LUCOBIT
THERMOPLASTIC POLYOLEFINS

FLEXIBLE POLYMERS

RECYCLING GRADES

... we make better polymers

OPPORTUNITIES FOR LUCOBIT PRODUCTS IN RECYCLING APPLICATIONS

TURN WASTE INTO VALUABLE PRODUCTS

GENERAL

The recycling of materials -post consumer as well as post industrial (see figures 1 and 2)- is an important challenge for the plastic industry. Pressure from the legislation as well as consumer demand more and more drive the industry to increase the recycling rate as shown in figure 3. Often heterogeneous plastic waste as well as separated mono-fractions are not fit for the majority of applications. Scission and crosslinking of the polymer chains as well as incompatibility of different plastics account for their poor mechanical properties. Blending these materials with a small amount of compatibilizer/modifier based on ethylene butyl acrylates and corresponding maleic anhydride grafted products results in a dramatic increase of mechanical properties.

This approach turns plastic waste into valuable feedstock for various extrusion and moulding applications offering tremendous economic opportunities for plastic converters.

Figure 1: Post industrial PP Film

Figure 2: Post consumer heterogeneous plastic waste

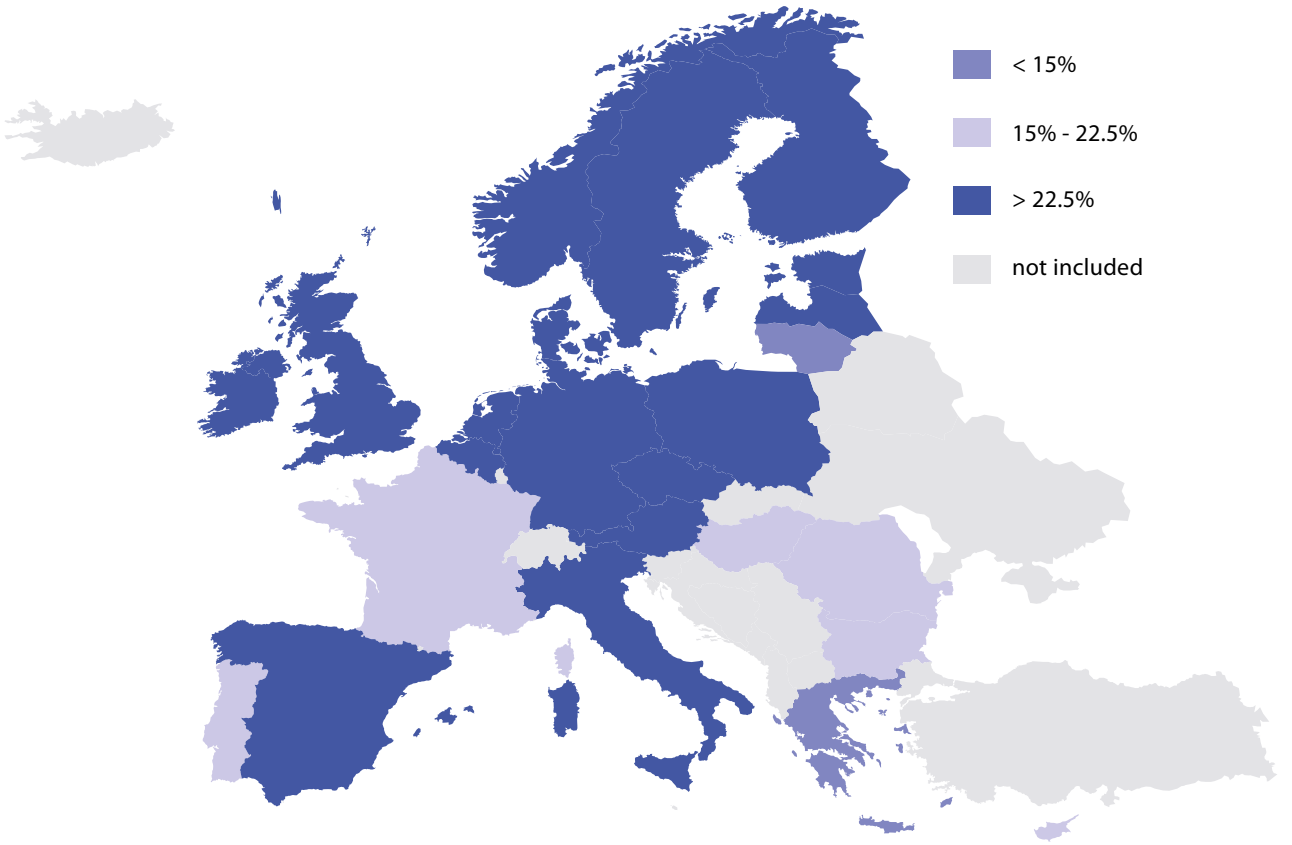

Figure 3: Recycling rates of plastic packaging waste across the EU in 2008

LUCOBIT MATERIALS FIT FOR USE IN RECYCLING APPLICATIONS

LUCOBIT AG, headquartered in Wesseling, Germany and former part of BASF, offers the following materials fit for use in recycling applications:

- two ethylene butyl acrylate copolymers (EBA):
  - Lucofin® 1400HN
  - Lucofin® 1400MN
- two maleic anhydride grafted (MAH) ethylene butyl acrylate copolymers (EBA):
  - Lucofin® 1494H
  - Lucofin® 1494M

All grades contain 16 % - 17 % butyl acrylate. On top of that, Lucofin® 1494H and Lucofin® 1494M contain a high amount of grafted maleic anhydride. Their molecular structure as shown in figure 4a and 4b explain many of their unique properties if added at moderate dosages to various kinds of plastic waste. Due to their low MFI Lucofin® 1400HN and Lucofin® 1494H are more suited for extrusion applications, whereas 1400MN and Lucofin® 1494M with their high MFI are used mainly in moulding applications.

The non grafted grades improve the mechanical properties of non polar mono-fraction plastics, while the grafted grades –often in combination with the non grafted grades to compromise technical performance as well as price competitiveness- raise the mechanical properties of heterogeneous plastic waste as well as polar polymers.

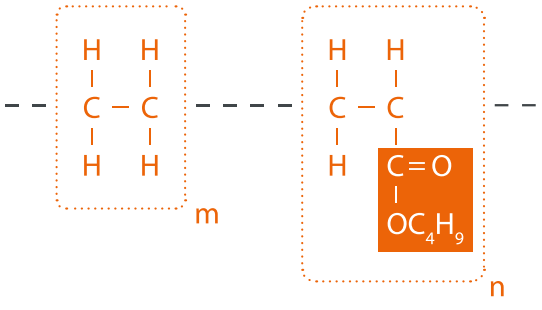

Fig. 4a: Molecular structure of EBA copolymers

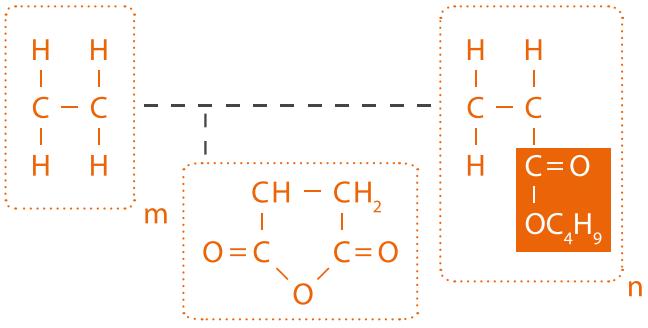

Fig. 4b: Molecular structure of MAH grafted EBA copolymers

UPGRADING MECHANICAL PROPERTIES OF MONO-FRACTION PLASTICS

Mono-fraction plastics can be a result of industrial processes, collected post consumer waste or heterogeneous plastic waste followed by a seperation system, such as the German green dot.

Adding 5 % - 20 % Lucofin® 1400HN / Lucofin® 1400MN to mono-fraction plastics based on PP, PE or PA –here a proportion of Lucofin® 1494M / Lucofin® 1494H is needed- significantly improves impact strength, elongation at break and puncture impact of the corresponding blends as shown in figure 5-8.

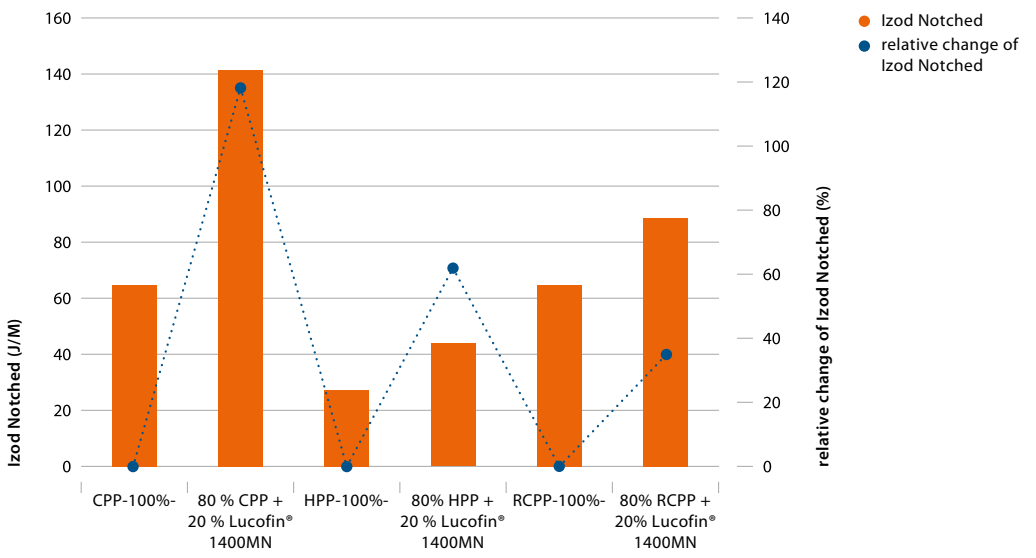

Figure 5: Notched Izod Impact Strength of various PP types compounded with 20 % Lucofin® 1400MN

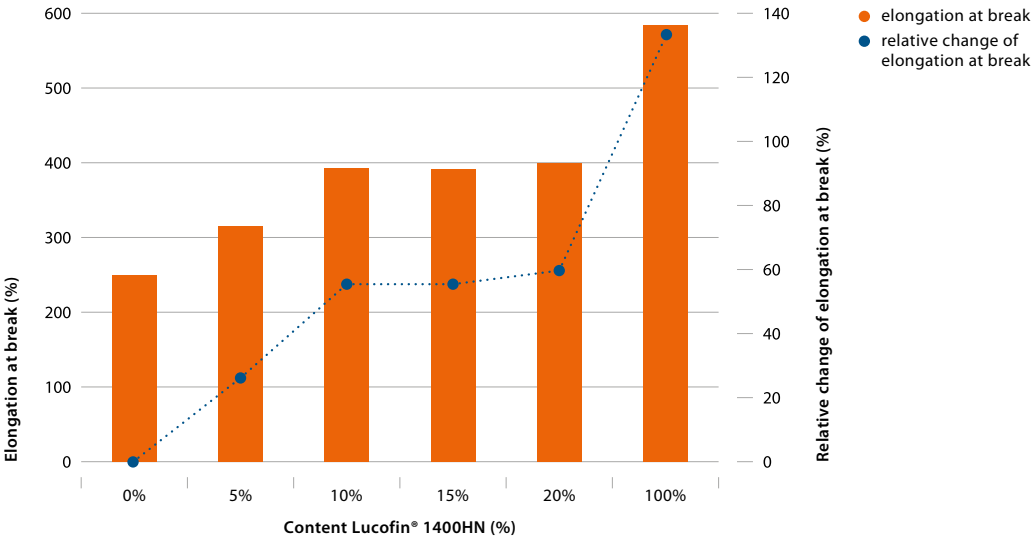

Figure 6: Elongation at break of LDPE / Lucofin® 1400HN blends

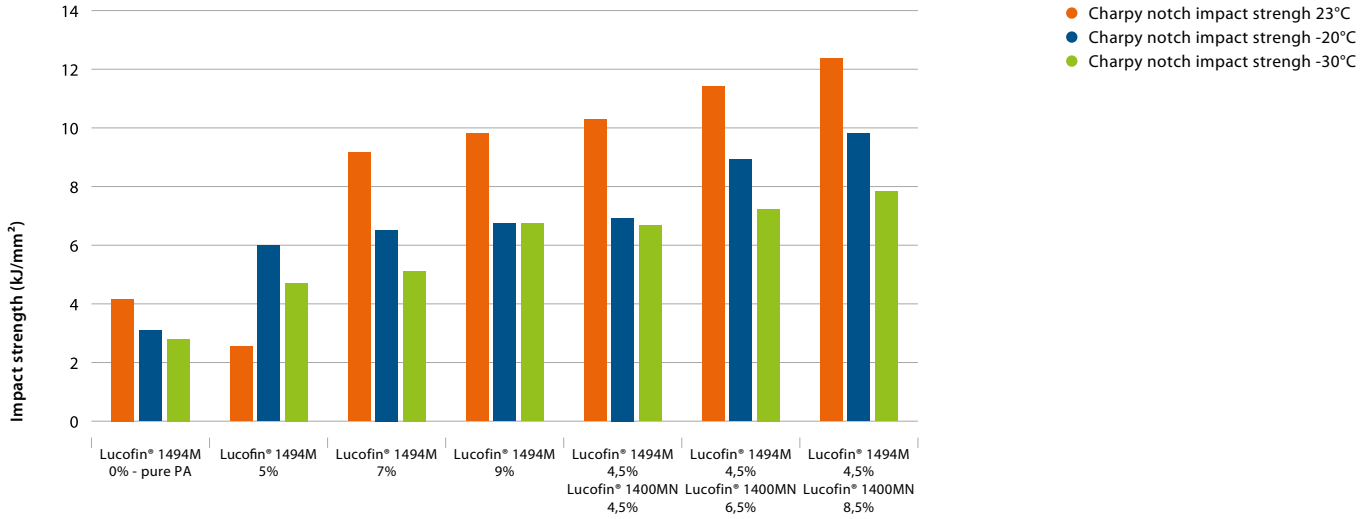

Figure 7: Impact strength of PA modified with Lucofin® 1494M/Lucofin® 1400MN

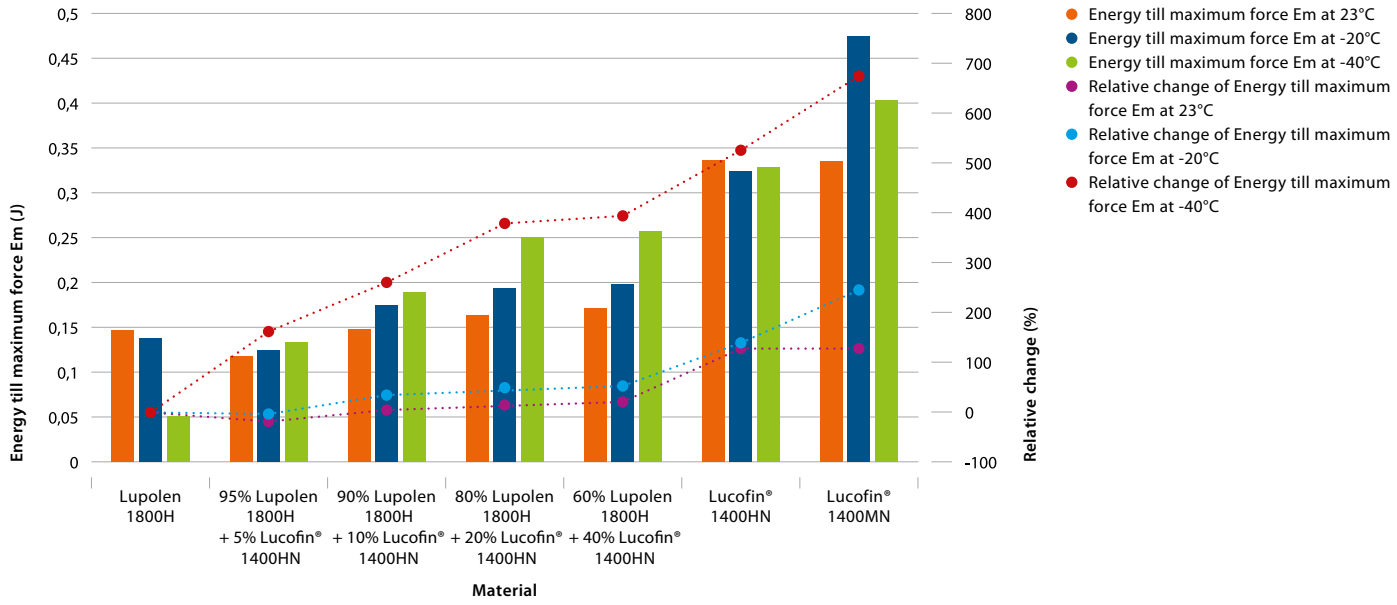

Figure 8: Puncture impact behaviour of LDPE/Lucofin® 1400HN blends- Energy till maximum force Em at various temperatures

Above mentioned effects are particularly enhanced at cold temperatures due to the low glass transition temperature of Polybutylacrylate (see figure 9). Below the glass transition temperature a polymer becomes brittle and stiff. Therefore, a low glass transition temperature is required in order to maintain toughness and flexibility. This is crucial for all parts exposed to cold temperatures, especially for outdoor parts in regions with harsh winters.

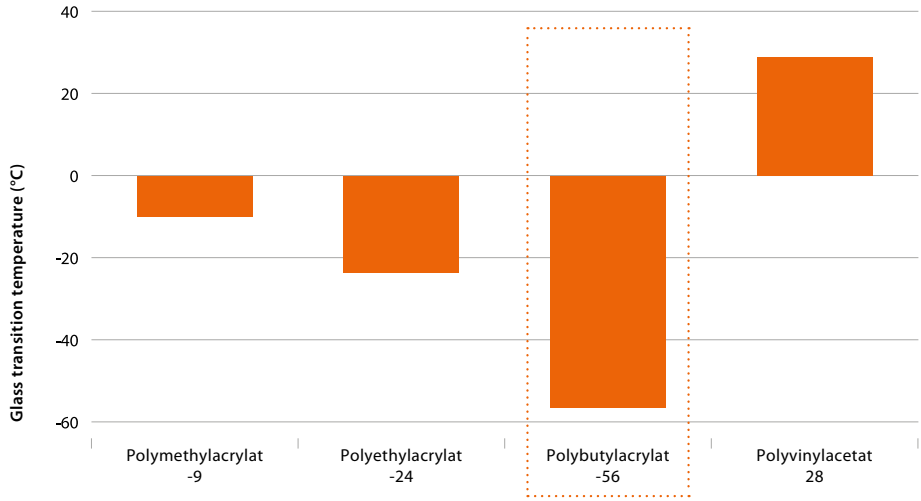

Figure 9: Glass transition temperature of some polar ethylene copolymers

UPGRADING MECHANICAL PROPERTIES OF HETEROGENEOUS PLASTIC WASTE

Heterogeneous plastic waste can be a result of industrial processes or post consumer waste.

Multilayer structures based on polyolefins –like LDPE, PP, HDPE- and engineering plastics – like EVOH PA and – are widely used in flexible, semi-rigid and rigid plastic designs. Flexible food packaging, agriculture films and automotive tanks are just some examples. Figure 10 shows exemplary the design of a totally impermeable film typically used in farming.

The polyolefin provides the structural integrity, whereas the engineering plastic serves as a diffusion barrier for gases like oxygen, nitrogen and carbon dioxide. As useful as these constructions are, they have one major drawback: their reluctance to fit into an efficient recycling stream due to the incompatibility of the constituting polymers resulting in poor mechanical properties and the impossibility of separating mono-fractions economically.

Therefore, dumping, incinerating and shipping to low cost countries have been the preferred ways of dealing with post-consumer and post-industrial material based on these multi-layer structures. However, with the banning of landfills and with the coming of ever stricter regulations to increase the recovery of products, the demand to subject these multilayer structures to a well-organised recycling process is becoming more and more urgent.

The dosage of some % of a compatibilizer based on maleic anhydride grafted ethylene butyl acrylate (EBA) –Lucofin® 1494H- and ethylene butyl acrylate (EBA) –Lucofin® 1400HN- or combinations thereof to a polyolefin/engineering plastic blend significantly increases the mechanical properties in comparison with the corresponding non-compatibilized blend. The mechanism of compatibilization is shown in figure 11.

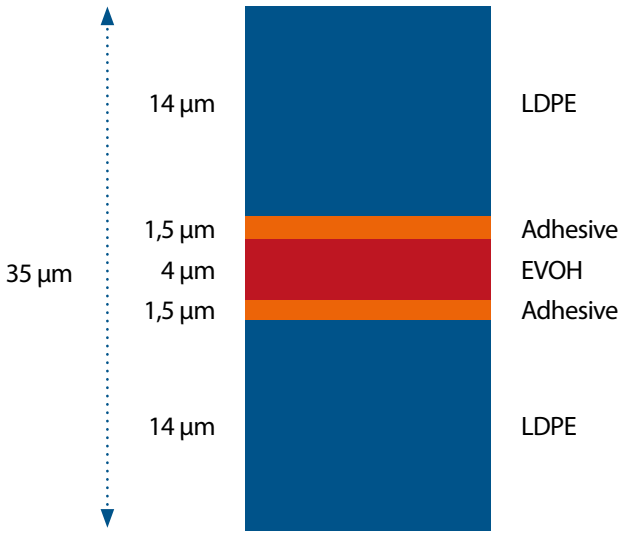

Figure 10: Design of a typical mulitlayered agricultutal film; due to the incompatibility of the constituting polymers not recyclable

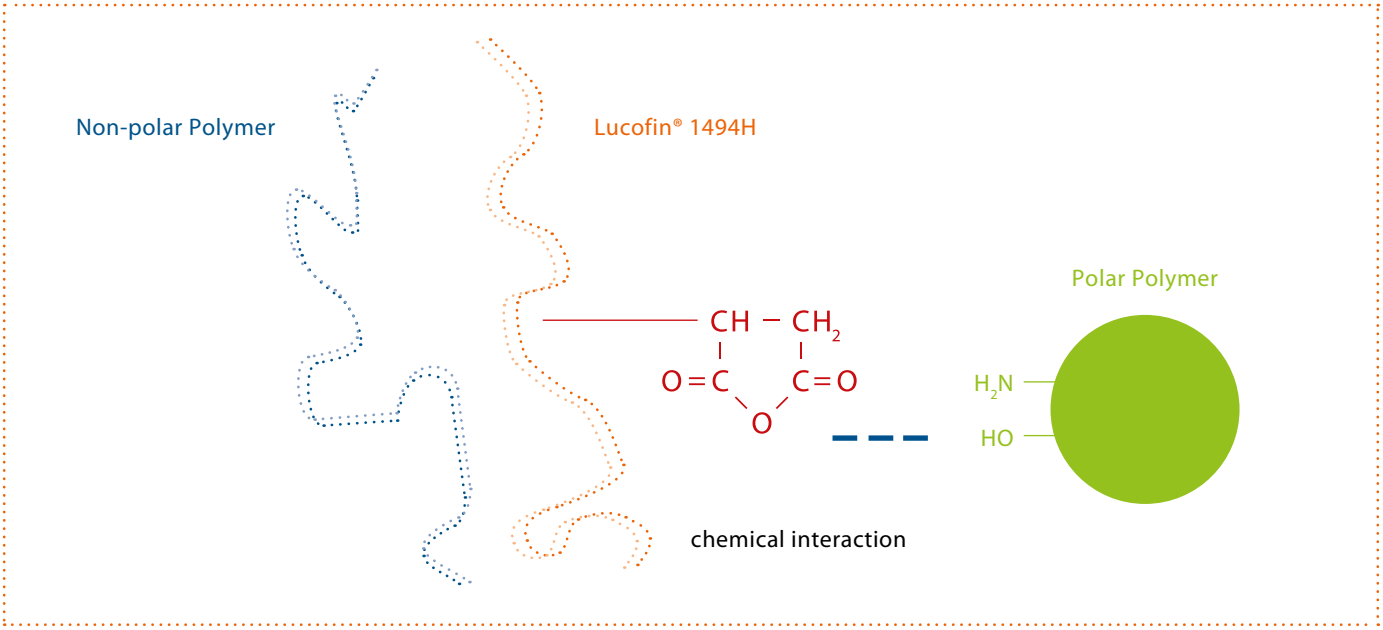

Figure 11: Chemistry of Lucofin® 1494H to compatibilize dissimilar plastics

Fig. 12 and 13 show exemplary the tensile impact toughness and the elongation at break of typical PP/LDPE/EVOH blends with varying types and contents of compatibilizers Lucofin® 1494H and Lucofin® 1400HN: improvements of up to several 100 % are achieved opening up recycling opportunities for the compatibilized blends in moulding, film and other extrusion applications.

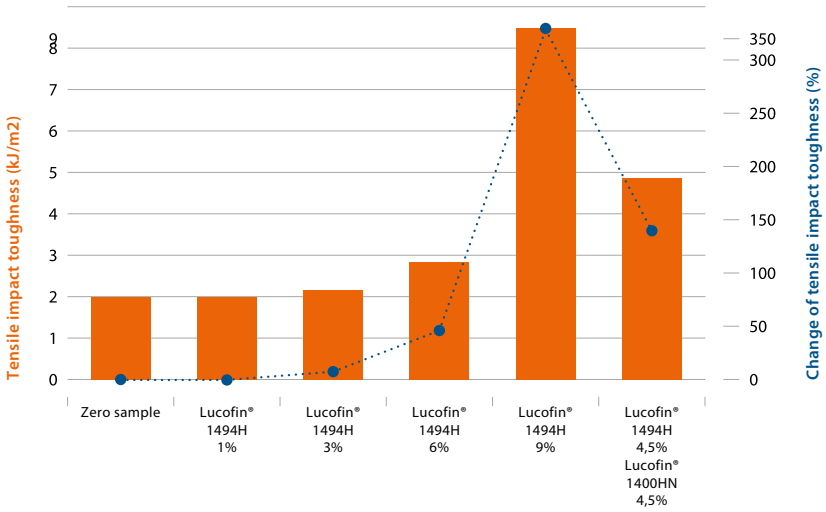

Fig. 12: Improvement of mechanical properties of a PP/EVOH (PP: 86 %, EVOH: 14%) blend by adding Lucofin® 1400HN/Lucofin® 1494H- tensile impact toughness

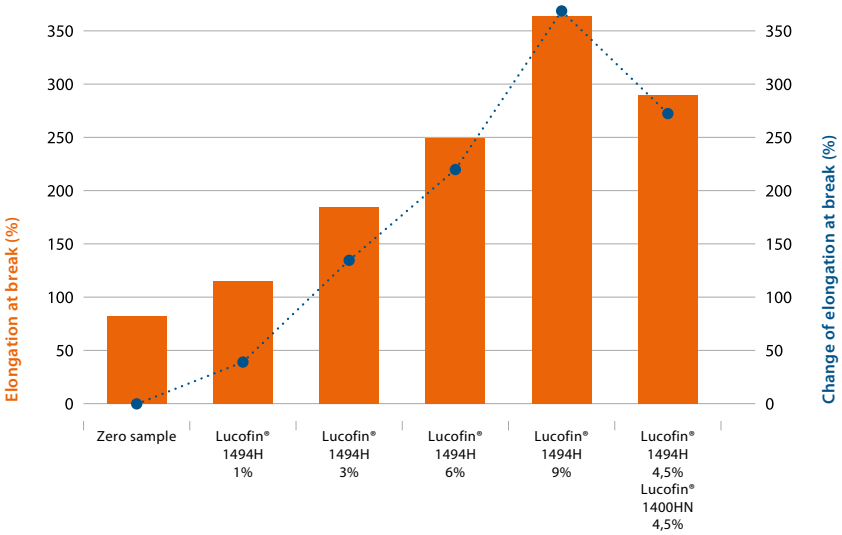

Fig. 13: Improvement of mechanical properties of a LDPE/EVOH (LDPE: 86 %, EVOH: 14%) blend by adding Lucofin® 1400HN/Lucofin® 1494H elongation at break

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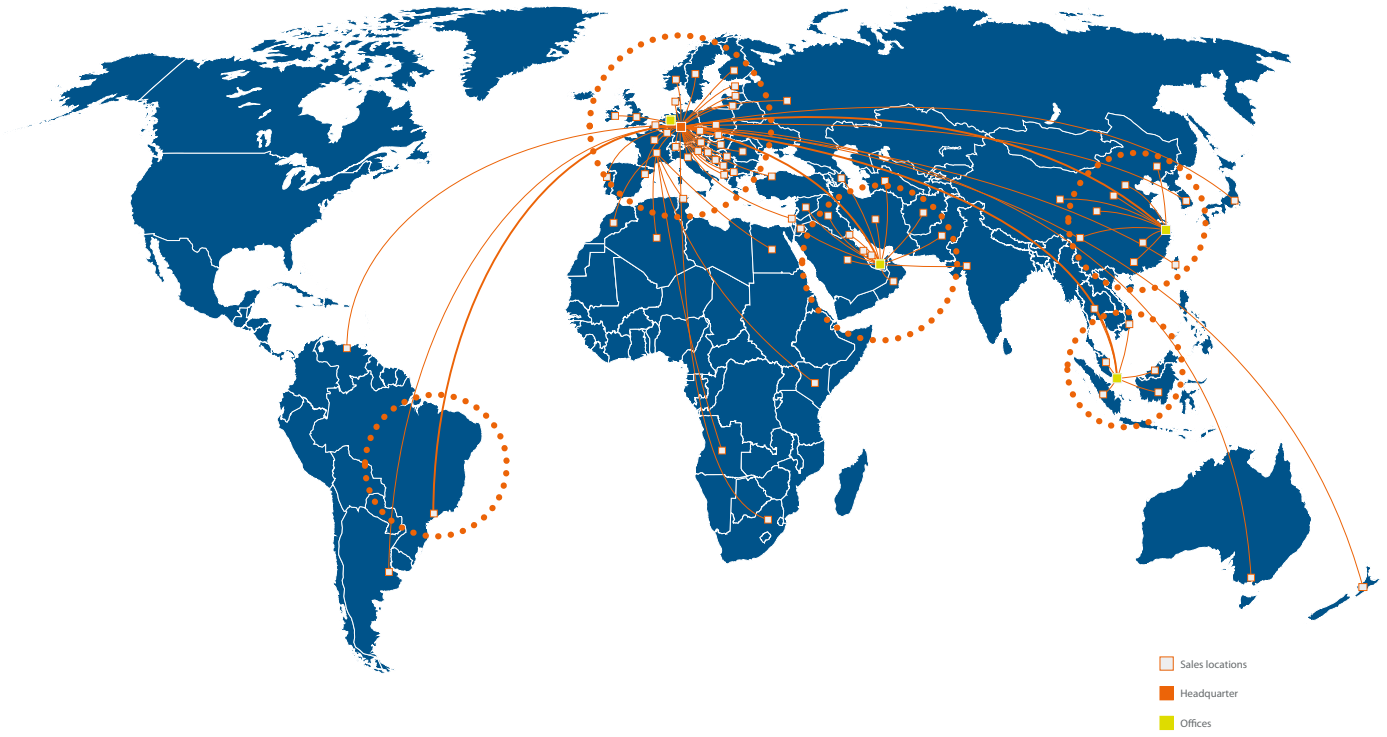
LOCATIONS



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