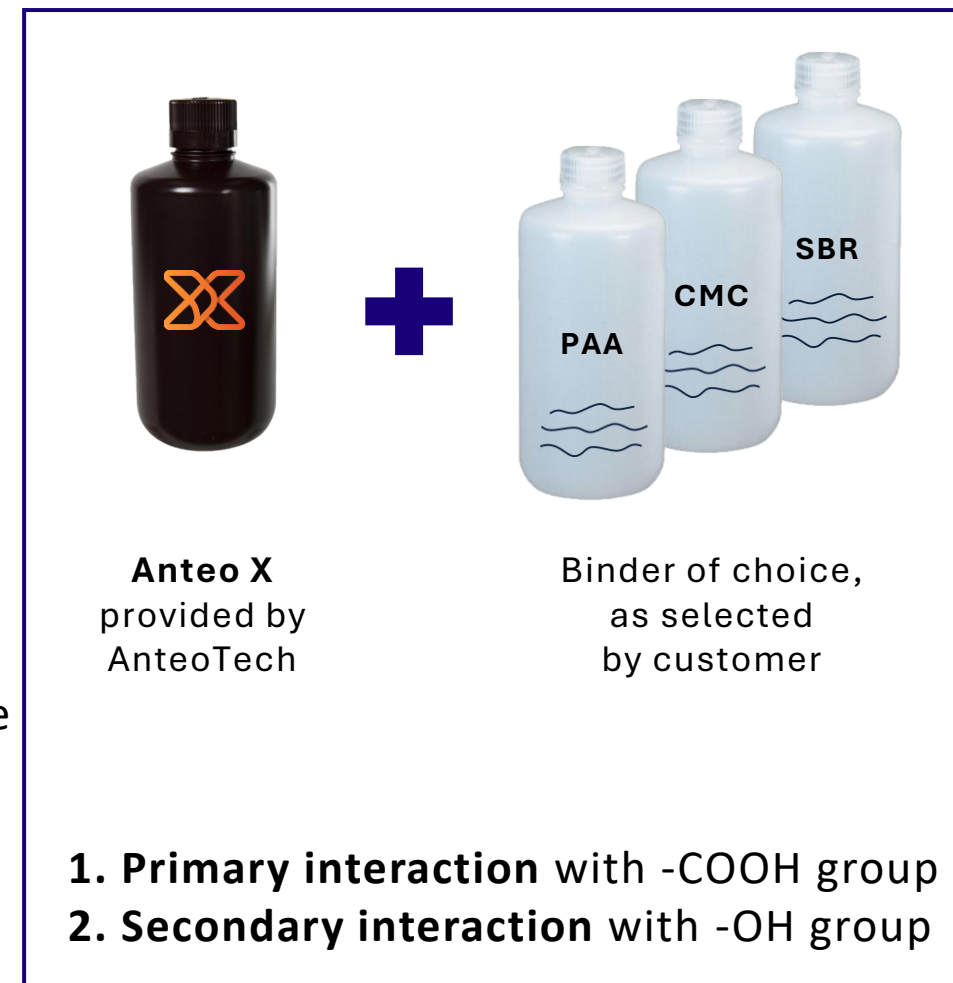
## Product specifications

- Water-based, PFAS free solution
- Water-like rheology allows simple mixing
- Customizable across cross-linking strength & pot-life



## Cost reductions

- Minimizes binder content
- Optimizes SWCNT content (can use SiMRAX)



# Case study – Automotive Customer

## Potential cost savings by optimizing the inactive material fraction of the anode

### Objective:

- AnteoTech to optimize anode formulation: Increase cycle life and minimize CNTs

### Process:

- Customer provided their baseline formulation as reference as well as preferred raw materials
- Internal screening in coin cells (>80 formulations)
- 100 meter roll-to-roll (R2R) coated electrode manufactured at 3<sup>rd</sup> party contractor
- Electrode tested in coin cells and single layer pouch cells

### Outcomes:

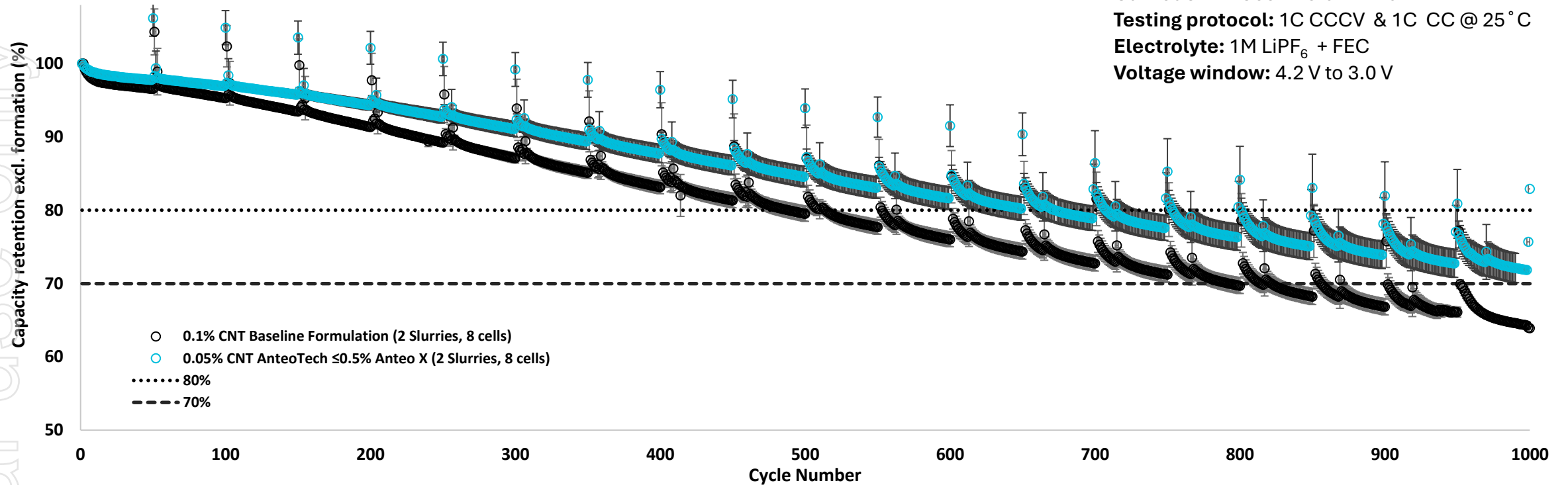
- ✓ Performance verified
- ✓ +330 cycles achieved in optimized formulation, integrating Anteo X; Scaled to SLPs.
- ✓ Electrode roll successfully sold back to customer for further evaluations

# Step 1 - Formulation Screening - 600mAh/g with Si/C and Gr



Potential cost savings by optimizing the inactive material fraction of the anode

**Cathode:** NMC532 – 3.6 mAh/cm<sup>2</sup>  
**Testing protocol:** 1C CCCV & 1C CC @ 25 °C  
**Electrolyte:** 1M LiPF<sub>6</sub> + FEC  
**Voltage window:** 4.2 V to 3.0 V



	Formation cycle discharge capacity @C/20 (mAh/g)	1 <sup>st</sup> cycle discharge capacity @1C (mAh/g)	Initial coulombic efficiency (%)	Cycle number at 80% capacity retention (excl. formation)	Cycle number at 70% capacity retention (excl. formation)	Final capacity at cycle 1,000 (mAh/g)
Baseline Formulation	603	467	84.68	489	793	287
0.05wt.% CNT ≤0.5wt.% Anteo X	603	474	86.00	674	>1000 (@71.85%)	340
<b>Improvement</b>	-	8	1.32	<b>185 (38% increase)</b>	<b>&gt;207 (&gt;26% increase)</b>	53

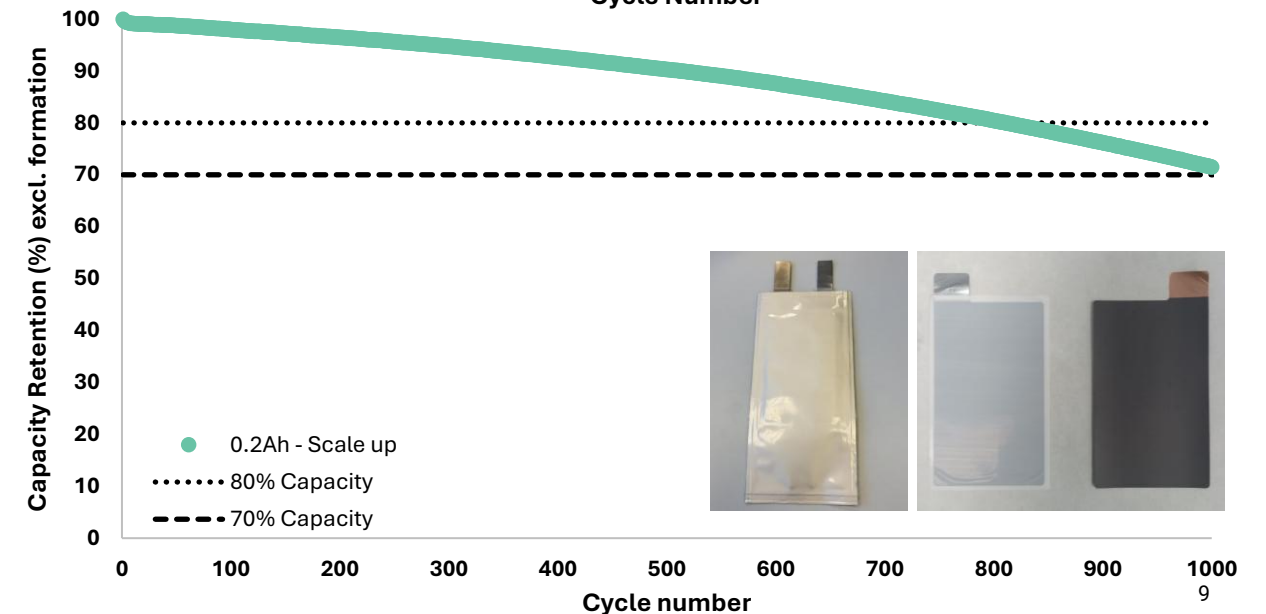
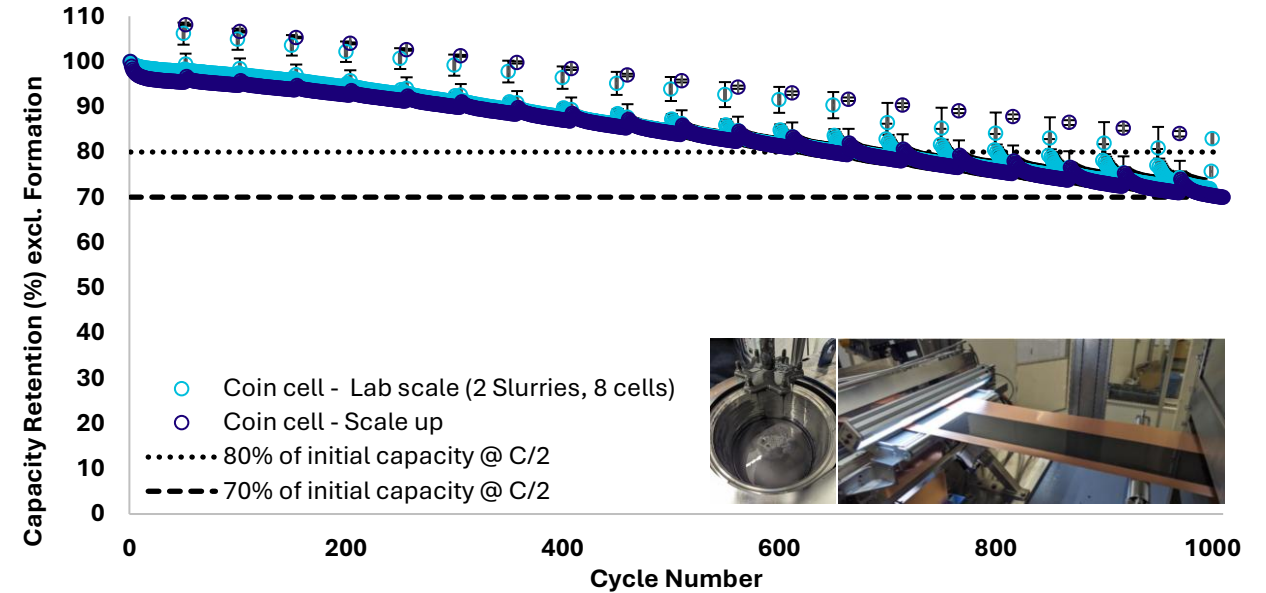
# Step 2 - Single-layer or Multi-layer Pouch Cell testing

## Lab-scale produced electrodes vs. R2R coated electrodes

- Full coin cells produced from A4 hand sheet coatings almost exact match with results produced from R2R coated anode formulation
- **Coin cell (A4 hand sheets): 673 cycles @ 80%**
- **Coin cells (R2R coated): 653 cycles @ 80%**

## Full Coin Cells vs. Single Layer Pouch Cells

- The R2R coated anode formulation tested in 0.2Ah SLP cells showed a 17% improvement in capacity retention when compared with coin cell data
- Results from full coin cell to SLP cells showed excellent scalability
- **0.2Ah SLPs (R2R coated): 820 cycles @ 80%**



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# Leading Cross-linking Technology Product Portfolio for Electrodes and Ceramic Separator Coatings



ANTEO S™

ANTEO X®

**SIMRAX**

Cross-linker for Ceramic Coated Separators (CCS)

Cross-linker for Silicon Anodes

Anteo X + SWCNT Combination Product

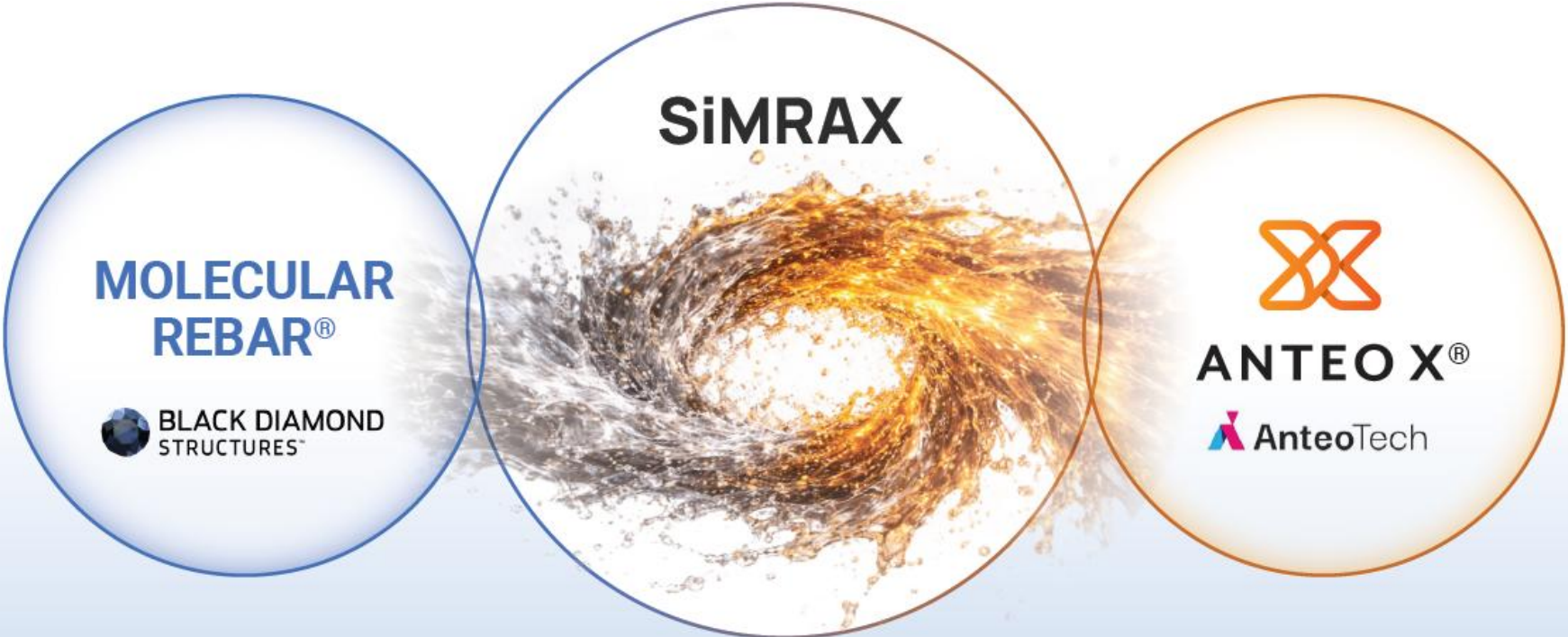
NEW

➤ All-in-one high silicon anode binder strengthening additive

NEW

# The most efficient binder strengthening system around AnteoTech

Demonstrated >50% higher cycle life in high silicon anode cell designs, at ultra low CNT loadings



**Leading CNT formulation technology**

Water-based dispersion

**SiMRAX**, suited to >15wt.% silicon anodes, improving performance, minimizing cost and simplifying addition processes

**Leading cross-linking technology**

Water-based solution

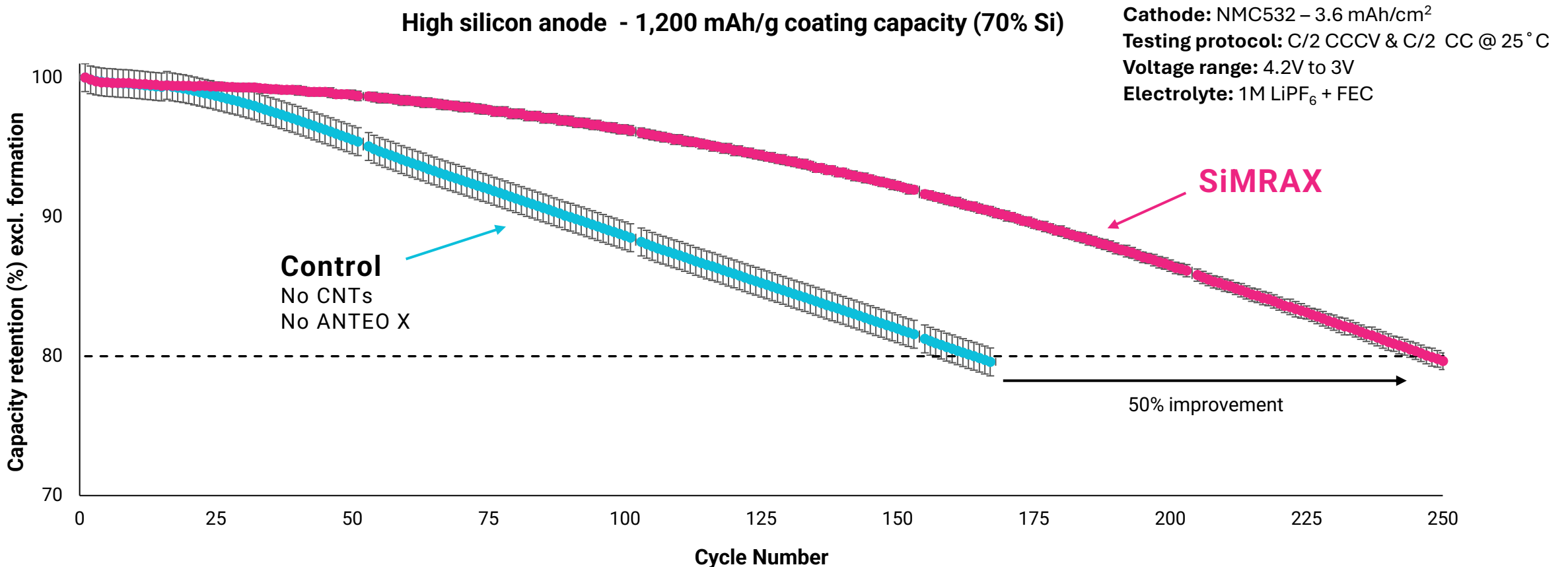
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# SiMRAX – Anteo X + Single Walled CNTs

First of its kind product enabling high silicon anode performance



A NEW product delivering the world's most efficient binder strengthening agent by combining high-quality carbon nanotube products with unique cross-linker technology into a one-shot enablement of high silicon anodes.



# AnteoTech's Production Facilities

GWh production capacity available

- **ISO 9001** certified, **20,000L** manufacturing facility
- ~1 GWh/year production capacity
- With capacity to expand to 2 GWh/year
- Located at AnteoTech's HQ in Brisbane (Australia)



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# Samples and Commercial Volumes

Samples are available in various volumes [liters] to meet all development stages

Stage	Anteo X	Anteo S	SiMRAX
Samples [L]	0.1, 1	0.1, 1	1
Pilot [L]	10	10	On request
Commercial [L]	500, 1000 (IBCs)	500, 1000 (IBCs)	On request






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# Leading in High Silicon Anode Technology



## ULTRANODE™

Application	Automotive & eVTOLs 	3C Markets and Micro-mobility 	UAS, Drones and Defence 
Ultranode technology	Ultranode® X	Ultranode® 70	Ultranode® 95
Cycle life	High (>1,000 @ 80%)	Medium (>500 @ 80%)	Medium (>200 @ 80%)
Coating capacities	Medium (700-1,100 mAh/g)	Medium (700-1,100 mAh/g)	High (1,800-2,400 mAh/g)
Supply Chain Options	Korea, China, US	Korea, China, US	Korea, China, US
Engagement pathway	<ol style="list-style-type: none"> <li>1. Technology partnership</li> <li>2. Joint Development Agreements</li> <li>3. Licensing</li> </ol>	<ol style="list-style-type: none"> <li>1. Ultranode samples</li> <li>2. Ultranode + Cathode sample packs</li> </ol>	<ol style="list-style-type: none"> <li>1. Ultranode samples and</li> <li>2. Ultranode + Cathode sample packs</li> </ol>

# Ultranode™ 95 – Superior Wh/kg for Superior Flight Time

High capacity and cost-effective anode technology that is available today



## Ultranode 95's unique Value Proposition



### Superior Wh/kg at anode/cell level

>2,400mAh/g of anode coating capacity possible



### Lowest \$/kWh silicon active material

Highly cost-effective anodes



### Supply chain security

Existing silicon raw material supply from US, KR, EU



### Highly customizable

Same active material different coating capacities



# Ultranode™ 95 – Roll-to-roll manufacturing scale-up



Roll-to-roll scale-up completed

## Process scale-up

- + Straight forward transition from lab-scale (protocols) to larger scale
- + 70% reduction in slurry mixing times compared to other lithium-ion anode slurries including graphite and Si/C
- + Project underway to progress to 5Ah cells and cylindrical cell builds for trials

**Purpose:** Scale-up of Ultranode 95

**Coating length:** 50m SS / 100m DS

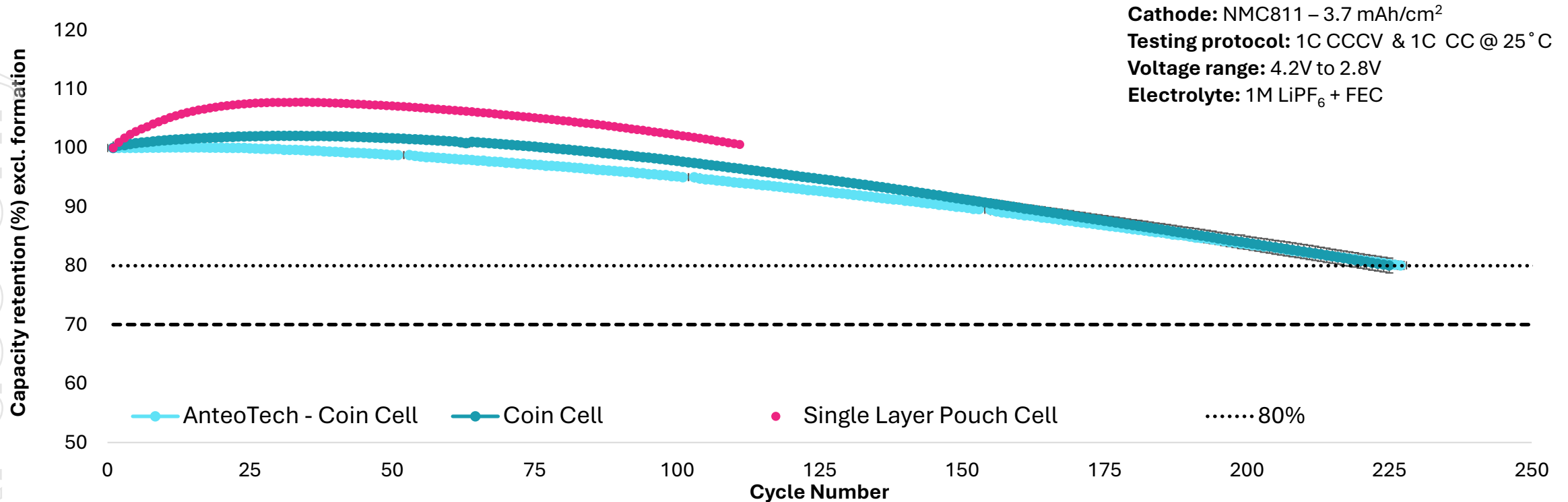
**Outcome:** Defect free Ultranode 95



# Ultranode™ 95 vs. NMC811 – Current Scale-up Program



Moving from Single Layer Pouch Cells into Multi Layer Pouch Cells to Cylindricals



Cell configuration Ultranode 95 vs. NMC811	Formation cycle discharge capacity @C/20 (mAh/g)	1 <sup>st</sup> cycle discharge capacity @1C (mAh/g)	Initial CE (%)	Cycle number at 80% capacity retention (excl. formation)	Cycle number at 70% capacity retention (excl. formation)
AnteoTech – Coin Cell	2,161	1,852	89.0	227	305
Coin Cell	2,013	1,721	88.5	225	TBD
Single Layer Pouch Cell	2,014	1,691	88.3	TBD	TBD

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# What our Products Deliver

Leading in silicon anode technology and performance improvements



**ANTEO X<sup>®</sup>**



**ANTEO S<sup>™</sup>**



**SiMRAX**

- **Anteo X<sup>®</sup>** cross-linking additive that improves silicon anode performance
- **Anteo S<sup>™</sup>** additive for ceramic coated separators improving cost and safety
- **SiMRAX** an Anteo X<sup>®</sup> + SWCNT combination product for silicon anodes
- “Accelerate” Implementation package available - Sample plus service
- +20,000L existing production capacity (~1 GWh)



**ULTRANODE<sup>™</sup>**

- **Ultranode<sup>®</sup>** is a fully integrated silicon anode
- Highly customizable for Maximum Capacity or Maximum Cycle Life
- Cost effective silicon material sourced from established supply chains
- Range of commercial partnering opportunities



**FORMULATION  
SERVICES**

- Can rapidly deliver into customer’s requirements
- Independent advice on silicon active materials including supply
- Flexible packages with staged pricing structures



# THANK YOU

Contact us for samples or partnership opportunities!

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