
THECORETECGROUP
Endurion

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The Coretec Group Team

Matthew Kappers, Chief Executive Officer

Matthew Hoffman, Chief Operating Officer and Chief Financial Officer

Dr. Michelle Tokarz, Vice President of Partnerships and Innovation

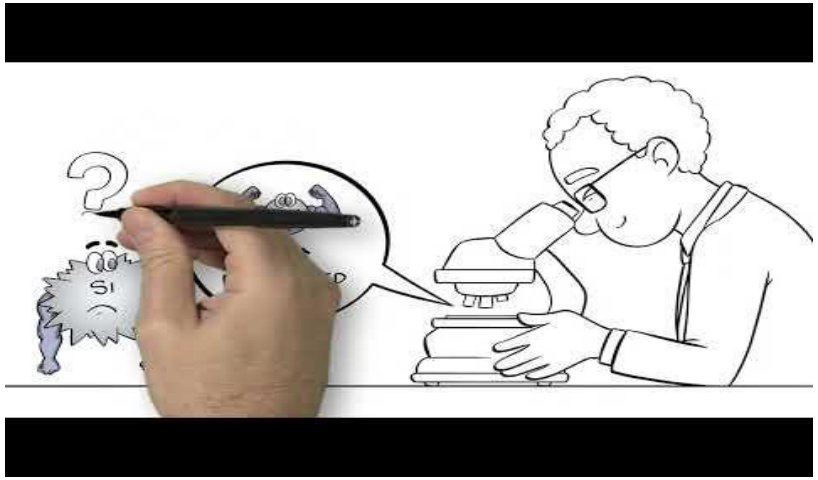
Agenda

December 14, 2022

- Endurion
- Partnerships
- Cyclohexasilane (CHS)
- C-Space
- 2022 Accomplishments
- Priorities for 2023
- Q&A

Endurion

Explainer Video



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Endurion Project Highlights

Developing a novel Si-based active anode material with an engineered SEI layer on Si-based nanoparticles

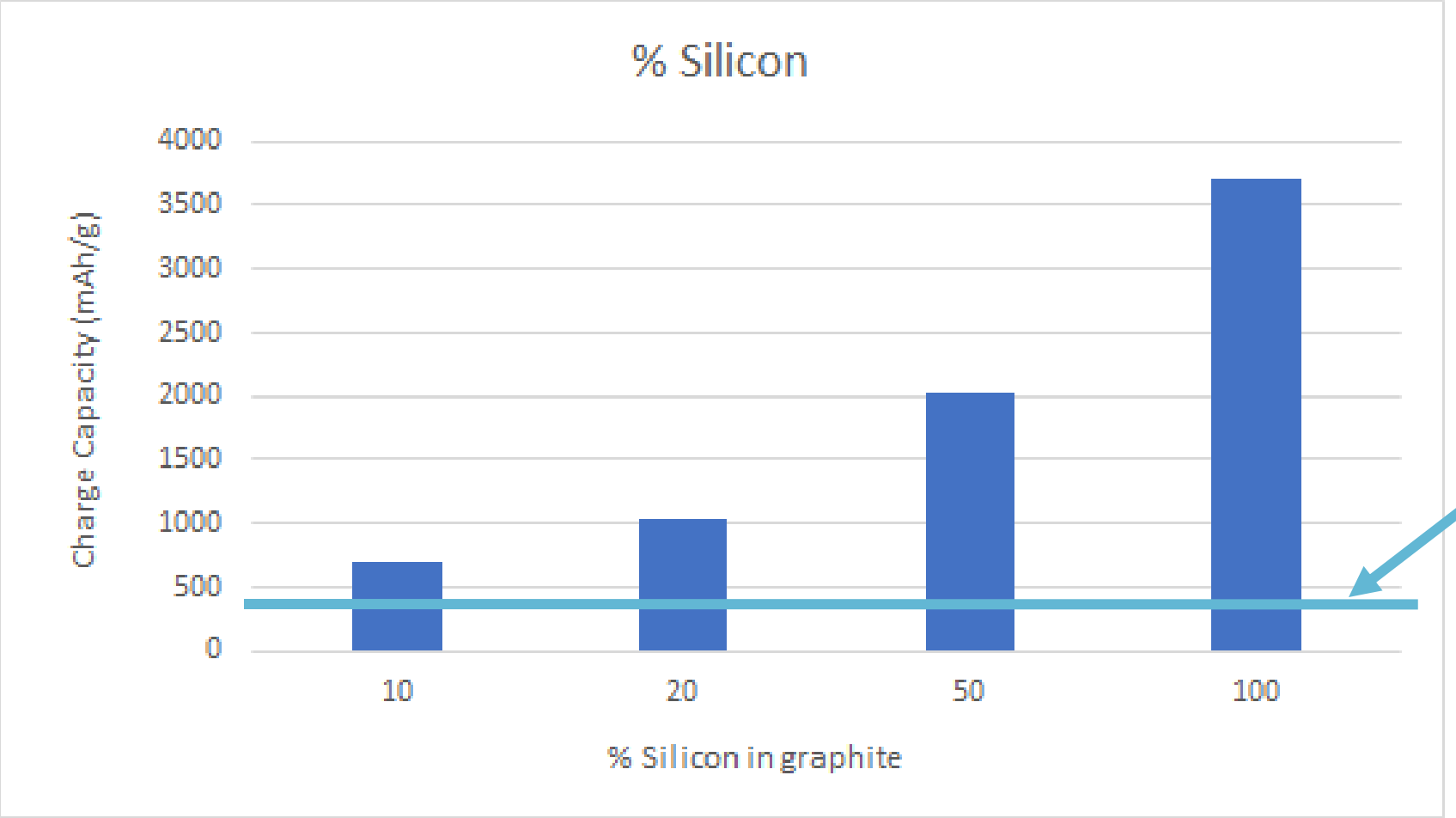
- Prototype being developed in Coretec wetlab
- IP on CRTG unique silicon anode technology filed

- ❑ Increased Energy Density
- ❑ Faster Charging
- ❑ Longer Lifespan

BENEFITS OF SILICON ANODES

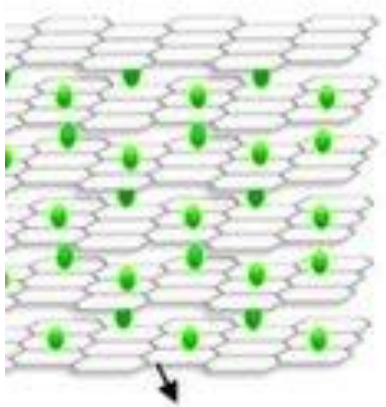
Why silicon in anodes?

Silicon → 10X charge capacity over graphite



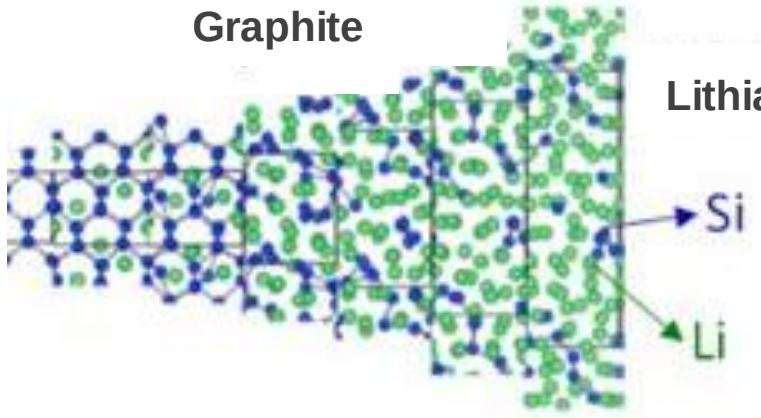
Graphite → Silicon

Fundamentally Different



Graphite

Lithium ion
Graphite 6-member ring
Silicon

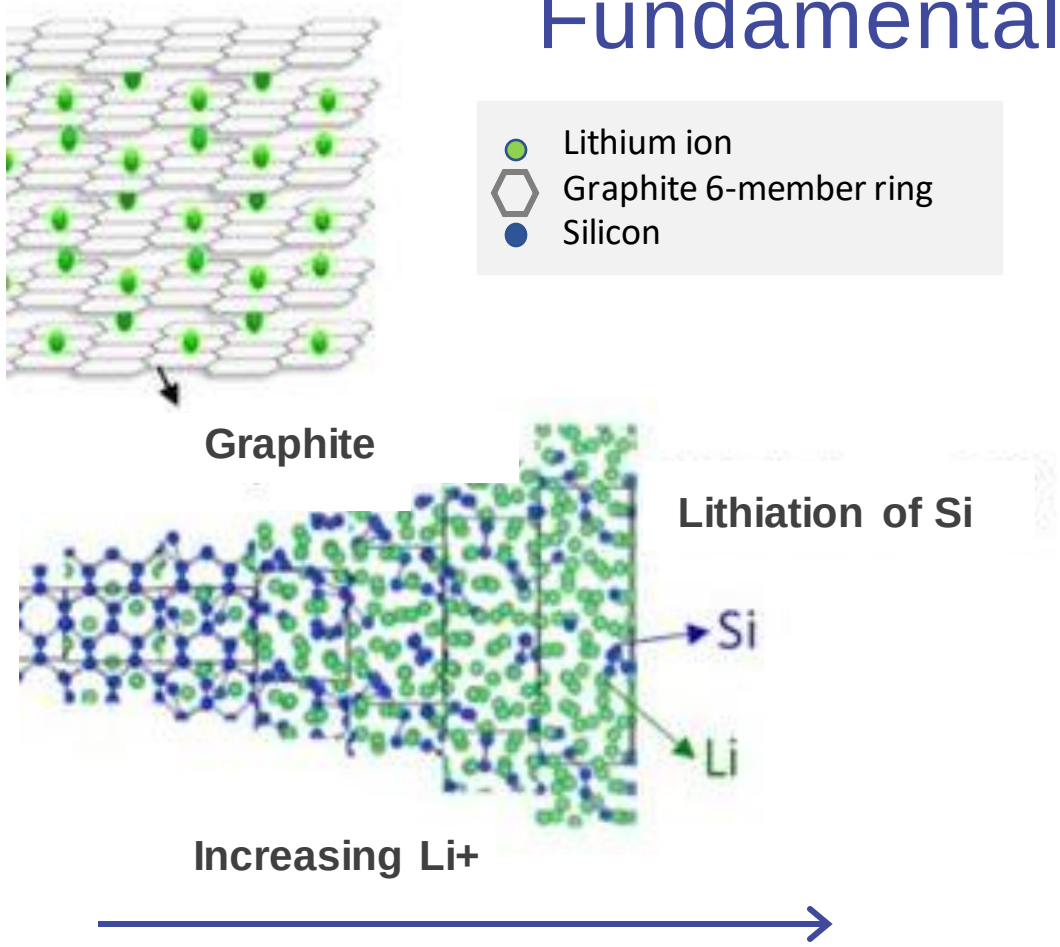


Lithiation of Si

Increasing Li+

*Okoro, Faith. (2018). Li-ion Batteries for Electric Mobility. 10.13140/RG.2.2.36748.77446.

Graphite → Silicon
Fundamentally Different



Lithiation (def) – The process by which an electrode interacts with lithium ions

Graphite Anode
- 6:1 C:Li+
- Expands ~ 13% upon lithiation

Silicon Anode
- 1:4.4 Si:Li+
- Expands 300-400% upon lithiation

Okoro, Faith. (2018). Li-ion Batteries for Electric Mobility. 10.13140/RG.2.2.36748.77446.

Expansion Issues → SEI – The Solution

Structure design

Intentional creation of artificial SEI

- Currently mostly an academic exercise
- Current solutions do not allow Li-ion conduction

Electrolyte additives

- Current industry approach

Pre-lithiation

- Current industry approach
- Costly

Lee et. Al., "Controlled swelling behavior and stable cycling of silicon/graphite granular composite for high energy density in lithium ion batteries," Journal of Power Sources, Volume 457, 2020, 228021,

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The Coretec Group's Solution

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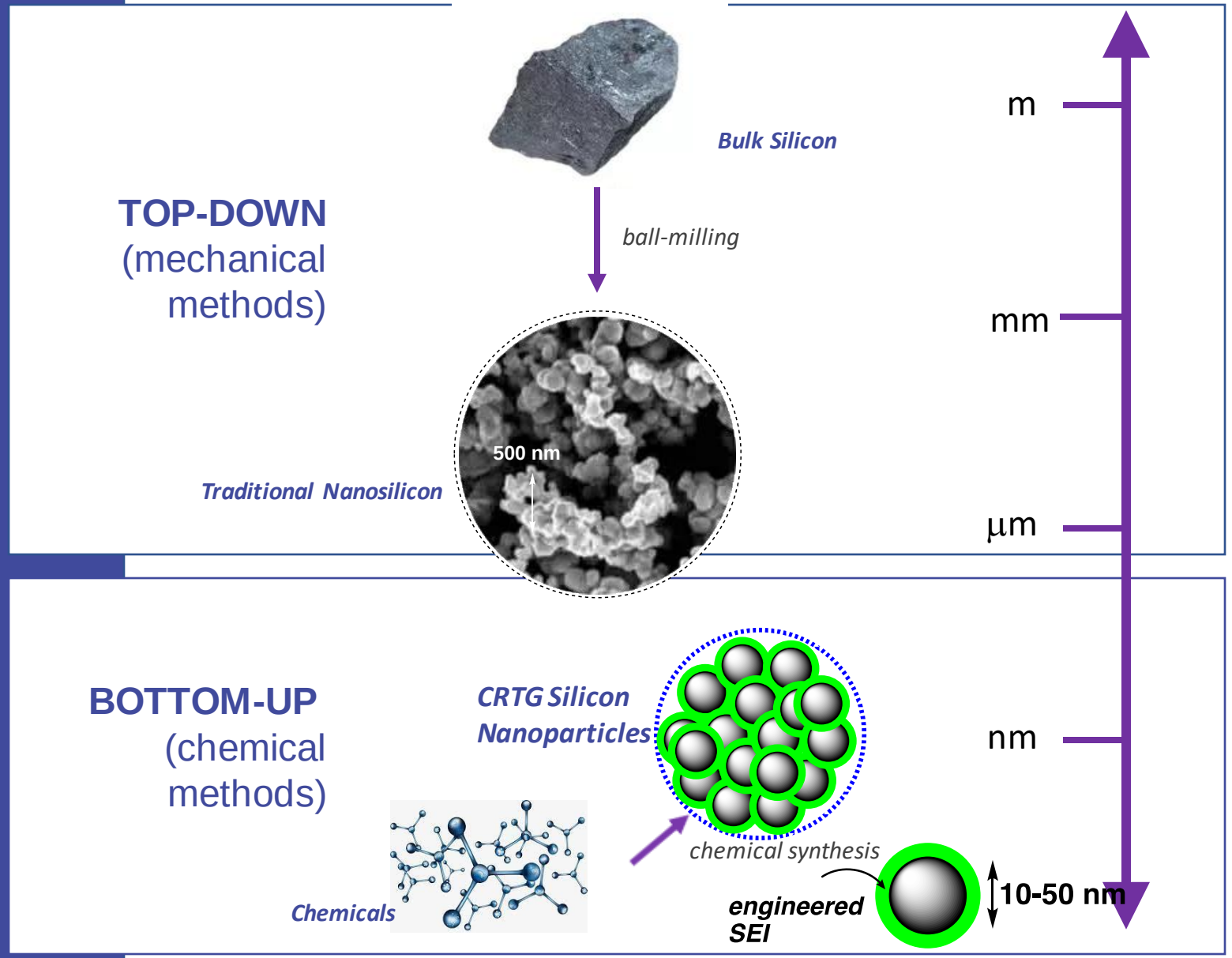
Si-BASED FUNCTIONALIZED NANOPARTICLES (Top-down VS. Bottom Up)



Si-BASED FUNCTIONALIZED QUANTUM DOTS (Top-down VS. Bottom Up)

TOP-DOWN (mechanical methods)

- Mostly ball-milling processes
- 100 nm diameter practical limit
- Non-uniform particle surfaces
- Tend to agglomerate

- ***Non-ideal for further chemical functionalization***

BOTTOM-UP (chemical methods)

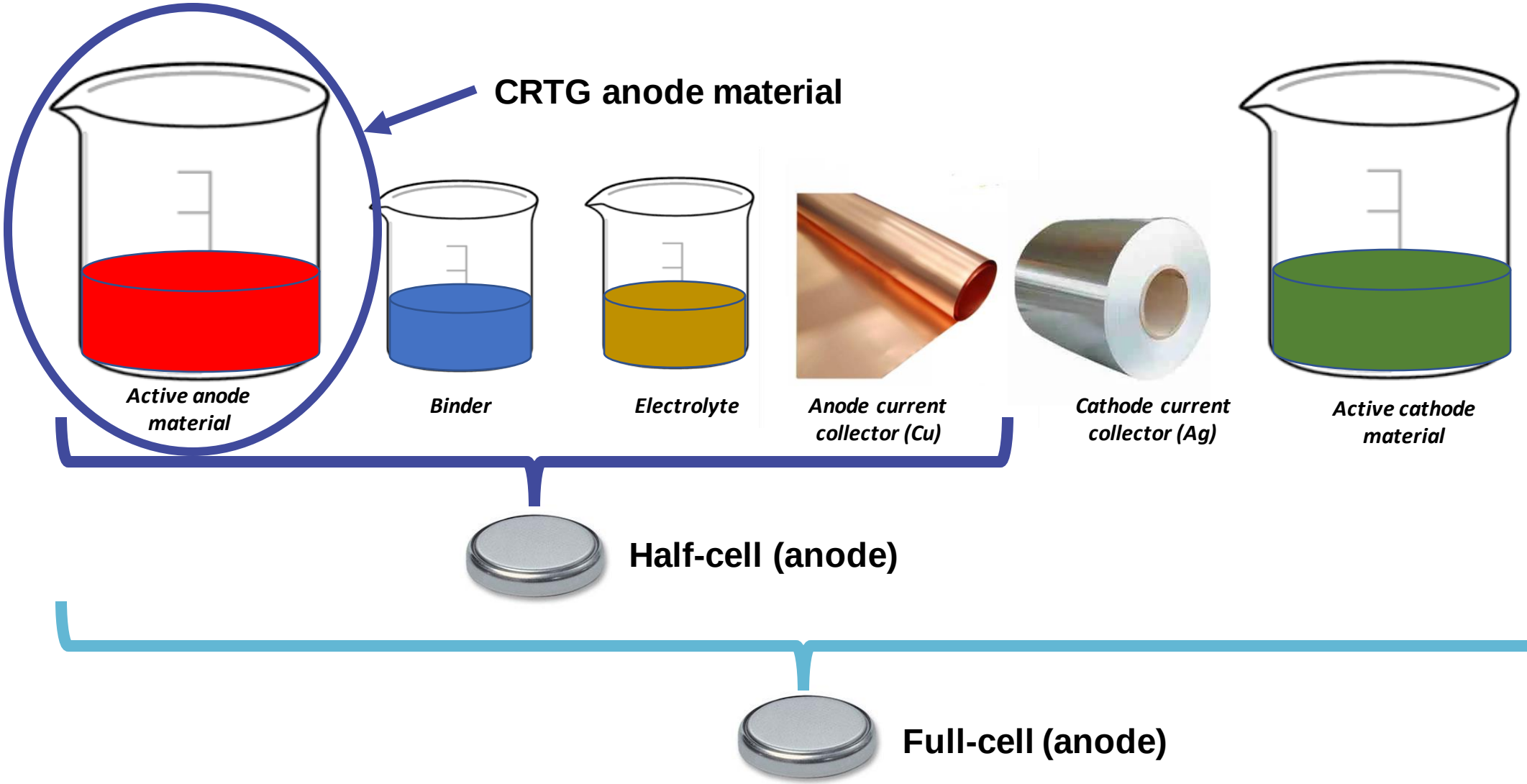
- Traditional chemical synthesis techniques
- 2-50nm diameter sized particles
- Chemically "tailorable" surfaces
- Grown and/or isolated on carbon-based templates

- ***Surfaces can be further functionalized* to create an "Engineered SEI" layer***

CRTG's active anode materials are a specific ***subset*** of nanoparticles that are ***customizable*** to create chemically specific SEI layers

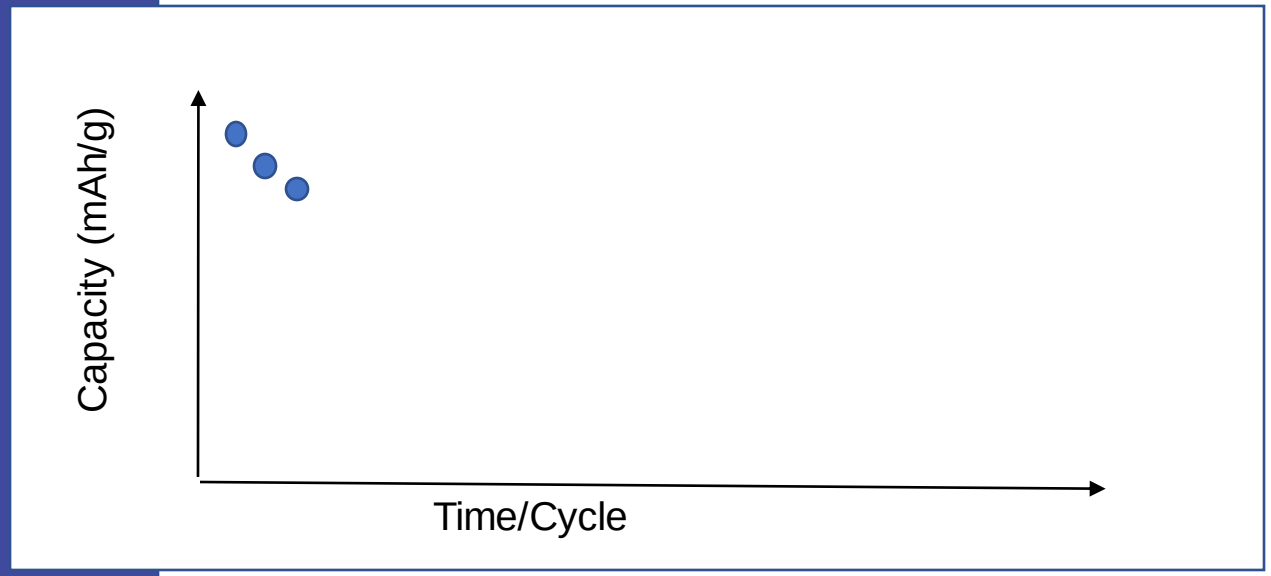
functionalize (def) - chemical reaction

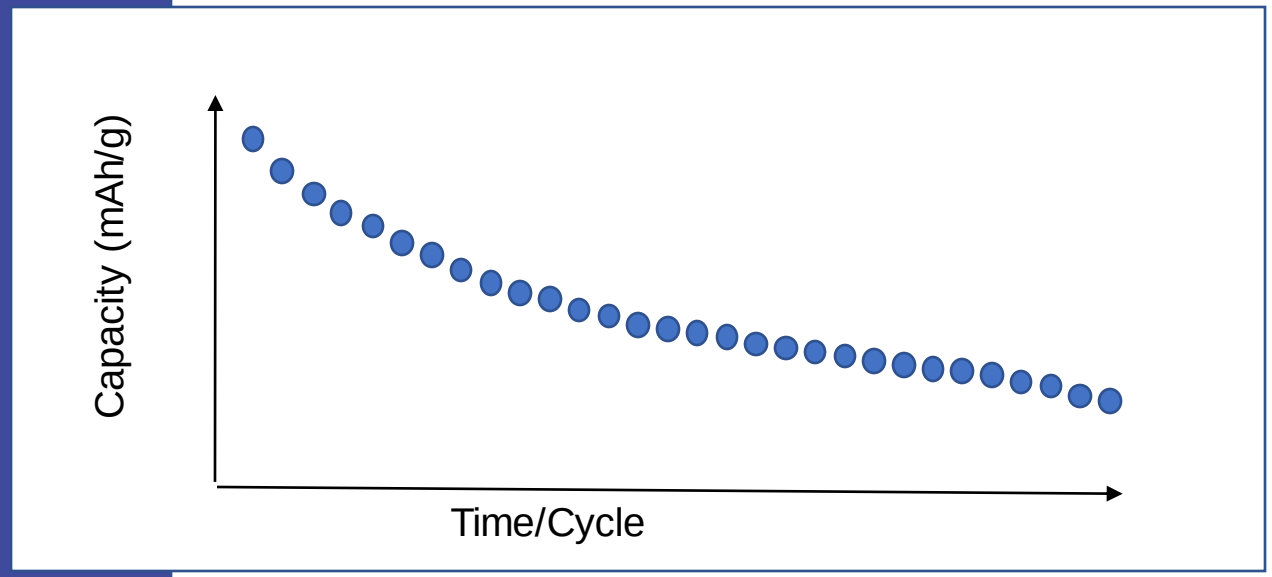
The Making Of A Traditional Slurry-based Electrode



BATTERY TESTING PROTOCOLS

- Optimization of anode slurry
- Production of coin & pouch cells
- Initial capacity
- Behavior during formation*
- Capacity loss during first few cycles
- Long term cycling behavior





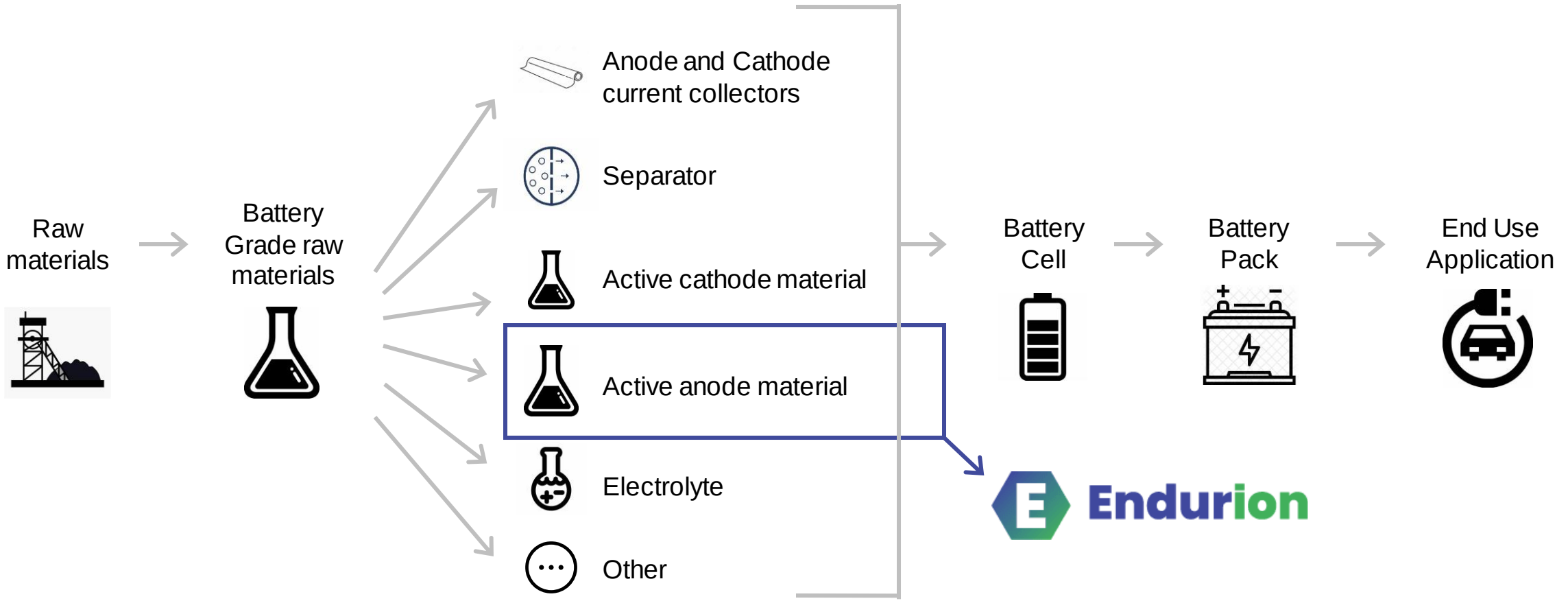
**Formation – refers to the first few charge/discharge steps of battery cell(s) to discern anomalous cells that need to be discarded from further testing*

ENDURION TECH STATUS

- Extensive labwork has resulted in active anode material for testing
- Our preferred battery testing partners are testing our active anode material during Dec and Jan
- Our team will be working at The Battery Lab, a commercial resource established in partnership with the UofM, MEDC, and Ford Motor

PARTNERSHIPS

Battery Ecosystem



PARTNERSHIPS

Downstream Partners	• Graphite/graphene suppliers • Active anode material suppliers
Component Partners	• Cathode manufacturers • Separator manufacturers • Electrolyte manufacturers
Upstream Partners	• Cell manufacturers • Pack manufacturers • End-use application manufacturers

MARKET OPPORTUNITIES

Global Markets	• Global Lithium Ion Battery • Global Electric Vehicles
Other Markets	• Military Applications • Grid-Scale • Consumer Electronics

CYCLOHEXASILANE (CHS)

CHS Update

- CHiPs Act
- Eindhoven University
- French Alternative Energy and Atomic Commission (CEA)
- Manufacturing partners

C-SPACE

C-SPACE Update

- University of Adelaide
- Tellurite Glass
- Australian Institute of Physics (AIP) Conference
- Research to be distributed in December 2022

2022 Accomplishments

- **Team (Additions) & Capabilities**
  - Research Scientist Hire (Dr. Downes)
  - Wet laboratory
  - COO role (M. Hoffman)

- **Technology**
  - C-Space
    - University of Adelaide partnership and contract
    - Material research (Tellurite glass) and December 2022 publication

  - CHS (Cyclohexasilane)
    - Atomic Energy Commission (CEA)
    - Low deposition temperature and high yields
    - Si nano-flakes & nanowires utilizing our CHS

2022 Accomplishments

- **Technology (con't)**
  - Endurion
    - Development of CRTG Si nanoparticles (SiNP)
    - Engineered material for SEI layer on SiNP
    - Testing coin cells using CRTG active anode material
- **Awareness & Outreach**
  - Endurion 'explainer' video
  - Dr. Tokarz Endurion selected presentation at "Bridging the Gap: Advancing America's Battery Manufacturing and Supply Chain"
  - The Battery Show, North American Auto Show & Industry Days, among others
  - NDA covered partnerships

2022 Accomplishments

- **Intellectual Property**
  - Filed Full Utility Patent for Development of Advanced Silicon Anodes (February 2022)
  - Endurion trademark
  - Renewed license agreement for C-Space related patents with Univ. of Oklahoma
  - Standard ‘upkeep’ with Patent Cooperation Treaty actions and renewals

Priorities in 2023

Development of Endurion

- Active anode material
- Partners for Endurion
- Intellectual property
- Government funding
- End user partners for Endurion

Q & A

#CRTG

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