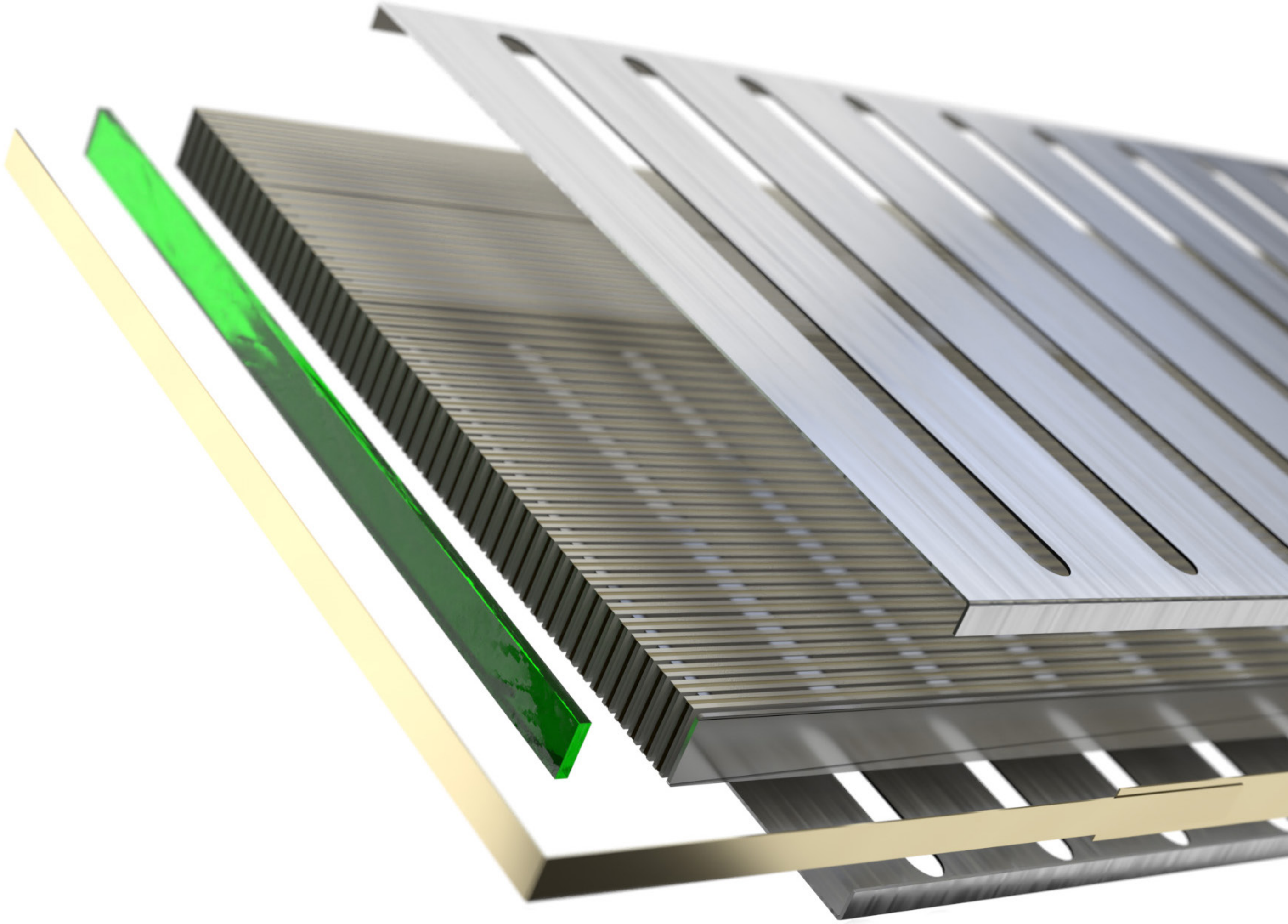
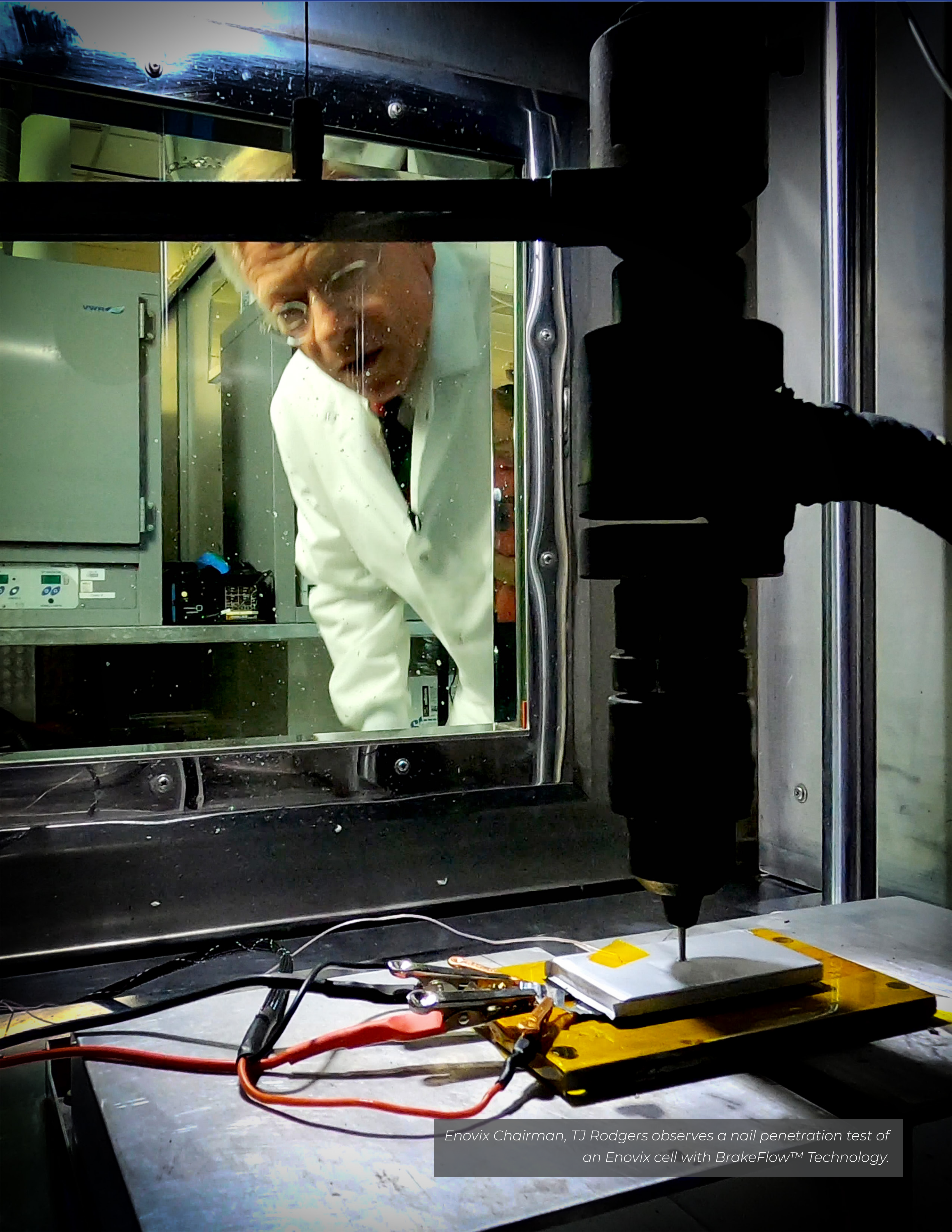


Enovix BrakeFlow™ Technology

An intra-cell system that significantly increases tolerance against thermal runaway from internal short circuits, without compromising high energy density.

October 2022

Contents



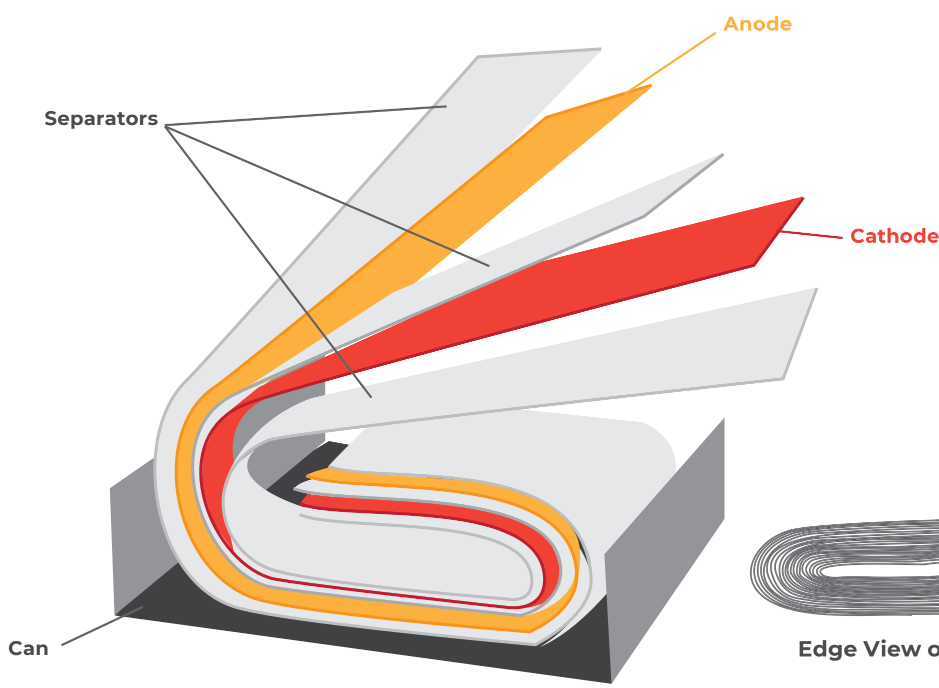
Enovix Chairman, TJ Rodgers observes a nail penetration test of an Enovix cell with BrakeFlow™ Technology.

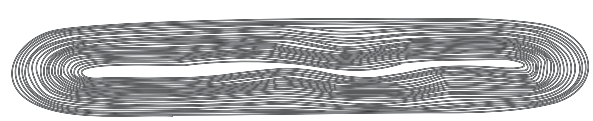
Overview

In order to power the technologies of the future, we need a better battery. However, significant increases in battery energy density can be accompanied with increased risk of an internal short, which could lead to a fire or thermal runaway.

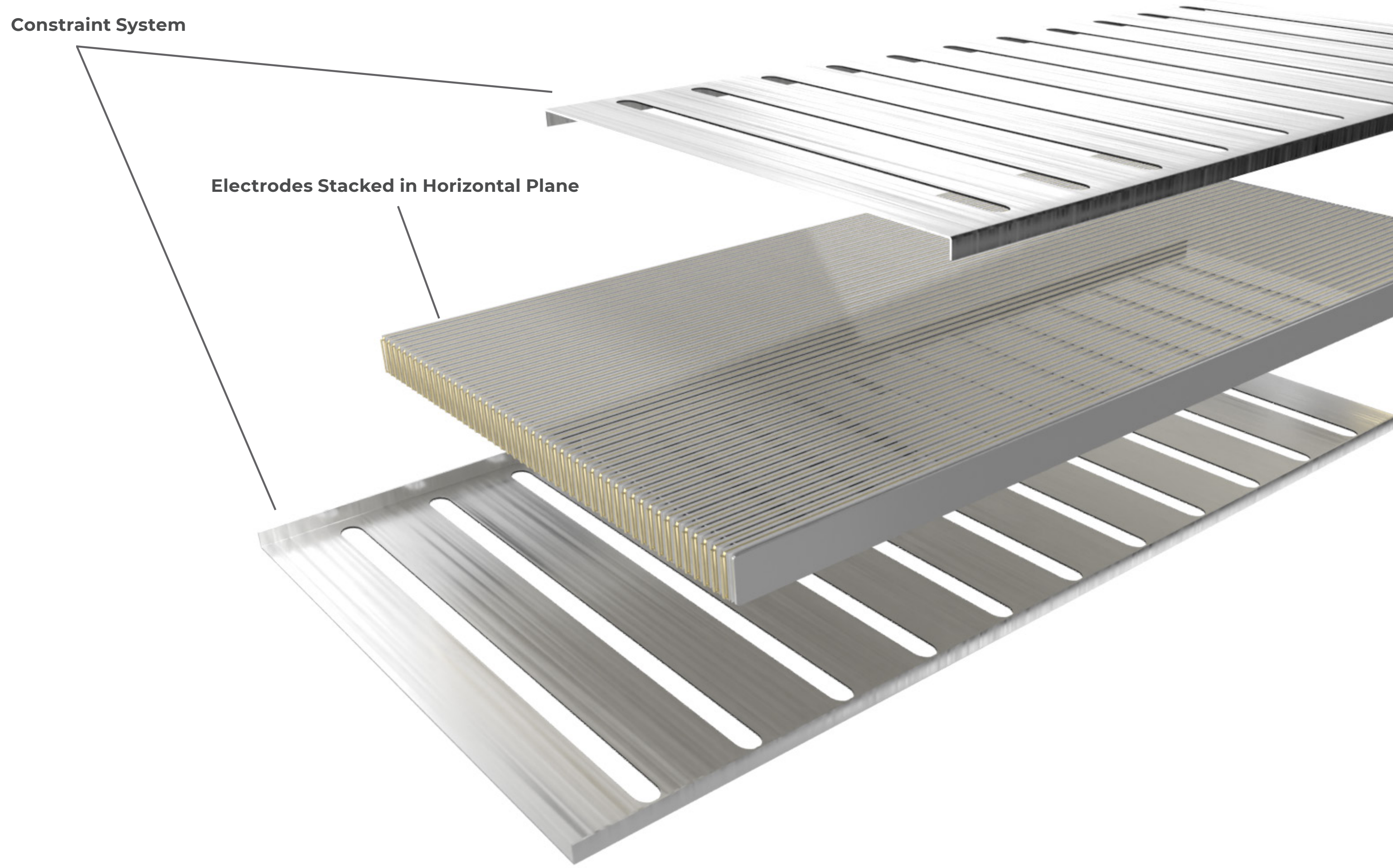
This conundrum—increasing energy density, without compromising safety—has translated to sluggish progress. Li-ion battery technology advancements have moved at a much slower pace than the related technological sectors where they could be deployed. Historically, the battery industry has been entrenched in decades of experience building batteries essentially one way, innovating incrementally with better materials and chemistries. To break out of this paradigm and create a battery with high energy density that doesn't compromise safety, we launched Enovix in 2007 and completely reimagined traditional battery architecture. Our architecture is made up of short, precise, laser cut electrodes that are stacked, versus the conventional large sheets or "jelly roll" architecture.

Conventional Wound Lithium-ion Cell





Edge View of Wound Cell in Final Form



Enovix Cell Architecture

Our novel 3D battery architecture has led to multiple advantages. Notably, the Enovix architecture accommodates the use of a 100% active silicon anode, a plentiful and sustainable ingredient that can theoretically store more than twice as many lithium ions as a graphite anode, which is used in most conventional Li-ion batteries today. The use of silicon within our architecture translates to a battery with high energy density in an efficient form factor.

The result? A breakthrough in Li-ion battery innovation.

What Causes Thermal Runaway?

In a commercial Li-ion cell produced for consumer electronics, external heat, overcharging, or an internal or external short circuit can lead to thermal runaway.[1] There are many ways to reduce the risk of an internal short; the industry, however, has not been able to prevent all incidents.

Thermal runaway in a cell can occur when the internal temperature gets high enough to ignite the components of the cell. If it reaches a critical temperature, large amounts of oxygen and heat are released from the cathode material, which is a recipe for thermal runaway.

Solid-state batteries are not immune to this problem. According to research by the U.S. DOE Sandia National Laboratories, published in the scientific journal Joule, "The solid electrolyte can still fail under certain circumstances, such as when the battery is crushed, punctured, or when built-up pressure causes a reaction between internal oxygen and lithium."[2]

During thermal runaway, temperatures can reach as high as 900°C, which can cause severe injury and extensive damage.[3]

Compounding the risk of thermal runaway is the need to power the technologies of the future with a battery with higher energy density.

Commercial cell phone battery succumbs to thermal runaway in a nail penetration testing machine.

BrakeFlow™ Technology – An Extra Layer of Protection

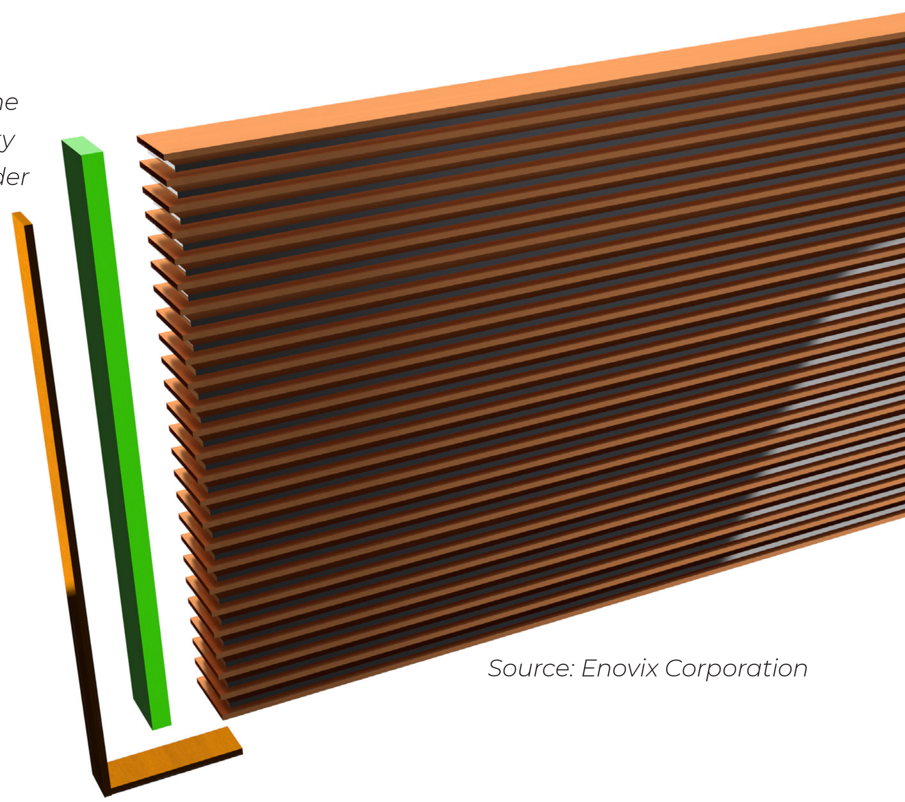
When a conventional lithium-ion battery is pierced or severely damaged, a short can occur, generating very high current and heating in microseconds and potentially releasing a violent and often fiery chain reaction. It is called thermal runaway and, well, it's bad. That is why we created BrakeFlow™, an intra-cell system that increases abuse tolerance.

It was not enough to reimagine the lithium-ion battery, we've also introduced a whole new level of safety.

"We believe our battery architecture is one of the most significant advancements in Li-ion battery design in decades," said Ashok Lahiri, Co-Founder and CTO of Enovix.

The Enovix cell architecture incorporates many features inside the cell to improve electrical, physical, and environmental abuse tolerance. These features reduce the potential of an internal short circuit and in the unlikely event that an internal short does occur, Enovix BrakeFlow™ technology adds an extra layer of protection to further reduce the risk of thermal runaway.

Enovix **BrakeFlow™** Technology



Source: Enovix Corporation

Unique to Enovix 3D cell architecture, BrakeFlow is an intra-cell system that significantly increases tolerance against thermal runaway from internal short circuits, without compromising high energy density.

How it works

The Enovix 3D cell is divided into many sub-cell units, each holding a small fraction of the battery's energy and each having a discrete connection to a common anode or cathode busbar. Each sub-cell is connected to the common busbar through the BrakeFlow system that is engineered, based on the number of electrodes and the individual electrode's area, to limit the discharge current from the remainder of the cell, through the shorted subunit. If BrakeFlow is working properly, the power dissipated at the short should not raise the temperature around the short location enough to trigger thermal runaway.

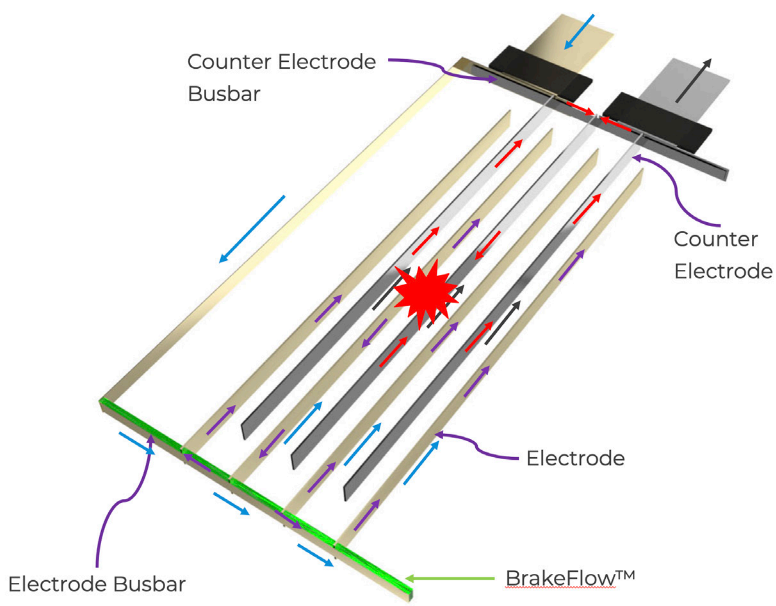
With BrakeFlow incorporated, instead of a sudden catastrophic release of energy, the battery is designed to discharge slowly and safely.

Ohm's Law

The most fundamental law in electricity is defined by Ohm's Law, where current is given by the ratio of voltage to resistance. (I=V/R) For a charged lithium-ion battery, the maximum voltage is around 4.35V. As an example, if the BrakeFlow resistor is set to be 1 Ohm resistance, the current will be defined as 4.35/1, which is 4.35 Amps. In the case of a conventional cell, where there is no BrakeFlow resistor, the resistance is on the order of milliohms. This can result in current in excess of 100 Amps through the short. More current means much more heat at the short location, increasing the risk of thermal runaway.

"Not only does our architecture enable a 100% active silicon anode, which notably increases energy density, but also enables us to launch new innovations like BrakeFlow, which by design, reduces the temperature rise at a short location, adding exceptional tolerance against thermal runaway," said Ashok Lahiri, Co-Founder and CTO of Enovix.

Figure 6 *– Enovix 3D cell architecture and BrakeFlow technology*



BrakeFlow—a system that includes a resistor engineered with a set value—at the electrode-busbar junction (green). In the event of an internal short circuit (red), BrakeFlow regulates current flux from other areas of the battery to the short. This limits the flow of current and reduces the rate of heating.

Conclusion

Advanced, high-energy, Li-ion batteries need advanced features to improve abuse tolerance and reduce the risk of an internal short circuit, which can lead to thermal runaway. In conventional Li-ion wound cell architecture, increasing energy density without compromising safety is not simple or easy. Battery designers have found that when they try to increase energy density, they may compromise safety, and vice versa.

The Enovix 3D cell architecture upends the conventional paradigm and enables both an increase in energy density and a high level of abuse tolerance to reduce the risks of an internal short leading to thermal runaway. BrakeFlow provides an additional layer of safety. As the technologies of the future demand a battery with higher energy density, Enovix is meeting the challenge and is poised to power the technologies of the future.

For more information on BrakeFlow and to watch a “how-to” video by Enovix Chairman TJ Rodgers, please visit www.enovix.com/BrakeFlow

References

[1]Andrey W. Golubkov, David Fuchs, Julian Wagner, Helmar Wiltsche, Christoph Stangl, Gisela Fauler, Gernot Voitic, Alexander Thaler, and Viktor Hacker, “Thermal-runaway experiments on consumer Li-ion batteries with metal-oxide and olivin-type cathodes,” Royal Society of Chemistry, November 27, 2013, https://pubs.rsc.org/en/content/articlehtml/2014/ra/c3ra45748f#cit3, accessed October 12, 2021.

[2]Stephen Edelstein, “Research suggests solid-state EV battery cells aren’t always safter than conventional lithium-ion, https://www.greencarreports.com/news/1135250_research-suggests-solid-state-ev-battery-cells-aren-t-always-safer-than-conventional-lithium-ion, March 8, 2022

[3]Andrey W. Golubkov, David Fuchs, Julian Wagner, Helmar Wiltsche, Christoph Stangl, Gisela Fauler, Gernot Voitic, Alexander Thaler, and Viktor Hacker, “Thermal-runaway experiments on consumer Li-ion batteries with metal-oxide and olivin-type cathodes,” Royal Society of Chemistry, November 27, 2013, https://pubs.rsc.org/en/content/articlehtml/2014/ra/c3ra45748f#cit3, accessed October 12, 2021.

Forward Looking Statements

This document contains forward-looking statements within the meaning of Section 27A of the Securities Act of 1933, as amended, and Section 21E of the Securities Exchange Act of 1934, as amended, about us and our industry that involve substantial risks and uncertainties. Forward-looking statements generally relate to future events or our future financial or operating performance. In some cases, you can identify forward-looking statements because they contain words such as “believe”, “will”, “may”, “estimate”, “continue”, “anticipate”, “intend”, “should”, “plan”, “expect”, “predict”, “could”, “potentially”, “target”, “project”, or the negative of these terms or similar expressions. Forward-looking statements in this document include, but are not limited to, the design, performance and increased energy density of our lithium-ion batteries, our ability to enable new opportunities and launch new innovations with respect to our lithium-ion battery solutions, our battery architecture enables increased energy density without compromising safety, improvements in abuse tolerance and tolerance against thermal runaway resulting from internal short circuits, and Enovix is meeting the challenge and poised to power the technologies of the future. Actual results could differ materially from these forward-looking statements as a result of certain risks and uncertainties. For additional information on these risks and uncertainties and other potential factors that could affect our business and financial results or cause actual results to differ from the results predicted, please refer to our filings with the Securities and Exchange Commission (the “SEC”), including in the “Risk Factors” and “Management’s Discussion and Analysis of Financial Condition and Results of Operations” sections of our most recently filed annual periodic reports on Form 10-K and quarterly report on Form 10-Q and other documents that we have filed, or that we will file, with the SEC. Any forward-looking statements made by us in this document speak only as of the date on which they are made and subsequent events may cause these expectations to change. We disclaim any obligations to update or alter these forward-looking statements in the future, whether as a result of new information, future events or otherwise, except as required by law.

About Enovix

Enovix is the leader in advanced 100% active silicon-anode lithium-ion battery development and production. The company’s proprietary 3D cell architecture increases energy density, maintains high cycle life, and enables advanced cell-level safety features. Enovix has built an advanced silicon-anode lithium-ion battery production facility in the U.S. for volume production. The company’s initial goal is to provide designers of category-leading mobile devices with a high-energy battery so they can create more innovative and effective portable products. Enovix is also developing its 3D cell technology and production process for the electric vehicle and energy storage markets to help enable widespread utilization of renewable energy. For more information, visit www.enovix.com.

ENOVIX
Just in time for the future.™

Enovix Corporation, 3501 W Warren Ave, Fremont, CA 94538 USA Tel 510.695.2350 enovix.com OCTOBER 2022