



## Hexcel Case Study: CFRP Transmission Crossmember

**High-volume, zero-waste process developed  
by Hexcel and partners, and enabled by Hexcel  
HexMC®-i 2000 moulding compound.**



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### Hexcel, IPPE, Engel and Alpex produce a lightweight transmission crossmember using a zero-waste process.

The structural automotive part is manufactured from high-performance Hexcel HexMC®-i 2000 using a fast compression moulding process ideal for high-volume manufacture. The part is comparable with aluminium versions in terms of performance and price, and could also be 30–35% lighter. Comprehensive simulation data from IPPE enables a highly optimized design. The process generates no waste.

### SMCs enable reduction in scrap rates

The compression moulding of carbon fibre Sheet Moulding Compounds (SMCs) is a promising option for the high volume manufacture of structural carbon fibre-reinforced plastic parts.

Compression moulding is well known by carmakers and their suppliers, and with relatively small tweaks the equipment used to press metal parts could be configured for use with SMCs. Due to the highly flowable nature of SMCs, preforms do not have to be near-net shapes for the production of parts with complex geometries. This means that scrap rates, which can be as high as 30–50%, can be significantly reduced.

In January 2017, Hexcel started working with the Institute of Polymer Product Engineering (IPPE, University of Linz), Engel and Alpex. The partners planned to optimize materials and processes to manufacture a generic structural part for automotive applications - a transmission crossmember - from carbon fibre SMC.

Transmission crossmembers are typically made from steel or aluminium. They connect either side of a vehicle's chassis together and support its transmission. These load-bearing parts must be stiff and strong, and as they are exposed to the road, they must be resistant to stone chipping and corrosion caused by water and salts. They can be difficult and costly to replace, so they must be highly resistant to fatigue.



To meet these challenges, the partners selected Hexcel's version of carbon fibre SMC, HexMC®-i 2000 - the best-performing moulding compound currently on the market. It has been designed specifically to bridge the price–performance gap between conventional SMC and preangs, and is stiffer than steel at approximately a fifth of the density. Its mechanical performance is highly consistent.

HexMC®-i 2000 comprises randomly orientated rectangular chips of unidirectional carbon fibre-reinforced preangs, impregnated with Hexcel's M77 snap-curing epoxy resin to form a 2000 gsm sheet material. The moulding compound can cure in as little as two minutes to form lightweight, strong and stiff parts. HexMC®-i 2000 can be used to produce parts of varying thicknesses and complex geometries, and can be combined with continuous fibre products such as Hexcel's unidirectional (UD) HexPly® M77 preangs, non-crimp fabrics (NCF) or woven reinforcements to increase the strength and stiffness in specific regions –

making it ideal for the production of a transmission crossmember.

Using advanced finite element method (FEM) simulation techniques developed by IPPE using Abaqus, LS-Dyna (the global automotive standard for structural FEM simulation) and Digimat, the partners have been able to validate the performance of HexMC®-i 2000. Tests are consistent on flat plates, simple shapes and complex parts, such as the transmission crossmember. This extensive data, coupled with the consistent high-performance properties of HexMC®-i 2000, means that for the first time automotive engineers can design optimized parts using moulding compound with confidence for the first time.

To produce the transmission crossmember, which is 8mm at its thickest, preforms of HexMC®-i 2000 are laid up in moulds fabricated by Alpex and compression-moulded using a v-duo press that has been tailored for SMC applications by Engel. Ribs, aluminium inserts and other functions can be moulded into the part using



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a single-stage process - reducing component-count in comparison with metal versions of the part and keeping costs low.

Any offcuts from the preforms can be interleaved between the plies of material to provide additional reinforcement in key areas - meaning that the process generates no waste whatsoever. Another option being explored by the partners is to transform these offcuts into carbon fibre mat preangs using techniques developed by Carbon Conversions Inc (CCI), a company in which Hexcel acquired a stake in late 2016. The zero-waste credentials of the process will be verified and validated by a life cycle assessment (LCA) carried out by the University of Linz.

The project is ongoing, but its initial results are particularly promising. The HexMC®-i 2000 transmission crossmember could be 30–35% lighter than aluminium versions while demonstrating the same mechanical properties, at no extra cost.

### The Data

To determine the mechanical performance of such a crossmember, the partners first manufactured three versions: one made entirely from HexMC®-i 2000; one made from HexMC®-i 2000 interleaved with recycled carbon fibre mat; and one made from HexMC®-i 2000 reinforced in key locations with UD carbon fibre-reinforced preangs tape.

These were all tested under quasi-static, monotonic loads (where an increasingly large load is applied to a specimen continuously) and demonstrated values of 23.4–26 kN. The minimum value required for a part such as this is 21 kN.

The part made entirely from HexMC®-i 2000 and the part reinforced with UD tape have both been subjected to preliminary fatigue tests and no damage has been observed after four million cycles.

Achim Fischereder comments: **"Hexcel is looking forward to working with our partners to further harness the benefits of high-performance HexMC®-i 2000. Using the predictable, zero-waste process we have developed, we have shown that we can match the performance of metal parts at competitive costs while reducing weight significantly."**

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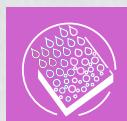
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