



SAFETY + FUNCTIONALITY

ELECTRIC VEHICLE BATTERY PACKS

LIGHTWEIGHT SPECIALTY THERMOPLASTIC MATERIALS



CHEMISTRY THAT MATTERS™

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COMBINING SPECIALTY THERMOPLASTICS EXPERTISE WITH IN-DEPTH KNOWLEDGE OF THE INDUSTRY TRENDS, SABIC'S SPECIALTIES BUSINESS IS COMMITTED TO KEEPING ITS CUSTOMERS IN THE E-MOBILITY INDUSTRY AT THE LEADING EDGE OF MATERIALS AND PROCESSING TECHNOLOGIES.

SABIC's Specialties business offers a portfolio of high performance engineering thermoplastic resins, compounds and composites. Our broad portfolio includes specialty compounds, film and sheet, with our range of branded materials such as NORYL™, ULTEM™, EXTEM™, and LNP™ products.

Together with extensive materials processing expertise, SABIC's Specialties business is committed to helping you, our customers, in the electrification revolution.

SAFETY, FUNCTIONALITY & PERFORMANCE FOR ELECTRIC VEHICLE BATTERY PACKS

With growing concerns of anthropogenic climate change and the imposition of stringent governmental regulations, today's mobility industry is increasingly moving towards battery-powered electric and hybrid-electric vehicles.

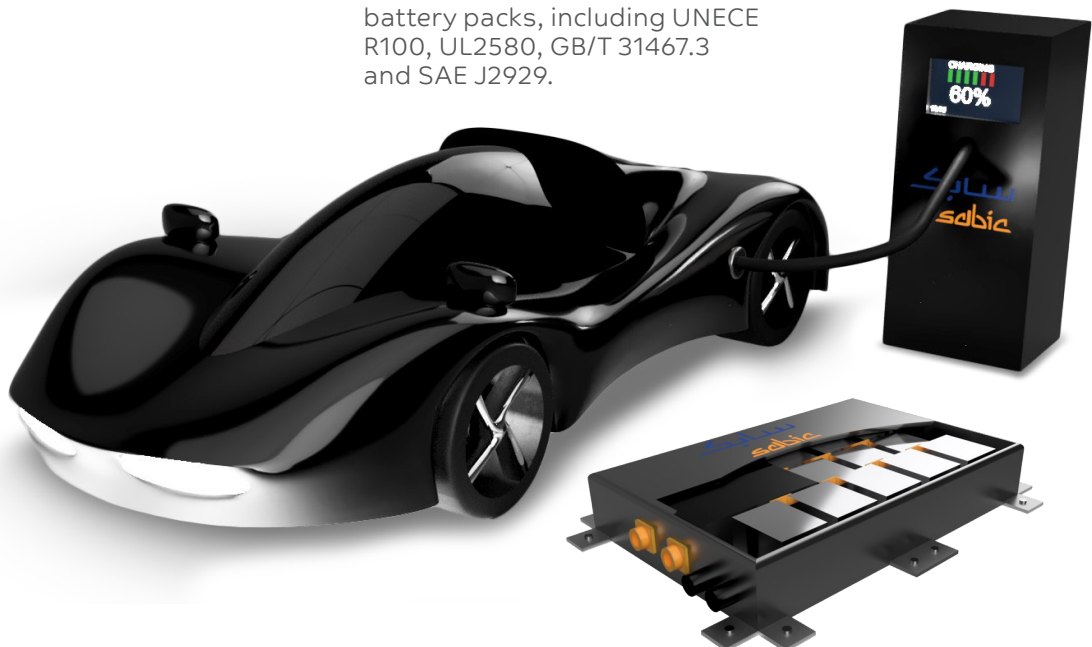
To support the 'electrification revolution,' there exists a growing need for specialty materials to realize the potential of energy storage technologies such as Li-ion batteries.

Our teams of dedicated experts work closely with our customers to tailor unique offerings that bring high standards of safety, functionality and performance. Our computer assisted engineering (CAE) team is here to assist you throughout every step of your journey, from design concepts all the way through to the completed product.

SABIC's Specialties business offers a number of materials for use in electric vehicle (EV) battery packs that can bring:

- Weight reduction
- Fire safety
- Thermal management
- Crash safety
- Design freedom
- Enhanced processing
- Lower system cost

Our Specialties portfolio of materials can assist our customers in addressing the rigors of regulations and standards for traction motor battery packs, including UNECE R100, UL2580, GB/T 31467.3 and SAE J2929.

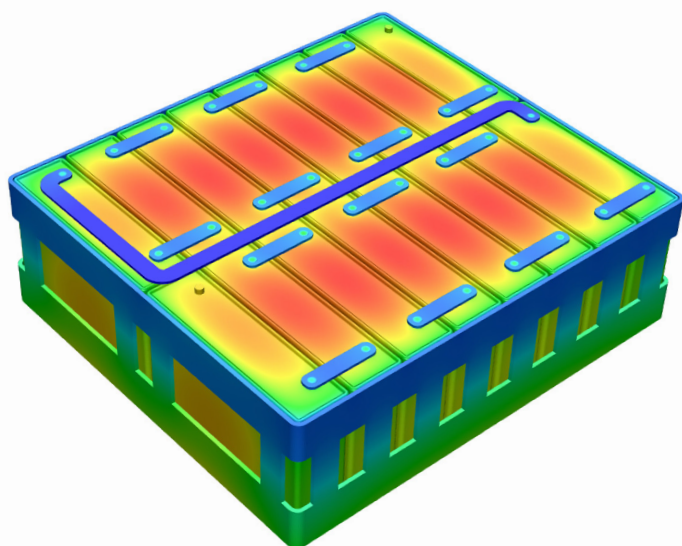


ENABLING THE EV REVOLUTION

SUPPORTING COMPLIANCY WITH APPROPRIATE THERMOPLASTICS

Electric vehicle safety is of unparalleled importance. In lieu of universal regulations for electric vehicle battery modules and packs, a number of stringent safety regulations and standards exist across the globe. While the robust vehicle exterior affords protection to the battery pack, the battery pack and its contents face the very real possibility of damage in the event of collisions, or even through falls during assembly and maintenance. As a result, electric vehicle battery modules and packs must undergo a series of rigorous tests including crush, drop, exposure to fire, immersion and short circuit.

SABIC's Specialties business offers a range of solutions with safety and functionality in mind. Our experts have a longstanding tradition of tailoring specialty solutions to meet demanding requirements, including those of electric vehicle battery packs. Whether these requirements are high impact strength and stiffness, electrical insulation or dimensional stability, or other specialty functionalities including non-chlorinated/brominated flame retardancy, electromagnetic shielding and thermal conductivity, our broad Specialties portfolio and expertise are available to help enable the global electric vehicle revolution.



COMPUTER ASSISTED ENGINEERING (CAE)

Our dedicated CAE team forms an integral part of our solutions offering and is on hand to assist our customers in every step of their developmental journey. Our customers can benefit from computer aided design and modeling to animation and simulation. At the application level, we offer structural and multiphysics analysis, as well heat and fluid flow and fluid-structure interaction. Additionally, our team is also on hand to assist you with resin processing, such as injection molding.

“Specialties’ CAE capabilities can greatly assist our customers in part and tooling design, metal replacement, thermal management and other initiatives related to electric vehicle battery pack development.”

LNP™ COPOLYMERS AND COMPOUNDS

For more than 70 years, the LNP™ product line has innovated highly specialized solutions for a wide range of performance requirements, including those unique to EV batteries. LNP compounds utilize more than 30 base resins and 200 different fillers to achieve various effects. LNP copolymers are adding new dimensions to the superior properties of LEXAN™ polycarbonate.

The LNP™ portfolio features a range of product families that include LUBRICOMP™ lubricated compounds, LUBRILOY™ lubricated compounds based on alloy technology, THERMOCOMP™ reinforced compounds, THERMOTUF™ impact modified compounds, STAT-KON™ electrically conductive compounds, STAT-LOY™ anti-static compounds, VERTON™ long fiber-reinforced thermoplastics (LFRTs), FARADEx™ EMI/RFI shielding compounds, KONDUIT™ thermally conductive compounds, and COLORCOMP™ custom-colored compounds. At LNP™ we ‘compound the answer’ to your specific challenges.

The LNP™ portfolio is now also leveraging a broad palette of LEXAN™-based polycarbonate copolymers with exceptional properties for compounding. The following LEXAN™ copolymers offers unique value compared to general purpose polycarbonate and include resin portfolios with high heat resistance (XHT & CXT), low temperature ductility (EXL), superior flow and ductility (HFD), prolonged resistance to UV exposure for outdoor applications (SLX), transparent flame retardancy at thin gage (CFR), and excellent flame, smoke and toxicity properties for mass transportation (FST).

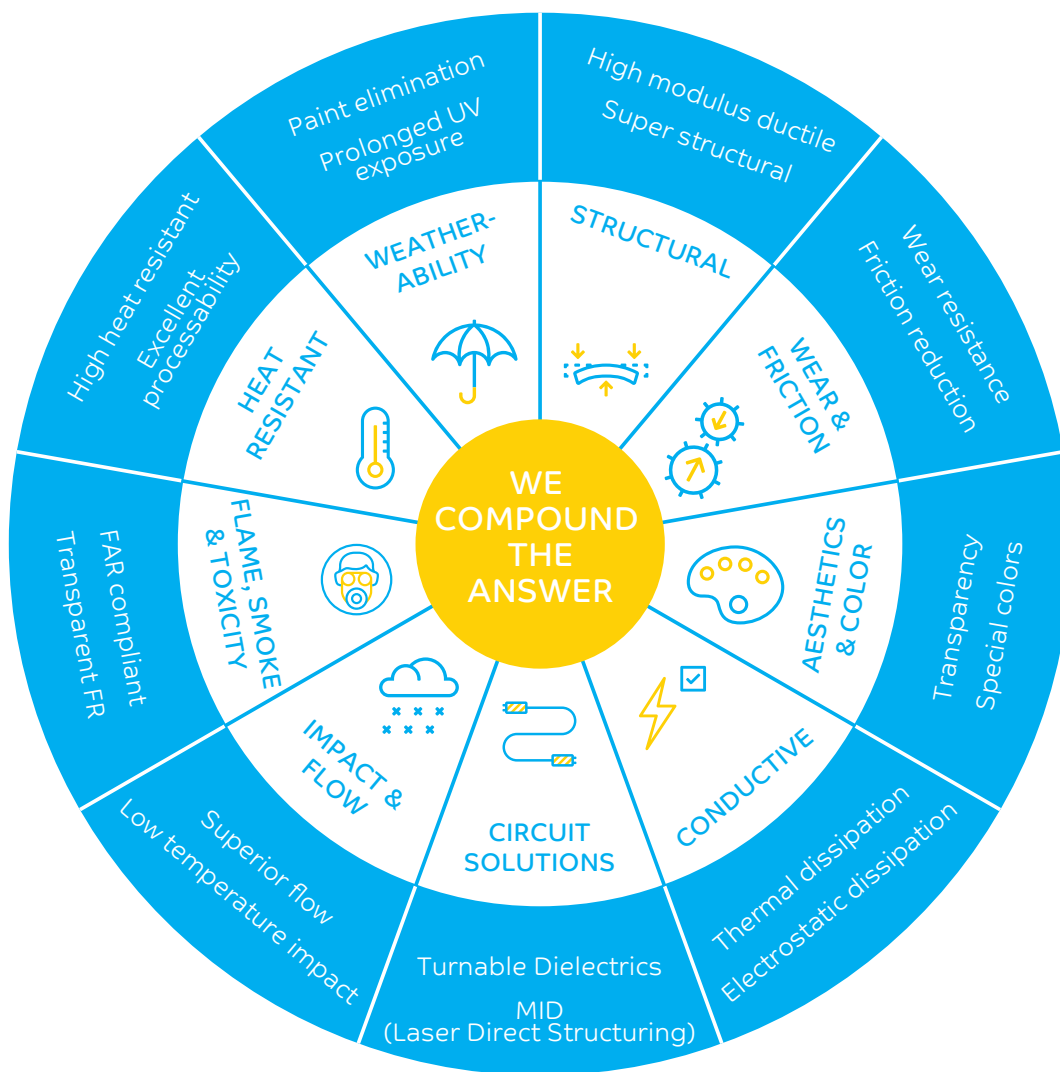


[Scan the QR code for more information about LNP™ compounds](#)

TABLE 1

LNP™ COMPOUNDS	
ELCRIN™	Sustainability
FARADEx™	EMI shielding
KONDUIT™	Conductive (thermal)
LUBRICOMP™	Wear & friction
LUBRILOY™	Wear & friction
STAT-KON™	Conductive
STAT-LOY™	Conductive
THERMOCOMP™	Structural, Circuit solutions
THERMOTUF™	Impact improvement
VERTON™	Long glass fiber: structural

LEXAN™ COPOLYMERS	
CFR	Low smoke
CXT™	Heat resistance
EXL™	Impact
FST™	Flame, smoke, toxicity
FXE™	Aesthetics
HFD™	High flow
SLX™	Weatherability
XHT™	Extreme heat
LUX-C™	Aesthetics



GRADE IN THE SPOTLIGHT

LNP™ CX7240 COMPOUND

LNP™ CX7240 compound is an injection moldable, medium flow, non-chlorinated, non-brominated flame retardant PC/ABS blend with good dimensional stability. LNP™ CX7240 compound has a UL94 V0 at 0.75mm, 5 VA at 3.0mm and 5 VB at 1.5mm flame rating and improved chemical resistance compared to standard PC/ABS blends. LNP™ CX7240 compound is a good candidate for thin wall applications including cylindrical cell retainers and is an excellent candidate for battery pack module covers/housing.

TABLE 2

Property	Nominal Value	Test Method
Specific gravity	1.19 g/cm ³	ASTM D792
Melt-mass flow rate (MFR) (260 °C/2.16 kg)	18 g/10 min	ASTM D1238
Tensile modulus	2600 MPa	ASTM D638
Flexural modulus	2500 MPa	ASTM D790
Notched IZOD impact (23 °C)	700 J/m	ASTM D256

NORYL™ RESIN

NORYL™ resins are built from a blend of polyphenylene ether and other polymers such as polystyrene, polyamide or polypropylene. These blends offer tunable material properties, allowing NORYL™ resins to excel in a range of different industry segments and applications. NORYL™ resins feature industry-leading low specific gravity, low moisture absorption and excellent hydrolytic stability.

The chemistry inherent to the polyphenylene ether (PPE) molecules creates mechanically strong polymers that are lightweight, high heat stable and char forming. The incorporation of various polystyrenes to PPE helps to create blends that mold and flow well in standard injection molding processes. NORYL™ resin generally exhibits excellent electrical properties that remain stable over a wide range of temperature, humidity and frequency variations. Such stability, together with a fine-tuned balance of thermal and impact properties, makes NORYL™ resin a potentially excellent candidate for a number of demanding battery pack applications. For example, select NORYL™ resin grades such as

NORYL™ N1150 resin, with its high ductility, UL94 V0 flame retardancy (to 1.5 mm) and resistance to Li-ion electrolyte* are already enabling lightweight module enclosures for our customers. For larger pack enclosures where modulus is more critical, glass fiber filled NORYL™ NHP5054 resin is positioned offering greater stiffness and a UL94 V0 flame rating at 0.8 mm. With its high-energy absorption capabilities, cost effective NORYL™ GTX™ resin battery protection solution can help protect the battery during impact. The single-piece, engineered plastic honeycomb structure is e-coat capable and offers a weight reduction of up to 60% compared to multi-piece metal reinforcements.



[Scan the QR code for more information about NORYL™ resin](#)

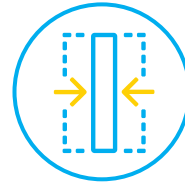
TABLE 3

PROPERTY	N1150	SE1GFN1	NHP5054	GTX964	UNIT	TEST METHOD
	Unfilled	10 % GF	20% GF	Impact		
Density	1.11	1.17	1.27	1.08	g/cm ³	ISO 1183
HDT (1.82 MPa)	109	135	115	185	°C	ISO 75/Af
Tensile Modulus	2700	4000	7300	2000	MPa	ISO 527
Tensile strength	52	75	110	50	MPa	ISO 527
Strain at break	7	2.5	2.5	5	(%)	ISO 527
Notched IZOD impact	6	6	7.5	50	kJ/m ²	ISO 180/1A
Flammability (0.75 mm)	V0	V1	V0	HB	/	UL94

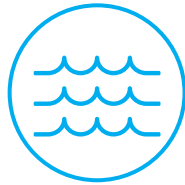
* e.g. 1M LiPF₆ in EC:PC:DEC (1:1:1 vol%)



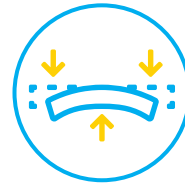
FLAME
RESISTANCE



DIMENSIONAL
STABILITY: WIDE
TEMPERATURE
RANGE



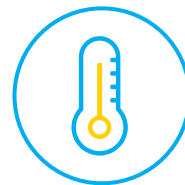
HYDROLYTIC
STABILITY:
LOW WATER
UPTAKE



LOW CREEP



CHEMICAL
RESISTANCE:
DILUTE ACIDS
AND BASES



HIGH
TEMPERATURE
RESISTANCE

GRADE IN THE SPOTLIGHT

NORYL™ NHP5054 RESIN

NORYL NHP5054 resin is a 20% glass reinforced blend of polyphenylene ether (PPE) and high impact polystyrene (HIPS). This injection moldable grade contains non-brominated, non-chlorinated flame retardant and carries a UL94 flame rating of V0 at 0.75 mm for thin-wall molding capability. NORYL NHP5054 resin is based on a unique copolymer technology and exhibits good dimensional stability, high heat resistance, strong electrical performance, and very low specific gravity. It is an excellent candidate for electric vehicle module and battery housings, automotive under-the-hood enclosures and components where thin-wall FR, modulus retention, and high heat resistance is required.

ULTEM™ RESIN

The ULTEM™ family of amorphous thermoplastic polyetherimide (PEI) resins offer outstanding elevated thermal resistance, high strength and stiffness, and broad chemical resistance. ULTEM™ copolymers are also available for even higher heat, chemical and elasticity needs.

ULTEM™ resins uniquely balance both mechanical properties and processability, offering design engineers exceptional flexibility and freedom. ULTEM™ resins are also inherently flame retardant and possess excellent dielectric character. ULTEM™ resins are therefore an excellent candidate for your electric vehicle battery needs where high heat resistance is required.

ULTEM™ resin is available in transparent and opaque custom colors, and can be glass filled for added stiffness.

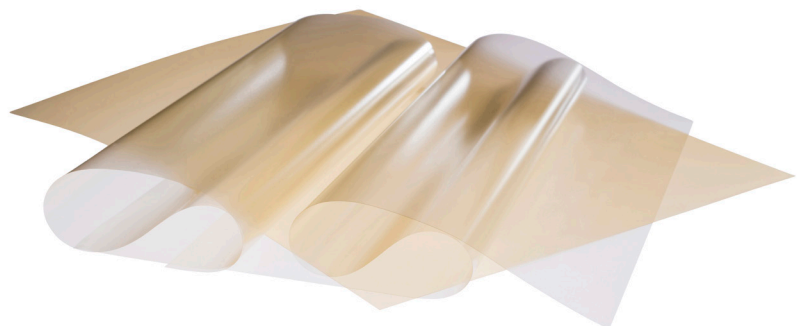
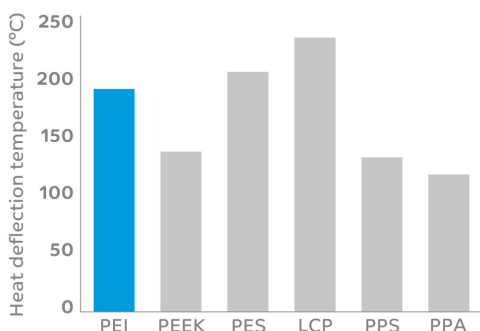
With its appreciable flow and dimensional stability, coupled with excellent resistance to Li-ion electrolyte, ULTEM™ resins such as ULTEM™ CRS5011 resin are today being used for insulation of Li-ion cell terminals. Given its excellent dielectric character, ULTEM™ resin is also an ideal candidate for bus bar insulation.

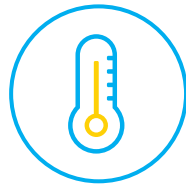
For other powertrain elements, such as DC power converters, ULTEM™ UTF120 dielectric film is already enabling high temperature film capacitors. Contact us to learn more.



[Scan the QR code for more information about ULTEM™ resin](#)

HEAT DEFLECTION TEMPERATURE

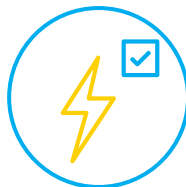




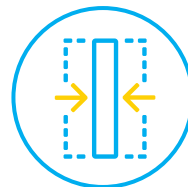
HEAT
RESISTANCE



DIMENSIONAL
STABILITY



DIELECTRIC
PERFORMANCE



MINIATURIZATION
AND THIN WALL




RESILIENCE

GRADE IN THE SPOTLIGHT

ULTEM™ CRS5011 RESIN

ULTEM CRS5011 resin is an unfilled, high temperature stable (T_g 225 °C), transparent, enhanced flow polyetherimide copolymer with enhanced chemical resistance to strong acids, bases, aromatics, and ketones. ULTEM CRS5011 resin also offers good chemical resistance to conventional Li-ion electrolytes and carries non-chlorinated/brominated UL94 V0 listing at 1.6 mm. ULTEM CRS5011 resin is an excellent candidate for EV battery pack applications where high heat, flame retardant electrical insulation is required, including cell terminal caps/covers and interlayers.



Ranging from 48 V mild hybrid to battery electric vehicle batteries, SABIC's Specialties business is committed to developing innovative solutions that enable our customers to realize their design ambitions. We offer a wealth of experience and technical expertise that can assist you through every step of your journey.

The following examples highlight a selection of our material offerings for a number of battery pack applications, including cell retainers, and pack/module casings. We are looking forward to partnering with you.



ENABLING THE 48-VOLT MILD HYBRID

ALL-PLASTIC 48 V BATTERY ENCLOSURES

As the mobility industry faces growing pressure to increase fuel efficiency and reduce tailpipe emissions, the case for vehicle electrification grows evermore strong. Concomitantly, 48 V mild hybrid electric vehicles (MHEV), enabled by 48 V batteries, are poised to grow considerably in the coming years.

Depending on crush requirements, 48 V Li-ion batteries may be constructed using all-plastic enclosures, helping battery designers to save weight. The Specialties portfolio contains a range of mechanically resilient, lightweight materials with added functionality such as UL94 flame retardancy and thermal conductivity that can aid passive cooling.

Our range of **LNP™ KONDUIT™** compounds offer thermal conductivity, thus can allow dissipation of heat build-up during battery operation.

Select **LNP™ ENH** compounds and **NORYL™ resin** grades offer non-chlorinated, non-brominated flame retardancy, together with 600 V (PLC O) comparative tracking index (CTI).



48 V BATTERY CASING



Where high impact and crush requirements are needed, we can provide **LNP™ VERTON™** compound and **THERMOCOMP™** compound with excellent mechanical properties.

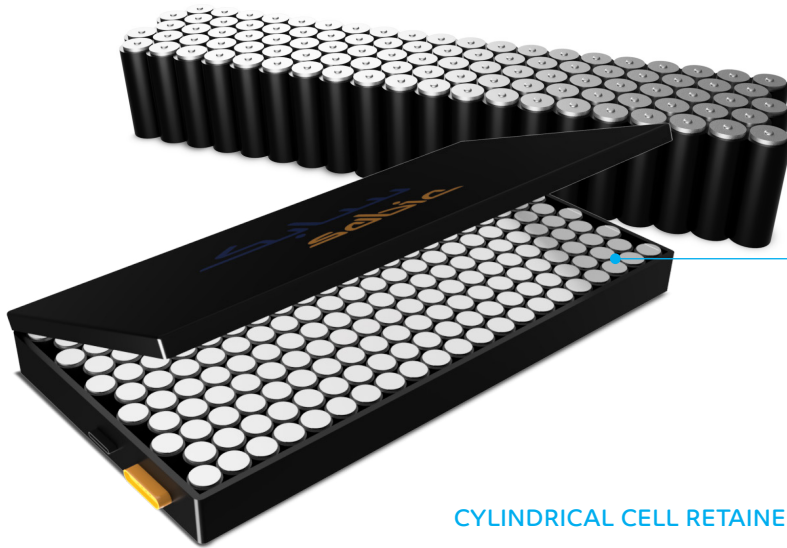
Where high dimensional stability, low specific gravity and thermal tolerance is warranted, we offer resilient **NORYL™** and **NORYL™ GTX™** resins.

CELL RETAINERS FOR BATTERY PACKS

INJECTION MOLDABLE, FLAME-RETARDANT SUPPORT MATERIALS

In supporting our customers' flexibility in electric vehicle battery design, SABIC's Specialties business offers a range of injection moldable materials for retaining cylindrical and pouch cell formats.

Working with you, our customers, we can tailor material characteristics to meet your needs such as level of flame retardancy, UV transmission or flow.



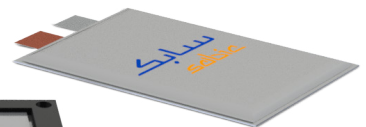
Specialties line of high-flow, injection moldable LNP™ CX PC/ABS compound enables the construction of single piece cylindrical cell holders.

Depending on requirements, UL94 V0 flame retardancy down to 1.0 mm is available.

CYLINDRICAL CELL RETAINERS



To aid stacking of li-ion pouch cells in electric vehicle battery modules, select NORYL™ resin grades offer low specific gravity, UL94 V0 flame retardancy, dimensional stability and thin wall processing.



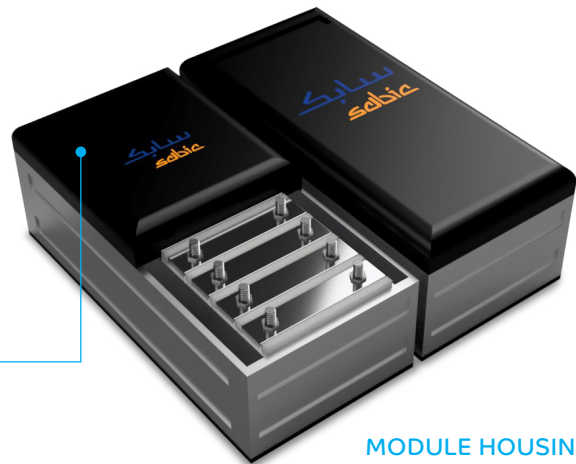
POUCH CELL FRAMES

LITHIUM-ION CELL/MODULE PERIPHERALS

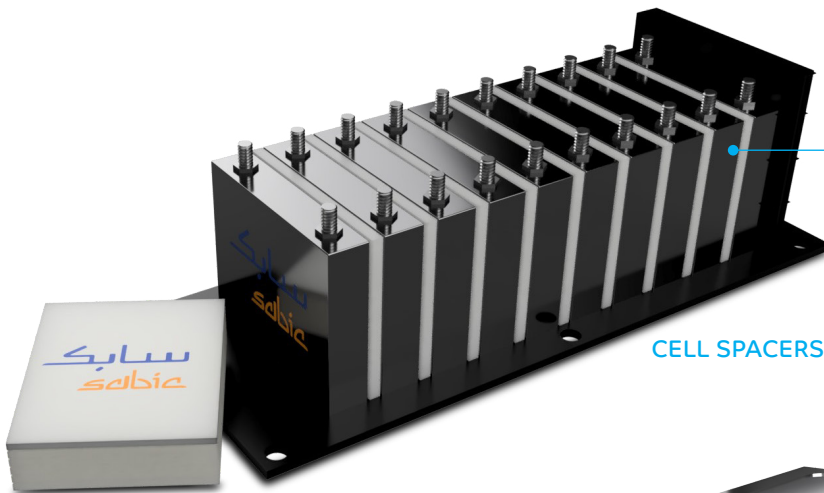
INJECTION MOLDABLE, FLAME-RETARDANT MATERIALS

Select Specialties injection-molding materials can be used in cell group/module designs. Highly dimensionally stable and affording appropriate electrical insulation, our materials may be used in various spacing applications, terminal covers, housings and enclosures for prismatic cells and modules.

With excellent dimensional stability, broad chemical resistance, processability and flame retardancy, a number of LNP™ compound and NORYL™ resin grades offer specific properties for module housings and covers. Materials may be compatible with a number of sealing and welding technologies.



MODULE HOUSING



CELL SPACERS

Specialties can offer a range of filled and un-filled materials for spacing cells within electric vehicle battery packs. Depending on requirements, material properties can include thermal conductivity or insulation, high heat tolerance, UL94 V0 flame retardancy and thin wall processing.

Given their highly processable character, excellent dimensional stability and low specific gravity, Specialties' line of NORYL™ resin grades are proven in the field to provide excellent protection for cell-group and module terminals.



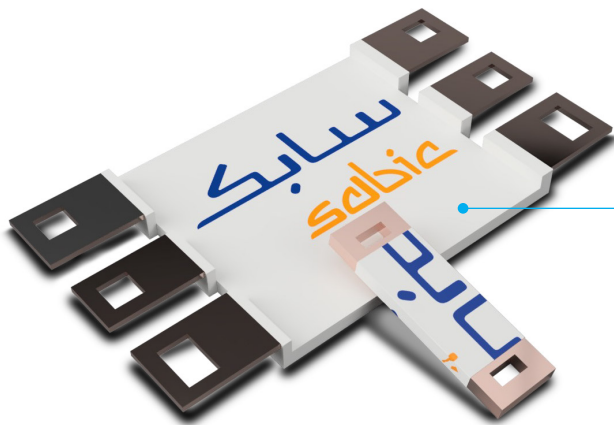
TERMINAL COVERS

BATTERY PACK PERIPHERALS

LIGHTWEIGHT BATTERY PACK PERIPHERALS

Depending on material and design requirements, SABIC's Specialties business can provide a number of materials for electric vehicle battery packs, including bus bar holders, covers, brackets, end plate assemblies and enclosures for battery management systems, control units, fuses and relays, etc.

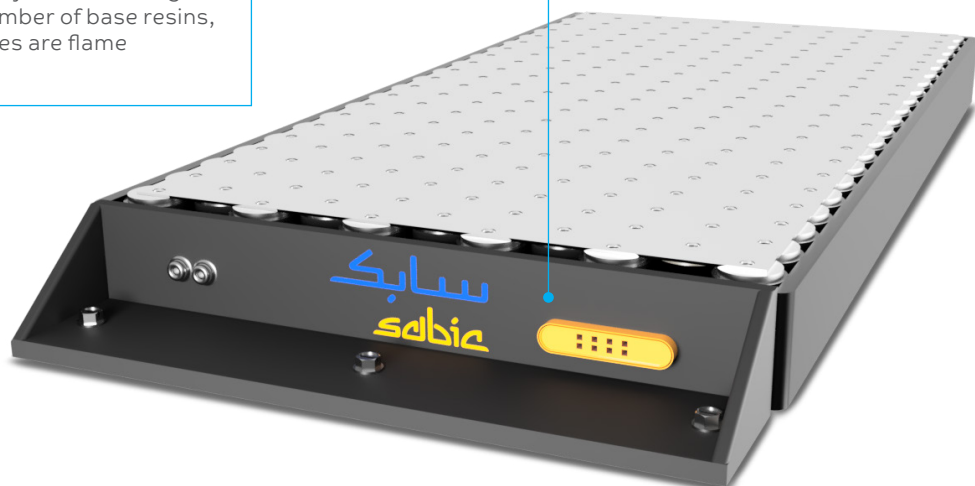
We are eager to help our customers reduce weight, while at all times ensuring utmost safety and compliance.



Battery pack designs require bus bar protection. Laminated bus bars can be realized using high temperature resilient **ULTEM™ resin**, **LNP™ compound** or **NORYL™ resin** with suitable dielectric character, excellent processability and UL94 flame retardancy.

To affix and prevent movement of cell groups and modules, Specialties' range of rigid, durable **LNP VERTON™** compound and other high modulus and ductile (HMD) grades may be used as battery pack end plates and retaining brackets.

Processable by way of injection molding and available with a number of base resins, select Specialties grades are flame retardant to UL94 V0.



HIGH VOLTAGE BATTERY ENCLOSURES

FLAME-RETARDANT, HIGH STRENGTH UPPER ENCLOSURES

High voltage (>60 V) electric vehicle battery pack enclosures can contribute significant weight to the overall battery pack, impacting its specific energy (Wh/kg).

Certain high performance engineering thermoplastic materials can replace traditional metals, saving weight and easing the burden of cumbersome processing.

Depending on individual requirements, such as pack dimensions, Specialties' portfolio of materials including flame-retardant

NORYL™ Resin, LNP™ VERTON™ and LNP™ THERMOCOMP™ compounds can offer the necessary qualities for electric vehicle battery upper enclosures.

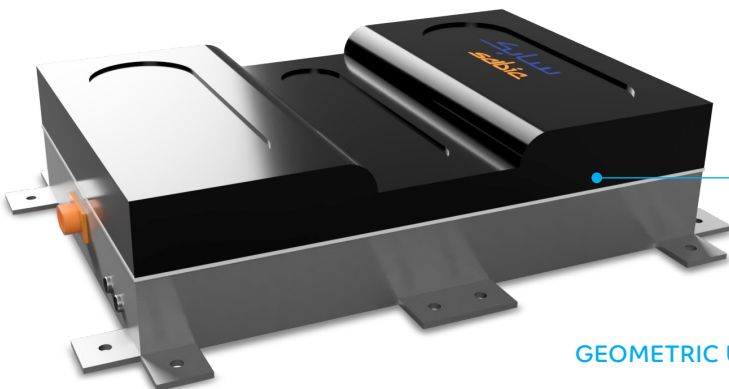
Where ultimate strength is required, customers may elect to utilize UD-MAX™ tape in combination with appropriate base materials.

Specialties' dedicated CAE teams can work directly with you can work directly with you to help tailor a range of next-generation, lightweight battery pack solutions.

Combining high modulus with impact strength and resistance to crack propagation, materials such as long glass fiber LNP™ VERTON™ compound could replace traditionally used metal or composite materials for upper battery pack enclosures. Depending on size and physical requirements, SABIC's Specialties business can also offer a number of high strength material alternatives including NORYL™ resin and LNP™ THERMOCOMP™ compound.



BATTERY PACK ENCLOSURE



GEOMETRIC UPPER ENCLOSURE DESIGN

Depending on enclosure size, Specialties' injection molding and thermoformable materials allow for non-standard upper casing architectures, permitting flexibility in module layout and pack design.

BATTERY PACK PROTECTION

TOUGH, ENERGY ABSORBING IMPACT PROTECTION

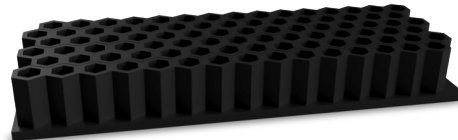
Our customers tell us that safety is of the utmost importance. Common electric vehicle battery side impact countermeasures are forged from multi-piece steel stamping and extruded aluminum profiles. Such solutions are heavy at a time when weight-saving is increasingly desired.

SABIC's Specialties business can offer single-piece, lightweight side impact countermeasures fashioned from engineered honeycomb structures using NORYL GTX™ resin, saving our customers up to 60% in weight compared to multi-piece metal reinforcements.



NORYL GTX™ resin rocker reinforcement for electric battery packs: tunable for strength and stiffness, the single piece, lightweight construction offers highly efficient energy absorption at comparable cost vs. incumbent metal solutions. The honeycomb reinforcement is e-coat capable and can be directly welded to the rocker.

ROCKER REINFORCEMENT



Specialties can also offer a range of materials for electric vehicle service equipment, including high temperature resistant connectors and structural housings. Contact one of our experts to learn more.



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