DSM is the global innovation leader for LIGHT and SAFE steering systems. DSM's high-performance Arnite® XT replaces metal parts in Electronic Power Steering (EPS) systems, meanwhile keeping safety and steering comfort at the highest level.

Driven by the need to reduce emissions, today’s automotive industry is strongly focused on improving vehicle efficiency by reducing weight through metal-to-plastic conversion. Around the globe, new and upcoming legislation is placing ever-tighter limits on vehicle emissions and carbon footprints during the manufacturing process to secure a brighter future. With close to 30,000 parts in a single vehicle, every element that can be successfully converted from metal-to-plastic contributes to the overall goal of reducing vehicle weight.

DSM is engaged in metal-to-plastic conversions for EPS systems and was honoured in 2014 by Frost & Sullivan for "enhancing value for Tier 1 suppliers of steering systems by establishing a new benchmark in weight reduction of EPS systems".

**Eco efficiency**

DSM successfully commercialized the metal-to-plastic conversions of EPS housings, resulting in up to 50% weight reduction and a cost reduction of 10-40%, depending on the complexity and region of production. Graph 1 illustrates the reduction of the carbon footprint of a 1kg aluminium die cast housing that is replaced by an injection moulded part in Arnite XT.

**Indicative carbon footprint comparison -Cradle to grave**

- Functional unit: 1 EPS housing in the car for 230000km
- Assessment method: IPCC2013 GWP 100a
- Sources: Ecolnvent database and DSM primary data

The data used for calculating the carbon footprint were retrieved from own DSM databases as well as external sources such as suppliers' data or publicly available databases. Therefore, due to internal and/or external developments in the databases, the footprint may change. This declaration has been prepared and issued on the basis of the information available at the issue date and our best knowledge and expertise.

The total impact of converting all EPS systems (~65 milj in 2020) would lead to 793 kT of CO2-eq savings which is similar to:
- the emissions generated by travelling around the world in a car ca. 150,190 times
- the average annual carbon footprint of ca. 99.125 people in Western Europe
**Safety and comfort**

Safety and steering comfort are key elements for EPS systems. DSM understands these requirements and is experienced and active in metal-to-plastic conversions of several safety critical applications in the automotive industry for many years.

Metal replacement of EPS housing and sensor components needs to meet the severe safety requirements, ranging from single event misuse tests to extreme durability tests:

1. Impact tests
2. Strength tests
3. Torque tests
4. Peak and misuse strength test
5. Thermal cycling
6. High temperature exposure
7. Gear durability tests (wear and fatigue resistance)

The tests aim to capture single events misuse and also long term durability at a high safety margin. Several housings and sensor covers in Arnite XT have passed the tests and lead to commercialization in 2014 with many more to come.

**Safety means ‘having a robust solution all the time’**

The Failure Mode and Effect Analysis system is used for the design (dFMEA), processing (pFMEA) and the material (mFMEA) to ensure the highest safety level of the solutions and exclude potential failure modes throughout the entire value chain (raw material production, design and part production).

DSM developed computer-aided engineering (CAE) models to calculate press fit calculations to enable precise fitment for the bearings, similar to that achieved by clamping or over-moulding. It also introduced mechanical CAE, computational fluid dynamics (CFD) and finite element analysis (FEA) models that have been used to carefully design wall thickness and locate critical sections in which ribs are positioned to meet the stringent misuse and durability tests. Thermal expansion CLTE
DSM’s Arnite XT is a high performance polyethylene terephthalate (PET) thermoplastic that offers extremely good dimensional stability due to its low moisture absorption and a very low and constant coefficient of linear thermal expansion (CLTE) that is comparable to aluminum. Low CLTE and low anisotropy in CLTE (GF orientation dependence) ensures good dimensional stability over the required temperature range.

In addition to the constant modulus of Arnite XT after heat aging at 160 °C, the tensile strength of the Arnite XT portfolio is up to 60% higher after 500 hrs. at 160 °C, compared to regular PET grades.

For precision parts such as brake booster valve bodies, gear housing and throttle valve bodies, parts have traditionally been designed in die-cast aluminum or steel because these materials have excellent strength and dimensional stability. At the same time, these components have very stringent precision requirements, often 50 microns or less. These requirements have proven difficult to meet with plastics, and even more difficult to achieve during mass production, which requires almost no variance in quality between material batches.

This best-in-class material tolerates a wide range of temperatures and environmental conditions, including chemical exposure. DSM’s unique technology enables it to produce Arnite XT to very narrow specifications, for example glass fiber content specified to 35.0 +/- 1.0% Fiber content Arnite.

As a result of continuous engine downsizing, particularly in the compact car segment, temperatures under the hood are going up, putting extra demands on plastics components used in this area. On top of this, identical electronic components are used in vehicles sold and used worldwide, which means they need to operate under a wide range of temperature and humidity conditions.

Lower moisture uptake (maximum 0.12-0.18% humidity absorption) compared to high-performance PPA, ensuring improved dimensional stability.
Arnite XT delivers substantial benefits over aluminum:

- A lower density (1.78 grams per cubic centimeter for Arnite XT versus 2.7 grams per cubic centimeter for aluminum) and the possibility to design thinner-walled parts lead to weight reductions up to 40%.
- Improved cycle time and cost reduction since Arnite XT is injection moldable, and therefore requires fewer processing steps compared to metal.
- A 40% lower carbon footprint cradle to use over die-cast aluminum.
- Reduced fuel consumption and lower emissions: replacing aluminum with Arnite XT in a metal gear box housing results in a 35% weight reduction. This reduced fuel consumption and lowers emissions.

Partnering for a brighter future

At DSM, we actively seek to partner with customers across the automotive value chain to replace their precision components with durable, stable and reliable plastic designs. Our portfolio includes a wide offer of grades that maintain their dimensional stability, strength and wear rates at a wide variety of operating temperatures, and ensure low variability from batch to batch. This enables metal to plastic replacement in demanding precision components as the automotive industry continues to work at reducing weight to improve fuel consumption and reduce emissions. DSM backs all of our material sales with extensive research and development, as well as a collaborative partnership where we support customers through grade selection, component design and testing.

Contact us today to discuss how DSM can help you redesign your precision components to create lighter and more efficient vehicles that don’t compromise on safety.

DSM Engineering Plastics

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