



Improving performance, safety and efficiency in batteries and energy storage solutions

Key considerations to increase efficiency for battery manufacturers

Electric vehicle (EV) batteries and industrial energy storage solutions can be incredibly complex products. Systems may involve dozens of individual components that all require precise design engineering to ensure proper performance.

Companies that build energy storage solutions need a partner who understands the intricacies of battery systems and can collaborate early in the process to avoid design challenges. Good supply partners find practical, cost-effective solutions to difficult challenges like thermal runaway prevention, EMI shielding, battery ruggedization, and more.

Thankfully, Boyd is here to help. We have extensive experience working with manufacturers to [make batteries better, safer, and more efficient](#). We created this whitepaper detailing some of the most important considerations for the design and production of Battery Energy Storage Systems (BESSs).

Boyd can help improve the performance of energy storage solutions and make manufacturing more efficient with our material converting services. Keep reading to learn more.

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Thermal management

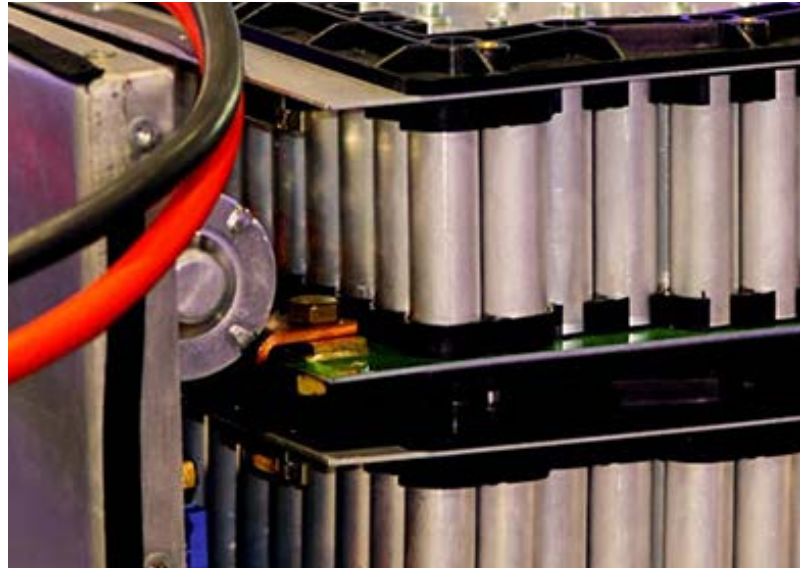
Improving thermal management is key to advancing battery performance and preventing thermal runaway is one of the most important user safety concerns. These two important performance challenges have historically been barriers to market adoption. It's critical for battery manufacturers to leverage smart designs that prevent thermal runaway, develop protective solutions to isolate catastrophic battery events if they happen, and increase battery power density to continue to grow BESS market adoption.

[Integrated liquid cooling systems](#) have emerged as one of the best solutions to address thermal challenges for EV batteries and other energy storage solutions. Liquid systems offer the most efficient cooling and flexibility in design to meet the requirements of both batteries and inverters within one central thermal system. [Liquid aluminum cold plates](#) can also 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 EVs with greater range.

[Thermal interface materials \(TIMs\)](#) can be used to facilitate heat transfer between a liquid cooling system's cold plate and battery module, reducing thermal resistance to maximize thermal system efficiency. These materials minimize the resistance of heat flow into, through, and out of a particular interface. Drawing heat away from sensitive components promotes greater power density and efficiency for improved performance and battery life.

[Thermal runaway protection](#) is enhanced with specialty materials and components that reduce the probability of a thermal runaway event and protect against thermal runaway propagation if a catastrophic event occurs.

Boyd's manufacturing capabilities combine the best raw materials to create optimized multilayer stack-



up configurations that prevent or isolate thermal runaway and help engineers achieve greater design flexibility in thermal management solutions. These materials can be combined with flame-retardant adhesives that enable composites and materials to meet UL® 94 V-0 and other fire prevention requirements. Single- and double-coated tapes with easy-release liners and filmic layers with strong dielectric properties additionally act as good flame and electrical barriers.

Cell wrapping

To improve safety in battery systems, manufacturers must develop proactive safety designs that ensure fire isolation in the case of catastrophic battery failure. To achieve this level of protection, battery cells and modules can be wrapped with [electrically isolating high performance films](#). These lightweight, rugged insulation layers wrap battery cells to prevent spark voltage between internal critical components that can lead to device shorting or fire. Using the highest flame-rated FR V0 isolation films helps to prevent fire from occurring and can also isolate it at the primary battery cell level in the unlikely event a cell combusts.

Compression pads

One of the most effective ways to improve durability and ruggedize EV batteries against collision impact, harsh road conditions, and temperature extremes is by using rugged, resilient [compression pads](#). Battery compression pads layer between battery cells and around the battery module to compensate for mechanical shock, friction, and extreme road vibration, as well as swelling forces caused by temperature changes either from the environment, or during charging cycles.

When installed between battery cells, they also provide consistent force to help keep cells aligned under a variety of conditions. Essentially, compression pads act as a battery impact protection barrier to not only improve battery durability, but also to enhance consumer safety and reduce battery-related warranty costs.

Boyd offers a wide variety of [closed and open cell foam options](#) that are highly resilient and meet the needs of many different temperature and environmental exposure applications. Certain foam materials can also offer EMI/RFI shielding characteristics, further enhancing the performance of battery assemblies. Boyd can help guide materials selection to identify optimal materials and design considerations to achieve application requirements.

Busbars

Busbars are common but critical components in allowing battery energy storage systems to perform their best and provide the most utility to end users. Battery manufacturers can enhance and protect these components using dielectric adhesives such as 3M dielectric tape.

[Dielectric adhesives electrically insulate busbars](#) with high heat resistance and flame protection that protects flexible printed circuits in battery assemblies to extend battery lifetime and maintain performance. It's important to note, however, that because busbars

feature precise designs and potentially complex geometries, dielectric adhesives must be converted with tight tolerances for precision through-hole placement.

Boyd has the converting capabilities to meet tight tolerance requirements, and our high-quality dielectric materials and adhesives are tested for breakdown voltage and dielectric strength requirements using GB/T 1408.1-2016 and ASTM D3755 testing methods. This helps ensure lasting durability to extend battery lifetime and maximize system performance.

Sealing and gasketing

From external housing components to internal parts such as battery packs, battery modules, and battery covers that require added environmental protection, properly sealing batteries is crucial to ensure proper performance and extend battery life.

Sealing the battery pack protects lithium-ion cells against liquid, gas, and dust particle intrusion, all of which are contaminants that could cause catastrophic failure or shorten battery life. Proper sealing solutions optimize performance and provide ingress protection against air, dust, and water while considering compression set and force deflection, assembly efficiency, [noise/vibration/harshness \(NVH\)](#), and other mechanical factors. Robust seals, [gaskets](#), and damper pads can also be 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.

Boyd's extensive portfolio of [seals and gaskets](#) includes hundreds of foams, polymers, adhesives, and other options for sealing and gasketing applications. We combine this material expertise with design for manufacturing (DFM) mass production capabilities to deliver customized designs that exceed high-performance operating conditions for battery pack contamination protection.

EMI/RFI shielding

Seams and openings in housing and other components provide avenues for rogue energy waves to enter or exit a battery system, potentially causing electromagnetic interference (EMI) that can negatively impact performance, user safety, and system longevity. [EMI shielding solutions](#) reduce electronic malfunction susceptibility and improve battery performance, safety, and reliability by blocking or [absorbing these unwanted waves](#). Shielding generally first deflects electromagnetic waves with reflective surfaces. This heats the shield, making moderate electrical and thermal conductivity essential characteristics of a complete EMI/RFI shielding solution.

Boyd offers a range of conductive foams, elastomers, adhesives, foils, and more that are designed to mitigate interference and shield unwanted signals, including EMI, radiofrequency interference (RFI), and electrostatic discharge (ESD). [Shielding materials can be die cut](#) with tight tolerances to create a custom shielding solution that helps improve reliability and efficiency in EV batteries and other energy storage systems.

Cell-to-cell bonding

Within battery pack constructions, manufacturers often seek to bond individual pouches and prismatic cells together to strengthen the integrity and durability of the overall energy storage system. This can be accomplished using a variety of [high-performance tapes and adhesives](#). In particular, pressure-sensitive adhesive tapes from 3M that offer high bond strength as well as dielectric and fire-retardant properties are often used because they do not require cure time, speeding assembly efficiency, and are easier to handle for improved manufacturability. Boyd converts PSA tapes to meet exact specifications with tight tolerances, helping battery makers quickly and easily bond cells, even in tight spaces where tape application can be challenging.

Custom solutions produce better batteries

Demand for EV batteries and other types of battery energy storage systems is growing exponentially, offering significant opportunity for manufacturers who can create superior solutions that outperform and outlast the competition. As with most things, the key to achieving such performance is in the details. By taking time to reevaluate material selection, design choices, and manufacturing processes, and by partnering with an organization like Boyd that can offer expert guidance and converting services, battery makers can improve energy storage solutions to get a leg up on the competition and win more business.

**Ready to start
your next project?**

Contact Boyd today!

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About Boyd

With over 90 years of customer-focused performance, Boyd's innovative, sustainable engineered material and thermal solutions make our customers' products better, safer, faster, and more reliable.