# A fully integrated and independent Supply Chain – for the Automotive Industry

## COMPANY OF MITSUBISHI CHEMICAL

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<td>Mitsubishi Polyester Film GmbH</td>
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<td>Bio Polymers, TPEs, PVC Compounds, Adhesives, 3DP Filaments</td>
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## Automotive Solutions | Functional

Vehicle Lightweighting and Sustainable Materials
Mitsubishi Chemical and its group companies are dedicated to the automotive industry with R&D aimed at interior, exterior and functional applications, as well as solutions for autonomous and electrified vehicles.

Our focus is on developing and bringing to market lightweight, sustainable materials for today's and future automotive industry needs.

*Mitsubishi Engineering Plastics is a joint venture between Mitsubishi Gas Chemical (50%) and Mitsubishi Chemical (50%)*
Functional

Product Overview

Automotive has been an integral industry for Mitsubishi Chemical with a long history of partnership and development with the top OEMs. R&D and growth in high performance materials and solutions aimed at interior, exterior and functional applications is at the core of our corporate strategy. Our focus is on developing and bringing to market lightweight, sustainable, high value and functional solutions.

Mitsubishi Chemical and its group companies offer an impressive portfolio ideal for demanding automotive applications such as carbon fiber, composites, high performance TPOs and (LGF-)PPs, TPEs, TPVs, films and other chemical products. As a solution-driven partner, Mitsubishi Chemical is bringing together high performance MATERIALS, engineering PROCESSES and innovative DESIGN expertise to allow automotive engineers to develop highly innovative solutions with new levels of functional integration.

Solutions for Lithium-Ion Batteries
- Sol-Rite™ | Formulated Electrolytes for Lithium-Ion Batteries
- Anode Materials for Lithium-Ion Batteries
- Hostaphan® PET Film | Battery Electrode Pack Spacer

Solutions for Under Body Shields
- PYROFL™ and GRAFL™ | High Tensile Strength Carbon Fiber GMT and GMtex | Composite Sheets

Solutions for Hydrogen and CNG Vehicles
- PYROFL™ and GRAFL™ | High Tensile Strength Carbon Fiber GMT and GMtex | Composite Sheets

Solutions for Sound Absorption
- XAI™ | Super Fine Acrylic Fiber
- SymaLITE™ | LWRT Light Weight Reinforced Thermoplastics

Solutions for Battery Pack Housing and Enclosures
- GMT and GMtex | Composite Sheets
- Reny™ | High Performance Polyamide
- XANTAR™ | Flame Retardant PC/ABS

Solutions for Connectors and Electronic Components
- NOVADURAN™ | ULTRA Hydrolysis-Resistant PBT

Solutions for Plastic Fuel Tanks and Components
- ADTEX™ | Adhesive Polymer
- Soarnol® | High Gas Barrier Resin (EVOH)

Solutions for Protective and Structural Applications
- GMT and GMtex | Composite Sheets
- Carbon FMC | Carbon Fiber Forged Molding Compound (CF-FMC)
- XANTARTM | Resins for Laser Direct Structuring (LDS)

Solutions for Connected and Autonomous Vehicles
- Radar Transparent / Absorbing Resins
- Laser Transparent / Absorbing Resins
- Materials with Electromagnetic Interference (EMI) Shielding
- Clearfit™ | Optically Clear Adhesives
- Mosmite™ | Anti-reflective Films
- Acrylic™ | UV-curable Abrasion Resistant Clear Coat

Solutions for Catalytic Converters and Fire Protection
- MAFTECTM | Polycrystalline Alumina Fiber
Sol-Rite™ – Electrolytes for Lithium-Ion Batteries
Mitsubishi Chemical is a leading provider of formulated electrolytes for Li-Ion Batteries for the automotive industry. Sol-Rite™ are formulated electrolytes in organic solvents. These are primarily used in lithium batteries and aluminum electrolytic capacitors. The use of functional additives improves the battery performance significantly.

General characteristics and appearance: Clear Liquid.
Main Components: Solvent (Carbonate), Lithium Salt (LiPF6), Additives.

Benefits and Advantages
• High power output, even under low temperature conditions
• Improves the safety under high temperature conditions
• Functional additives protect electrodes to suppress the gas generation under high voltage conditions
• Battery capacity is retained at high level under high voltage condition
• Functional additives control side reactions on the electrode and improve cycle performance

Anode Materials for Lithium-Ion Batteries
Mitsubishi Chemical provides two types of anode materials for lithium-ion batteries:
MPG: natural graphite-based materials
ICG: artificial graphite-based materials
These modified graphites with a controlled structure absorb and release lithium ions smoothly. MPG shows excellent power performance whilst ICG has good life performance.

Benefits and Advantages
• High Output: MPG, natural graphite-based anode materials for high output performance even under low temperature
• A very low level of reaction resistance was achieved through the further improvement on the low-resistance materials
• High Safety: The improved MPG shows higher safety due to the amorphous surface layer, thus lower Li deposition
• High Voltage: The artificial graphite-based anode materials suppress gas generation under high voltage
• High Durability: The new improved ICG (artificial graphite-based anode materials) have improved cyclife, high durability, and high output at ambient temperature, with high material density
Mitsubishi Chemical is developing a thermal responsive spacer for controlling the heat flow to suppress the propagation of a thermal runaway between cells of a Lithium-Ion battery pack.

The thermal responsive spacer exhibits high heat conductivity at normal operating conditions for good heat exchange, but reduces its heat conductivity to a low level at high temperatures, allowing to slow down the event of a thermal runaway leading to fire and thus allowing additional time for the passengers to safely escape.

Due to its composition and mechanical properties the thermal responsive spacer also contributes to compensating pressure variations in the battery pack caused by cell breathing.

Hostaphan™ PET Film – Battery Electrode Pack Spacer

Mitsubishi chemical is providing high temperature resistant substrate polyester film (PET film) for long endurance electrical insulating spacers between battery packs. The transparent or milky white PET films fulfill the higher than standard requirements in terms of thermal behavior like shrinkage as well as surface properties.
Electric Vehicles
Battery Pack Housing | Enclosure Solutions

**Batterie Pack Housing – Enclosure Solutions**

Mitsubishi Chemical and its related group companies offer a wide range of structural, lightweight materials suitable for battery pack housings and enclosures. These materials are based on thermoplastic as well as thermoset resin systems. Reinforcement is provided by short and/or long glass or carbon fibers and/or endless glass mat/weave technology.

**Carbon FMC**

Carbon Fiber Forged Molding Compound (CF-FMC) is a compound of chopped carbon fiber and resin. Mitsubishi Chemical’s CF-FMC combines unique mechanical properties. Strength and modulus are comparable to aluminum alloys. But it has short molding cycles with excellent moldability and ultimate design flexibility for complex shapes. Mitsubishi Chemical’s CF-FMC technology provides the customer the opportunity to use carbon fiber composites in volume applications.

**GMT | GMTex – Composite Sheets**

Mitsubishi Chemical Advanced Materials is considered the world market leader in the production of classic glass-mat-reinforced thermoplastics (GMT). This semi-finished product in panel form was developed primarily as a substitute for metals (steel, aluminum, etc.). The material can be pressed into complex 3D structural components, although it is also used as panels.

GMT offers outstanding impact resistance but benign crash behavior. Its low relative density, excellent hardness and rigidity even at low temperatures, resistance to moisture and chemicals, durability and ease of recycling have established GMT as an extremely successful material for automotive applications. Its special long fiber technology ensures high energy absorption before fracture and thereafter benign failure behavior without sharp lines of fracture.

Based on GMT, the composite GMTex has been further developed for applications demanding high impact resistance, strength and durability. GMTex is moldable and serves as a substitute for steel, aluminum, magnesium etc., or is employed for the additional reinforcement of GMT materials.

**Reny™**

Reny is a proprietary molding compound based high performance polyamide, that has been reinforced with glass fiber, carbon fiber or special minerals. Reny generally has superior mechanical strength and modulus compared with other engineering plastics.

**XANTAR™**

With a 20+ year track record in industrial battery solutions, specially tailored flame retardant PCABS materials are available for battery enclosures, ranging from small sized to large heavy duty back-up power solutions used for emergency vehicles. Key determining factors are high reliability under demanding circumstances, combined with a balanced performance up to high temperatures.
Application Example

**GMT | GMTex – Battery protection**

Mitsubishi Chemical Advanced Materials AG developed this battery protection application in close cooperation with the OEM and the Tier 1. A combination of GMT and GMTex has been used to pressmold this battery protection part. GMT was beneficial due to its 3-dimensional flow to fill the tool cavity. GMTex contributed to fulfill the mechanical stiffness, impact and crash requirements.

**NOVADURAN™ PBT – ULTRA Hydrolysis-Resistant**

NOVADURAN™ offers excellent mechanical properties, rigidity, heat aging resistance and chemical resistance. NOVADURAN™ also provides superb moldability, abrasion resistance, colorability and electric properties. NOVADURAN™ is suitable for multiple applications in the electronics and automobile industries, like connectors and electronic components. Mitsubishi Engineering Plastics produces PBT in an integrated manufacturing process using the raw materials dimethyl terephthalate and 1,4-butyleneglycol.

The newly developed Novaduran ULTRA-HR hydrolysis resistant PBT grades offer following additional benefits:

- Improved thermal shock durability
- Low warpage, high dimensional stability
- Laser-transparent BLACK with high color stability for optimized laser-welding capability
- Optimized silicone and epoxy adhesion

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![Battery Protection Example](image-url)

**Hydrothermal Aging Test**

<table>
<thead>
<tr>
<th>Time (hr)</th>
<th>Tensile Strength Retention (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>1000</td>
<td>80</td>
</tr>
<tr>
<td>2000</td>
<td>60</td>
</tr>
<tr>
<td>3000</td>
<td>40</td>
</tr>
</tbody>
</table>

![Battery Protection Test](image-url)
Mitsubishi Chemical and its related group companies offer a wide range of structural, lightweight materials and adhesives suitable for CNG and Hydrogen vehicles. These materials are based on thermoplastic as well as thermoset resin systems. Reinforcement is provided by short and/or long glass or carbon fibers and/or endless glass mat/weave technology. Applications include pressure vessels and also the relevant pressure vessel carriers, fulfilling the most demanding crash and mechanical property requirements.

Mitsubishi Chemical Carbon Fiber and Composites offers one of the most diverse carbon fiber product ranges on the market today. Our PAN-based carbon fibers are available in filament counts ranging from 3K to 60K. PYROFIL™ and GRAFIL™ carbon fibers, are advanced high-performance materials born from technology centered on synthetic high polymer chemistry, in which Mitsubishi Chemical excels. Our PYROFIL™ and GRAFIL™ high tensile strength fibers with outstanding processing characteristics are used in a variety of industrial applications, including pressure vessels such as compressed natural gas tanks, storage tanks and type 4 hydrogen tanks. Available in 18K and 30K tow sizes.

**PYROFIL™ | GRAFIL™** – High Tensile Strength Carbon Fiber for Pressure Vessels
- High performance tensile strength: 5.4-5.6GPa
- Tensile modulus: 255-260GPa
- Excellent processability
- 30K fiber with conventional 24K TEX
- Excellent translation of tensile strength
- Developed for high strain applications

**Application Example**

**GMT | GMTex** – Pressure Vessel Carrier
- Co-development with customer
- Stringent crash requirements (up to ~40 g)
- Part design and simulation and prototyping by MCAM
- Functional integration of structural underbody shield
- Structural integration and fixation of tanks
- One shot process (incl. integration of inserts)
- ~50% weight saving vs. steel concept
Solutions for Connected and Autonomous Vehicles

**XAI™ – Super Fine Acrylic Fiber**
- Patented spinning method technology
  - The world’s top class acrylic fine fibers (diameter = 3μm)
- Super fine fiber for acoustic absorption felts
  - High sound absorbing performance
  - High level weight reduction
- Higher performance than urethane.

- Mixed felt could be supplied at lower price.
- vs. Urethane: Significant weight reduction.

**Soarnol™ – High Gas-barrier Resin (EVOH)**
Statistical ethylene-vinyl alcohol copolymer resin
- Excellent gas barrier properties
- Solvent barrier and chemical resistance
- Oil / fuel resistance for fuel-related applications
- Antistatic properties
- Global OEM approvals

**Solutions for Plastic Fuel Tanks and Components**

<table>
<thead>
<tr>
<th>Application</th>
<th>Adhesive polymer</th>
<th>Tie layer Resin</th>
<th>Gas Barrier polymer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Tank, Filler pipe</td>
<td>F-Tex, T-Ex</td>
<td>2k-valve, tube</td>
<td>Fuel Tank, Filler pipe</td>
</tr>
<tr>
<td>Co-Extrusion, Blow-molding</td>
<td>Co-Extrusion, Blow-molding</td>
<td>Co-Extrusion</td>
<td></td>
</tr>
<tr>
<td>Adhesive polymer</td>
<td>Tie layer resin</td>
<td>Gas Barrier polymer</td>
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<tr>
<td>Adhesive Polymer</td>
<td>Tie layer resin</td>
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<td></td>
</tr>
<tr>
<td>Process</td>
<td>Grade</td>
<td>Adherent</td>
<td>Special characteristics</td>
</tr>
<tr>
<td>EVOH, PA</td>
<td>Adhesive Polymer</td>
<td>Tie layer resin</td>
<td>Gas Barrier polymer</td>
</tr>
<tr>
<td>EVOH, PA, PE</td>
<td>Adhesive Polymer</td>
<td>Tie layer resin</td>
<td>Gas Barrier polymer</td>
</tr>
<tr>
<td>EVOH, PA, PE, Metal</td>
<td>Adhesive Polymer</td>
<td>Tie layer resin</td>
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</tbody>
</table>

- Permanent Pinch-off Strength
- Low Fuel permeation
- Low Fuel permeation
- Heat resistance
- Recycling friendly

**XAI™ – Two ways to use**

- Improved sound absorption performance
- 50% weight reduction with same performance

- Sound absorbing efficiency improved by mixing XAI™.
- The price depends on XAI™ composition.
- vs. Urethane: Sound absorption is greatly improved.
Mitsubishi Chemical and its related group companies offer a wide range of functional, lightweight, materials, films, adhesives and coatings suitable for various applications for connected and autonomous vehicles of the future. The wide range of materials for those demanding applications feature special functionalities to support the needs of our customers.

Mitsubishi Chemical and its related group companies offer solutions for connected and autonomous vehicles including e.g.:

- Radar transparent / absorbing resins
- Laser transparent / absorbing resins
- Resins with electromagnetic interference (EMI) shielding
- Optically clear adhesives
- Anti-reflective films
- Anti-scratch coatings and resins
- Resins for laser direct structuring (LDS)

**Materials for Laser Direct Structuring (LDS)**

LDS allows the realization of 3D-electrical circuits in a plastic part, using conventional processing steps. Higher data density and system cost saving are achieved through integration. Significant flexibility in true 3D-design and production stage, allows for faster time to market.

MEP has the broadest market leading portfolio of robust, consistently high-quality materials suitable for Laser Direct Structuring, and covers the entire temperature range including the demanding reflow soldering process.

**Application Example**

**XANTAR™ LDS** – Interconnected antenna with high data density

- Integrated antenna on plastic components
- Higher data density achievable
- Better antenna position by 3D-design freedom
- Ease of prototyping and fast time-to-market
- Multiple antennas on 1 part in 1 cycle
Carbon Fiber FMC
Carbon Fiber Forged Molding Compound (CF-FMC) is a compound of chopped carbon fiber and resin and is an ideal material for higher volume structural automotive applications. Carbon Fiber FMC enables the production of 3-dimensional, complex parts. Compared to steel or aluminum significant weight savings can be achieved. Carbon fiber FMC allows the production of complex geometries and the integration of functions (ribs, inserts, etc.) in one molding step with very short cycle time. Additionally Carbon Fiber FMC offers an unique surface appearance and can pass through an E-coat process.

Application Example
Carbon Fiber FMC – Structural Underbody Shield
- Short cycle time (snap cure resin)
- High surface quality
- Design freedom for complex geometries
- Integration of functions (inserts, ribs, etc.)
- Very high mechanical properties
- One Shot Hybrid Molding with various materials like rubber, TPE, metal or carbon fiber reinforcements possible
- New stylish carbon look

Application Example
GMT – Structural Wireless Charging Carrier
- Aluminum-benchmark: 4 parts (incl. plastic underbody shield)
- Part design and simulation by MCAM
- Integration of all parts into one GMT part
- Higher charging efficiency vs. aluminum-benchmark
- One shot process (incl. integration of inserts)
- ~20 % weight saving vs. aluminum-benchmark
Solutions for
Protective and Structural Applications

MAFTEC™ – Support Mat for Catalytic Converters, Filters and Fire Protection

MAFTEC™ is a proprietary polycrystalline alumina fiber with high thermal insulation and very high heat resistance.

- Polycrystalline mullite fibers: 72% Alumina / 28% Silica
- Support- and mounting mat for automotive exhaust gas aftertreatment
- Very durable in extreme conditions
- Can be used up to 1100°C
- Superb resiliency and sealing ability
- Maximum use temperature up to 1300°C
- High resistance against gas erosion
- Fiber area density up to 2800g/m² (single layer)
- No. 1 global market share

Application Example
SymaLITE™ | GMT | GMTex – Underbody Shield
- Hybrid molding: SymaLITE, GMT, GMTex
- SymaLITE™ for acoustic performance
- 2-way sound absorption: B/W side and street side
- GMT for complex geometry (ribs / thickness variation)
- GMTex for mechanical and crash requirements
- OEM’s RR requirements fulfilled
- Performance improvement of acoustic and mechanical properties vs. PP-GF injection molded part

Application Example
QTex Organo Sheet | GMTex – Fuel Tank Protection
- Hybrid molding: QTex Organo Sheet and GMTex
- Thickness 0.6 mm / 1.2 mm, production width of 2.4 m possible
- Material can be provided as blanks or on rolls

Application Example
GMT – Crash Element
- Molded with GMT – Thickness variations possible
- Hybrid Molding with various metal reinforcements possible
- Protection of high-voltage and electrical cables of the engine

Solutions for
Catalytic Converters and Fire Protection