

# Dielectric Insulation for EV Batteries

## Why Pressure-Sensitive Adhesive Tapes Offer a Better Solution For Electrical Insulation In EV Battery Packs

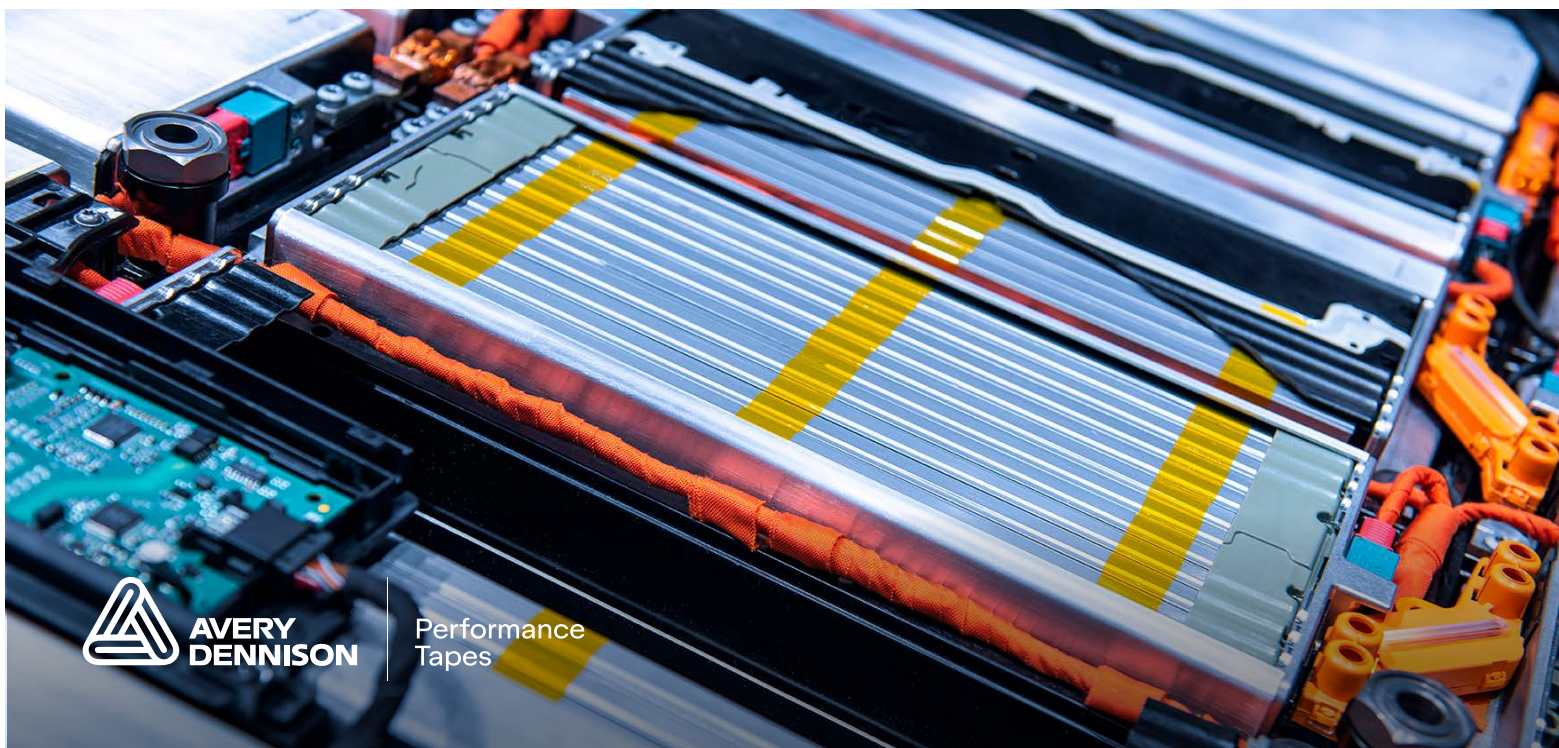
An Avery Dennison White Paper

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### Executive summary

The electric vehicle (EV) marketplace is expected to grow rapidly this decade. There's an increasing demand for EV battery packs that are reliable, safe and efficient. One of the critical design challenges facing manufacturers during this time is the prevention of electrical arcing.

This white paper will explore the use of films integrated with pressure-sensitive adhesive tapes in EV battery packs. Such tapes offer not only the electrical insulation batteries need but can provide additional properties that make them a superior choice to traditional electrical insulation materials.



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## Introduction and background

Avicenne Energy forecasts the EV marketplace to grow from 2.3 million global sales in 2020 to 25.5 million sales by 2030, a CAGR of 27%. Hybrids and plug-in hybrids are expected to account for another 21 million vehicles sold. This growth is driven by changing consumer tastes, regulation and legislative action such as the U.S. Inflation Reduction Act. The latter is investing billions in EV manufacturing and charging infrastructure while extending a tax credit to Americans who purchase EVs.

OEMs have responded by committing more than \$500 billion to EVs in the next several years. By 2030, EVs, HEVs, and PHEVs will require 2 million MWh of battery power. Global battery production will grow to 2,800 GWh.

These forecasts bode well for manufacturers of battery packs used in EVs and other eMobility applications. Yet, significant engineering challenges remain, including the need for high-performance dielectric protection solutions that are cost-effective and highly compatible with modern, compact battery pack designs.

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## Prevention of electrical arcing is critical

EV batteries have high energy density. For instance, Tesla's 4680-type battery cell has an estimated energy density between 272–296 Wh/kg, according to InsideEVs. Therefore, preventing electrical arcing within the confined spaces of EV battery packs is essential.

Prevention of arcing avoids:

- Short circuits, which may lead to vehicle failure or fires
- Thermal runaway
- Electrical hazards for the driver, passengers and service technicians

Traditional electrical insulation solutions include PET tapes, polyimide tapes and various coatings. While these may be effective strictly at preventing electrical arcing, their broader characteristics often make them a less-than-optimal solution for modern EV battery pack design and manufacturing. EV battery manufacturers, therefore, are often forced to make trade-offs involving cost, insulative performance and mechanical properties when working with these materials.

New solutions are needed — solutions that prevent manufacturers from having to make these trade-offs. Dielectric films integrated with pressure-sensitive adhesive tapes are the answer.

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**Traditional electrical insulation solutions often force EV battery manufacturers to make trade-offs involving cost, performance and mechanical properties.**

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## An introduction to pressure-sensitive adhesive tapes

A pressure-sensitive adhesive bonds with other materials upon brief contact and light pressure. When presented as part of a tape, an adhesive is often laminated to a carrier made of film, foam or other material. This carrier may provide key functionality, such as electrical insulation, flame retardance or cushioning.

A proven technology, tapes are used across many industries, including automotive, aerospace, building and construction, electronics, general industrial, and print and packaging.

These tapes offer a range of advantages:

- **Ease of manufacturing** — Tapes provide an instant bond with no curing time needed.
- **Durability** — Certain tapes quickly wrap around edges without tearing, which avoids waste and rework. Conformable solutions are available for complex geometries.
- **Safety** — Tapes with flame-retardant solutions meeting UL® 94 V-0 standards are available. They can incorporate electrically insulative components to boost dielectric strength.
- **Thermal performance** — With their inherent thinness, tapes offer minimal resistance to heat flow.

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## Creating an alternative dielectric insulation solution with pressure-sensitive adhesive tapes

Pressure-sensitive adhesive tapes combined with dielectric films are a sound alternative to traditional electrical insulation solutions for EV batteries.

Such tapes are offered through the Avery Dennison Performance Tapes portfolio. They provide a variety of performance qualities:

- Tested for breakdown voltage and dielectric strength requirements using GB/T 1408.1-2016 and ASTM D149 and D3755 test methods
- Fit easily in confined spaces, such as inside a battery pack
- Durability
- Support ease of assembly

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**A proven technology, pressure-sensitive adhesive tapes combined with dielectric films offer significant advantages as an electrical insulation solution for EV batteries.**

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## Pressure-sensitive adhesive tapes offer advantages beyond dielectric insulation

What sets pressure-sensitive adhesive tapes apart for EV battery pack applications are their advantages beyond electrical insulation. These allow manufacturers to avoid facing the trade-offs associated with traditional insulation materials.

### Challenge: Reducing flammability

Flammability and prevention/mitigation of thermal runaway events are crucial challenges in EV batteries. Traditional dielectric solutions lack flame-retardant properties.

### Solution:

Besides providing electrical insulation, pressure-sensitive adhesive tapes with dielectric films can help prevent/mitigate fires and thermal runaway events.

The Avery Dennison adhesive portfolio includes thousands of proprietary formulations, including the Flame Tough™ adhesive platform. Suitable for use with dielectric films in EV battery packs, Flame Tough passes UL® 94VTM and UL® 94V testing protocols.

**FAIL**



**Traditional Non RF PET/Acrylic**

**PASS**



**FT 0065: Flame Tough™ PET/Acrylic**

**PASS**



**FT 0975: Flame Tough™ PI/Silicone**

*The lack of scorching on the middle and right test strips demonstrates the flame retardance of Avery Dennison Flame Tough™ adhesives.*

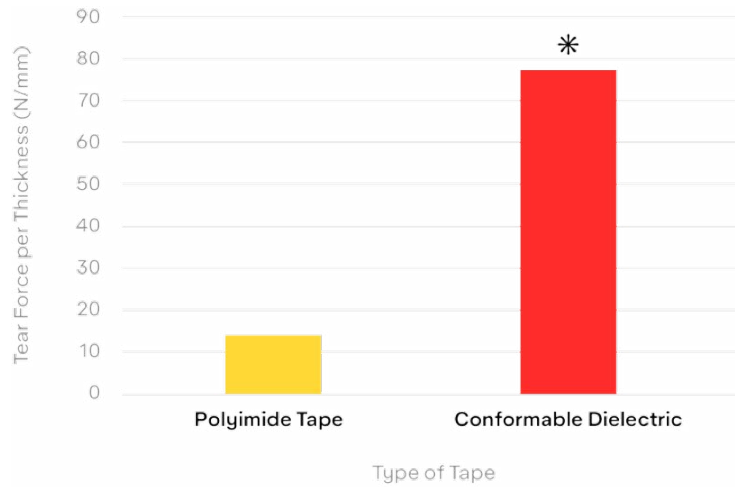
**Challenge: Mechanical durability**

PET and polyimide tapes tend to tear on sharp corners and edges, creating waste and requiring rework. Many coatings have difficulty providing uniform coverage on sharp or thin metallic corners.

*Avery Dennison Conformable Dielectric Film products withstand up to seven times the tear force of competing technologies.*

**Solution:**

State-of-the-art pressure-sensitive adhesive tapes can be placed around sharp metal corners without tearing. Avery Dennison's Conformable Dielectric Film withstands up to seven times the tear force of a polyimide tape of similar thickness.



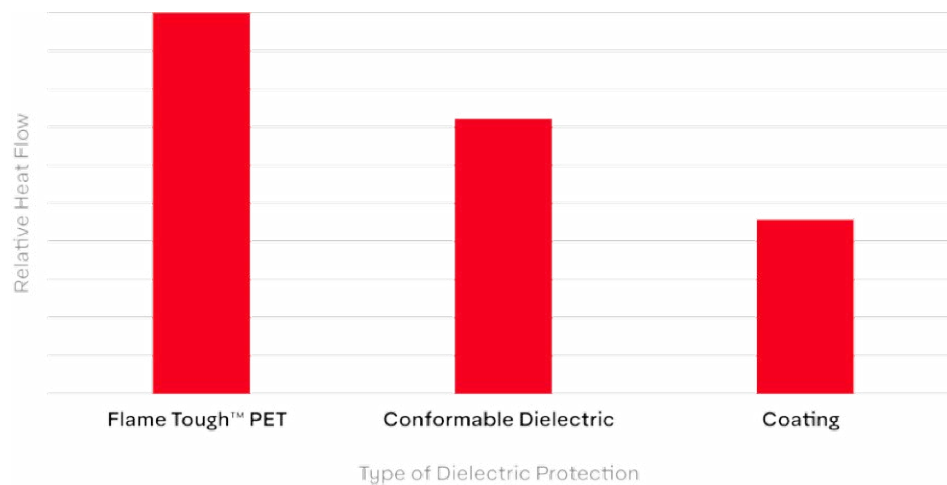
**Challenge: Heat flow**

Traditional solutions, such as powder coatings, impede heat flow when applied at thicknesses required to provide effective electrical insulation. This is especially undesirable when electrical insulation solutions are applied to cooling plates, fins, ribbons, heater films and heat spreaders.

*Avery Dennison Dielectric tapes offer less resistance to heat flow compared to powder coating.*

**Solution:**

Thin, pressure-sensitive adhesive tapes offer the optimal combination of dielectric protection and heat flow.



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## Pressure-sensitive adhesive tape applications for dielectric insulation

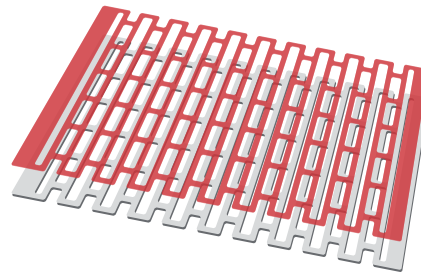
Dielectric tapes can be used for bonding and protection in various applications throughout a battery pack.

- Pack structural components
- Flexible and rigid busbar and cell connection systems in EV battery assemblies
- Graphite-based heat spreaders
- Various cooling components, including chill plates and cooling ribbons

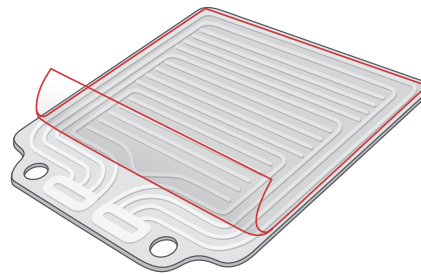
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State-of-the-art tape solutions, such as those in the Avery Dennison EV Battery Portfolio, offer dielectric insulation with reduced flammability, enhanced tear resistance and improved heat flow.

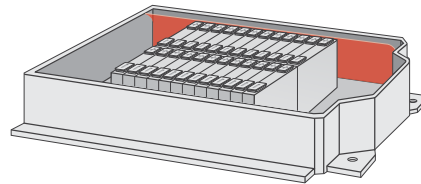
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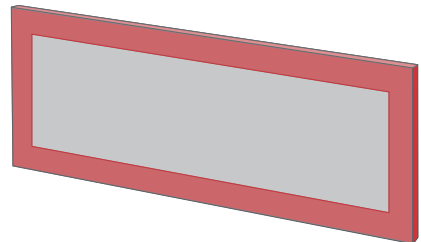
*Busbar / Cell  
Connection Systems*



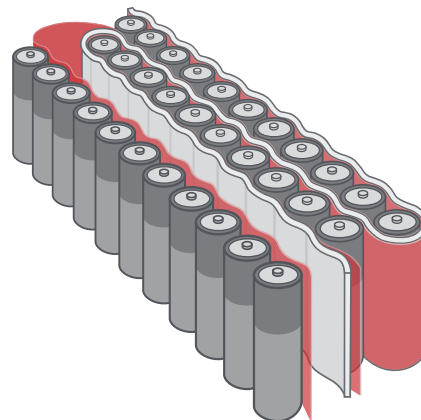
*Chill Plate*



*Pack Structure*



*Structure Edge  
Insulation*



*Cooling Ribbon*

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## The Avery Dennison portfolio

The Avery Dennison EV Battery Portfolio includes various functional bonding and protection tapes built on multiple pressure-sensitive adhesive technologies. These are engineered to make EV batteries safer, more efficient and easier to assemble.

The portfolio can help manufacturers solve some of the most common challenges in battery design and construction, including reducing flammability, boosting dielectric strength and design/assembly optimization.

The company also offers support beyond its product portfolio. This includes extensive application and 3D design support, plus testing capabilities that include flame and dielectric performance, environmental, compression testing and battery cycling simulation, and bulk property testing (peel, tack, and shear). All testing is completed in ISO-certified laboratories.

## Summary

The automotive industry must address vexing battery pack engineering issues related to safety and performance to meet the global EV demand in the coming years. Effective and practical electrical insulation solutions are needed.

Traditional electrical insulation solutions force engineers to make trade-offs around cost, performance and mechanical properties. These trade-offs are minimized with dielectric tapes incorporating pressure-sensitive adhesives. State-of-the-art tape solutions, such as those in the Avery Dennison EV Battery Portfolio, offer the dielectric insulation needed. They also provide reduced flammability, enhanced tear resistance and improved heat flow compared to traditional solutions.


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## Contact Avery Dennison to learn more



If you're an OEM, automotive tier supplier or converter representative looking to better understand the potential for pressure-sensitive adhesive tapes in EV batteries, please contact me directly at [max.vanraaphorst@averydennison.com](mailto:max.vanraaphorst@averydennison.com).

To learn more about Avery Dennison Performance Tapes' solutions, visit [www.tapes.averydennison.com/evbattery](http://www.tapes.averydennison.com/evbattery).

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