Whitepaper

Envalior
Imagine the Future

CROSS–CAR BEAMS: *UNLOCKING THE POWER* OF HYBRID TECHNOLOGY

Hybrid cross–car beams are boosting efficiency and driving innovation in strength, sustainability, and design flexibility.

As a design engineer, you understand that the automotive industry is constantly evolving. Innovative material solutions are at the forefront of this transformation, with hybrid cross–car beams leading the way. These beams integrate metal and thermoplastics to optimize performance while minimizing material usage, weight, and cost.

ADVANTAGES OF HYBRID CROSS–CAR BEAMS

Hybrid cross–car beams combine lightweight, low–density materials with superior design flexibility, resulting in a robust yet adaptable structure. These beams are engineered to support vehicle components such as:

- Instrument panel carriers
- Airbags
- HVAC ducting
- Screen displays
- Steering columns
- Electrical components

INDUSTRY CHALLENGES DRIVING MATERIAL INNOVATION

Weight Reduction
Automakers are under constant pressure to reduce vehicle weight to improve fuel efficiency.

Structural Integrity
Cross–car beams play a major role in managing crash absorption. Beam geometries need to be optimized for safety while reducing weight.

Multi–Functional Space
Cross–car beams need added functionality to meet space constraints for integrated components without additional weight.

Cost Reduction & Sustainability
Automakers are seeking faster, cheaper, and more sustainable processes.

By incorporating high–modulus polyamide compounds, hybrid beams achieve:

- **Exceptional strength and rigidity** – Reinforced with glass or carbon fiber to enhance mechanical properties
- **Weight reductions of 20–30% versus full metal solution** – Contributing to improved vehicle efficiency and sustainability
- **Complex design capabilities** – Allowing for more advanced vehicle structures and the integration of functionalities

COMPREHENSIVE DEVELOPMENT SUPPORT FROM ENVALIOR

With over two decades of expertise in design, simulation, and production support, Envalior is at the forefront of hybrid cross–car beam development. Beyond supplying advanced polyamide compounds, we offer extensive support for manufacturing processes, including:

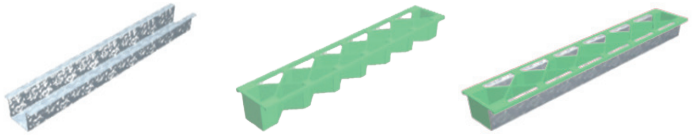
1. Plastic–Metal Hybrid (PMH) Technology
2. Hydroformed Hybrid Technology
3. Hollow Profile Hybrid (HPH) Technology
4. Full Plastic Solutions

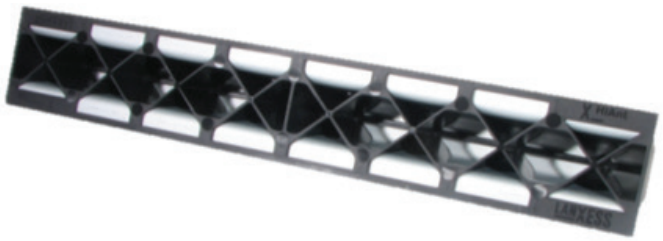
PLASTIC–METAL HYBRID (PMH) TECHNOLOGY

Automotive manufacturers have been utilizing PMH technology for more than 35 years because it cleverly combines the best properties of both materials — metal for strength and stiffness and plastic for lightness and design flexibility. This technology has been popular for both cross–car beams and other complex structures with high load capacities such as front–end vehicle modules, vehicle seating and doors.

With PMH technology, an open metal channel is over–molded with thermoplastic resin to create an integrated plastic–metal hybrid beam. The integration of thermoplastics and metal results in a structurally strong and lightweight beam structure.

Metal (Thin wall metal sheet)	Thermoplastic (injection molded rib structure)	Hybrid





This plastic–metal hybrid cross–section features an open profile – the metal channel is not completely enclosed.

Key Advantages:

- Higher torsional stiffness.
- Higher load capacity.
- Plastic parts can be injection–molded, which is fast and good for complex shapes.
- Reduced tolerance variation and quality in production and use.
- Reduction in required parts (e.g., fewer fasteners).
- High integration of functional elements, eliminating the need for secondary operations like welding.

ENVALIOR: HISTORICAL HALL OF FAME WINNER FOR PMH TECHNOLOGY

Envalior has a long history in supporting PMH applications. In fact, Envalior (formerly LANXESS HPM) was named a hall of fame winner by the Automotive Division of the Society of Plastics Engineers (SPE) in 2019 for the first PMH front–end structure used on the 1999 C170 Ford Focus.

1999 Ford Focus C170 GOR

For more than 15 years, Envalior's Durethan® BKV30H2.0 resin (30% glass filled PA6/heat stabilized) was used in this structural part, enabling a 40% weight reduction, a 30% cost reduction, high functional integration with reduced process steps, higher accuracy and quality, and a higher load capacity compared to a 100% steel structure.

These highly–desired benefits inspired the wide adoption of PMH technology within the automotive industry.

HYDROFORMING HYBRID PROCESS (HHP)

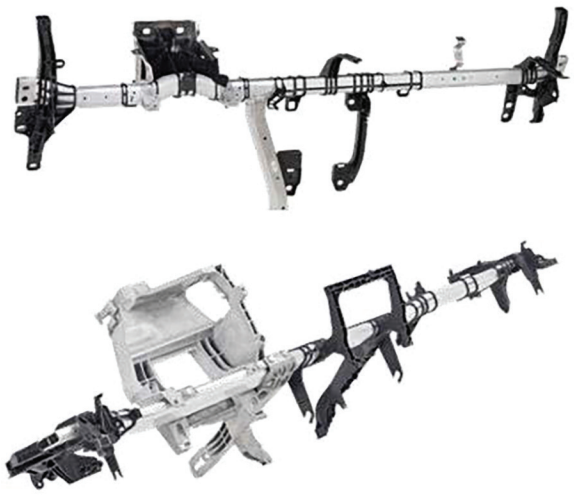
Auto manufacturers use hydroforming technology for cross–car beams primarily because it offers a combination of strength, lightweighting, and design flexibility that traditional stamping or welding methods can't match.

Hydroformed hybrid technology is a process in which incompressible fluid is highly pressurized to form a hollow metal tube. The tube is then overmolded with a lightweight plastic. The internally pressurized fluid prevents it from col–lapsing, resulting in a durable hybrid part.

While the HHT process requires the added expense of specialized equipment and sealing, these cross–car beams can be made stronger and more rigid, which is crucial for vehicle safety and performance, especially in crash zones.

Key Advantages:

- Hydroforming allows for the creation of seamless, one–piece components with complex shapes. This means optimal utilization of metal performance, with added design–freedom by using plastics.
- Hydroformed parts often have thinner walls but retain or even improve strength, allowing manufacturers to reduce weight without compromising safety.
- Improves vibration and noise dampening.
- Enables functional integration of components.
- Simplifies the assembly process (minimizes the need for assembled or welded connections).



Examples of cross–car beams created using hydroforming hybrid process.

HOLLOW PROFILE HYBRID (HPH) TECHNOLOGY

The newest evolution of cross car beam manufacturing is HPH technology. This approach enables next–level weight reduction, part integration, and crash performance by creating a plastic–metal hybrid part using the inherent strength of a hollow metal tube.

Whereas Hydroformed Hybrid Technology (HHT) requires a fluid to pressurize the inside of the tube, Hollow Profile Hybrid (HPH) technology eliminates this step.

HPH technology eliminates the need to pressurize the tube.

The result is a single, highly optimized component that has greater stiffness and torsional strength than could previ–ously be achieved.

Envalior HPH technology is successfully being used in first series production applications.

Key Advantages:

- Weight savings ~20–30 %.
- Higher precision manufacturing (low tolerances).
- Improved NVH performance (on steel).
- Low cycle times ~60–70 seconds.
- No post–processing needed.
- Enables the functional integration of components.
- Wide area overmolding enables thicker & stronger connections of plastic and metal.
- High torsional strength and stiffness.
- Simple processing – eliminates the need for welds, bolts and additional fasteners for low cost production.
- Better dimensional reproducibility of injection molding in comparison to steel–welded structures.
- Works with standard machinery – no special auxiliary equipment is needed.

FULL PLASTIC ALTERNATIVE SOLUTIONS FROM ENVALIOR

As an alternative solution, Envalior offers two full–plastic cross–car beam solutions:

Option 1: Tepex® Composite Sheets

Tepex composite sheets (organo sheets) can provide a fully plastic alternative for cross–car beams.

- Tepex is made from continuous fiber materials (glass, carbon, aramid, flax) combined with plastics (polyamides, polypropylene, polycarbonate, TPU, etc.).
- With its glass or carbon fiber reinforcements, Tepex features exceptionally high strength and rigidity and extremely low weight.
- Modern Tepex part molding processes combine the advantages of injection molding with the outstanding mechanical performance of the composites, resulting in the shortest cycle times and superior functional integration. In addition to its technical advantages, like no need for corrosion protection and further post–processing, this leads to significant cost savings potential.
- Sustainable options are available by incorporating recycled and bio–based raw materials.

Several of these full–plastic automotive structural components are already on the roads, proving the readiness of Envalior materials for series production.

Option 2: Akulon® (PA66) / UDea™ Tape

Envalior has developed a PA66 material incorporating recycle carbon fiber (PA66 rCF40) to deliver on the vision of a full thermoplastic cross–car beam.

The PA66 rCF40 material offers superior–specific strength and stiffness compared to commercially available glass–filled (GF)–based material offerings.

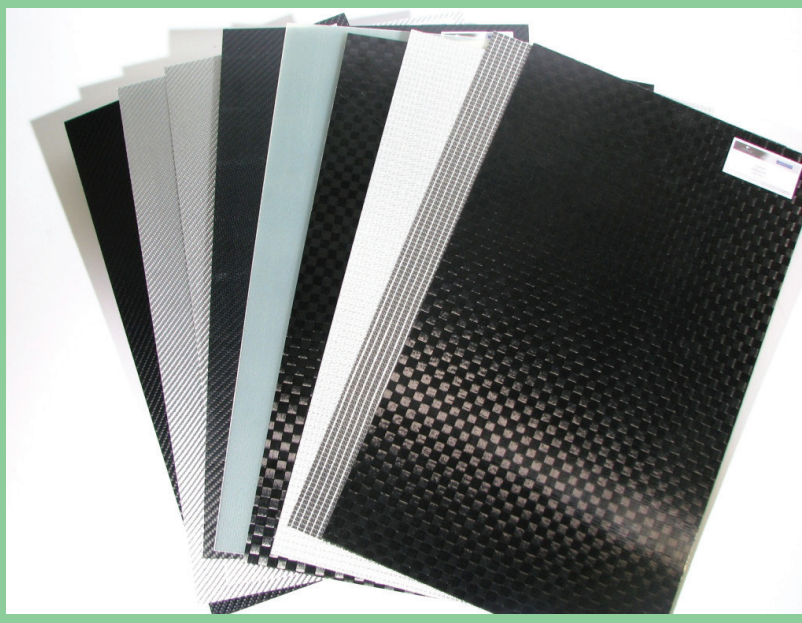
The inherent attributes of this material can maximize mass reduction of a hybrid metal and plastic system while offering a material solution that eliminates the complexity of metal component integration.

Studies suggest that the material may be further enhanced with the integration of UDeaTM tape for local reinforcement.

Envalior is exploring the feasibility of a full plastic cross–car beam with various OEMs today.

Four Reasons to Consider a Full–Plastic Cross–Car Beam Solution:

1. **Localized Reinforcement Can Stay the Same** –You can still use targeted reinforcements in specific areas, just like with traditional designs.
2. **Alternative to PMH–Type Beams (Sheet Metal)** – A full–plastic design can replace the sheet metal used in PMH–type cross–car beams. This makes the component much lighter and fully recyclable — although it may offer slightly less stiffness.
3. **Alternative to HPH–Type Beams (Metal Tubes)** – Plastic can also replace the metal tube in HPH–type beams. While the stiffness is reduced, using thicker Tepex® or UDea™ materials helps the structure withstand injection molding pressures.
4. **Hybrid Design Possibilities** – A hybrid setup is also an option — for example, keeping a metal tube on the driver's side (like in HPH beams) and combining it with a Tepex® or UDea™ C–shaped overmolded structure.



Tepex® is a high–performance composite laminate system made with thermoplastic polymers. The innovative combination of continuous reinforcing fibers with thermoplastic polymers results in exceptionally high strength and rigidity, coupled with extremely low weight.

COMPARISON OF TECHNOLOGIES FOR CROSS-CAR BEAMS

Feature	Plastic-Metal Hybrid (PMH)	Hydroforming Hybrid Process (HHP)	Hollow Profile Hybrid (HPH)	Full-Plastic Solution
Core Structure	Thin-walled metal stamping	Metal tube	Metal tube	Continuous fiber composite sheet
Process	Overmolding onto metal insert	Overmolding onto internally pressurized tube	Overmolding onto hollow tube	One-step forming and overmolding
Weight Reduction	✓	✓✓	✓✓✓	✓✓✓
Functional Integration	✓✓	✓✓	✓✓✓	✓✓✓
Noise/Vibration Control	✓✓	✓✓	✓✓	✓
Part Integration	✓✓	✓	✓	✓✓✓

FREQUENTLY USED MATERIALS FOR CROSS-CAR BEAMS

Popular advanced material solutions from Envalior for cross-car beams include:

- **Durethan® BKV60H2.0EF DUS060**
- **Akulon® Ultraflow K-FHG12 and K-FHG0**

These semi-crystalline polyamides give engineers more design freedom by offering the ideal combination of high mechanical strength and stiffness, good dielectric properties, high resistance to both heat and chemical attack, and good friction and wear properties. These high-flow PA6 glass-reinforced grades save costs by enabling thinner wall thicknesses so that less material is needed, which can also help manufacturers to reduce injection molding cycle times by up to 40%.

DRIVING THE FUTURE OF AUTOMOTIVE INNOVATION

The integration of hybrid material technologies in cross-car beams represents a significant leap forward in vehicle design.

By enhancing strength, reducing weight, and streamlining manufacturing processes, these innovations will help you contribute to safer, more efficient, and more sustainable vehicles.

Contact us today to learn more about how Envalior's high-performance materials are shaping the future of automotive engineering.

To learn more, contact us Envalior.com.

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