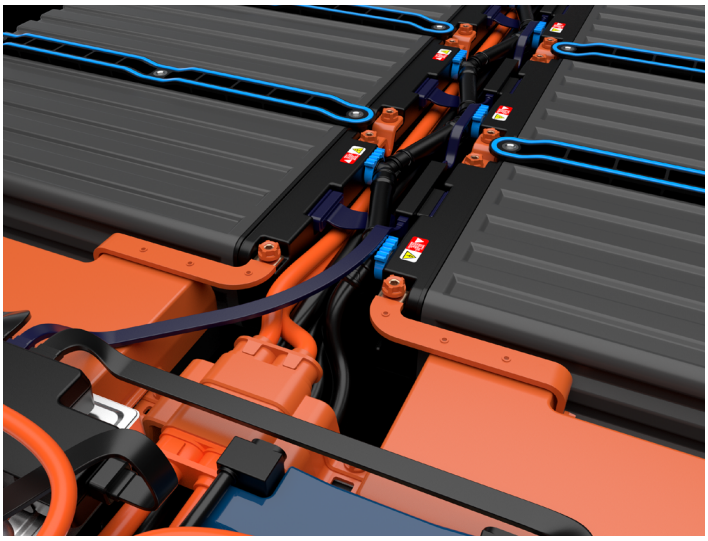
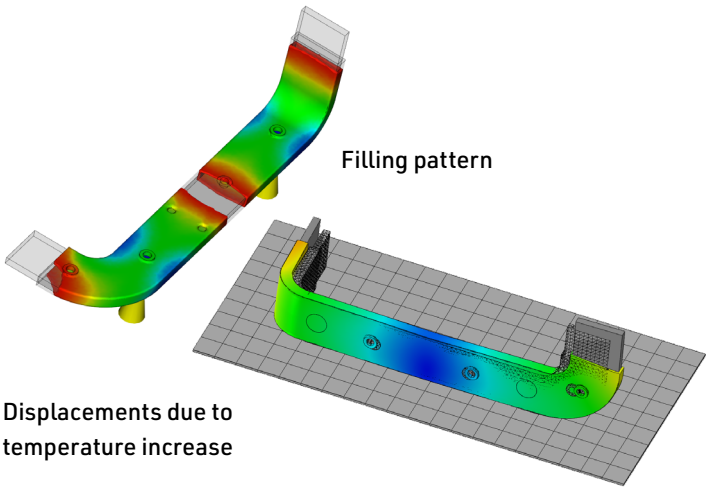
SOLUTION SHOWCASE

Celanese

STREAMLINE BUS BAR OVERMOLDING FOR XEV BATTERIES WITH MATERIAL-PROCESS-SERVICE SOLUTION





Filling pattern

Displacements due to temperature increase

Our Engineered Materials team provides robust material cards to perform simulations such as:

RHEOLOGICAL ANALYSIS

- Filling pattern
- Displacement of over-molded insert
- Warpage and residual stresses

STRUCTURAL / THERMAL / ELECTRICAL ANALYSIS

- Crack prediction under thermocycling tests
- Temperature changes under electrical loads
- Part stiffness during assembly process

Celanese Engineered Materials is breaking new ground for manufacturers of xEV battery components with a combined material-process-service solution for overmolding bus bars with Zytel® PA, Zytel® HTN PPA, and Crastin® PBT materials.

Bus bars are a workhorse component essential for distributing power in xEV batteries. These components are found in virtually every battery system. They transfer current from module to module, inside the junction and relay box, up to the terminal connector in high-power battery packs. With the right materials, a bus bar can enhance a battery's pack energy density, durability, and electrical safety.

However, it must also insulate adequately if the battery suddenly overheats, a condition known as thermal runaway. And it should avoid any additional risk of module-to-module propagation.

Our goal is to provide an excellent material for the application, along with assisting customers in their bus bar design and overmolding, to help them achieve their performance and production goals.

Bus bars within xEV batteries must meet several requirements, including:

- Resistance to thermal runaway without loss of insulation function
- Qualification via demanding thermal cycling and electrical tests
- Efficient production to reduce manufacturing time and cost
- Stable orange color to indicate high voltage, even after prolonged exposure to high temperatures

To determine the optimal combination of material and process for this application, our team conducted a study of over 30 grades of materials, including PET, PBT, PA612, PA66, PPS, and PPA.

The materials were overmolded in a proprietary tool onto copper bus bars of 60mm^2 section at 1mm thickness, then subjected to various thermal testing at temperatures up to 550°C.

At extreme temperatures, PET and PBT failed, but several PA, PPS, and PPA grades passed. These were then inspected for failure (appearance of cracks or holes), and if passed, submitted to a dielectric strength test. The breakdown voltage after the heat test determined several materials that passed, especially the Zytel® HTN PPA range.

Zytel® HTN (PPA) was identified as an excellent material solution for this application. For example, safety standards dictate that bus bars in EV batteries maintain a stable orange color indicating high voltage, even after repeated exposure to high heat. Zytel® HTN accelerated aging testing shows no noticeable color shifts, even at 130°C. It also contributes insulative properties for safer thermal runaway, and easily overmolds onto aluminum or copper, the most common bus bar metals.

Utilizing a host of production equipment, lab testing, and engineering capabilities within our Center of Excellence, the Celanese Engineered Materials team has gained expertise in the overmolding process for bus bars, providing robust technical and processing support to the market. We have also developed and validated an anisotropic simulation methodology to couple filling and structural analysis for bus bars. Using these sophisticated computer-aided analysis tools, our team collaborates with you to predict and avoid failure, reduce manufacturing time and cost, and still maintain performance and safety standards.

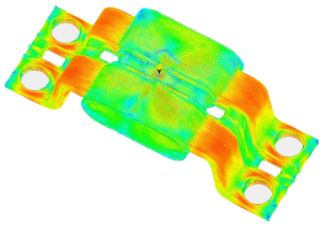
MATERIAL TESTING SUMMARY:

- Zytel® HTN high-performance aromatic polyamide resin helps enhance durability with high heat shock performance
- High heat exposure resistance improves retention of geometry and electrical properties during exceptional thermal events
- High dielectric strength retention at temperatures >180°C
- Non-halogen flame-retardant formulations

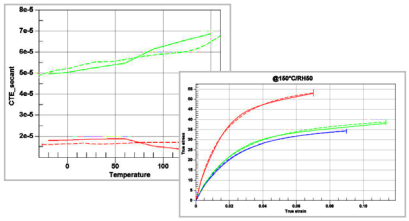
PART DESIGN SUPPORT SUMMARY:

- Structural/thermal/electrical analysis
- Crack and thermal prediction under thermocycling and electrical tests
- Part stiffness and deformation during assembly process
- Guidelines for insert overmolding and processing parameters

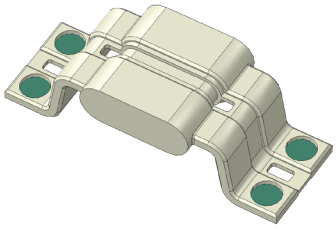
FEA METHODOLOGY FOR BUS BAR THERMOMECHANICAL ANALYSIS



Filling analysis provides glass fiber orientation and potential insert displacement



Material card models the influence of temperature and fiber orientation on properties



Anisotropic coupled FEA predicts potential thermocycle failures and enables optimized bus bar design

SUPPORTING YOUR SUCCESS

Celanese provides solutions for engineering and production challenges. We understand that getting it right, and doing that quickly, matters to your reputation and your bottom line. Engage us for support with EV battery bus bar overmolding and more:

- Material selection and material data
- Part design review and optimization through FEA analysis
- Processing support and optimization through molding simulation
- Material sampling
- Prototyping and testing

DISCOVER MORE

For more information about overmolded bus bar material-process-service solutions for EV battery applications, contact your Celanese representative.

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Form No. 001-20827-HMC0123