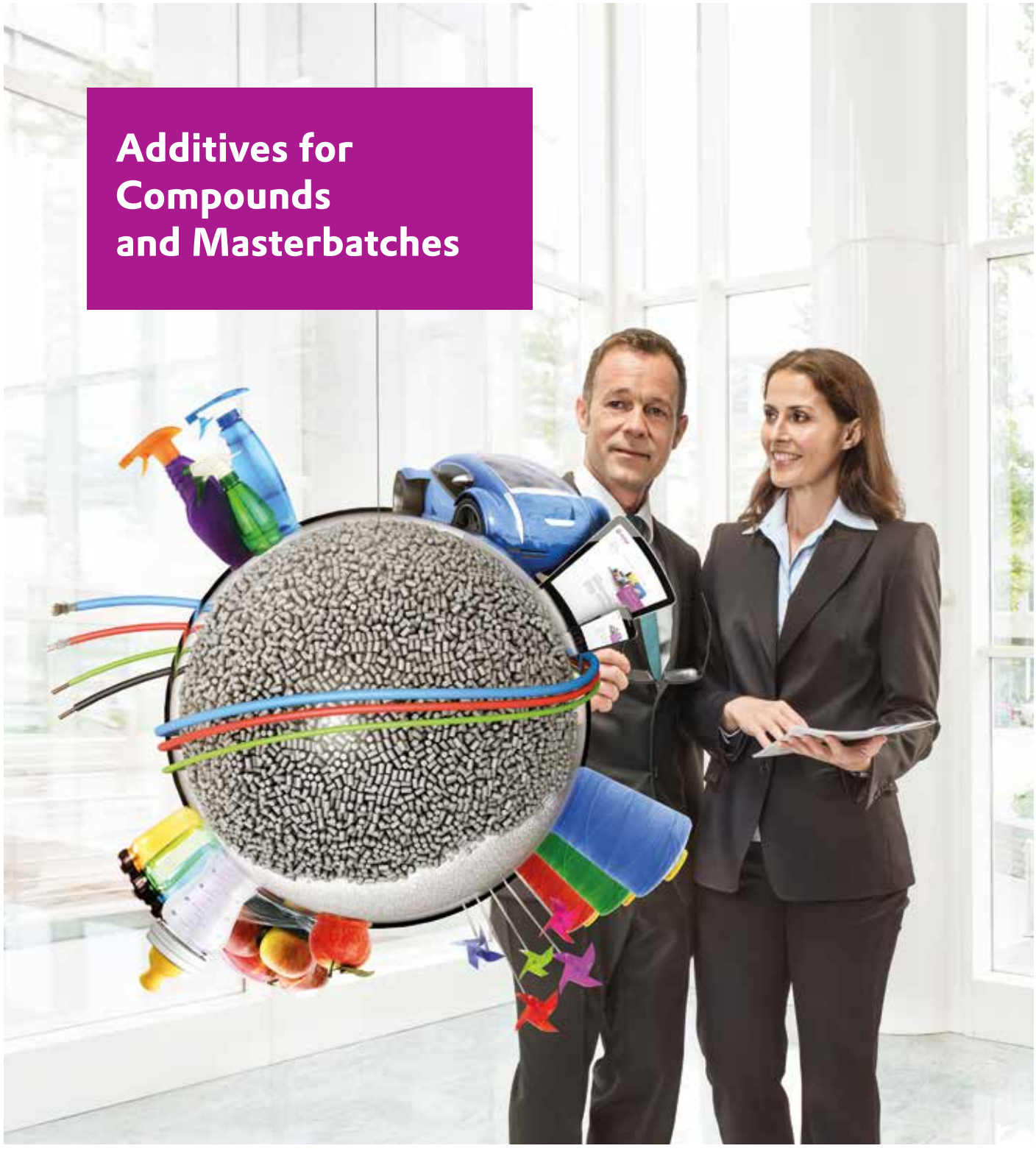
Additives for Compounds and Masterbatches



EVONIK
POWER TO CREATE

Our global plastics world supported by additives from Evonik

Functions | Markets | Applications | Industries

PROCESSING AIDS

TEGOMER® additives allow faster manufacturing, provide smooth surfaces, and prevent die drool and shark skin in high filled compounds, such as ATH/MDH filled HFFR cable applications or $CaCO_3$ filled film applications.

SCRATCH AND MAR RESISTANCE

High-end products such as cars, electronic devices or consumer goods require long-lasting, damage-free surfaces. For this purpose, Evonik provides a range of TEGOMER® AntiScratch products for a large variety of polymers that will help to develop new applications in this field. Other surface properties can be enhanced as well, e.g. COF reduction or improved surface appearance of glass fiber filled polymers.

FOOD COMPLIANCE

TEGOMER® dispersants and TEGOPREN® additives have been developed to meet the needs of the fast growing packaging industry with food contact compliance.

DISPERSING AIDS

TEGOMER® dispersants are successfully used for high-end masterbatches with special requirements for an extremely high dispersability where not only coloration but also an outstanding reduction of filter pressure value are required, e.g. for fiber and film applications. TEGOMER® dispersants are successfully used for high-end masterbatches with special requirements for an extremely high dispersability where not only coloration but also an outstanding reduction of filter pressure value are required, e.g. for fiber and film applications.

Contents

ORGANOMODIFIED SILOXANES (OMS) – PERFORMANCE ADDITIVES

OPTIMIZED COMBINATIONS FOR BEST PERFORMANCE

Organomodified siloxanes (OMS) are used during the production of polymeric materials as processing additives for extrusion, injection, and blow molding. In addition to serving as compatible internal slip and release agents, these specialties can also be applied as surface modifying agents or as material property enhancers by permanent implementation in thermoplastics and elastomeric polymers. As a result, they are used in a wide variety of applications, such as automotive parts, domestic and consumer goods.

Organomodified siloxanes consist of a siloxane backbone with attached organic groups. The organic groups ensure a permanent functionalization of the polymer with no OMS bleeding.

Different molecular architectures of OMS derivatives are available. Figure 1 shows the comb-like as well as the linear structure of the OMS together with the possible functional groups.

Organomodified siloxanes (sold as TEGOMER® or TEGOPREN®) can be tailored to the final application by varying the density and nature of the attached organic groups. Figure 2 shows the functionalization of a polymer matrix with OMS. These derivates can either work for bulk modification (case A) or for surface modification (case B).

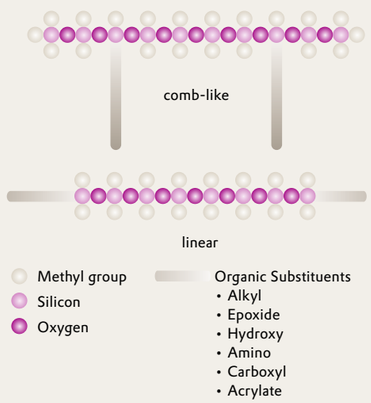


Figure 1: Structures of organomodified siloxanes

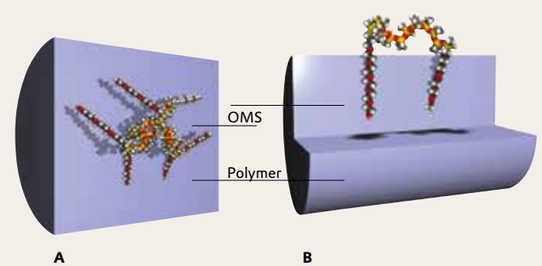


Figure 2: Anchorage of an OMS by organic side chains

BENEFITS OF OMS AS A PLASTICS ADDITIVE

Processing
- Rheology of polymer melt
- Improved mold fill operation
- Suppression of melt fracture
- Improved mold release
- Increased productivity
- Lubrication
- Higher filler content

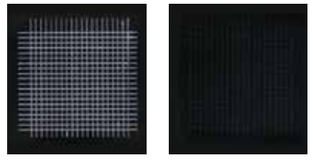
Surface modification
- Improved scratch resistance
- Suppression of shark skin
- Lowered surface roughness
- Improved chemical resistance
- Improved water resistance

Material property enhancer
- Improved impact strengh
- Reduced brittleness
- Higher plasticity
- Higher elongation
- Enhanced flame resistance
- Improved low temperature stability
- Improved heat distortion temperature

Organomodified siloxanes influence and improve the production process of a plastics product as well as the properties of the final product. The table summarizes the benefits of OMS with regard to the processing, surface modification, and properties of the final plastics product.

APPLICATIONS FOR OMS ADDITIVES

AUTOMOTIVE AND ELECTRONICS INDUSTRIES



Above: Pure compound.
Below: 2% TEGOMER® AntiScratch 100 applied to the automotive compound

Figure 3: Improvement of scratch resistance by using OMS derivatives

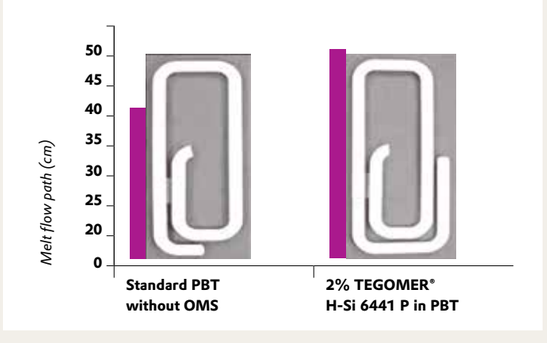
EFFECT ON SCRATCH RESISTANCE

Scratch and mar resistance are important issues for automotive applications, electronic devices, domestic appliances, and the furniture industry. These characteristics can be evaluated by various methods, most of which were developed in the automotive industry. Figure 3 shows the effect of the organomodified siloxane TEGOMER® AntiScratch 100 (additive concentration = 2%) evaluated in a PP talc compound using an Erichsen scratch tester. Doing so significantly reduces Delta L (as measured by the change in brightness between the scratched and non-scratched plate), which describes the damage to the surface.

Figure 5: Mold for flow spirals

Figure 7: Significant melt flow improvement can be illustrated with the molded spirals when using TEGOMER® H-Si 6441 P in various polymers, such as PA.

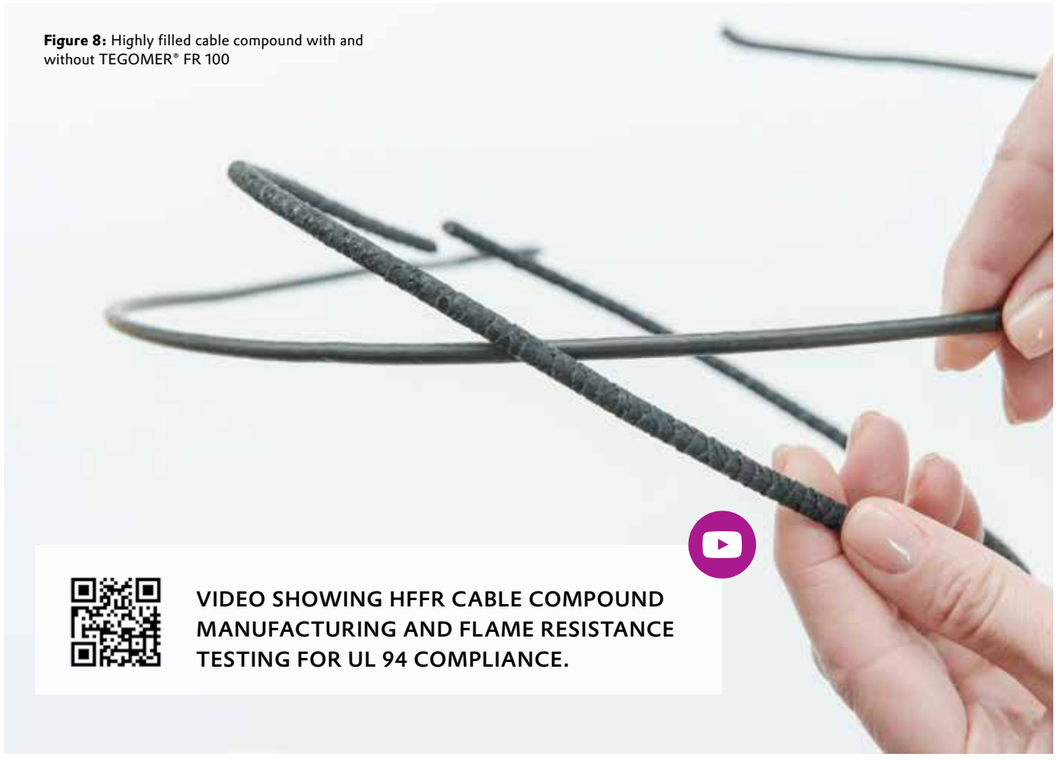
Figure 6: Improvement of melt flow path by TEGOMER® H-Si 6441 P



EFFECT ON MELT FLOW INDEX (MFI)

The positive influence of OMS additives on viscosity can be shown by MFI determination as well as by melt flow path evaluation. Our technical department is equipped with an injection molding tool to determine the influence on melt flow behavior. For example, the addition of 2% TEGOMER® H-Si 6441 P to a PBT compound leads to an improvement of 25% of the melt flow length (Figure 6).

Figure 8: Highly filled cable compound with and without TEGOMER® FR 100



EFFECT ON FLAME RESISTANCE

Flame resistance is an important issue to consider for a variety of new compound developments used in cable jacketing materials for building and transportation as well as for electronics. OMS additives improve die drool and throughput in halogen-free flame retardant (HFFR) EVA compounds. It allows for fillings containing up to 65% of ATH or MDH, which yields the highest level of flame resistance. Figure 8 illustrates the effect of 2% of TEGOMER® FR 100 in a cable compound containing 65% ATH.

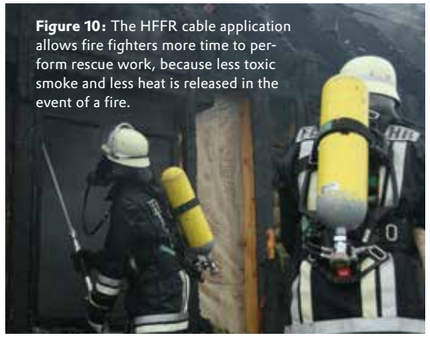


Figure 10: The HFFR cable application allows fire fighters more time to perform rescue work, because less toxic smoke and less heat is released in the event of a fire.

DISPERSING ADDITIVES FOR PIGMENTS, FILLERS, AND FLAME RETARDANTS

STABILIZING WITH KNOW-HOW

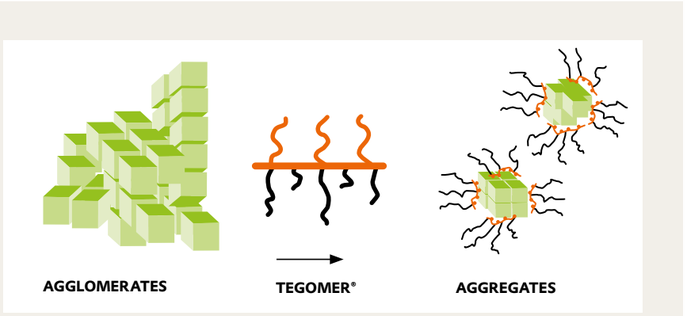


Figure 11: How TEGOMER® dispersants break down and stabilize agglomerates in order to develop color intensity.

Evonik offers dispersing agents for pigments, fillers, and flame retardants under the trade names TEGOMER® and TEGOPREN®. These additives are invaluable for optimizing the distribution of fillers and inorganic pigments in compounds and for dispersing organic pigments in color concentrates such as masterbatches and liquid pastes.

As a result of their polar surfaces, most organic pigments are not compatible in nonpolar or less polar matrices, such as PE, PP, PA. Such particles tend to form agglomerates that are big enough to influence the overall performance of the final polymer or the masterbatch formulation. This behavior causes some undesired effects.

Dispersing additives help to cover the newly formed surface of the aggregates and primary particles during the dispersing process. Aggregates that are covered with the dispersing additive can no longer agglomerate. In addition, they also become compatible with the matrix via the polymer chains attached to the dispersing additive.

Evonik also offers organic dispersants for water- and solvent-based pigment manufacturing processes and for final surface treatment based on organomodified siloxanes (OMS).

OUR PRODUCTS ARE ESSENTIAL INGREDIENTS TO:

- Improve development of color
- Prevent clogging of filter sieves
- Avoid blocking of spinning nozzles
- Manufacture fibres without capillary fractures
- Reduce speck formation within films or thin-walled parts
- Increase productivity or reduce maintenance efforts
- Avoid pigment bleeding
- Not only can our products be used for polyolefins—they are also suitable for engineering resins thanks to their higher temperature resistance

BENEFITS OF OUR PRODUCTS IN DIFFERENT DISPERSING APPLICATIONS

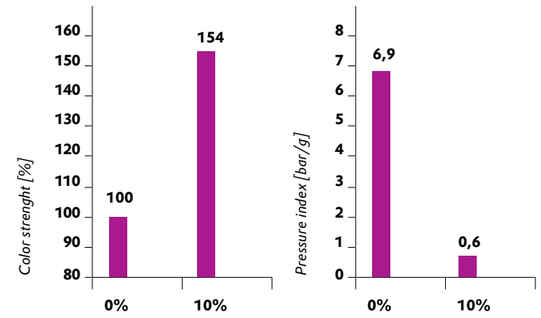
Coloration of masterbatches
- Improvement of color strength
- Application in polyolefines and engineering plastics
- Masterbatches that are easier to process
- Higher pigment loading
- Easy processing without bleeding
- Reduced filter pressure index

Pigment, fillers, and flame retardant manufacturing and treatment
- High filler or pigment loading
- Easy dispersing process
- Easy processing of masterbatches
- No restrictions in final application (e. g. sealing, printing)
- Higher bulk density

Liquid pastes for coloration
- High pigment loading
- Improved color strength in compounds
- Low viscosities of pastes
- Prevention of settlement

VIDEO ON MASTERBATCH MANUFACTURING, FILTER PRESSURE VALUES, AND FILM MANUFACTURING.

Figure 12: Influence of 10% TEGOMER® P 121 on color strength and pressure index



EVALUATED PROPERTY	TEST METHOD/EQUIPMENT
Color strength	Full shade and tinted systems with Datacolor equipment
Speck evaluation	Microscopic evaluation on 50 micrometer plates or on film samples
Pressure index	Brabender equipment, e. g. DIN EN 13900-5
Polymer rheology	Melt flow index determination or Anton Paar Viscometer

In-house evaluation technologies for dispersants

Dispersing and wetting pigments are core competencies of Evonik. Our laboratories are able to perform a multitude of test methods that are important standards of the industry. The table on the left-hand side shows the test methods we can conduct in house.

The technical advice we offer our customers is based on the many trials we conduct in our laboratories on a variety of pigments and polymers used in masterbatch manufacturing. Guiding formulations, along with our knowledge of the resulting rheology effects, make it easy for customers to get started. Take, for instance, the effect of 10% TEGOMER® P 121 in a PA masterbatch with pigment Green 7 (shown in Figure 12): the use of TEGOMER® P 121 increases color strength by 54% and dramatically reduces pressure from 6.9 to 0.6 bar/g. That makes this additive suitable even for use in fiber and film applications, as illustrated by the filter pressure equipment shown in Figure 13.

Figure 13: Filter pressure equipment

Figure 14: Titanium dioxide surface treated with TEGOPREN® 6875 is able to float on the surface of water, despite its high density.

VIDEO REGARDING THE USE OF DISPERSANTS DURING PIGMENT, FILLER, AND FLAME RETARDANT MANUFACTURING AS WELL AS SURFACE TREATMENT WITH ORGANOMODIFIED SILOXANES.

SURFACE TREATMENT OF PIGMENTS, FILLERS, AND FLAME RETARDANTS

Figure 15: This unique surface treatment technology is available as a 100% active substance (TEGOPREN® 6875) and as an emulsion (TEGOPREN 6875-45).

Figure 16: Improved flame restistance and processing by using either an additive for surface treatment or in-situ during compounding.

A range of specialty dispersants for pigment, filler, and flame retardant manufacturing is available in addition to our solid dispersants in powder form (for use in masterbatches) and our liquid 100% dispersants for liquid colorants.

The dispersants of Evonik can be used in water-based filler, pigment, and flame retardant manufacturing processes to reduce the viscosity of the slurry and to achieve a high loading of fine-sized particles in the filter cake. Reduced water content in the filter cake requires less drying capacity, allowing manufacturers to save valuable energy while achieving a high-end dispersion of the pigment, filler or flame retardant.

The resulting pigments can be used in all conceivable end applications, such as polymers or paper coating.

Complementing this range of dispersants is a specialty surface treatment for polymeric applications (based on OMS technology) requiring extreme hydrophobicity. This means that products such as TEGOPREN® 6875-45 (emulsion) can be stirred into the filter cake or slurry after grinding and before drying.

This product can be applied in a spray dryer. Even a 100% variation is available (TEGOPREN® 6875) which withstands extremely high temperatures, such as those found in steam mills.

SPECIALTY ADDITIVE – TEGO® Sorb

GIVING THE WORLD A CLEAN SMELLING BACK

In addition to OMS based performance additives and dispersing additives, we also offer a specialty additive for odor absorption.

Odor absorbers are used for preventing undesired odors in polymer applications and the excellent odor absorbing properties of TEGO® Sorb effectively control odors arising from pigments, polymers, compounds, or masterbatches. Typical odor-creating substances that TEGO® Sorb masks include hydrogen sulphide, mercaptane, and amines. Odor absorbers also prevent emissions from recycling polymers, masterbatches of ultramarine blue pigment, TPEs, PA, and others.

The application of our products is especially important for the automotive industry, as it effectively provides a way of managing the odor in the interior of the car. The film industry and manufacturers of caps for bottles have critical organoleptic demands, and TEGO® Sorb helps to meet those requirements.

Chemically TEGO® Sorb is a zinc ricinoleate, whereby the central metal zinc ion is capable of binding the components that cause odors. Figure 18 shows the chemical structure of TEGO® Sorb, as well as a computer model of the molecule. TEGO® Sorb is compatible to polyolefines and technical polymers. A concentration between 0.5 and 2.0% is sufficient for significantly reducing unpleasant odors. Figure 19 shows an example of reduced emissions from sulfur compounds in recycled Polyamide 6.

Figure 18: Molecular structure of TEGO® Sorb

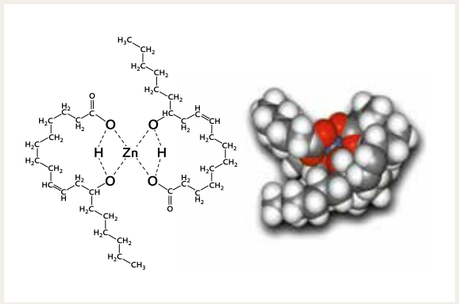
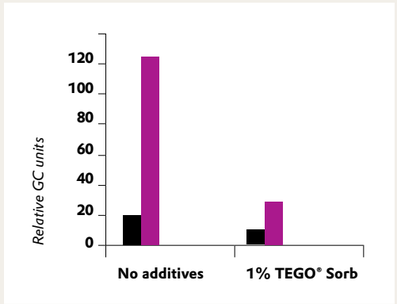


Figure 19: Reduction of hydrogen sulfide and mercapto methane by TEGO® Sorb



TEST SETUP Polymer: Recycled Polyamide 6
Odor absorber: 1% TEGO® Sorb
Measurement: VOC thermo desorption (VDA Norm 278)

THE BENEFITS OF TEGO® Sorb CAN BE IDENTIFIED IN THE FOLLOWING MANUFACTURING STEPS:

- During compounding to guarantee an environment free of malodor
- For reduced odor of the final product
- Especially effective for eliminating odors in recycling materials and in rubber production

Figure 17: Electric device from recycled polymer with TEGO® Sorb

BASE ADDITIVES

ADDITIONAL PRODUCTS THAT MAKE PLASTICS WORK

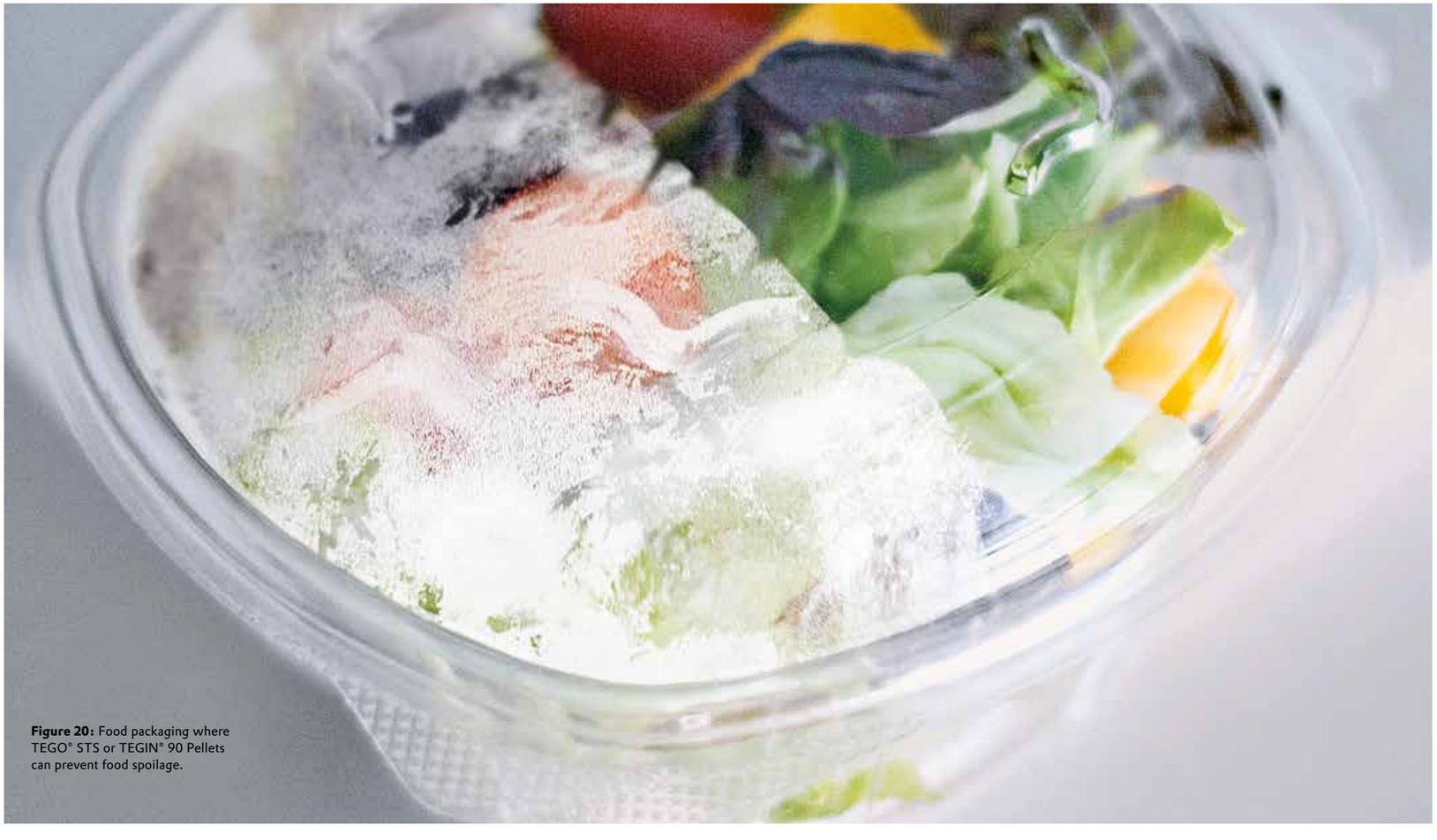


Figure 20: Food packaging where TEGO® STS or TEGIN® 90 Pellets can prevent food spoilage.

ANTIFOGGING ADDITIVES

Fogging occurs when water condenses as small, discrete droplets on the surface of transparent plastics films. The use of antifogging additives avoids this problem. In greenhouses, water droplets can act like small lenses and damage plants leaves. In food packaging, droplet formation leads to an unfavorable appearance and may cause food spoilage.

When used as an antifogging additive, TEGO® STS acts as a surfactant or wetting agent, and prevents the formation of discrete water droplets by building a continuous water film. TEGO® STS is often used in combination with TEGOMER® P 121 or P 122 in masterbatches.

ANTISTATIC AGENTS

Antistatic agents offer a solution to the negative effects of electrostatic charge, such as static discharge and dust attracted to the surfaces of plastics parts.

As an antistatic agent, TEGIN® 90 Pellets can be incorporated into the final production step of basic polymers or in masterbatches and compounds, where it migrates to the surface of the polymer film or part. In combination with atmospheric humidity, TEGIN® 90 Pellets form a conductive film on the surface of the polymer, thereby dissipating the charge.

TECHNICAL SERVICE

OUR TECHNICAL SERVICE – AN OFFER FOR YOU

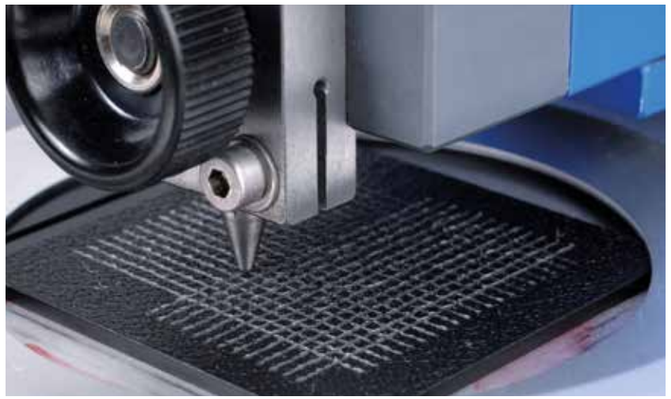


Figure 22: Erichsen Scratch pattern

Please do not hesitate to contact us to discuss your special requests. We will be pleased to support you with our additives and applications knowledge using the excellent capabilities of our Plastics Technical Plant in Essen/Germany to run trials with you.

EVALUATED PROPERTY	TEST METHOD/EQUIPMENT
Scratch and mar resistance	Erichsen Scratch tester, e.g. GM 10640, Five Finger Scratch test, Crockmaster
MFI properties and viscosity	Melt flow path, Melt flow index by DIN 1133 or ASTM D 1238, Anton Paar Viscometer up to 400 °C
Flame retardence	UL 94 evaluation, low oxygen index
Impact test Notched impact test	Izod and Charpy method at room temperature and at low temperature between -20 °C and -40 °C
Tensile strength, elongation	Zwick machine
Shark skin	Blow film line from Brabender
COF modification	e.g. DIN EN ISO 8295
Gloss and color evaluation	Datacolor, e.g. DIN EN ISO 2813 and 5033

Figure 21:
Multifinger Scratch test

Figure 22: Plastics Technology Center – Essen/Germany

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