

I. General

What makes Hexion's material unique compared to other solutions? Why cannot I pay less for the same performance using other materials?

Hexion's system is the only phenolic-based SMC resin system on the market that is designed to support high volume automotive EV battery enclosure applications. Among other features, the patented system has exceptional FST (fire, smoke, and toxicity) performance, is lighter weight versus aluminum, offers greater design flexibility and has a lower total cost than solutions requiring secondary countermeasures. There are lower cost battery enclosure materials on the market, but none that provide comparable performance without adding additional protection.

II. Mechanical Performance and Durability

How does composite compare to steel from a mechanical performance perspective? Can it be made strong enough to meet crashworthiness requirements?

An enclosure made with Eponol™ Resin TRAC 06921 will perform as well as metal if designed properly. Customers must have a thorough understanding of loads acting on the battery enclosure and recognize that energy absorption of a composite will behave differently than metal. The static and dynamic mechanical performance requirements for covers are significantly lower than for a structural tray. While steel offers excellent FR performance, its density/weight can be a liability relative to both aluminum and SMC.

What is the impact performance of a composite? The material is brittle isn't it?

EPONOL 06921 retains up to 65% of its impact resistance after a full fire event. Generally, composites are more brittle than metals. Brittleness, or lack of elongation under stress, does not imply a "weak" material. It requires that the failure mode of the composite subject to impact must be taken into design consideration. As well, SMC as a format is used almost exclusively for covers in multi-material battery enclosure designs – today in more than 100 serial production EV platforms globally.

Composites are brittle; doesn't this property become worse in cold weather?

Thermoset composites typically IMPROVE their impact performance at lower temperature. This is counter to most engineers' intuition and experience with other materials.

Will composites stand up to salt spray?

Customers must conduct their own use tests. However, phenolic-based composites are resistant to salt spray corrosion – having negligible mass loss after 3000 hours immersed in corrosive fluid at 120°C. (Test Method: ISO 175:2011-03).

Won't composites cause metal corrosion? How is this prevented?

Five conditions are required for galvanic corrosion to occur. Usually, this situation is only of concern when a carbon fiber reinforced part comes into contact with steel or aluminum. There are numerous methods to provide material isolation if needed.

What are the NVH properties of a composite enclosure?

Sound transmission loss factor of typical SMC is 40000×10^5 versus aluminum at 7×10^5 and steel at 2×10^5 .

III. Thermal and Electrical Characteristics

How can a “plastic” material outperform metal for fire resistance?

Phenolic resins have an inherent characteristic when exposed to fire. Phenolics form a “char” or intumescent layer that inhibits progression of an open flame: the flame becomes “starved” for combustible material. (See Hexion Fire Test Video: [here](#)).

Isn't composite a thermal insulator? Won't this cause the battery to overheat?

EPONOL 06921 will act as a thermal insulator. This fact must be considered when designing the battery thermal management system as compared to a metal design.

IV. Part Design

How can I use modeling tools to design with composites and have confidence in consistent performance especially for a safety-critical component?

The customer must have accurate load information for developing an effective composite design and must be matched to the vector performance of the continuous fiber laminate (or SMC) to be used in building the part. The process for generating an efficient composite design takes into simultaneous consideration the material and process to be used in making the part.

Can Hexion provide design support?

Hexion can recommend customers to outside companies who are experienced in various aspects of composite design.

How does the composite attach to the (metal) body-in-white?

There are numerous in-production examples of how composites are joined and/or integrated within a body-in-white structure.

Is it possible to attach directly to the composite?

Yes. There are self-tapping screws designed specifically for thermoset materials.

What is the best design for sealing a composite enclosure?

Seal channels can be molded in at near zero draft angle to accommodate O-rings. Other seal designs exist to alleviate common issues such as pinching and roll-out. Hexion recommends that customers consult with their seal supplier for determining the best overall seal and closure design depending on the box geometry. Also, a dual-stage vent can be easily integrated into the composite design.

What is the tolerance capability of a composite design? This concerns flatness and ability to seal along the perimeter flange.

A composite design made from EPONOL 06921 should have the capability of an IT12 tolerance class (+/- 1.3 mm per 1000 mm) as molded.

How can we incorporate EMI shielding to a composite design?

The requirement for EMI shielding will depend on the OEMs specific design. Many designs only require EMI shielding over the portion of the battery cover that corresponds to the battery control electronics. If EMI shielding is a requirement, there are a number of methods to achieve the specific performance desired.

What is the CLTE of the composite material? Won't this cause problems next to metal of a different CLTE?

The CLTE of the EPONOL 06921 SMC is between 0.12 – 0.16 versus cast aluminum at 0.22 and steel at 0.10 – 0.11. Designs must be toleranced accordingly.

V. Manufacturing Considerations

How can a composite be integrated to my assembly process?

A common approach for integrating large composite parts to the traditional body structure is to use "weld bonding." Weld bonding and variants allow for the composite to be "trapped" between two metal flanges that are then welded together as normal on the assembly line. Adhesives may be used to reinforce the joint. Phenolic SMC can also be directly bolted and does not pose any risk for galvanic corrosion; compression limiters (if required) can be directly molded into the component.

Can the composite travel through my e-coat process?

The inherent high temperature characteristics of phenolic should present no problem for an EPONOL 06921 SMC to withstand most OEM e-coat processes. As always, specific tests should be conducted by the customer.

VI. Economics and Supply Chain

What is the cost of the composite battery box system?

Based on the assumptions of one OEM's battery tray concept, EPONOL 06921 SMC is 25% less costly and 70% lighter than a cast aluminum design (assuming additional countermeasures are required with the aluminum design to pass thermal runaway)

How is it possible that composites are less expensive than metal – ever?

A smartly designed composite that makes efficient use of the material and fiber orientation according to use loads, can be very cost-effective. The EPONOL 06921 material used for the battery enclosure makes additional FST countermeasures such as intumescent coatings, mica layer, etc. unnecessary and avoids the extra associated assembly processes.

What kind of capital investment is needed to mold the composite material?

EPONOL 06921 requires no special molding equipment beyond what is need for a standard SMC operation.

VII. Sustainability EHS

Can a composite battery enclosure be recycled?

Yes. EPONOL 6921 SMC can be recycled the same as many other thermoset composite materials.

Aren't phenols and formaldehydes dangerous materials?

These ingredients, as with any other chemicals, must be handled with care. All the materials are REACH compliant and meet EU directives for recyclability.