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Automotive Components Made of Packaging

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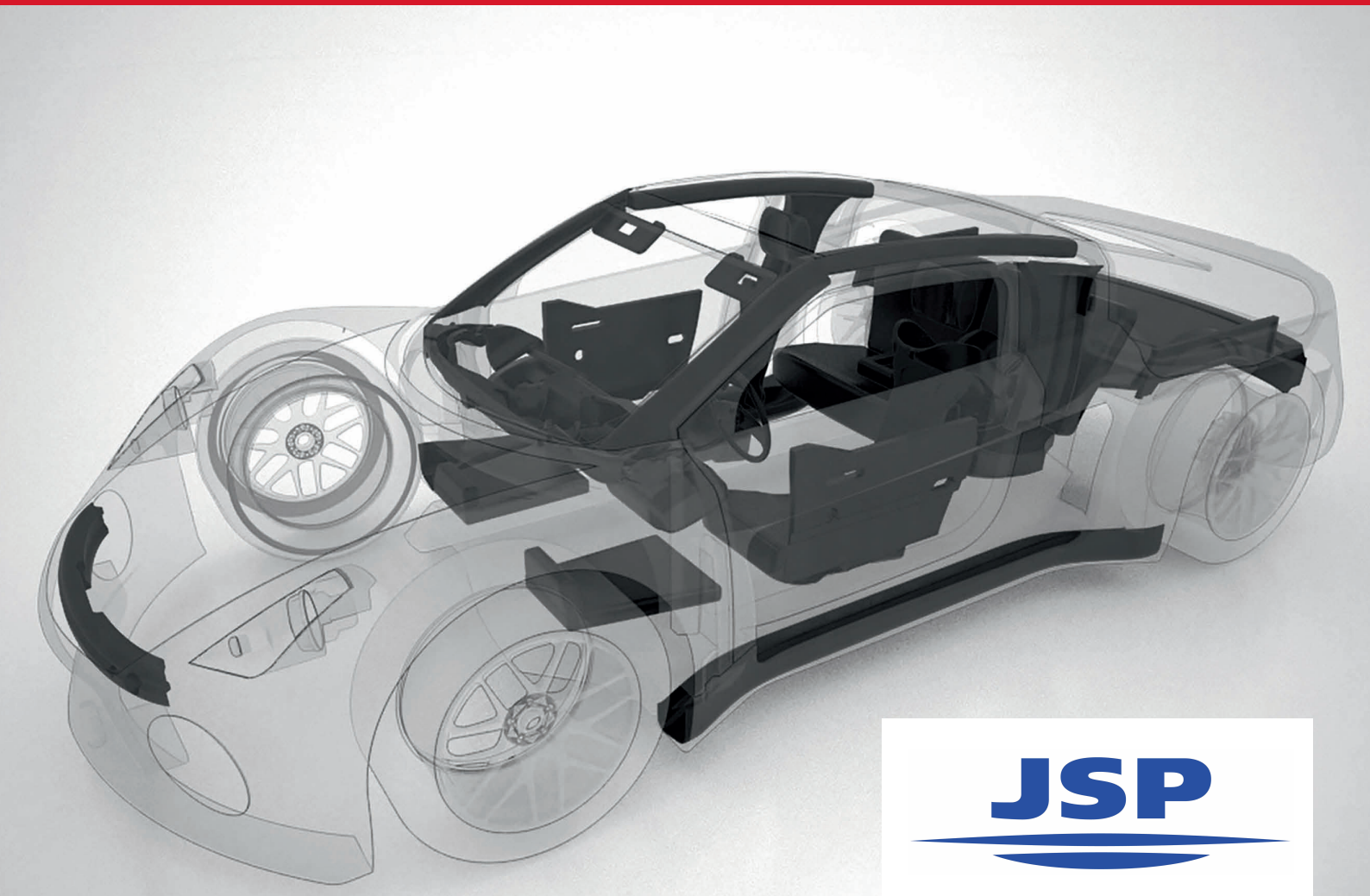

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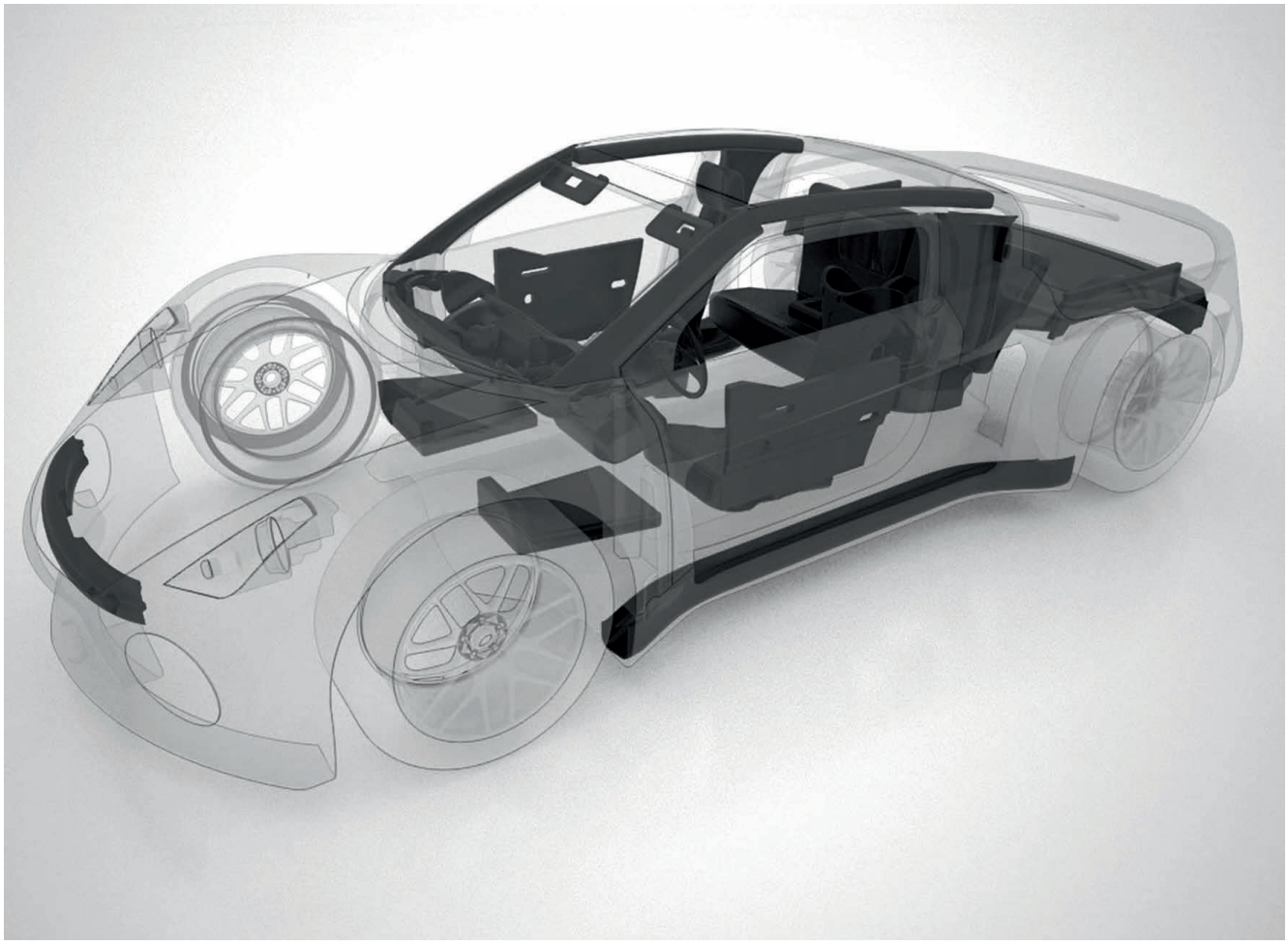
Automotive Components Made of Packaging

Circular Economy for Expanded Polypropylene (EPP)

Currently, recyclates are in high demand, including the automotive industry. Previously, component suppliers had reservations about using recyclates in safety-related areas, because mechanical properties varied too widely. Now, materials producer JSP has developed an expanded polypropylene with 25 % recyclate content precisely for these application areas. But to ensure high quality, close cooperation with the recycling company is essential.



The use of expanded polypropylene in vehicles, including safety-critical areas such as passenger and pedestrian protection is vastly increasing (© JSP)

Driven by EU regulations and own sustainability programs, European automakers are demanding the use of polymers with recyclate content to an increasing extent. Hereby, Volvo has progressed very far: the Swedish automaker is planning that at least 25 % of all plastics used in their vehicles are made from recycled material by 2025 [1]. Recycling is definitely not a new topic for the automotive industry. For many years, attempts have been made to recycle a large proportion of plastic waste, such as production scrap, vehicle scrapping, load trays, and lightweight packaging. Also, the

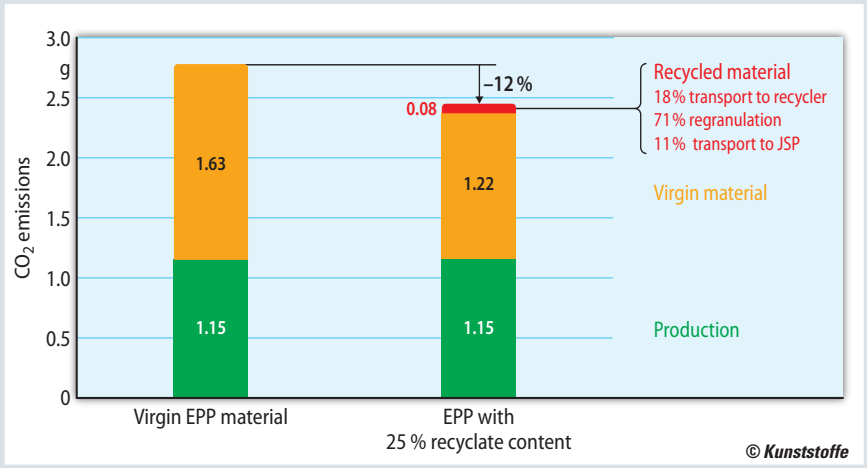


Fig. 1. Compared with virgin EPP from JSP, 1 kg of EPP with 25 % recyclate content generates 12 % less CO_2 emissions (source: JSP)

recyclate content of individual vehicle components is continuously increasing. Irrespective of the current discussions regarding CO_2-neutral production in the automotive industry, considerable efforts in plastics recycling have already been made in the past. However, the present debate has accelerated development once more.

One good example of this development is a recycling system established jointly by the materials producer JSP International Sarl in Estrées-Saint-Denis, France, and the recycler General Industries Deutschland GmbH (GID) in Kassel, Germany. GID collects load trays made of expanded polypropylene (EPP) from automakers and suppliers, recycles them, and delivers the newly produced material to JSP. JSP uses the material to produce its EPP Arpro 5134 RE (**Table 1**) with a recyclate content of 25 %. This not only saves resources but also reduces CO_2(e) emissions by up to 12 % compared with virgin material – CO_2(e) stands for CO_2 equivalent and describes the emissions of all greenhouse gases converted into CO_2 – without sacrifices in mechanical properties or processability (**Fig. 1**).

EPP in Automobiles on the Advance

In pursuit of higher operating ranges for electrically powered vehicles and the reduction of CO_2 emissions from conventional IC engines, the amount of plastic used in the automotive industry is rising. Up to 50 % of the volume of today's vehicles consist of plastic. In terms of weight, the polymer content in the automotive industry is presently about 18 %. Forecasts indicate that this is likely to increase to 25 % by 2027 [2–4].

Of the more than 39 different types of plastic used by automakers, 70 % are accounted for by polypropylenes (PP), polyurethanes (PU), polyamides (PA), and polyvinyl chlorides (PVC) [5]. Thanks to its versatility, PP has a wide range of uses in different application areas in the automotive industry and represents up to 30 % of the plastic installed in a vehicle. It also has an increasing use in the form of EPP (**Title figure**). Similarly, the applications are gaining in importance, e.g. as impact absorbers in the fields of pedestrian safety and passenger protection. For the latter, it is particularly well suited, thanks to its closed-cell foam structure, which ensures good absorption of energy with multiple impacts.

Since 2008, JSP has been offering an EPP with 15 % recyclate content, produced from packaging and production scrap. However, the product was only used in niche applications such as fittings insulation [6]. To keep up with the increasing demand in Europe, JSP has built up a closed-loop system for molded EPP parts at the end of their service life [7]. Recycling molded parts, thereby becoming independent of the supplier of the original material.

And this is where JSP's partnership with plastics recycler GID comes into play. The company specializes in the automotive industry. To provide country-wide coverage for plastic waste processing, GID makes use of its production sites, operates in-house plants in OEM assembly plants, owns mobile recycling plants, and works with partner companies. Alone in the automotive sector, GID recycles 12,000 t/a of plastic waste (**Table 2**) into high-grade recyclates (ground stocks, agglomerates, regranulates, and compounds).

Material	Recycled quantity [t/a]
PP/GF-PP	5000
HDPE	3000
PC/ABS	2000
ABS/PS	1000
PA6 / PA66	500
Others	500

Table 2. Plastic waste processed by GID in the automotive sector, itemized acc. to materials (source: GID)

	25 % compression [kPa]	50 % compression [kPa]	75 % compression [kPa]	Tensile strength [kPa]	Tensile elongation [%]	Compression set (with 25 % compression, 22 h, and 23 °C) [kPa]	Burning rate [mm/min]
45 g/l	240	340	720	715	27	11,5	55
60 g/l	340	475	1000	930	25	11,5	40

Table 1. Physical properties of EPP Arpro 5134 RE for mass concentrations of 45 and 60 g/l (source: JSP)

Fig. 2. Decommissioned load trays are collected, compacted, and then granulated (© JSP)

Amounting to some 4500 t/a in Europe, recyclable packaging from the automotive sector in particular – such as load trays – are an important source for the circular system (**Fig. 2**). Load trays made of EPP are returnable containers for vehicle components, which are shuttled between the OEM factories and the suppliers. Most of them are customized trays, designed for components of specific vehicle models. When production of that vehicle model stops (end of production, EOP), all the trays are scrapped or disposed of by the OEM. Their service life depends on transported components. Containers for components that are replaced after a facelift are mostly used for three to four years. With the introduction of a new model, all EPP containers are scrapped after four to six years at the latest. With a market share of about 60 % or 2650 t/a, GID is the market leader for recycling EPP load trays in the automotive sector.

Circular System with OEMs

For this, the company has been operating an intelligent return system with most OEMs for several years, e. g. with Volkswagen, Audi, Seat, Skoda, Daimler, and Opel. To reduce transport costs and CO_2 emissions, GID discusses the phase-out plan with the OEM's container management in advance, before the vehicle's EOP. Also taken into account are all challenges faced by the OEM and its assembly plants involving the load trays. Load trays have large volumes but a low weight due to the EPP materials. For lack of space, storage is usually out of the question.

What's more, transport is very inefficient and expensive. GID frequently works together with local EPP compactors, e. g. located at the OEM's site for empty containers, and enabling the load trays to be compacted on site. The compacting performance of these units is 150 kg/h, and special EPP agglomerators manage 400 kg/h. In this way, the low weight of uncompacted EPP containers of just 1.2 t per truck load can be increased to 22 t per truck load. In all other locations where such EPP containers accumulate, the OEMs' contract freight forwarders transport them directly from the location to the nearest GID site. »

Fig. 3. At the Eschwege (Hesse) site, the collected load trays are processed to EPP granulate and subsequently examined for key properties in the laboratory (© GID)

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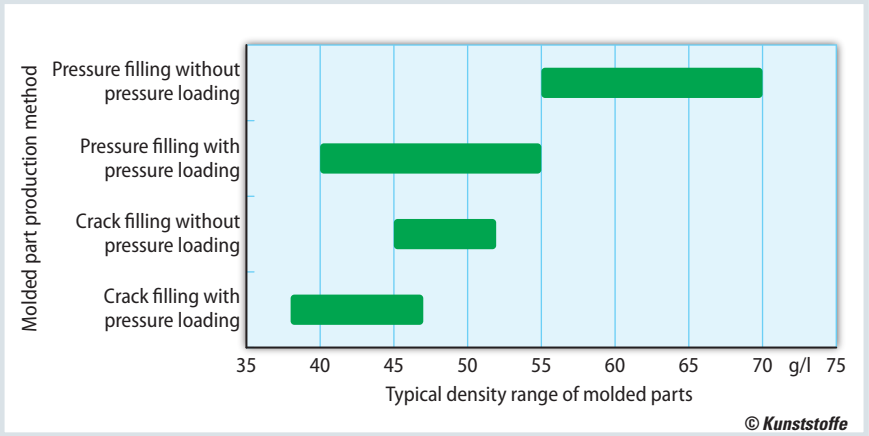

Fig. 4. Arpro 5134 RE can be processed using the crack filling or pressure filling method, with or without pressure loading (source: JSP)

Such collection centers are located e.g. in the German towns Bremen, Kassel, Brunswick, Wolfsburg, Stuttgart, Ingolstadt, Nuremberg, Eschwege (Hesse), and Neckarsulm (Baden-Württemberg). Moreover, the network includes European partner companies in Poland, the Czech Republic, Hungary, Slovakia, Austria, and Spain, for example.

The EPP load trays are sorted according to strict quality standards. This tight goods inwards inspection is important to ensure the necessary quality for the materials producer's treatment process, for the foaming process of the molded component's manufacturer, and to meet the automakers' specifications. Particularly because material recycling is independent of the producer, GID manages the material flows in the entire chain from supplier to their recycling facilities.

Quality is distinguished according to the following criteria:

- ESD and non-ESD containers (ESD = electrostatic discharge),
- black & colored goods (with colored particle foams),
- with/without labels,
- with/without foreign matter (e.g. EPE foam, shipping envelopes, hinges, aluminum trays etc.).

Only non-ESD black containers without labels and foreign matter are rated as A quality. All other load trays are rated as B quality.

After sorting and compacting the EPP containers according to quality criteria, they are processed to EPP regranulate at the GID site in Eschwege, Germany (**Fig. 3**). Apart from goods inwards inspections during sorting and granulating, GID also examines the recyclate in an own laboratory for key properties such as melt flow index, notch impact and tensile strength, and filler content. This ensures that the material meets the automotive industry's tight specifications.

Such stringent quality assurance by the recycler as well as the producer of the material is necessary to permit recyclate to be used for safety-relevant areas in vehicles. Together, GID and JSP ensure that equivalent mechanical properties, emissions, and the same flammability as virgin material are achieved. Therefore, components made of Arpro 5134 RE (**Fig. 4**) can also be used for bumpers and pedestrian protection (**Fig. 5**).

Previously, when using plastics with recyclate content, component manufacturers avoided safety-relevant applications to a great extent. This was mainly due to the widespread of mechanical values such as elongation at break and tensile strength. If the materials are also to be used in these areas, they must be comparable and exhibit far more constant properties. In future, materials with recyclate content must also meet the quality criteria of virgin material. This can only be achieved if the materials producer and recycler work closely together. ■

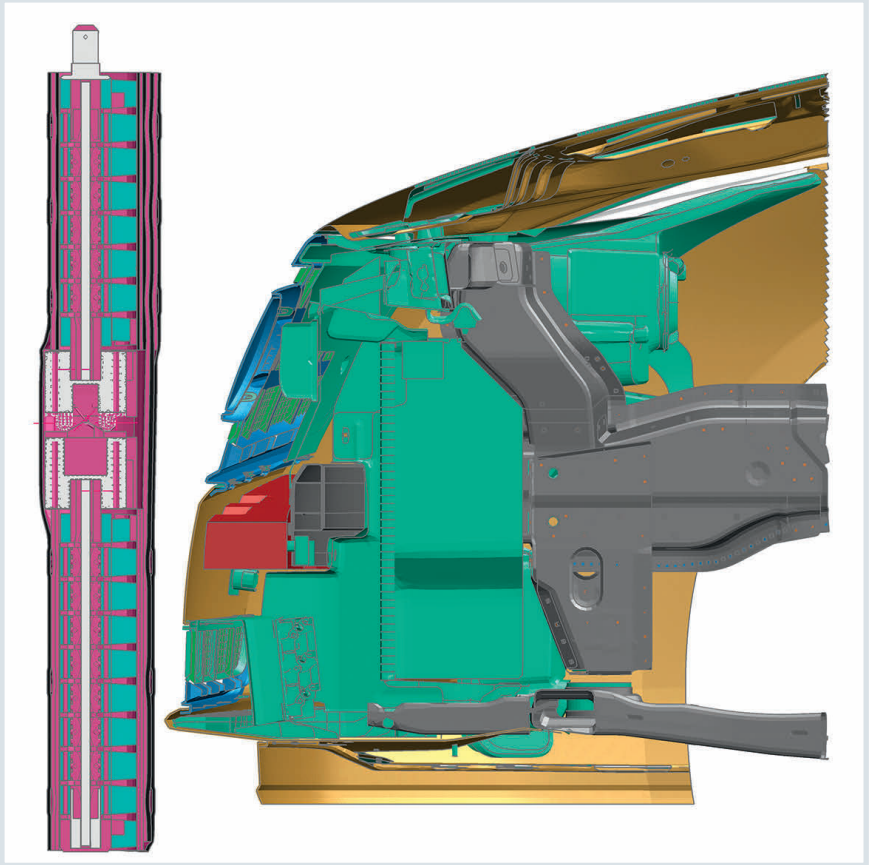

Fig. 5. Finite elements analysis (FEA) with the LS-Dyna software: safety-relevant areas in the automobile, like the pedestrian protection here, are tested via simulation. The area shown red in the simulation consists of EPP and absorbs some of the energy in case of a collision, e.g. with a pedestrian's leg (© JSP)

GREEN IS THE NEW BLACK

ARPRO pioneer the first Expanded Polypropylene to use 25% recycled content from end-of-life moulded products. The ARPRO 5134 RE contributes to reduce CO_2 emissions by 12% compared to virgin material.

ARPRO Expanded Polypropylene is a 3D engineering material that delivers energy absorption with structural strength at very low weight. It also offers chemical resistance as well as thermal and acoustic insulation. **ARPRO is 100% recyclable.**

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