Simple Battery Pack Assembly & Robust, Efficient Batteries with Norseal® PF Compression Pads

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The electric vehicle (EV) revolution continues unabated. In 2008, there were fewer than 500 EV charging stations in the United States; as of last year, there are over 47,000. As recently as 10 years ago, North American car buyers had just four battery or fuel-cell electric car models to choose from; now there are upwards of 50 electric and hybrid automobiles available. The market for EV batteries is also set for dramatic growth, with recent forecasts projecting a 20% compound annual growth rate (CAGR) to a $15 billion market by 2026.

This dramatic growth will require significant improvements in battery and module construction technology. Improved resilience during both hot and cold temperatures will be necessary to extend battery life and improve driving range. Battery module production costs need to decrease, and reducing the number of manufacturing steps and the complexity of those steps will allow automation to play a role in bringing down module costs. Reducing battery weight and size can also bring down vehicle materials costs and improve driving range. These disparate challenges all seem to need different solutions — fortunately, **Saint-Gobain® Norseal** PF Series compression pads can help address all of them simultaneously.

Temperature Issues in Lithium-ion Batteries

Battery performance in cold weather is a necessity for electric and hybrid vehicles. Low temperatures cause the chemical reaction to slow down when charging and discharging, hurting battery efficiency. The battery components themselves are also altered by extreme cold; plastics get brittle and elastomers stiffen and fatigue, for example. The total effect contributes to both the reduced range and lifetime of the battery.

Research has determined that optimal battery life is achieved by letting the battery "breathe" while still applying enough pressure to secure electrical and thermal connections, a process that can be challenging when dealing with large battery packs containing many cells. When a battery is recharged, changes in its internal chemistry can actually cause it to physically change and expand, an effect that can lead to delamination of the internal cells and components or battery pack deformation.

Compression pads — also called dielectric foams — are responsible for maintaining pressure on the face of a pouch cell (and also, in some cases of prismatic cells). In many instances they also insulate the cells to promote a uniform face temperature. If the elastomeric (rubber) compression pad demonstrates poor resilience or poor recovery at low temperatures, micro-cracks develop and ultimately lead to fatigue. The result can be little or no face pressure on the cell, resulting in premature failure.

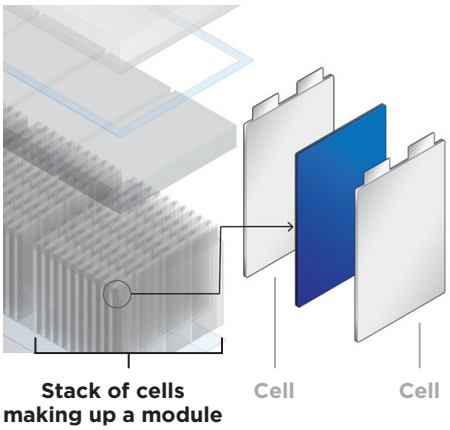

Figure 1: Compression pads inside of a battery module for defined pressure on cells.

Source: **Saint-Gobain**.

Compression pads maintain enough pressure on the battery pack to ensure secure electrical and thermal connections while allowing the package itself to expand and change shape. The foam's spring-like characteristics deflect and return energy and then diffuse it across a range of compression amounts, a property called compression force deflection (CFD). Foam cushioning is also highly resistant to permanent deformation when subjected to extreme pressure or compression loads, and will typically maintain effectiveness beyond the lifespan of the battery pack.

To evaluate this effect, the cold temperature resilience of various compression pads found in the market can be tested. The results for PF47 Series microcellular polyurethane foam versus a competitor's microcellular PUR foam are compared in the graph below.

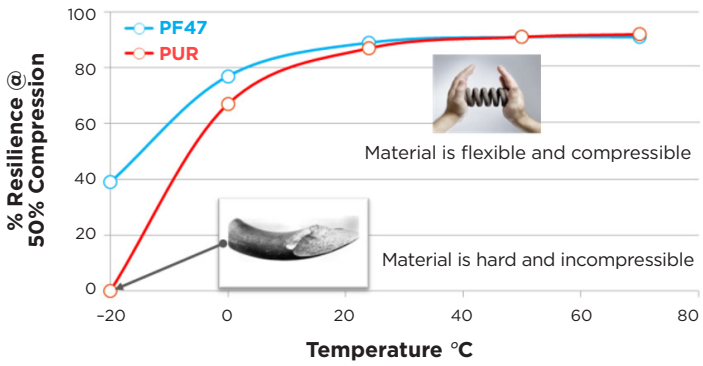

Figure 2: The difference in compression between **Norseal** PF Series and PUR materials.

Source: **Saint-Gobain**.

Saint-Gobain Norseal PF Series materials have excellent capability to withstand low temperatures, thereby providing better, more consistent resiliency over a wider range of temperatures than other PUR solutions in the market. With respect to overheating at high temperatures, foam's insulative properties are not adversely affected by compression — it urges heat to dissipate into the heat sink rather than spreading into neighboring cells. Overheating is the primary reason for battery and electronics failure.

Tackiness and Foam Surface Tailoring

Battery production will have to increase significantly to meet EV demand, meaning automation will play a bigger role in battery production and battery-pack assembly moving forward. As automation takes a stronger foothold, minimizing the number of steps and parts in the manufacturing process will be crucial. In many cases, when compression or tolerance pads are between the cells, an additional step is required to hold the pads to individual cells during the assembly — this is often done by using adhesive or glue. The disadvantage of adhesives is that the pad must be removed from the cell if an alignment error occurs, resulting in wasted materials and costs. Fixes like this also impact the production process by slowing or stopping an otherwise smoothly running production line.

To handle this issue and make the process easier to automate, **Norseal** PF Series pads were developed to have an inherent tackiness to them, thereby eliminating the need for adhesive or glue. In the case of an error, the pad can easily be peeled off and replaced without wasting material. Tackiness is measured using a method developed specifically to simulate the application. The **Norseal** PF Series' tackiness is compared to competitor pads in the chart below.

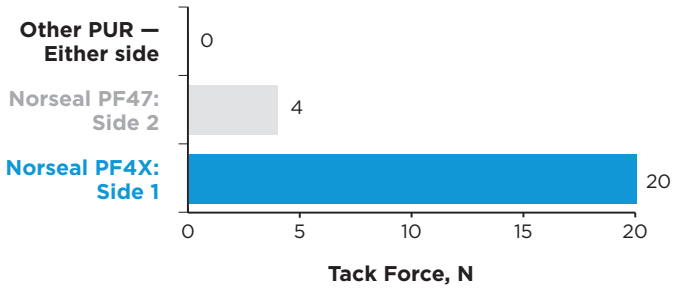

Figure 3: The **Norseal** PF Series is available in different tackiness meeting specific application needs.

Source: **Saint-Gobain**.

For certain applications, tackiness may not be necessary. **Norseal** PF Series therefore includes an option to make the pad surface less tacky or non-tacky. For compatibility with other automatic assembly processes, PF Series products are also available with either a removable or permanent PET liner.

Thickness and Density Range

Norseal PF Series products provide the widest range of thicknesses in the industry, even at densities as low as 150 kg/cm^3. Low density is key to minimizing the overall weight of the module, pack and vehicle itself. PF Series products have overcome an important hurdle to reach thicknesses as low as 1.5 mm at densities of 150 kg/m^3.

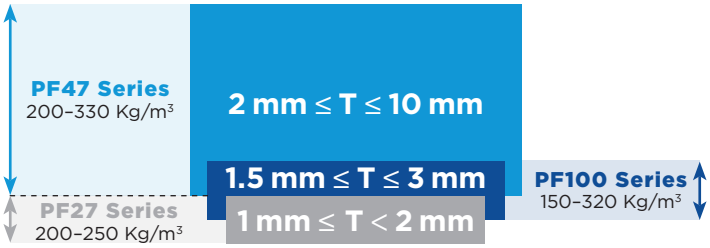

Figure 4: Possible thickness and density ranges for PF27 Series, PF47 Series, and PF100 Series. Refer to individual TDS for standard available configurations.

Source: **Saint-Gobain**.

The PF Series' customizable densities are designed to help address scenarios in which the cell chemistries and types (for example, prismatic versus pouch) demand firmer foams to withstand cell swelling with higher forces. The PF Series offers a unique combination of both low thickness and low density as a standalone foam, while other manufacturers' foams require an additional film support layer to achieve a similar combination of density and thickness.

Building Longer Lasting EV Batteries

Improvements in battery manufacturing technology are critical to fulfilling the promise of efficient, low-cost and long-range electric vehicles. Modern foam materials, such as the **Norseal** PF Series, operate reliably and efficiently over wide temperature ranges, support improved automation in the manufacturing and placement processes, and provide low weight while improving battery robustness. Their use will be key to electric vehicle growth and an overall greener future.

Find out more about **Norseal** PF Series microcellular PUR tape solutions or contact your local representative for personal information.

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