european bioplastics

FACT SHEET

European Bioplastics

Bio-based plastics in the automotive market – clear benefits and strong performance

Overview of materials and market development

Cutting fuel consumption and emissions by reducing a vehicle's weight is a central objective and major challenge for the automotive industry. Bioplastics materials are well suited to contributing towards this goal. Leading automotive brands around the world are already using bio-based plastics (e.g. bio-based polyamides, bio-based polyesters, etc.) with the aim of reducing their products' environmental impact.

This fact sheet presents an overview of available bio-based plastic materials, general benefits of bio-based plastics, bio-based plastics market development, and bio-based plastic performance in the automotive sector.

What are bio-based plastics?

Bio-based plastics comprise a range of materials with differing properties[1]:

1. Bio-based or partially bio-based, non-biodegradable (i.e. durable) plastics such as
    a. Mass commodity plastics e.g. bio-based polyethylene (PE), or polyethylene terephthalate (PET)
    b. Bio-based technical performance polymers e.g. polytrimethylene terephthalate (PTT) or thermoplastic copolyester elastomers (TPC-ET) or bio-based polyamides
2. Plastics that are both bio-based and biodegradable e.g. polylactic acid (PLA), polyhydroxyalkanoates (PHA) and polybutylene succinates (PBS), but can also be used in durable applications.

Several bio-based plastics are used in the automotive market, including bio-based polyamides, PTT and bio-based polyolefines as well as PLA-blends.

Benefits of bio-based plastics

Saving scarce resources, counting on renewable feedstock

Bio-based plastics help to reduce the dependency on limited fossil resources, which are expected to increase in price significantly over the coming decades. Renewable resources are gradually substituting dwindling fossil resources. These renewable resources are predominantly land-efficient annual crops,

[1] *The definition of bioplastics also includes biodegradable plastics based on fossil resources.*

such as corn and sugar beets, castor oil plants, switch grass, or perennial cultures, such as cassava and sugar cane. The latest developments in second-generation products use cellulose as feedstock basis.

Reduced dependence on volatile energy markets

Bio-based plastics are not as affected by oil price volatility in the way that petroleum-based materials are.

Reducing emissions, tackling climate change

Bio-based plastics contribute to the reduction of Greenhouse Gas emissions or can be carbon neutral. Plants absorb atmospheric carbon dioxide (CO_2) as they grow. Using this biomass to create bio-based plastic products constitutes a temporary removal of CO_2 from the atmosphere. This carbon fixation extends for a further period of time if the material is recycled.

Closing the loop, increasing resource efficiency

Another major benefit is that bio-based plastics can 'close the loop' and thus increase resource efficiency. This potential is realised by establishing use cascades. Renewable resources are firstly used to produce materials and products before being recycled mechanically, where possible. Finally, these resources are used for energy recovery. In this way, the carbon loop is closed.

Detailed Life Cycle Assessment (LCA) data are available for most bioplastics and need to be taken account of when considering end-of-life options.

Bio-based plastic market grows continuously

Currently, bioplastics represent about one percent of the 360 million tonnes of plastic produced annually[2]. But as demand is rising, and with more sophisticated biopolymers, applications, and products emerging, the market is continuously growing.

In 2019, capacities amounted to approximately 2.11 million tonnes per year[3]. Market data collected by European Bioplastics in cooperation with nova-Institut (Germany) forecasts production capacities to grow by 2024 to roughly 2.4 million tonnes.

Technical applications within the automotive sector are one of the most important upcoming markets for bioplastics. Volumes are expected to increase from around 155,000 tonnes to 166,000 tonnes over the next five years.

The automotive industry – counting on renewable alternatives

'Light-weighting' is a hot topic for the automotive industry and the main reason why plastics have continuously been used to substitute heavier materials such as metals. Beyond the benefits of reduced weight, the future lies in choosing the most resource efficient plastics. Bio-based plastics contribute to minimise the environmental impact of car production by further reducing CO_2 emissions and energy use. Additionally, materials such as bio-based polyesters or bio-based polyamides feature all the performance criteria to produce high quality car components.

Major converters and car brands adopt bio-based plastic solutions

A front-runner in adopting bio-based plastics is Japanese car manufacturer Toyota, which uses bioplastics such as bio-based polyesters, bio-based PET and PLA-blends in its production process. The Toyota SAI and Toyota Prius models already feature a number of bio-based plastic applications such as headliners, sun visors, or floor mats. For example, the Toyota hybrid vehicle Prius alpha features automotive interior parts made of DuPont™ Sorona® EP polymer, with similar performance and molding characteristics as petroleum-based, high-performance PBT (polybutylene terephthalate).

The fuel line made of renewably sourced DuPont™Zytel®RS provides long-term resistance to biodiesel.

[2] *Source: Plastics Europe Facts and Figures 2019.*
[3] *These data include both bio-based and biodegradable plastics based on fossil resources. Bio-based plastics represent 44 percent of the total production capacities of bioplastics (0,94 million tones).*

Toyota uses the renewably sourced polyester DuPont™Sorona®EP to produce e.g. the vent louvers of the Toyota Prius.

Furthermore, up to 60 percent of the interior fabrics are made of bio-based polyesters, which provide mechanical properties equal to or even better than PBT.

Compared to PBT, bio-based polyesters:

- provide a higher stiffness
- feature very good dimensional stability and lower warpage
- feature better thermal shock resistance
- provide good electrical properties
- are easier to process
- provide a better surface gloss[4]

Italian manufacturer Fiat is another major player in the automotive industry counting on bio-based plastics. In 2011, the use of castor oil-based long chain polyamide in some fuel lines won Fiat and DuPont the Society of Plastics Engineers' Automotive Innovation Award in the environmental category.[5]

The use of bio-based plastics in the automotive industry already started 100 years ago

- 1910s: Henry Ford conducted the first experiments with agricultural materials such as wheat.
- 1915: Ford's model T had coil cases made from wheat gluten with asbestos fibres.
- 1920s: Soybean products became of interest: Soy oil was used in automotive paints/enamels, rubber substitutes and in the production of glycerol in shock absorbers. Soy meal (protein/cellulose) was used to produce plastics, which were reinforced with hemp fibres (final mix about 70 percent cellulose/10-20 percent soy meal). Soy meal plastics were used for glove-box doors, gear-shift knobs, accelerator pedals, distributor heads, interior trim, and many other automobile parts.
- 1941: Exhibition of a "plastic car" prototype: 14 plastic panels fixed to a welded tubular frame, total weight 1043 kg.

[4] The data displayed refers to the bio-based polyester brand Sorona®EP of European Bioplastics' member DuPont de Nemours. Sorona EP is a line of 20 percent to 37 percent starch-based polymer resins. More information available at: www2.dupont.com/Plastics/en_US/Products/Sorona/sorona_ep.html.

[5] In this context, Fiat used the bio-based polyamide brand Zytel RS of European Bioplastics' member DuPont de Nemours. Zytel RS is a renewably sourced long chain of nylon products, between 60 percent and 100 percent bio-based, that can be adapted for temperature resistance. More information available at www2.dupont.com/Plastics/en_US/Products/Zytel/zytelrs/index.html

Mercedes Benz engine cover made of EcopaXX, a 70 percent bio-based polyamide (PA4.10) produced by DSM.

Besides bio-based polyesters and polyamides, bio-based PBS converted into a high performance natural fibre composite is another relevant material for the automotive market.

Bio-based PBS is made of bio-succinic acid and 1,4-butanediol (BDO). It features an interesting thermal-mechanical balance of properties close to that of a polyolefin; it is easy to process and has good affinity with cellulosic fibers. Since 2018, bio-based PBS can be 100 percent sourced from renewable feedstock.

Mitsubishi Chemicals is the producer of DURABIO, a partially bio-based engineering plastic made from plant-derived isosorbide, which presents higher resistance to impact, heat and weather than conventional engineering plastics. DURABIO is designed for applications requiring durable transparency and visual appearance with scratch and impact resistance as well as chemical inertness. Renault has been the first European automobile manufacturer to choose DURABIO. The French company uses this material for the dashboard of the Renault Clio.

Moreover, the Mercedes Benz A-class chose the bio-based polyamide DSM's EcoPaXX® Q-HGM24, which is derived from castor oil plants, for the engine cover. This material offers good chemical resistance, low moisture absorption, and a very high melting point to tolerate high temperatures, a high crystallisation rate and great aesthetics.

Bio-based plastics have reached maturity as a suitable material for a large number of automotive applications, offering high-performance and a unique potential for reducing a product's environmental impact. It is therefore no surprise that the automotive market is one of the fastest growing application fields for the bioplastics industry.

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