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EndurIon

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Why silicon in anodes?

Anode Charge Capacities – A Comparison

Graphite* – 372 mAh/g

Silicon – 4200 mAh/g (~3600 for $Li_{3.75}Si$)

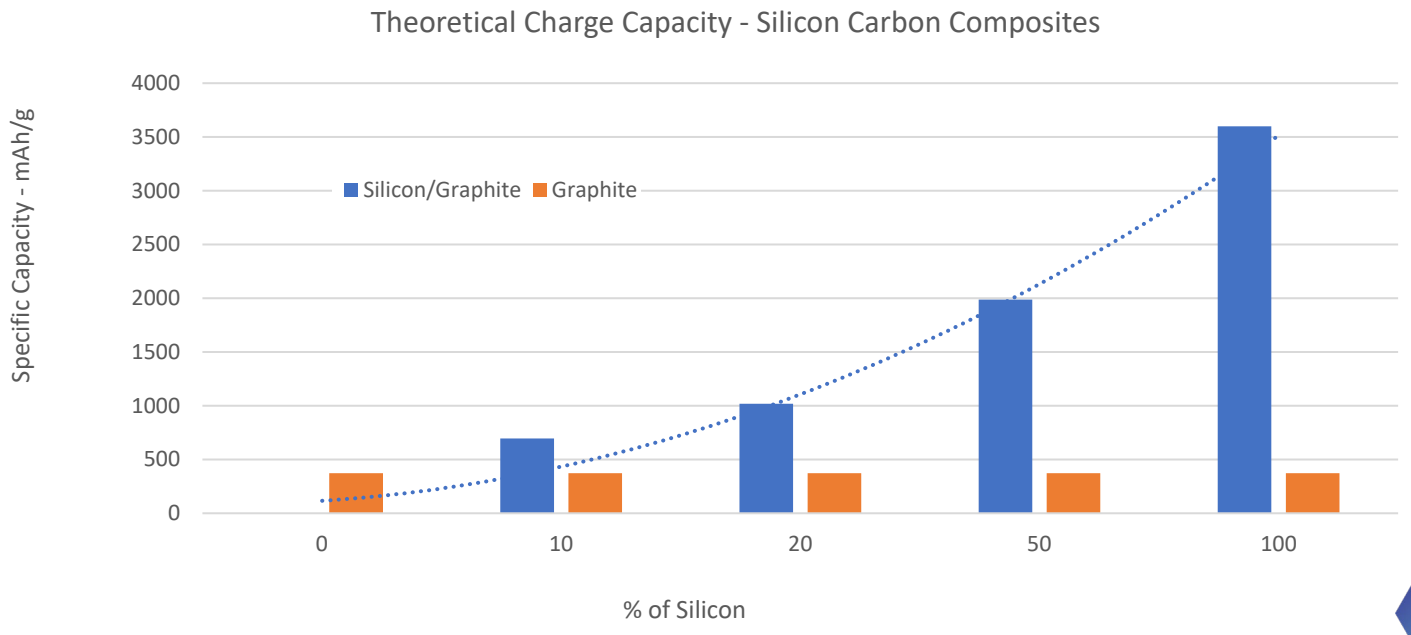
Theoretical Charge Capacity - Definition

– "the maximum amount of charge that a material can hold, typically expressed in mAh/g or mAh/L"

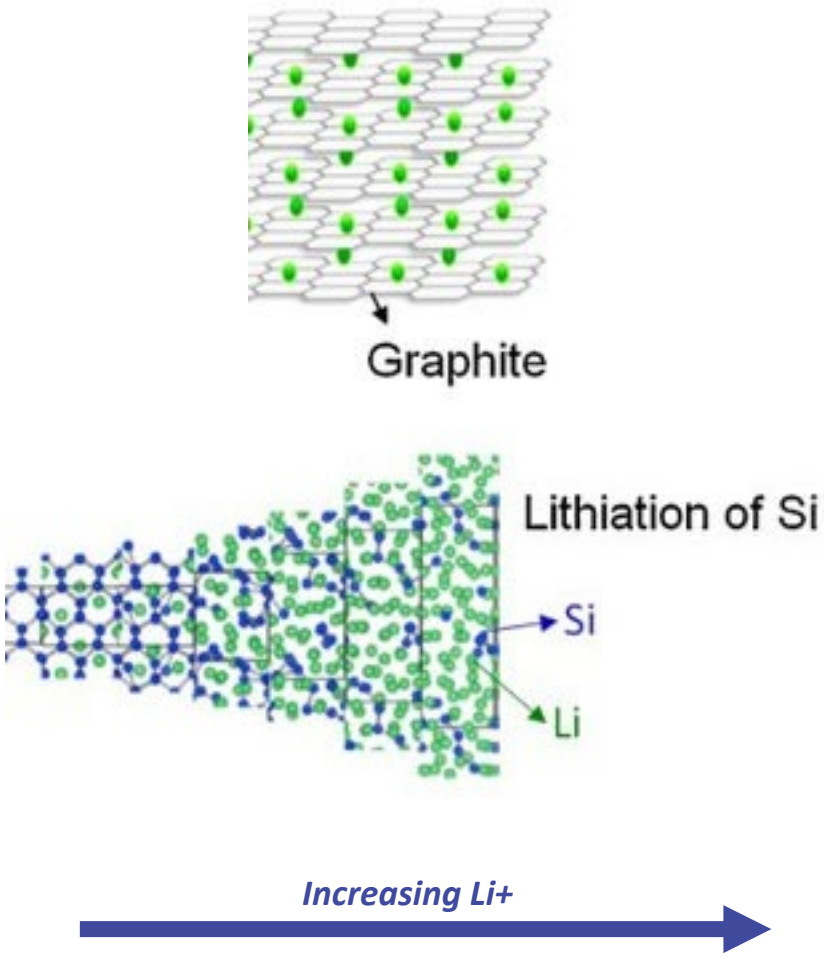
- Is a fundamental ***material property*** independent of how it is used in application

Because of the 10X increased capacity of silicon, even small additional amounts in a graphite matrix contribute substantially to overall increased anode capacity

**Graphite has been traditionally used as the anode material in a good majority of lithium ion batteries*



Graphite >> Silicon: Fundamentally Different



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

Graphite Anode
- Traditional
- “Intercalation” chemistry
- Weak interactions between Li+ and C
- 6 : 1 C:Li+
- Expands ~ 13% upon lithiation

Silicon Anode
- New material
- “Alloying” chemistry
- stronger bonds between Li+ and C
- 1 : 4.4 Si:Li+
- ***Expands 300-400% upon lithiation***

Implementation of Silicon Into Anodes

Expansion/Contraction of Si leads to

- Pulverization
  (loss of contact w/current collector)
- Unstable SEI
  (solid-electrolyte-interphase)

Current solutions include

- Nanoscale structure (thin films, nanowires, nanoparticles, etc.)
- Surface modification
  - Easier slurry processing
  - Artificial SEI (enhanced conductivity)

Coretec's Unique Si-based Solution

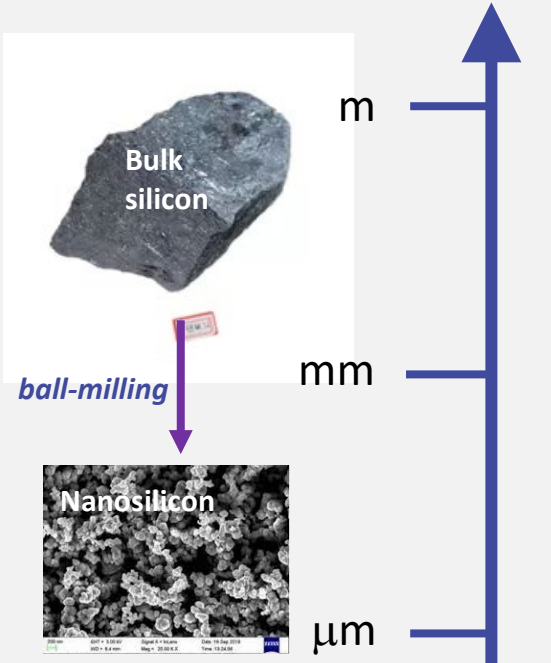
Si-based Nanoparticles

An ENGINEERED SEI that will allow Li ion conduction and ideal processing

Si-based active anode material capable of long cycle-life while maintaining higher capacity

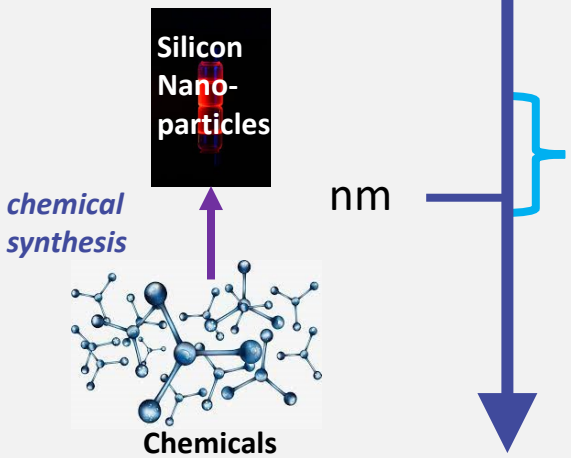
Si-Based Functionalized Quantum Dots (Top-Down Vs Bottom-Up)

Top-Down
(Mechanical Methods)



- Mostly ***ball-milling*** mechanical processes
- Nanoparticles ~ ***100 nm***
- ***Non-uniform*** particle surfaces
- Tend to ***agglomerate***
- ***Non-ideal*** for further chemical ***functionalization***

Bottom-Up
(Chemical Methods)



CRTG Active anode material

- Traditional ***chemical synthesis*** techniques
- Chemically ***"tailorable"*** surfaces
- ***Grown*** and/or isolated on carbon-based ***templates***

Can be further functionalized to create "Engineered SEI" layer

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ENGINEERING SILICON TO IMPROVE LIFE

Graphite -> Silicon: Fundamentally Different

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