
# Enovix Novel Cell Architecture & Electrode Design

## AABC San Diego

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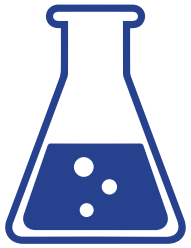
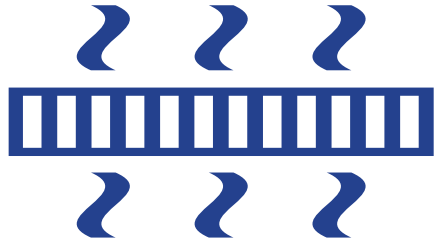
# The Enovix Advantage

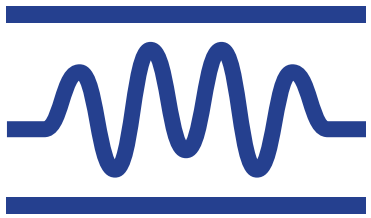


Enables Next-Gen Active Materials that Change Volume & Require Pressure

Step-Change Increase in Energy Density

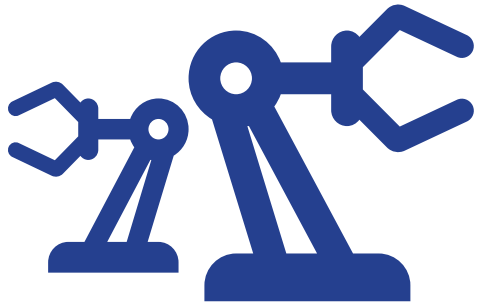


Exceptional thermal performance enabling fast charge



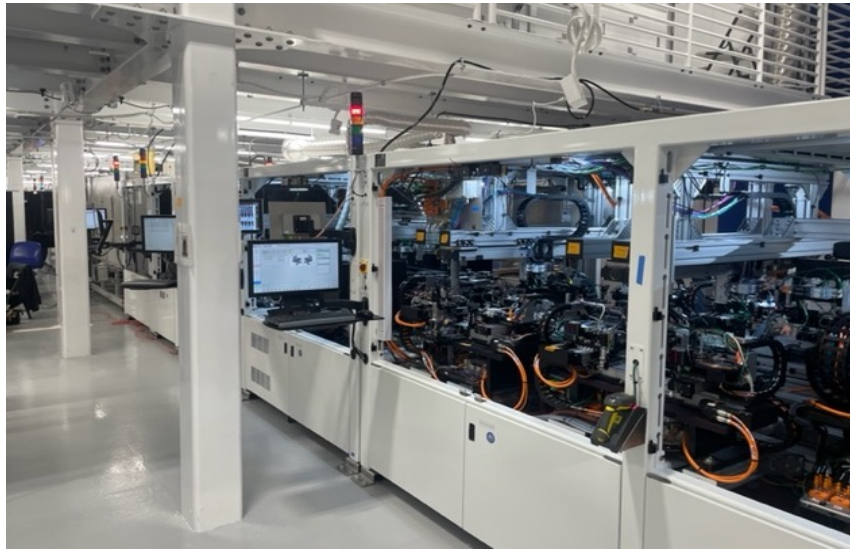
BrakeFlow Technology – Significantly Increases Tolerance to Internal Shorts

Patented Battery Architecture and Process Technology



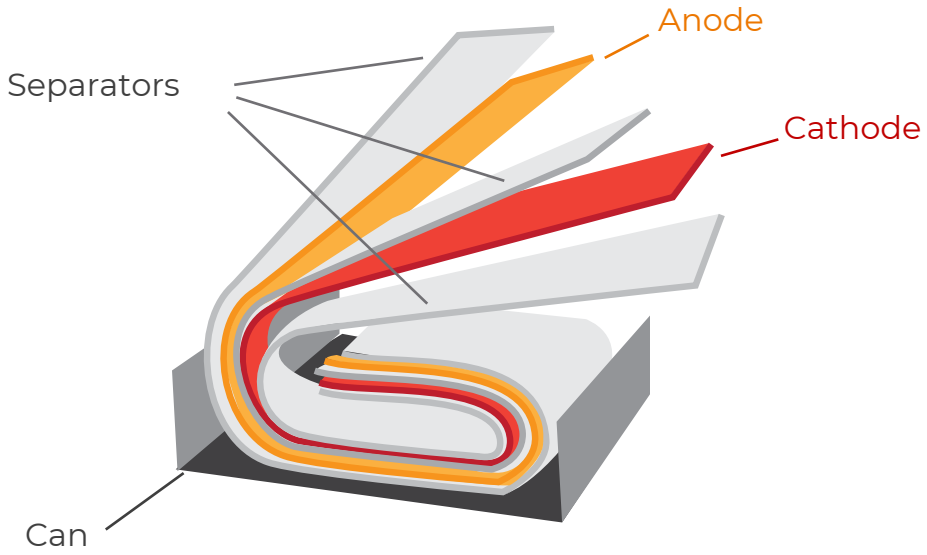
Scaling up commercial production

# Fab-1: Fremont, CA

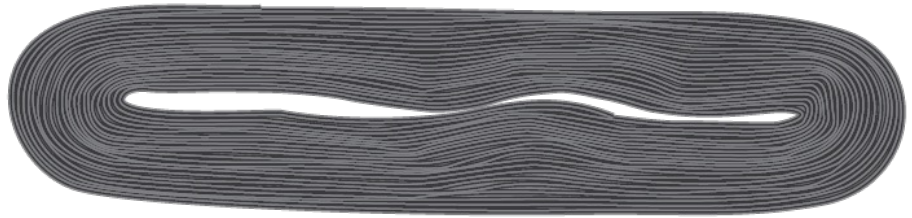



# Conventional Cell Architecture

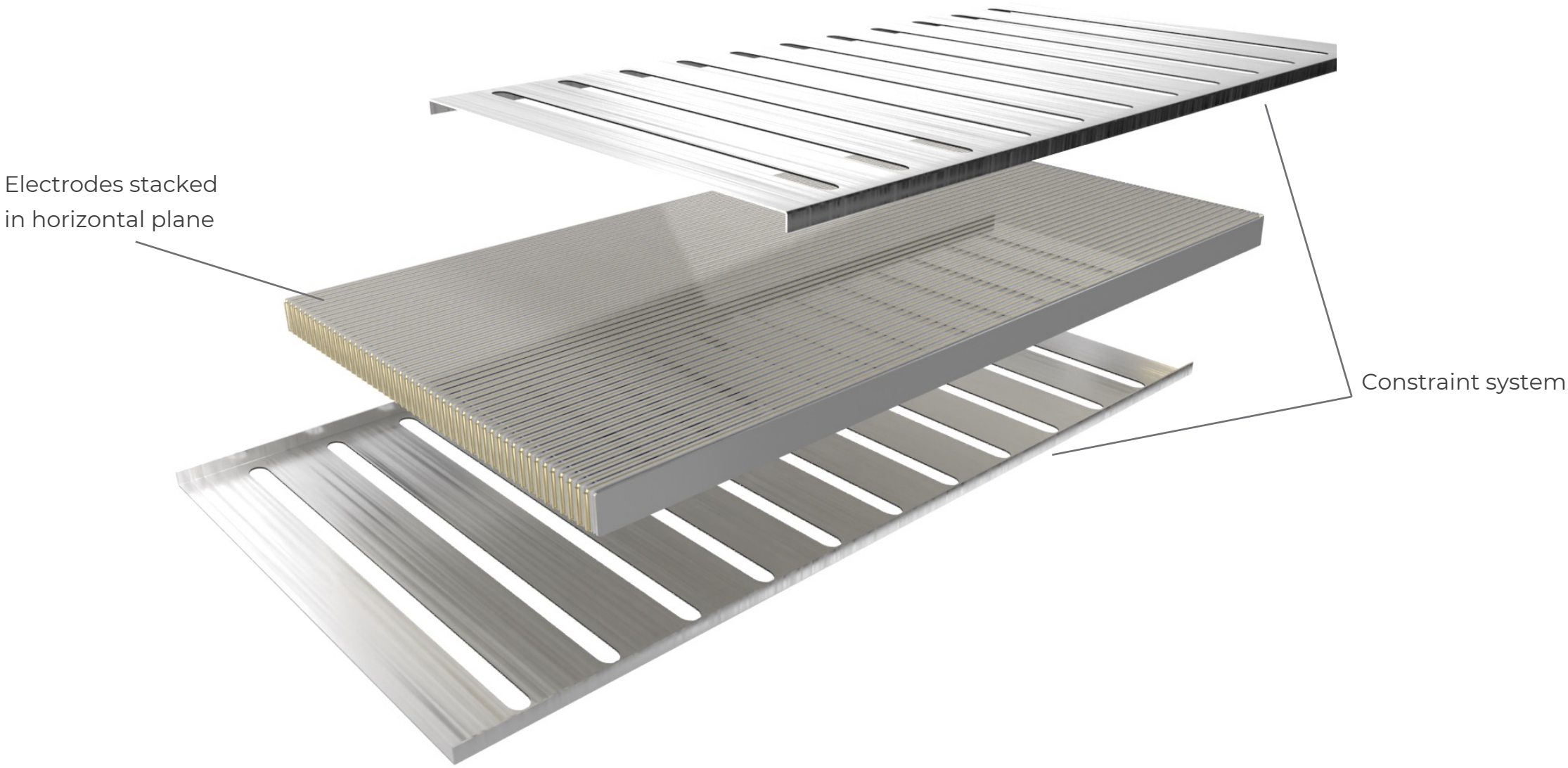
Conventional **Wound** Lithium-ion Cell




**Illustrated Cross-Section**



# Enovix Cell Architecture



# Enovix Architecture

- High Energy Density
- High Cycle and Calendar Life
- Fast Charge
- Excellent Thermal Performance

# Enovix Architecture

**High Energy Density**

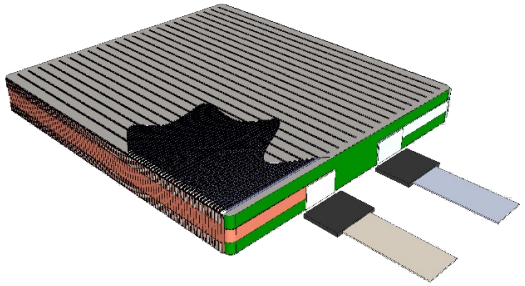
High Cycle and Calendar Life

Fast Charge

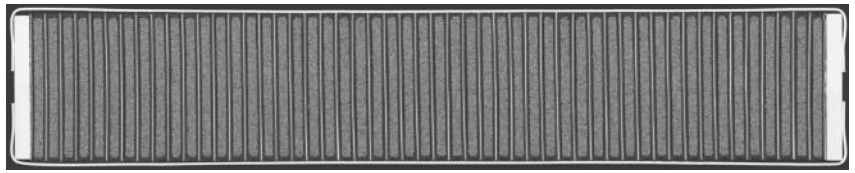
Excellent Thermal Performance

# Enovix 3D Architecture Enables Si Anodes

**Enovix 3D Silicon** Lithium-ion Cell



**Photomicrograph Cross-Section** [1]



**Silicon Anode Material Capacity**

**1800 mAh/cc** [2]

Conventional **Wound** Lithium-ion Cell

**Illustrated Cross-Section**

**Graphite Anode Material Capacity**

**800 mAh/cc** [3]



[1]Source: Enovix Corporation. [2]De-rated from theoretical capacity of 2194 mAh/cc for Li trapping losses. [3]Nominal capacity between host capacity of 841 mAh/cc and lithiated capacity of 719 mAh/cc.

# Enovix Architecture

High Energy Density

**High Cycle and Calendar Life**

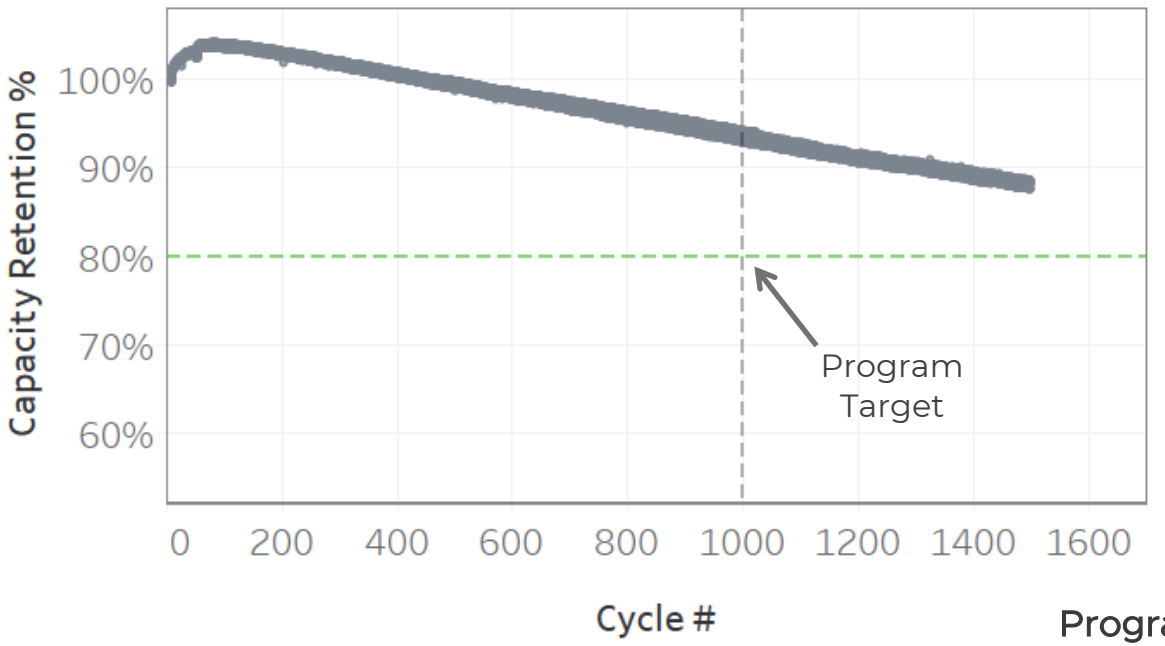
Fast Charge

Excellent Thermal Performance

# High Cycle and Calendar Life

## Demonstrated development cell cycle life >1500 cycles and >10 year projected lifetime[1]

**88% capacity retention after 1,500 cycles**




**Projecting >10-year calendar life based on high temperature testing performance**


**0.27Ah NMC-622 Cycle Life**
267 mAh (29 mm x 17 mm x 3.4 mm)
541 Wh/l packaged energy density (889 Wh/l core)
695 Wh/l modeled packaged energy density for 55Ah cell
4.2 – 2.5V Cell Voltage @ 30 deg. C
0.33C CCCV Charge – 0.33C Discharge with periodic multi-rate diagnostic discharge steps

Program Collaborators

NREL Transforming ENERGY
Multi-component model predicting Si integrity

Mitsubishi Chemical
Optimized electrolytes for Si anodes

**0.27Ah NMC-622 – Calendar Life**
267 mAh (29 mm x 17 mm x 3.4 mm)
541 Wh/l packaged energy density (889 Wh/l core)
695 Wh/l modeled packaged energy density for 55Ah cell
0.33C CCCV Charge – 0.33C Discharge after storage at various temperatures at TOC voltage of 4.2V

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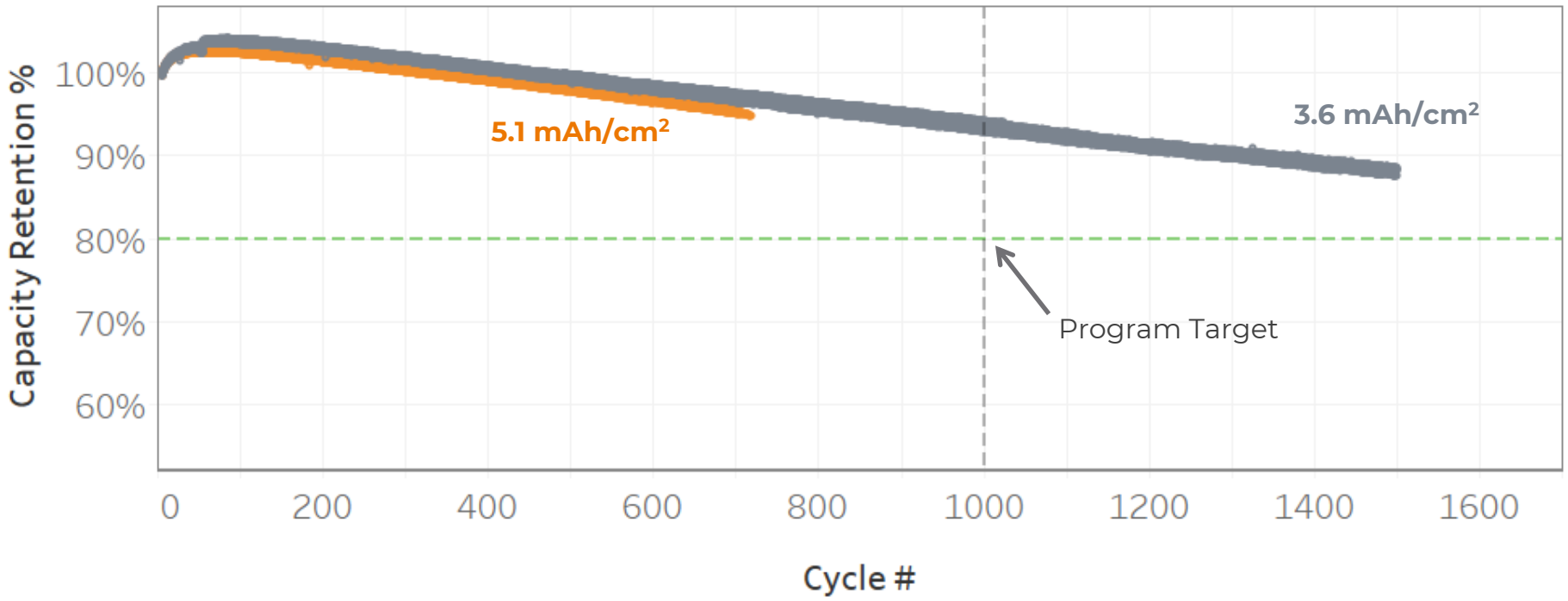
[1] As of November 2022

# High Cycle Life

## Demonstrating high cycle life across wide range of electrode loadings




**3.6 mAh/cm2 NMC-622 CELL DATA**

267 mAh (29 mm x 17 mm x 3.4 mm)
541 Wh/l packaged energy density (889 Wh/l core)
695 Wh/l modeled packaged energy density for 55Ah cell
4.2 – 2.5V Cell Voltage @ 30 deg. C
0.33C CCCV Charge – 0.33C Discharge with periodic multi-rate diagnostic discharge steps

**5.1 mAh/cm2 NMC-622 CELL DATA**

293 mAh (30 mm x 17 mm x 3.5 mm)
570 Wh/L packaged energy density (976 Wh/L core)
750 Wh/L modeled packaged energy density for 55 Ah cell
4.2-2.5 V cell voltage @ 30 deg. C
0.33C CCCV Charge – 0.33C Discharge with periodic multi-rate diagnostic discharge steps

# Enovix Architecture

High Energy Density

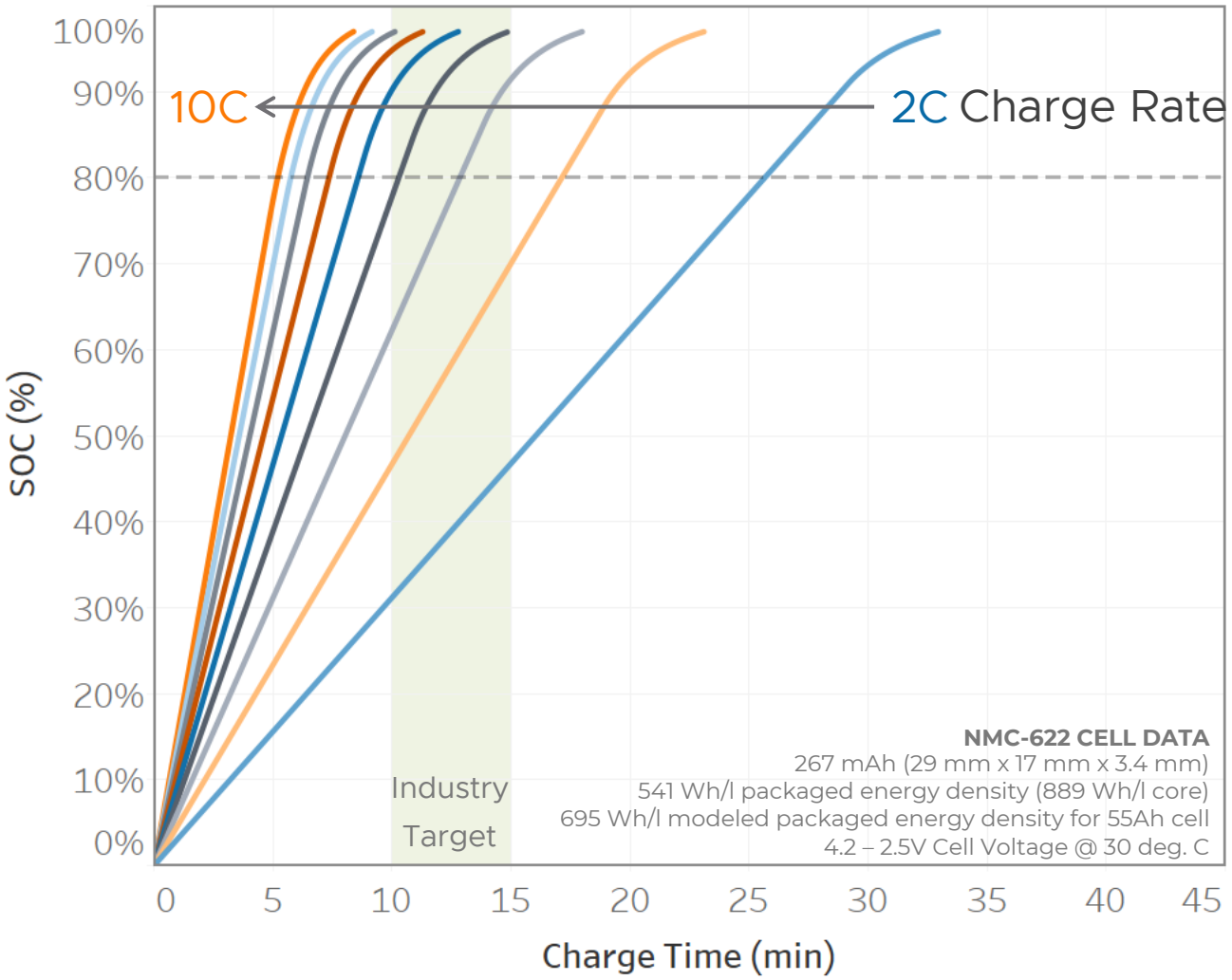
High Cycle and Calendar Life

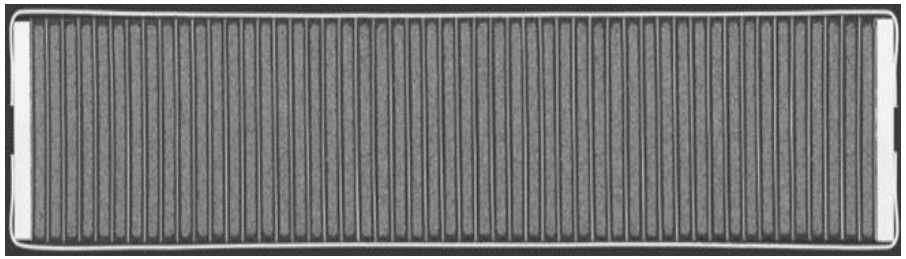
**Fast Charge**

Excellent Thermal Performance

# Architecture & Chemistry Built for Fast Charge

0.27 Ah EV test cells achieved 0-80% state-of-charge in 5.2 minutes



## Fast Charge Enabled by Silicon

~ **56%** thinner anode than graphite[1]

~ **140mV** higher lithiation potential[2]

[1]100% active Si anode de-rated from a fully-lithiated theoretical capacity of 2194 mAh/cc to account for Li-trapping and pre-lithiation

[2]0.22V vs Li/Li+ for Si; 0.08V vs Li/Li+ for Graphite

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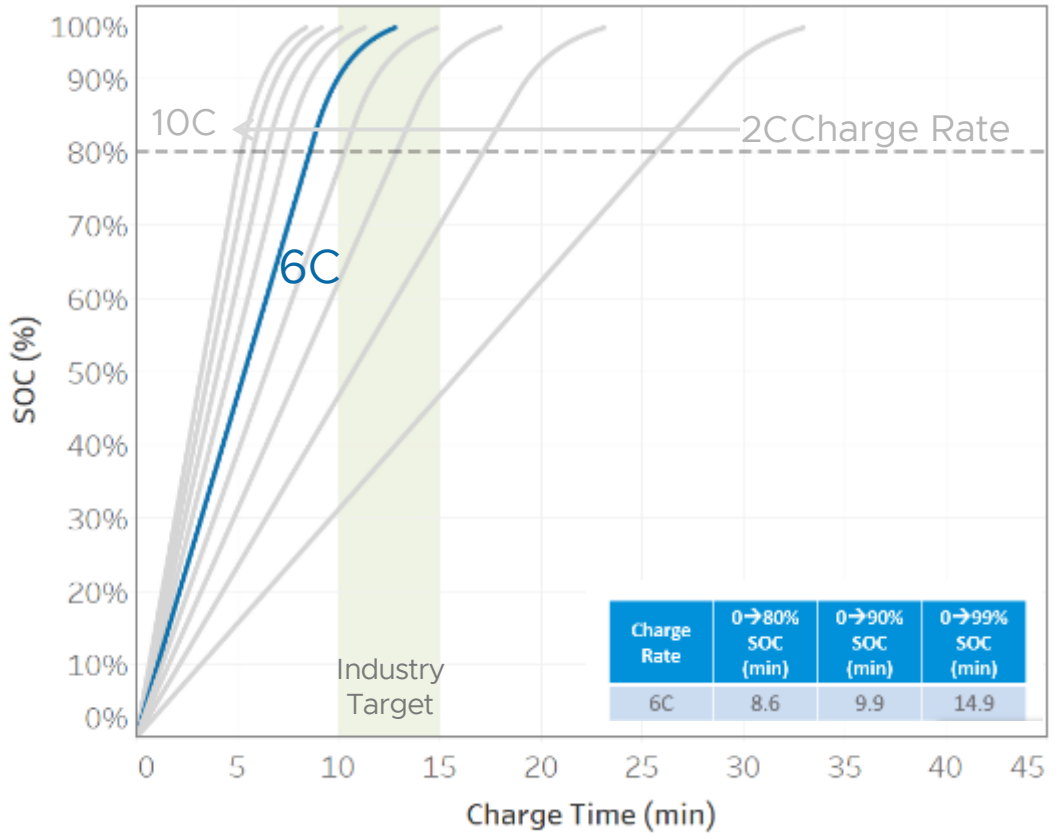
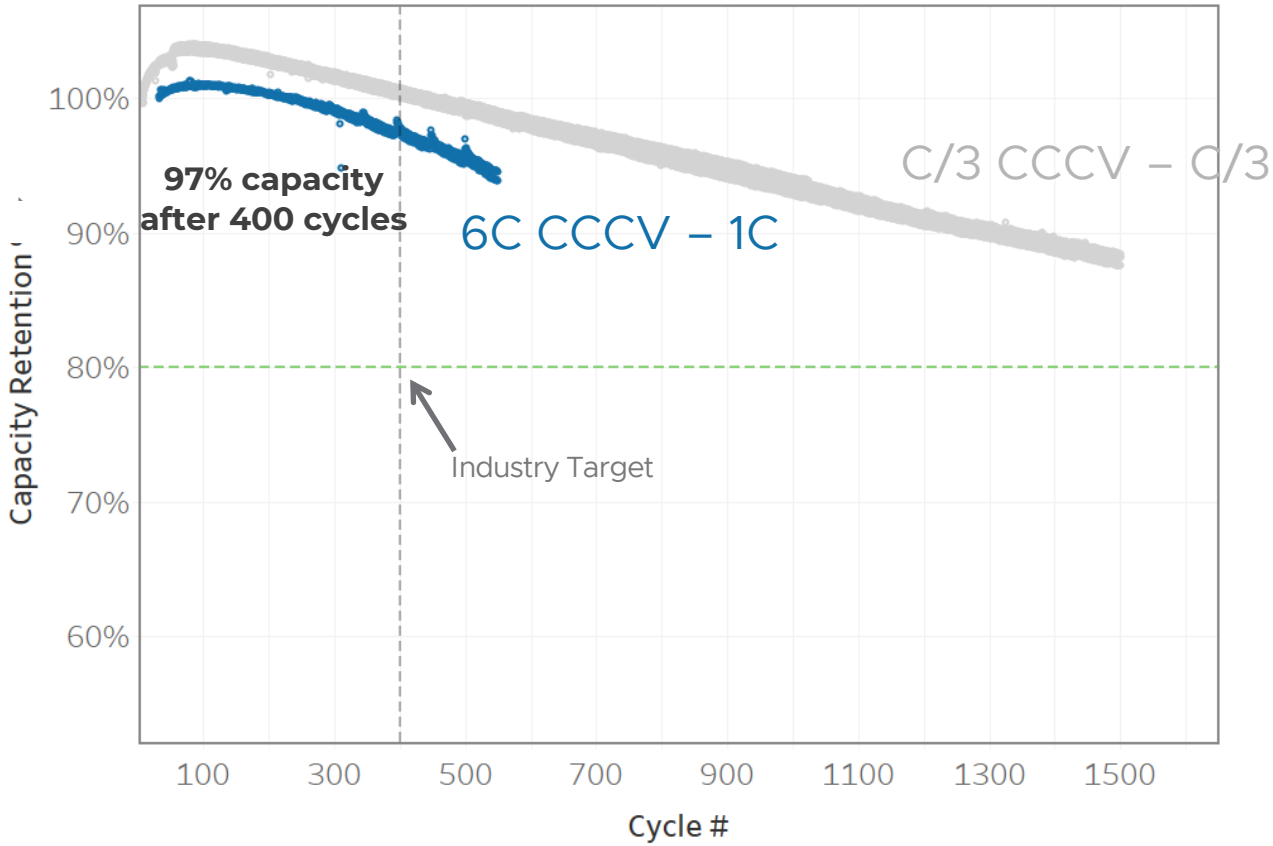
# Architecture & Chemistry Built for Fast Charge

0.27 Ah EV test cells achieved 0-80% state-of-charge in 5.2 minutes




| Charge Rate | 0→80% SOC (min) | 0→90% SOC (min) | 0→99% SOC (min) |
|---|---|---|---|
| 6C | 8.6 | 9.9 | 14.9 |




**NMC-622 CELL DATA**
267 mAh (29 mm x 17 mm x 3.4 mm)
541 Wh/l packaged energy density (889 Wh/l core)
695 Wh/l modeled packaged energy density for 55Ah cell
4.2 – 2.5V Cell Voltage @ 30 deg. C
6C CCCV Charge – 1C Discharge with periodic multi-rate diagnostic discharge steps

# Enovix Architecture

High Energy Density

High Cycle and Calendar Life

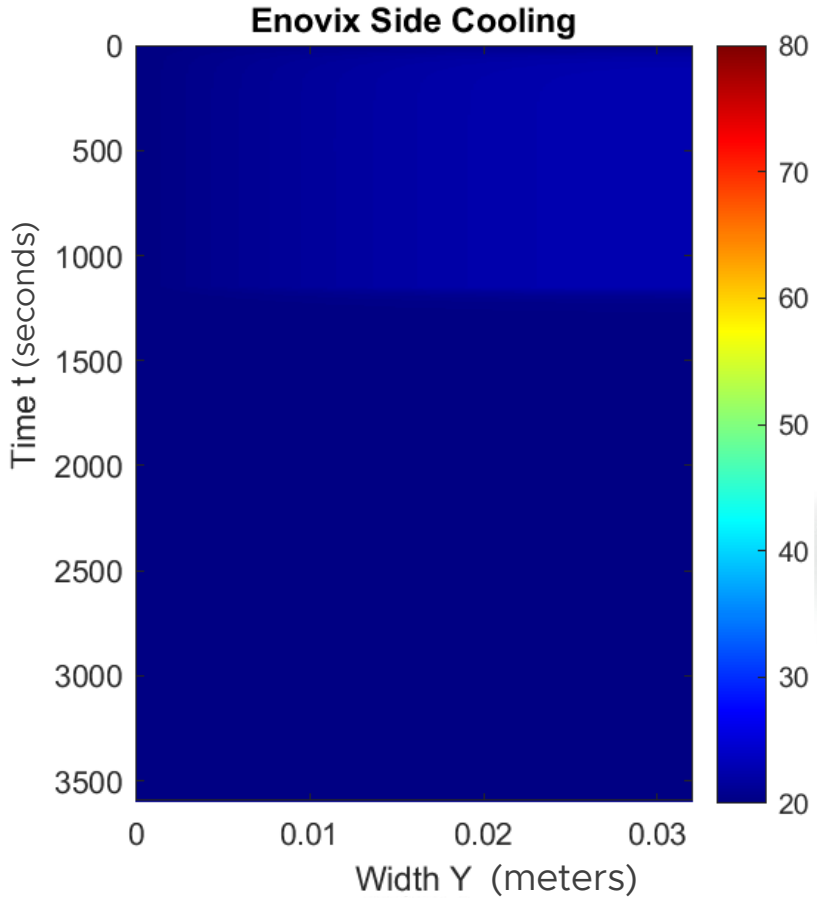
Fast Charge

**Excellent Thermal Performance**

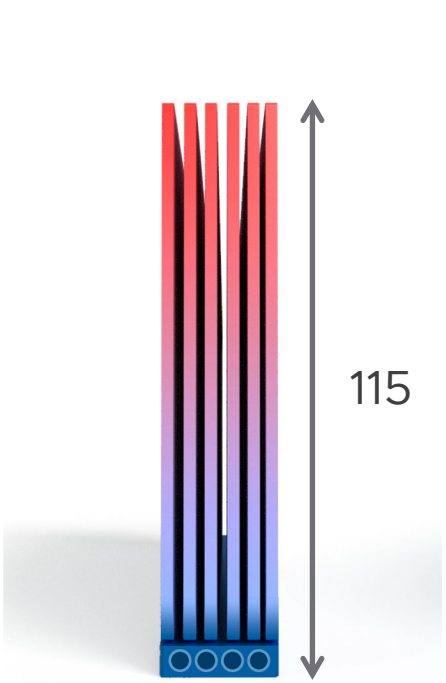
# Reoriented Electrodes Designed to Deliver Excellent Thermal Performance

*33X Higher* thermal conductivity to large face of prismatic cell*

**2.5C Fast Charging Temperature Profile**



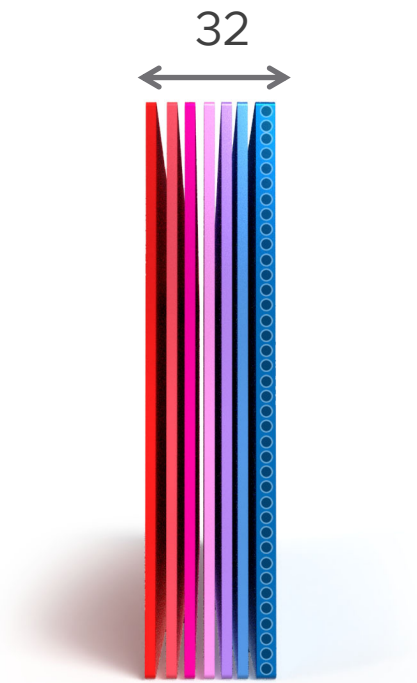

**Cell Dimensions: 173 x 115 x 32 mm**




**Conventional Stack Cell Bottom-Cooled**

$\Delta T_{max}$ =

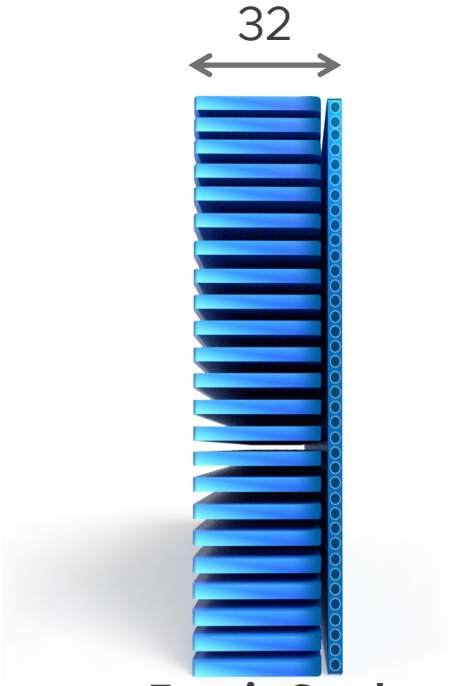
31.9˚C




**Conventional Stack Cell Side Cooled**

$\Delta T_{max}$ =

53.8˚C




**Enovix Stack Side Cooled**

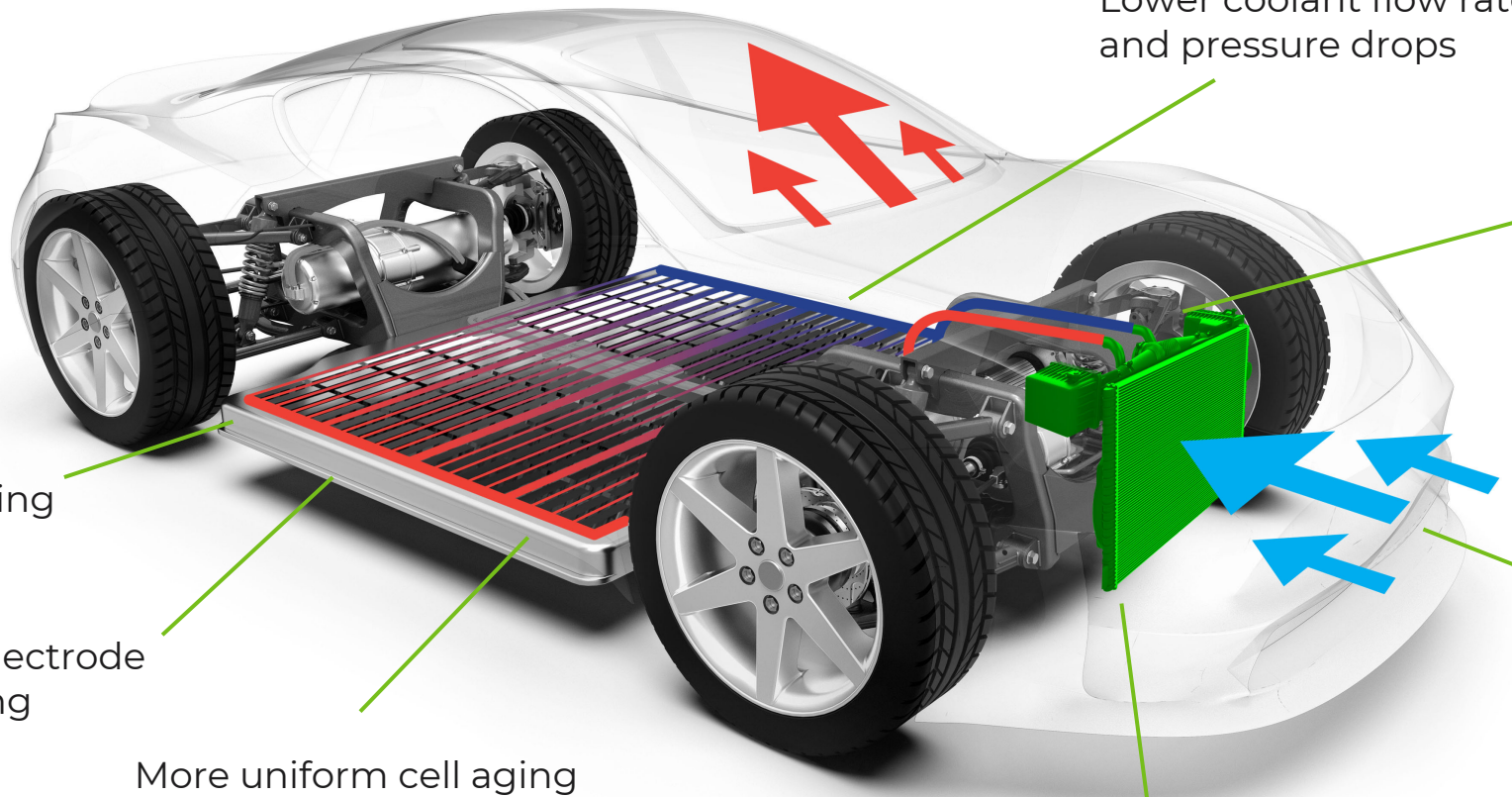
$\Delta T_{max}$ =

2.8˚C

*Assumptions: 2.5C charging 0-80% SOC, 27.6 W/mK in-plane conductivity, 0.82 W/mK thru-plane conductivity, 1046 J/kg heat capacity, 2.4g/cc density, 25 ohm cm2 constant ASI, 4 mAh/cm2 electrode loading, 336 uM wave pair thickness, 1-dimensional heat transfer constrained to electrodes

# Cell Thermal Design Key to System Performance

*Significant opportunities to reduce system cost, improve performance*



Lower coolant flow rate and pressure drops

Reduced compressor size, weight and power

Faster charging

Increased electrode loading

More uniform cell aging

Enables warmer coolant and greater heat rejection

Smaller radiator

# Developing the Future EV Cell Platform

- Enovix cell architecture is designed to enable next-gen active materials with high energy density and excellent thermal performance
- Uniquely positioned amongst EV entrants via the ongoing success in consumer space - validation of our new architecture
- Actively engaging with OEM's and industry partners to bring our technology to the automotive industry
- Contact us: Mobility@Enovix.com

ENOVIX | mobility


# Thank You

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