Material Solutions in Electric Vehicle Batteries

Creating Competitive Advantage in eMobility Applications

OVERVIEW

For EVs and other eMobility applications, batteries are critical not just for function but for market adoption. Continued EV market growth, therefore, depends on the development of batteries that are safer, more reliable, faster-charging, and that provide greater charge range. These factors make the battery and battery compartment arguably the most integral part of EV design and development. Several factors, however, threaten battery function and performance. These include harsh and unpredictable environments, noise, vibration, shock, thermal runaway, overheating, dust and fluid contamination, electromagnetic interference, and other risks. Battery compartments also require collision impact solutions to enhance consumer safety and reduce warranty expenses.

Engineered material solutions can help mitigate these factors. Developed correctly, they can improve battery performance for better range, safety, and reliability. This paper addresses current trends and projections for the EV market and explores material science design challenges for EVs, focusing on batteries. It will aid engineers in understanding the role of material applications to improve system development and foster design creativity.

ELECTRIC VEHICLE MARKET TRENDS AND PROJECTIONS

The EV market is expecting rapid growth in the 2020s and beyond. According to the report, "Global EV Outlook 2021," published by the International Energy Agency, EVs are expected to make up 20% of the global fleet by 2030, with up to 230 million vehicles on the road. Unit production will grow globally at a 34% CAGR from 2020-2030.

Several interrelated factors will power this dramatic rise.

- **Costs:** EVs are becoming more affordable. This is due to a reduction in the cost of battery technology and an increase in the cost of ICE technology related to carbon emission and fuel-efficiency requirements.

- **Regulations:** Policymakers in the U.S. and abroad are enacting measures to accelerate the adoption of EVs. As an example, California has announced a ban on the sale of ICE vehicles in the state by 2035. Several EU nations, along with the U.K., have announced phaseouts of new ICE vehicle sales. Most of these initiatives are set to start in 2025 or 2030.

- **OEM goals:** More OEMs are setting time-bound goals to be exclusively electric in response to various factors, including changing consumer tastes and regulatory activity. General Motors has a plan to be all-electric by 2035. Volvo now offers electrified (including hybrid) versions of all its models and aims to

have 100% of its sales volume be fully electric by 2030. Tesla delivered nearly 500,000 cars worldwide in 2020. The company aspires to produce 20 million vehicles annually by 2030.
These commitments complement significant investments in R&D, engineering, and manufacturing. For example, in September 2021, Ford announced an $11.4 billion investment in electrification. It includes two new campuses devoted to battery production and EV assembly.

- **Innovation:** Battery technology is improving rapidly. EV range is increasing — and is expected to continue to increase — while charging times decrease. Other factors related to early EV batteries, including safety and durability, are being addressed by engineers.

Concerns that have previously limited EV adoption have been or are being addressed. These include battery costs, safety, reliability, charging station availability, and technology limitations. Battery capacity has doubled in the last five years. Today's batteries charge faster than ever, power is more efficiently converted, and electronics' speed, complexity, connectivity, and processing power have increased.

Yet, key engineering challenges remain related to the most critical component in an EV, the battery pack. EV battery manufacturers must address factors such as electrical shortages, dust and fluid contamination, shock and collision, thermal management, and others. For the EV and eMobility market to continue on its growth path, manufacturers must produce cars and trucks that match or exceed ICE vehicles for safety, reliability, durability, and range.

To help address these challenges, Boyd collaborates closely with leading raw material suppliers to offer the widest range of high performance converted and engineered material solutions for battery compartment protection, sealing, and cooling. With advanced global manufacturing processes and decades of development experience, Boyd solutions address issues relating to flammability, dielectric insulation, cell cushioning, and more.

This focus ensures our EV battery solutions help OEMs and tier suppliers address these challenges and further drive innovation in the marketplace. We engineer customizable and scalable solutions to prevent thermal runaway, extend battery life, optimize energy use, protect against collision, reduce weight, and more.

KEY ENGINEERING CHALLENGES FOR EV AND EMOBILITY BATTERIES

The average age of vehicles on U.S. roadways is 12.1 years, up from less than ten years in 2001. Cars are driven longer and perhaps harder than ever before and need to stand up to years upon years of abuse from environmental factors such as rain, UV light, ice and road salt, stop-and-go traffic, poorly maintained roads, and more.

Compounding these factors are the vehicles themselves. They’re far more complex than ever before, loaded with expensive computerized electronics, sensors, and other equipment.

Material Solutions in EV Batteries

CREATING COMPETITIVE ADVANTAGE IN EMOBILITY APPLICATIONS

CHALLENGE: THERMAL PROTECTION

EVs have an entirely different set of cooling needs than ICE vehicles, with a completely different system design. To ensure safety and promote consumer adoption, EV and battery manufacturers have strict requirements to prevent and manage thermal runaway, a unique challenge to lithium-ion batteries. Battery manufacturers rely on mica, ceramic fibers, other materials, and smart system design to prevent these thermal runaway events.

CHALLENGE: ELECTRICAL SHORTAGES

Applying insulative layers can prevent spark voltage between critical internal components, preventing electrical shortages or fires.

Boyd offers adhesive tape products, including multilayer stack configurations with tight tolerance control that prevent shorting in flexible, printed circuits and other high voltage components such as lithium-ion cell subassemblies. Combining electrically insulating double-coated tapes with compression pads and other materials creates multi-functional solutions that prevent electrical shortages and absorb road vibration or collision impact energy. Single-coated insulating tapes applied to liquid cooling system components, such as aluminum cold plates and other metal structures, add electrical performance to thermal systems.

CHALLENGE: DUST AND FLUID CONTAMINATION

Sealing the battery pack protects lithium-ion cells against liquid, gas, and dust particle intrusion — contaminants that could cause catastrophic failure or shorten battery life. Seals should optimize performance and provide waterproofing while considering compression set and force deflection, assembly efficiency, noise/vibration/harshness (NVH), and other mechanical factors.

Display seals and bonding solutions are not in the battery pack but are still crucial to the consumer driving experience. Boyd's are engineered with innovative pressure-sensitive adhesives and acrylic foams to protect the display assembly through its lifetime. Their ultra-tight tolerances can achieve “zero-gap” performance, offering unbeatable protection against dust and liquid contamination. We design these solutions for simplified customer assembly, design-for-manufacturing (DFM) throughput, and material optimization.

Our portfolio of seals and gaskets includes hundreds of foams, polymers, adhesives, and other options. We combine this material expertise with DFM mass production capabilities to deliver customized designs that exceed your high-performance operating conditions for battery pack and display assembly contamination protection.

Material Solutions in EV Batteries

CREATING COMPETITIVE ADVANTAGE IN EMOBILITY APPLICATIONS

CHALLENGE: SHOCK AND COLLISION

Battery packs must be protected against collision impact, harsh road conditions, and temperature extremes. The placement of rugged and resilient compression pads, layered between lithium-ion cells, compensates for swelling forces due to charge cycling. When placed around the battery module, these pads serve as an impact protection barrier by absorbing mechanical energy from collision impact, extreme road conditions, and extended vibration for enhanced consumer safety and reduced warranty costs.

Boyd offers a range of closed and open-cell foams. These provide varying performance characteristics to meet the needs of a broad spectrum of temperature and environmental exposure applications. Foams can be combined with single- and double-coated tapes that incorporate dielectric films for electrical insulation in EV batteries.

These foam solutions reduce your total cost of ownership by solving technical challenges while promoting easy assembly and efficient installation.

CHALLENGE: THERMAL MANAGEMENT

With EV design and functionality evolving to heavily incorporate advanced electronics, EV engineers are turning to traditional electronic system thermal management market leaders for thermal system innovation.

EV battery designers look to maintain homogenous temperatures across battery cells. They must do this while enabling faster charge/discharge cycles, reducing battery overheating, isolating catastrophic battery events when they happen — or better yet, preventing those events from ever happening. Boyd's complex material assemblies integrate lithium-ion battery cell-to-cell cooling with impact-absorbing and heat/flame isolating solutions to address the primary mechanical, thermal, and environmental factors that prevent thermal runaway.

Thermal interface materials (TIMs) facilitate heat transfer between the liquid cooling system's cold plate and battery module, reducing thermal resistance to maximize thermal system efficiency. They help minimize the resistance of heat flow into, through, and out of an interface. Drawing heat away from sensitive components promotes greater power density and efficiency.

Boyd's manufacturing capabilities combine raw materials from multiple vendors to create optimized multilayer stack-ups of material configurations, helping engineers achieve greater design flexibility. These materials can be combined with flame-retardant adhesives that enable composites and materials to meet UL® 94 V-0 and other flame retardancy requirements, along with single-and double-coated tapes with easy-release liners and filmic layers with strong dielectric properties.

Our liquid aluminum cold plates provide Robust Structural Support (RSS) and high-efficiency cooling for today's highest performing battery modules and packs. Their low profile and light weight create extra design space for more powerful batteries and more reliable vehicles with greater range.

Material Solutions in EV Batteries

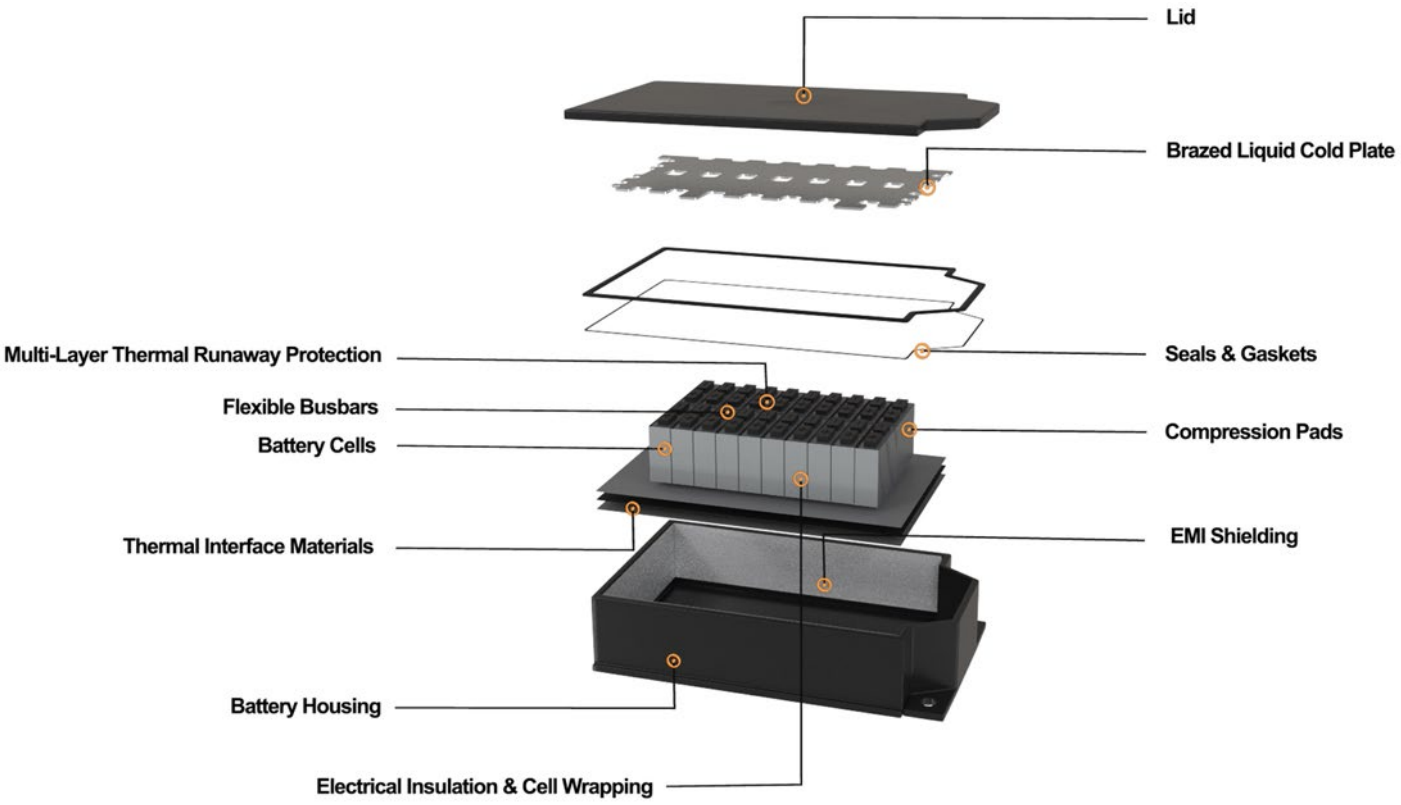
CREATING COMPETITIVE ADVANTAGE IN EMOBILITY APPLICATIONS

CHALLENGE: ELECTROMAGNETIC INTERFERENCE

Seams and openings provide avenues for rogue energy waves to enter or exit a device, causing electromagnetic interference (EMI). EMI shielding reduces electronic malfunction susceptibility and improves battery performance, safety and reliability by blocking or absorbing these unwanted waves. Generally, this shielding first deflects electromagnetic waves with reflective surfaces. This heats the shield, making moderate electrical and thermal conductivity essential characteristics of an EMI/RFI shield.

Boyd's LectroShield metal foils, conductive foams, elastomers, and adhesives are designed to manage interference energy. The outcome is improved reliability and efficiency.

BOYD'S EV BATTERY PROTECTION MATERIAL SOLUTIONS



Brazed liquid cold plates

A cold plate transfers heat from surfaces with high heat loads to the fluid in a liquid cooling system. The performance of the cold plate is critical to the overall effectiveness of the liquid system.

Seals and gaskets

Seals and gaskets protect the battery module and cells against contamination from liquids, gases, and particles for longer battery life, improved safety, and reduced warranty costs.

Compression pads
Rugged and resilient compression pads protect batteries against collision impact, harsh road conditions, and temperature extremes. Pads are layered between cells to compensate for swelling forces or placed around the module as an impact protection barrier.

EMI shielding
Shielding reduces electronic malfunction susceptibility and improves battery performance by blocking unwanted electromagnetic waves, increasing battery performance.

Electrical insulation and cell wrapping
Insulation and wrapping prevent spark voltage between internal critical components that can lead to device shorting or fire.

Thermal interface materials (TIMs)
TIMs facilitate heat transfer between the cold plate and battery module while minimizing the resistance of heat flow into, through, and out of an interface**.** Designed specifically to keep batteries within their optimum temperature ranges, especially in unpredictable environments, TIMs reduce draw from battery power required for cooling and heating systems.

Dielectric adhesives for busbars
Dielectrics protect flexible printed circuits in battery assemblies, helping extend their lifetimes.

Multilayer thermal runaway protection
Complex cooling and impact absorption protection layers meet strict requirements to prevent thermal runaway.

Battery housing seals and collision protection
Robust seals, gaskets, and damper pads are designed to withstand and absorb variable force and mechanical energy from extreme road conditions, sudden impact, or prolonged vibration, minimizing the detrimental effect on the battery and reducing warranty costs.

THE BOYD ADVANTAGE

Boyd Corporation is a world-leading innovator of technologies in material science, engineered material, and thermal management that seal, protect, interface with, and cool our customers' most critical applications. We embrace science to solve ambitious performance targets. Boyd architects material innovation, combining technologies in novel ways to redefine the possible. Continually redefining the possible has driven over 90 years of innovation and customer success.

Material Solutions in EV Batteries

CREATING COMPETITIVE ADVANTAGE IN EMOBILITY APPLICATIONS

Boyd's focus on innovation and customer partnerships ensures that our material solutions for EV batteries and eMobility applications are as innovative as the vehicles they support. Our commitment to eMobility research and development assures our innovation stays ahead of the next generation's requirements.

To receive more information, please visit www.boydcorp.com.