High-Density High-Efficiency Silicon-Dominant Composite Anodes & Cells

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Traditional Li-ion Batteries

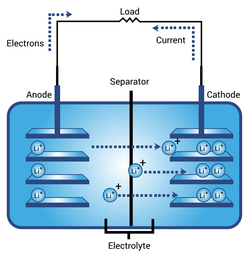
Graphite has historically been the anode material of choice for lithium-ion batteries. Silicon is an anode material that has been of great interest due to its high gravimetric energy density.

Graphite-dominant Li-ion cells using silicon as an additive are easier to implement, but additive amounts are typically less than 10% and the additives themselves are diluted silicon compounds such as silicon oxide.

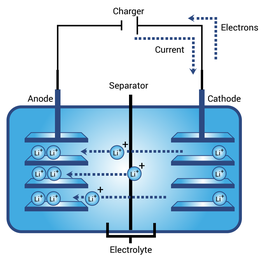
Other silicon-dominant (more than 50% silicon) approaches to date—such as those using silicon wafers and silicon nanowires—are typically difficult to manufacture and offer low material density at the battery cell level.

Due to lithium plating on the anode surface, conventional graphite cells fade quickly when charged at high rates, i.e. the available battery capacity degrades after just a few charge and discharge cycles.

Lithium-ion rechargeable battery Discharge mechanism



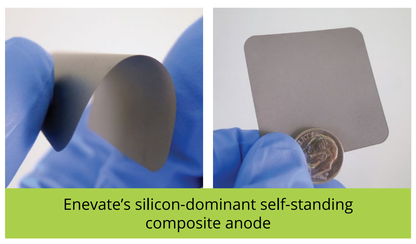
Lithium-ion rechargeable battery Charge mechanism



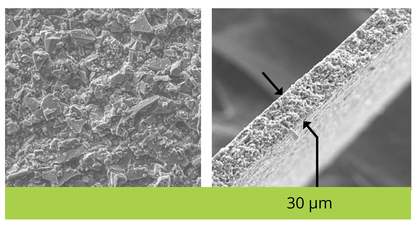
Enevate Corporation's Unique Approach

Enevate's HD-Energy Technology, a self-standing, silicon-dominant composite anode with more than 70% silicon, delivers more than 4X the energy density of conventional graphite anode materials in an ultra-thin form factor for today's ultra-slim devices.

Enevate's conductive, silicon-dominant composite film anode is essentially 100% active material that can store lithium and has a high electrical conductivity. This anode enables Enevate to deliver ultrafast charging, high energy density, and long runtimes in its Li-ion batteries.



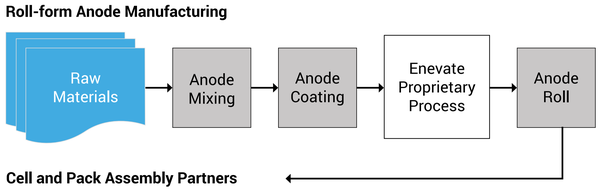
Enevate's silicon-dominant self-standing composite anode



Properties of Enevate inexpensively manufactured silicon-dominant active anode material film:

- Silicon-dominant: >70% silicon
- Gravimetric energy density: ~2800 mAh/g
- 1500 mAh/g utilized in cell design with volumetric and energy densities of ~750 Wh/L, ~300 Wh/kg
- High initial Coulombic efficiency: 93% for anode, ~90% for full cells
- High density of anode: 1-1.5 g/cc
- Silicon surface area: <10 m^2/g
- Compatible with existing high volume manufacturing processes - unlike nanowire or silicon wafer approaches

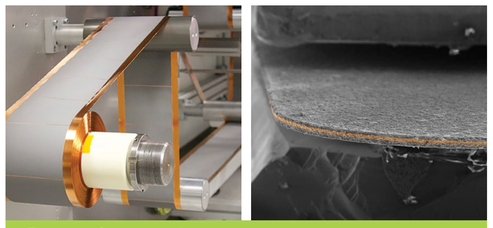
Roll-form Anode Manufacturing



The cell construction process used for conventional stacked Li-ion pouch cells is the same process we use today but using a significantly thinner anode due to its 4X higher energy density.

Enevate's Composite Anode

- Composite comprised of carbon as conductive matrix, silicon as main active material, silicon-carbide as silicon-surface protecting nanometer-scale layer
- Anodes are bonded with proprietary process to the current collector
- Anodes are then sent to Enevate's cell assembly partners



Enevate's Composite Anode

Testing

Two Android smartphones with removable battery packs of same exact size—one with conventional 3180 mAh graphite from a major Japanese Li-ion battery manufacturer vs. Enevate 4000 mAh—were tested on the AT&T 3G/4G network. The batteries were charged/discharged until auto shutdown.

Enevate 4600mAh

Conventional 3180mAh

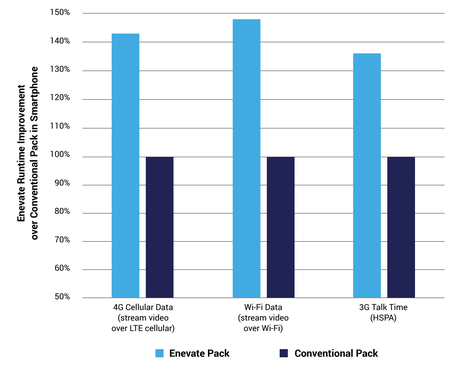
Android smartphone, removable pack

- Enevate testing on AT&T 3G/4G network
- Charged/discharged until auto shutdown

Results

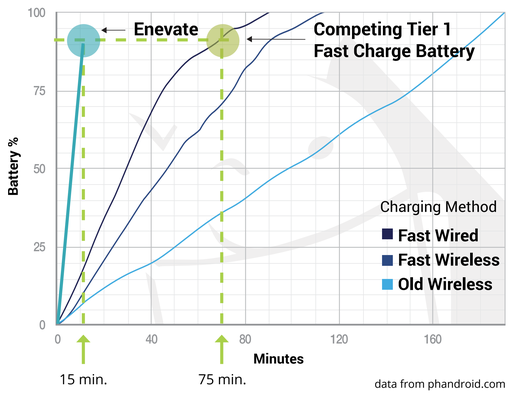
Up to 50% Longer Runtimes than Conventional Batteries

Enevate Li-ion cells can power up devices to meet users' needs for true all-day or multiple-day runtimes under normal or heavy use—even without turning off or "managing" some features. In fact, in recent tests, smartphones powered with Enevate HD-Energy® Technology cells delivered 35-50% more runtime when compared with conventional batteries.



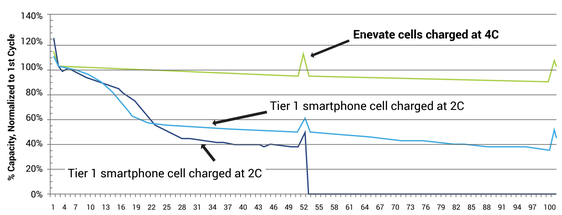
The HD-Energy cell design has excess capacity in the anode—and the anode voltage is higher than a graphite anode in a conventional cell when fully charged—Enevate's cells can support higher rates of charge without lithium plating. Enevate cells have been tested to charge at 4C and cycle well, while top-tier conventional graphite cells fade quickly even when charged at only a rate of 2C. This is due to lithium plating causing early death in the graphite cells.

Enevate cells charge 5X faster than the competing Tier 1 Fast Charge cells

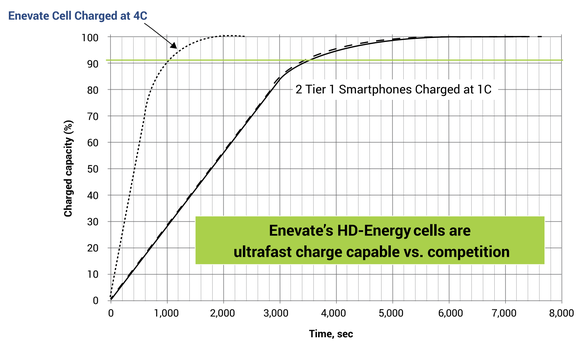


8X Faster Charge over Conventional Graphite Li-ion Batteries, Up to 5X Faster than the Best "Quick-Charge" Li-ion Batteries

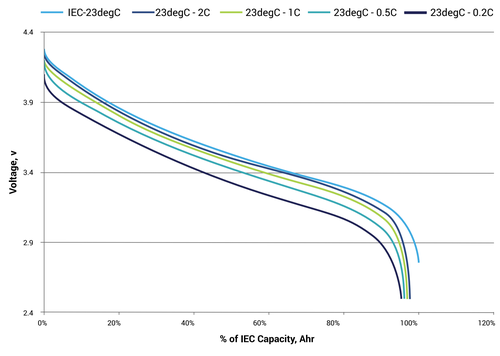
Advanced Enevate HD-Energy Technology batteries charge to 90% in 15 minutes, and 50% in just over 5 minutes—8X faster than conventional batteries and more than 5X faster than the best "fast-charge" batteries.



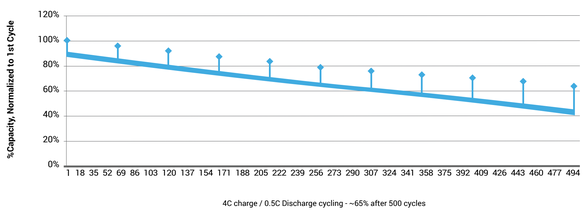
Percent capacity charges vs Time



Discharge Voltage vs Capacity



Average of DCC Discharge Capacity



Low Temperature Performance Down to -20°C

When discharged at a normal rate, cold temperatures will typically lower the discharge capacity of conventional Li-ion batteries by about 20% at -10°C. If the discharge rate is high, then the low temperature capacity performance can collapse even more—50% or more during cold temperature operation.

However, Enevate HD-Energy Technology Li-ion batteries offer excellent low temperature performance at -10°C, even down to -20°C. Operating a device with Enevate batteries in cold temperatures will minimally impact the devices' capacity and power performance.

ENEVATE®
Innovating Energy Storage

Safety

Rigorous Third-Party Lab Testing and Certification to Ensure Safe Operation

Enevate Li-ion energy cells have undergone rigorous testing in third-party labs and certification houses to ensure their safety under normal operating conditions, and have been proven to meet the safety and quality certifications listed below.

- UN 38.3 Cell and Pack
- UL 1642
- CTIA/IEEE 1725 Cell and Pack
- UL 2054
- UL 60950
- IEC 62133

Additional testing is underway to ensure the safety of Enevate Li-ion energy cells in other applications, such as ultrathin PCs/tablets, drones, wearables, and electric vehicles.

Summary

Ultrafast Charging – Full charge in 15 minutes and 50% charge in just over 5 minutes with minimal cycle life degradation—up to 8X faster than conventional Li-ion batteries and 5X faster than so-called "fast-charge" Li-ion batteries. All this is possible without sacrificing energy density as is normally the case in graphite batteries.

Longer Runtime/High Energy Density – Up to 50-80% longer runtime over same-sized conventional battery in devices such as smartphones.

Certified Safe – Rigorous testing by independent and third-party labs to multiple international safety certifications for safe battery operation.

Excellent Low Temperature Performance – Excellent performance in -10°C, even -20°C temperatures.

Investors

$60M funding raised from leading VCs and confidential strategic partners

Mission Ventures, Tsing Capital, Infinite Potential Technologies (IPT), Draper Fisher Jurvetson (DFJ), Sumitomo, China Electronics Corp (CEC), and strategic OEMs

Enevate's board of directors and advisors include:

Mike Lazaridis
Board Director (IPT): Blackberry Founder, former CEO and Chairman

Steve Altman
Advisor: Former Qualcomm President & Vice Chairman

Dr. John Goodenough
Advisor: Key Inventor of Li-ion Battery, University of Texas - Austin

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