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Advanced Cell Contacting System Structure Helps Mitigate Unwanted Hotspots in EV Batteries

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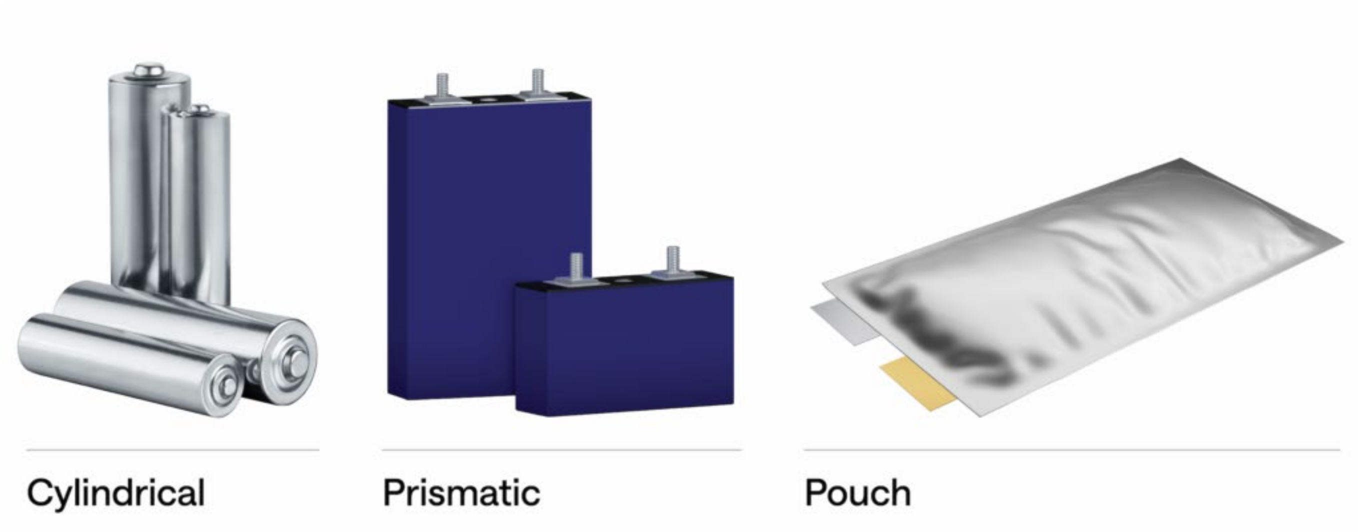

The Advanced Cell Contacting System Structure Helps Mitigate Unwanted Hotspots in EV Batteries.

The heart of every electric vehicle is its battery pack, supplying the necessary electricity for the drivetrain. As the most expensive component within the car, it heavily influences the overall bill-of-materials (BoM) costs – ensuring its longevity is of paramount importance. This article explores how the structure of the battery cell contacting system will play a crucial role in extending the battery pack lifespan.

Automotive manufacturers face several key objectives in EV development, prioritized as follows:

Cost Management: Minimizing BoM costs is imperative, as EVs remain pricier than equivalent internal combustion engine (ICE) vehicles. To bridge this pricing gap, manufacturers must focus on production and raw material cost efficiencies.

Range Optimization: Addressing range anxiety is crucial by increasing the distance EVs can travel before needing a recharge. Achieving this involves enhancing both the battery pack's energy storage capacity and performance and reducing vehicle weight. Models with larger, denser battery packs and lightweight designs offer extended range, enhanced user convenience, and increased market appeal.

Battery Longevity: Maintaining the health of EV battery packs is essential to prolong their lifespan and avoid premature replacements. Given the battery's significant share in the total cost of ownership (TCO), minimizing replacements is key for owners. IN addition, short battery life spans can tarnish a carmaker's reputation.

Common Battery Cell Formats

In an EV, energy storage relies on cells as the fundamental building blocks. These cells are arranged within modules, and multiple modules constitute a battery pack. There are three primary cell formats used in EV battery packs:

Cylindrical: As the name suggests, these cells have a cylindrical shape, which helps to minimize stress and internal pressures, including prevention of swelling. Currently, they are the smallest type of battery cells in use. Consequently, more cells are required to fill a module, necessitating a greater number of connections. Also, because of their shape, when packed into a module there is dead space between the cells, which wastes valuable space.

Prismatic: These cells have a rectangular shape and are enclosed in rigid casings – they are typically larger than cylindrical cells. An important advantage is that fewer connections are needed, reducing the amount of welding work required. This makes them well-suited for streamlined EV production processes that carmakers are looking to implement.

Pouch/polymer: Similar to prismatic cells, pouch/polymer cells are sealed within a laminated foil pouch instead of a rigid casing. They offer high package density due to their flexibility in shape. However, they are prone to swelling and are more susceptible to punctures or damage, requiring a solid protective case structure.

Battery module advancement

There is a notable trend in the battery sector toward reducing the number of modules in EV battery packs. Modern packs often consist of only a few modules, each containing many cells. This approach increases battery storage capacity by minimizing dead space, simplifies battery packs, and reduces production costs. Eventually, this progression will lead to the adoption of cell-to-pack (CTP) or cell-to-chassis (CTC) arrangements, eliminating modules entirely. This shift will free up space for greater storage capacity and contribute to lighter battery packs. However, this transition must be carefully balanced with safety considerations concerning larger battery entities.

The connection of cells within modules and battery packs has significant implications for system effectiveness and manufacturing costs. The selected cell contacting system for EV deployment requires a combination of characteristics to be favorable.

Conventional EV battery module interconnect assemblies typically use aluminum-based alloys due to their cost-effectiveness and lighter weight compared to copper-based alloys. However, for certain cell types, these assemblies can be intricate, requiring multiple layers and varying thicknesses. Variations in metal thickness and current flow through the interconnects lead to uneven current density and heat distribution.

Uneven energy density distribution and the generation of hot spots can adversely affect battery pack lifespan, resulting in premature aging of certain cells. Since a battery is only as strong as its weakest cell, if multiple cells deteriorate prematurely, the entire module may need replacement earlier than expected.

While there are methods for cell balancing to compensate for poorly performing or poorly connected cells, there are limits to their effectiveness, especially as battery packs grow larger and contain more cells per module.

Cell contacting system optimization

The ENNOVI cell contacting system is capable of supporting EV battery modules based on both cylindrical and prismatic cells, with laser welding being utilized for cell attachment. This unique approach maintains current density consistency across all the cells it is connected to. The upshot is that it places far less stress on individual battery cells, thereby keeping battery packs in operation for longer.

Through precision engineering, the thickness of the cell interconnect system can be adjusted in specific areas, such as reducing material in the cell tabs and increasing it in the main current paths. This thinner profile, with fewer layers, creates additional space for energy storage. Moreover, less metal conductor material is required, resulting in reduced heat generation that needs to be dissipated.

Inadequate heat dissipation places greater stress on battery cells, accelerating their deterioration and leading to premature end-of-life scenarios. While alternative cell contacting systems may address the heat issue by adding extra insulation, this would only add to BoM costs. Alternatively, the only other thermal management option would be to enhance the cooling system. This could involve either specifying a larger cooling system, occupying more space, or running it with higher power consumption. Either approach would result in increased electricity usage, reducing available battery charge for propulsion and limiting the vehicle’s range.

ENNOVI’s patented U-Turn technology achieves a significantly more uniform distribution of current density, effectively reducing the formation of hot spots within the module. Unlike standard cell contacting systems that utilize an additional return busbar, which adds an extra layer and generates excess heat, the U-Turn technology organizes energy flow more efficiently from the positive to the negative terminal. This streamlined approach requires only a single conductor layer, enhancing heat dissipation. Moreover, this solution is fully scalable, accommodating modules and battery packs of any size, and meets the high-volume manufacturing demands of the automotive industry.

Conclusion

Ensuring a long-lasting battery resource is crucial for making EV models appealing to consumers. Maximizing the lifespan of individual cells within the battery pack is paramount. The uneven current and heat distribution seen in existing cell contacting systems accelerates cell deterioration and unnecessarily raises production and material costs.

Transitioning to a better-optimized cell contacting system architecture, whether at the module or CTP/CTC level, offers numerous invaluable benefits to carmakers and gigafactories. Implementing the right technology will result in interconnects that subject cells to equal amounts of stress, promoting more uniform aging rates. Additionally, these optimized interconnects will be simpler and less costly to implement.

About the Author

Till Wagner is Product Manager, Energy Systems at ENNOVI (formerly known as Interplex), a provider of interconnect solutions. He plays a crucial role in advancing EV technology and his expertise lies in optimizing battery performance while ensuring prolonged battery lifespan and addressing key challenges faced by automotive manufacturers. linkedin.com/in/wagnertill

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