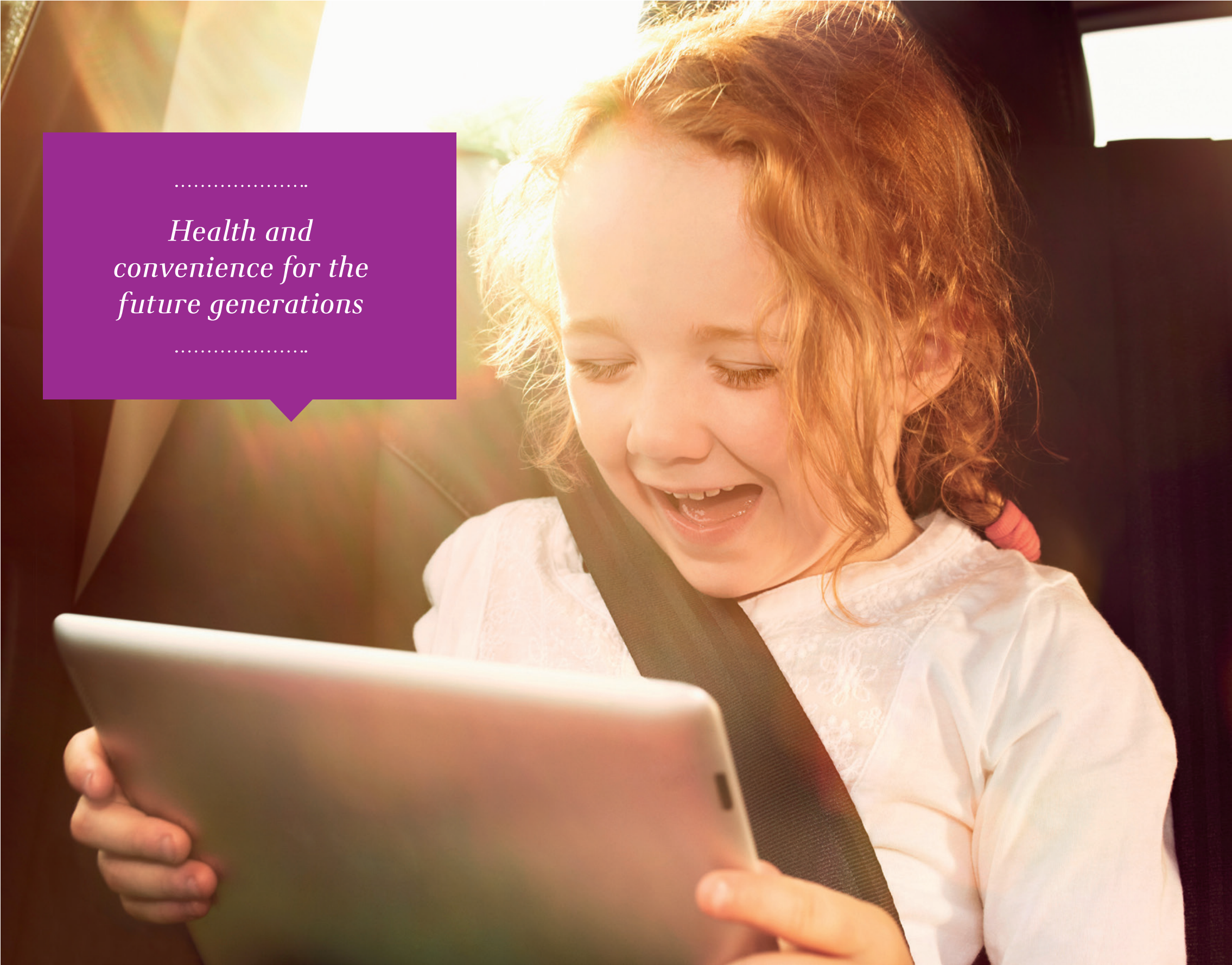


Adding to
your life

ADDITIVE SOLUTIONS FOR POLYMERS

SPECIALIZED
FOR YOUR
NEEDS



.....
*Health and
convenience for the
future generations*
.....

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The future
depends on
what we do
in the present.

MAHATMA GANDHI

Adding to your life

OUR ADDITIVE SOLUTIONS FOR POLYMERS

What will tomorrow's world look like? What technologies can we expect to see and what possibilities will they offer us? What challenges will the Plastic Industry face in terms of the cost and availability of raw materials and energy, improving sustainability with better recycling and resource efficiency, as well as maintaining continuous innovation?

Only those who raise these questions today, will be in a strong position to identify the emerging trends and predict the needs of the future. At the Interface & Performance Business Line we invest significantly in research and development to come up with and develop future oriented solutions for our customers and the next generations. Our global set-up for manufacturing and applied technology, together with our well-equipped pilot plant in Essen, Germany gives us the foundations to offer our customers the expert advice and close collaboration they need. By doing so we comply with global standards, seek for necessary labelling and test our products rigorously to ensure they exceed and outperform the highest industry standards.

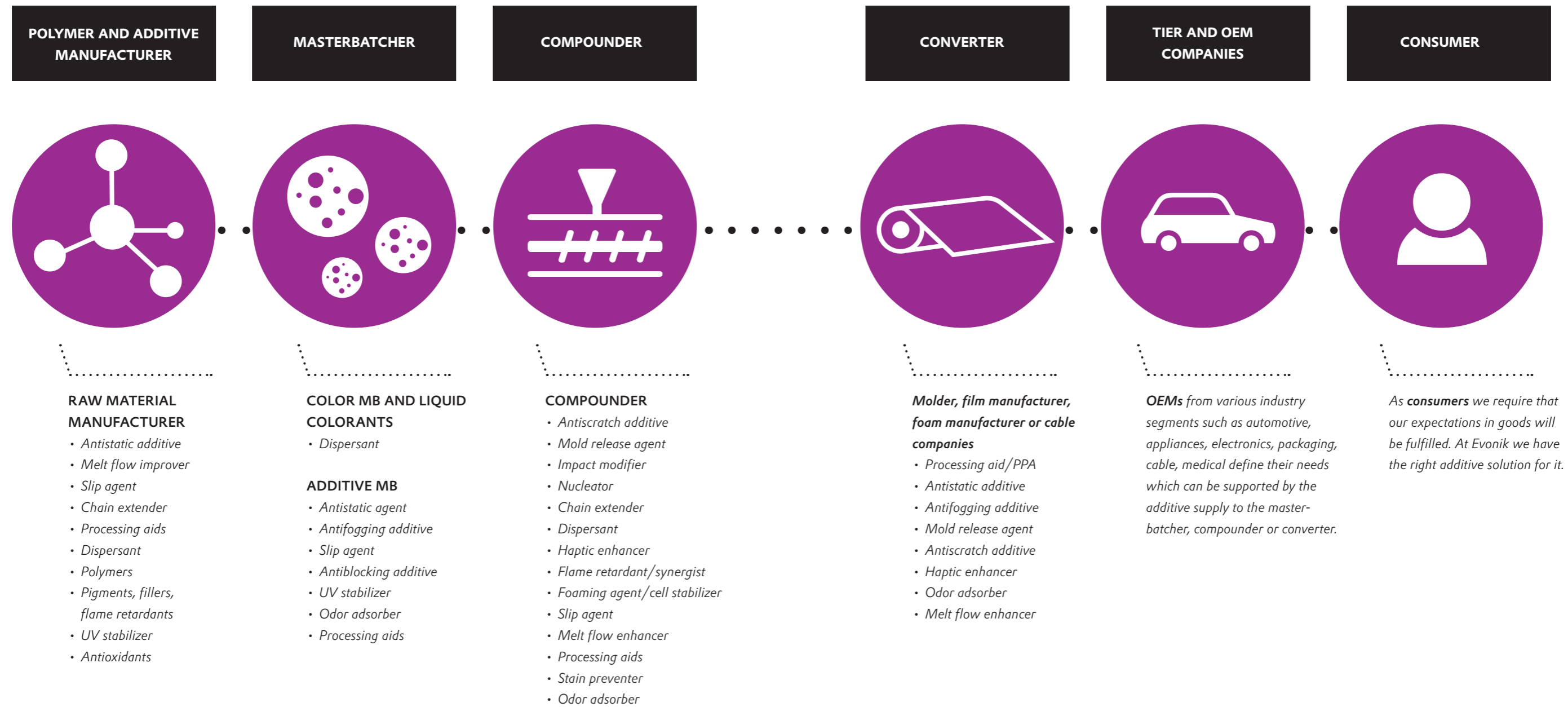
Our broad portfolio of liquid and solid products (e.g. additives, additive masterbatches and porous carriers for additives) is based on organic chemistry or organo-modified siloxanes and provides solutions for many different plastic technologies along the Plastic Industry's value chain. From raw material modification, right up to offering various additive masterbatches, we can support you in your compounding and converting processes.

Our additives can be used as performance enhancers or processing aids and are adjustable to meet the needs of multiple industries including automotive, packaging, electronics, cables and consumer goods. Recycling, flame retardant plastics, e-mobility or packaging products with specific requirements are just some of the areas we look forward to discussing with you to ensure you can overcome the challenges you face today and in the future!

Enabling solutions for the future

SPECIAL EFFECTS FOR THE NEEDS OF THE VALUE CHAIN

6
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Overview

TOOLBOX #1: THE MASTERBATCHER

As a masterbatcher, you can count on our support to ensure that your product quality and your overall cost performance is strong. Our high temperature resistant dispersants enable you to achieve the best color enhancement, reduce fibre breaks and avoid lacing in polyolefin and engineering resins.

As a compounder, you can take advantage from Evonik's extensive range of additives to improve performance in fire resistance, melt flow or anti-scratch behaviour. You can also experience processing additives for cost optimization potential in your own production processes.

Converters from the film, packaging, foam or molding industry can fulfill their needs for antistatic, antifog, demolding efficiency or antiscratch performance by using highly filled additive masterbatches.



TOOLBOX #2: THE COMPOUNDER

■ Effects/functionalities ■ Application/Market



10
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TOOLBOX #3: THE CONVERTER

Effects/functionalities Application/Market



Our brands

ACCUREL®

ALBIDUR®

NANOPOX®

TEGO Sorb®

TEGOMER®

TEGOPREN®

TEGOSIL®

Do you want to know more about our product portfolio?



.....
*Contributing to
a better future*
.....

Our Solutions for processing and performance

ENABLING A NEW CULTURE

Avoiding plastic waste, using environment-friendly materials, making more efficient use of resources and energy, and improving the quality of life: These are just some of the challenges that the coming generations will have to deal with to a much greater extent than we do today. To tackle these challenges, new sustainable high-performance materials that have a reduced impact on the environment will be key.

High-performance plastics contribute to the efficient use of resources as they help to reduce weight without affecting mechanical, optical or haptic characteristics. However, not all questions on the sustainable use and the recycling of such plastics have been fully answered yet. This is where Evonik comes in; we work intensively to develop strategies and solutions on the key topics such as recycling, biodegradability and improving the efficiency of resources – replacing the "end-of-life" concept with restoration and re-use and entering the circular economy culture.

FLAME PROTECTION

ENABLING FLAME RESISTANT SOLUTIONS INDEPENDENTLY OF THE BASE MATERIAL

Due to their high carbon content, plastics are highly combustible. Using flame retardants can significantly lower the risk of fire, but they do also have some disadvantages, as they modify the polymer properties of the material. This can often cause the required mechanical or electrical properties to be rendered ineffective. However to counter act these tendencies innovative additives based on organically modified siloxanes from Evonik are available.

Flame retardancy is becoming increasingly important, especially in the transport and construction sectors. The Construction Products Regulation (CPR) specifies new standards for cable applications in construction. The intention is to prevent fire from spreading for example through cable shafts. Our TEGOMER® V-Si 4042 and TEGOMER® FR 100 have enabled the development of suitable HFFR cable compounds – without adversely affecting the material properties.

Another example is the EN 45545 standard for transportation applications: For safety reasons, regular EPDM-based rubber is being increasingly replaced in railway cars by silicone rubber using TEGOSIL® FR 1000.

In e-mobility, in electronics and in electrical systems, flame protection is critical – for cables, switch cabinets, casting compounds for components, etc. Even just a minimal amount of additive from Evonik can make a key contribution to performing a task better. Here TEGOMER® H-Si 6441 P has become the product of choice for applications in high-performance plastics such as PA, PBT or TPE.

Using the right additives can not only mitigate the disadvantages of flame retardants, but can even help to meet further industry and legislative requirements – such as minimal smoke formation and low heat release rates in the event of a fire. Organically modified siloxanes from



HARD FACT



1/3 of fire events are caused due to electrical devices having insufficient flame resistance.

Evonik can serve as little magical add-ins to open up new possibilities in the development of flame retardant compounds.

COMPOSITES

LIGHTWEIGHT, STABLE AND DURABLE

When it comes to reducing weight in the automotive, aircraft or shipbuilding industries composite materials are often first choice. Modern wind turbines would be unthinkable without them. The materials used are mostly fiber-reinforced plastics based on glass or carbon fiber. Despite their lightness, these composites need to be as strong, stable and durable as metal. It's the innovative additives from Evonik that help to achieve this.

In order to obtain a uniformly loadable structural component, the fiber matrix and polymer mixture of resin, hardener and additive must form an inseparable bond with one another. In the production of thermoplastic structural components, this requires that there is good flowability of the polymer composition when pressed at high temperatures with the fiber matrix. This flowability is significantly improved with the use of TEGOMER® H-Si 6441 P.

Other products from the TEGOMER® family help facilitate the thermoplastic production of composite metal composites. When added to the polymer compound, they ensure that there is a good adhesion of the different layers of material and they help to make additional bonding superfluous.

Composites based on thermosets provide challenges of a different kind: Here, it is important to reduce the brittleness of the material which is made possible thanks to our products from the ALBIDUR® and ALBIFLEX® brands.

When it comes to the highest demands on load capacity and longevity – for example in the rotor blades of wind turbines on the high seas – Evonik also scores points with its NANOPOX® products. This additive also helps to contribute to lightweight structural components that are built to last and do not require any repair for up to 25 years.



HARD FACT

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Germany has 30.000 windmills with >50.000 megawatt capacity. This avoids 50 nuclear power plants.
.....



A FRESH LOOK AT PACKAGING

Many consumers hardly give it a moment's thought, but packaging is a really high-tech product: Sensitive electronics are protected by special plastic packaging that does not become statically charged. Food packaging is manufactured in such a way that it does not show fogging. This ensures that an appealing presentation is maintained, and it also has hygienic advantages: It means that there is no build-up of condensation, which could drop onto the packaged product and increase harmful bacteria levels.

In many cases, special additives from Evonik impart new properties to packaging materials made of plastic ensuring their use in multiple scenarios. To ensure the performance additives can be easily processed a masterbatch is used. Evonik

supplies the defined blends, in which the basic packaging materials and additives are present in a fixed proportion under the ACCUREL® brand name. These innovative additives ensure the necessary dosage accuracy and the even distribution throughout the entire packaging material.

Special additives such as TEGOMER® 6810 and TEGOMER® 6850 provide an even greater level of sustainability in the manufacture of packaging materials. As polymer processing aids (PPA), they improve the mechanical and optical properties of the finished packaging material as well as the performance of the production process. Additives based on organo modified siloxanes provide an environmentally friendly alternative to the previously used fluorine-based additives.

HARD FACT

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Food packaging can make food last 2-3 times longer and be more durable than without packaging.
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15%
.....
Packaging is preventing food waste – 15% of the CO₂ emissions of the world are caused by food waste.

LIQUID SILICONE RUBBER / HIGH CONSISTENCY RUBBER



COOL FILLER FOR HOT MATERIALS

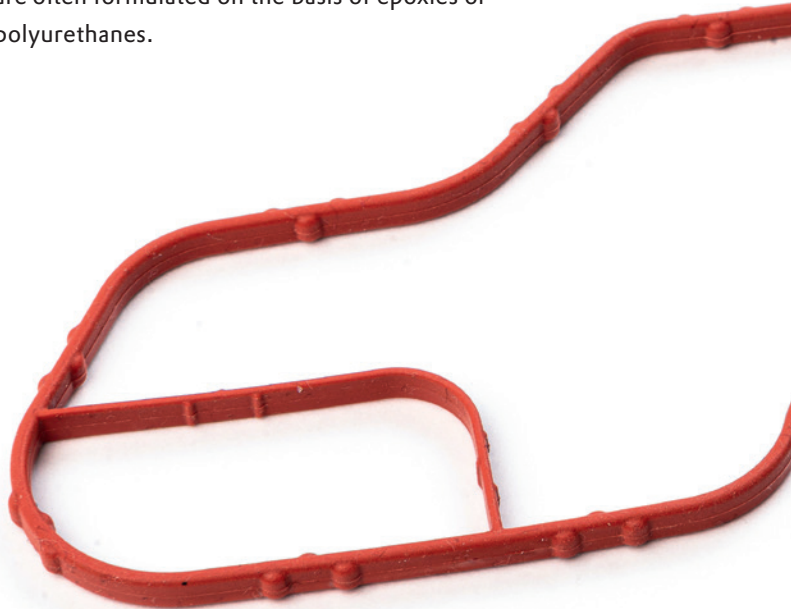
At first glance, the rubber coating for an industrial roller used in the manufacture of laminates, the seals in an automotive vehicle engine compartment, and the accordion-shaped rubber gaiter of an articulated bus or rail car do not seem to have too much in common. But, in each of these cases, there is an Evonik product providing the necessary properties to the rubber materials enabling them to fulfill their task.

The components consist of especially high-performance rubber materials, liquid silicone rubbers (LSR) or high consistency rubbers (HCR). Under the brand name TEGOSIL®, Evonik supplies homogeneous pastes, non-toxic and highly filled with fillers that significantly improve the thermal conductivity or flame retardancy of products. In the covers for laminate rollers, the functional fillers ensure that as much heat as possible is transferred from the roller to the laminate and is not lost during the production process.

Vehicle gaiters made of silicone rubber using TEGOSIL® meet very stringent fire safety protection standards: If the material is ignited during an accident, it will burn without the formation of any smoke. So, in the case of an emergency, more time is available for people to exit the danger area. TEGOSIL® has also become an indispensable component of e-mobility: For example, it improves

the heat resistance of the seals in batteries. With the addition of the Evonik product, the heat resistance of silicone rubber rises from approximately 200°C to an impressive 300°C. This allows extremely compact construction methods which enable the space close to the hot engine to be put to optimal use.

In power electronics too, silicones found in cars or in telephones and tablets must be heat resistant up to 150°C and able to withstand frequent temperature changes. Additionally, TEGOSIL® products are also increasing durability. Our NANOPOX® and Polymer VS additives are used in electronics, for example, when casting compounds are required to effectively conduct heat away from the processor, and these compounds are often formulated on the basis of epoxies or polyurethanes.



AUTOMOTIVE APPLICATIONS

ENABLING THE MOBILITY OF THE FUTURE NOW

Alternative mobility concepts are gaining in popularity. However, with the new automotive drive systems, the requirements on the materials used are also increasing. Innovative additives from Evonik are providing new opportunities in lightweight construction by improving thermal conductivity and flame protection, while also helping to give a high-quality appearance to final components.

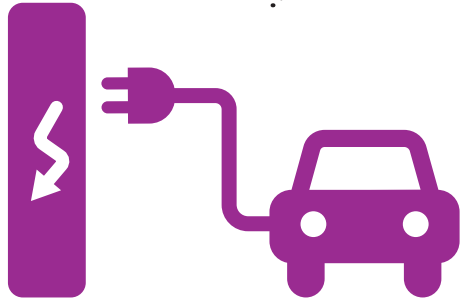
As a result of the high currents in electric drive systems, high temperatures are created. Therefore especially in electric cars, lightweight

components that are also high-temperature-resistant and flame-retardant are indispensable. These are frequently formed from highly filled plastic compounds. Additives such as TEGOMER® H-Si 6441 H or TEGOMER® E 525 help to improve the flowability of these compounds to enable low wall thicknesses to be achieved. They ensure that flame retardants exert their protective effect even in low concentrations, or that up to 20% more particles can be incorporated for improved thermal conductivity. This makes the molding compounds easier to work with and improves the surface quality of the finished components.

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HARD FACT

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A super charger requires 1/4 charging time compared to the standard charging of EV cars (e.g. 1h instead of 4h) and heat conductivity is a key requirement.
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No matter how your passengers behave – our TEGOMER® AntiScratch additives will always leave the car looking like new.

Integrated lightweight construction also ensures greater driving dynamics and efficiency in conventional-drive vehicles. Metal-plastic composites enable weight savings of up to 40%. Previously in order to achieve optimal mutual adhesion, the two materials were often glued to each other. Now, products such as our TEGO® XP 21010 have made this additional step unnecessary. With their functional groups they ensure that, at the boundary layer of both materials, the polymer-based fiber composite adheres optimally to the metal. Since the otherwise

obligatory adhesive step is no longer required, the composite materials are inline, capable and can be used immediately.

In automotive interiors many manufacturers rely on modern materials such as plastics. TEGOMER® AntiScratch 100 and TEGOMER® H-Si 6441 H make these surfaces scratch-resistant helping the components to look new for much longer. The high molecular weight additive does not migrate out which provides many years of protection without the need for a coating.

RECYCLING / ODOR ADSORPTION



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FRESHENING THE AIR

When it comes to sustainability, there is no alternative to the recycling of plastics. Food packaging that is collected from households can emit odors even after the cleaning process and this rules out any further usage. The problem can even affect non-mixed plastics, such as those originating from wastage during industrial production: Since the material is heated during the recycling process, undesirable characteristic odors from adhesives or polymer degradation can arise. With the TEGO Sorb® additives, Evonik has developed a plant-based material that counteracts the development of odors even in low concentrations. The material works in accordance with the lock and key principle. Odors are not merely masked, instead TEGO Sorb® irreversibly binds the odor-causing mole-

cules to each other. This works best for nitrogen or sulfur-based odors.

In many formulations, the addition of just a minimal percentage by volume of TEGO Sorb® to the total mass is usually enough to achieve permanent improvement. This enables recycling manufacturers to use a higher percentage of recycled materials making their products even more sustainable.

In addition to odor blockers, Evonik supplies many other useful additives, such as anti-foaming agents or wetting agents. These products help to ensure optimal cleaning and separation of the plastic flakes in the recycling process, and enable to remove the paper labels that have been attached to plastics with adhesives more easily.

HARD FACT

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The European Plastics Strategy has a target of ensuring 10 m. tons of recycled plastics are used in new products by 2025. That means the recycling capacity has to be tripled in the next years.

PARTICLE TREATMENT

HARD FACT

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Fillers give reinforcement, flame resistance, electrical and heat conductivity as well as barrier properties to plastic materials.
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MADE TO MEASURE

Pigments, fillers and flame retardants are all important components for many plastics formulations, giving the product the desired appearance or the desired technical features. The problem: The particles are usually too hydrophilic, making it difficult to mix them with the polymer matrix.

Many manufacturers of these raw materials rely on additives from

Evonik, which make targeted changes to the surface properties of the particles so that they are much easier to process. Organically modified siloxanes such as TEGOPREN® 6875 or TEGOPREN® 6879 are used by the manufacturers of pigments, fillers, and flame retardants to make the surface of their particles more hydrophobic. A further advantage: In contrast to others, the special additives we provide also improve the dispersion properties of the products. This means that

compounders can work the particles into the polymer matrix more easily. The special additives from Evonik perform their positive effect via two mechanisms: Firstly, the plastics formulations can be manufactured especially efficiently – because the same effect can be achieved with a lower volume of surface-treated particles – or, secondly the products with superior material properties can be manufactured because the same volume of particles has a more powerful effect.



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*Our Plastics
Technology Center*
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Technical Service

HELPING YOUR
PRODUCTS TO
PERFORM BETTER

Evonik's global Plastics Technical Pilot Plant & Technology Service Center in Essen, Germany supports customers from the masterbatch, compounding and converter industry in the development of new recipes for thermoplastic, thermoset and elastomer applications.

Extrusion compounding, thermoplastic and silicone rubber molding, blown and cast film lines are just some examples of what is available to test the powerful additive performance according to industry standards.

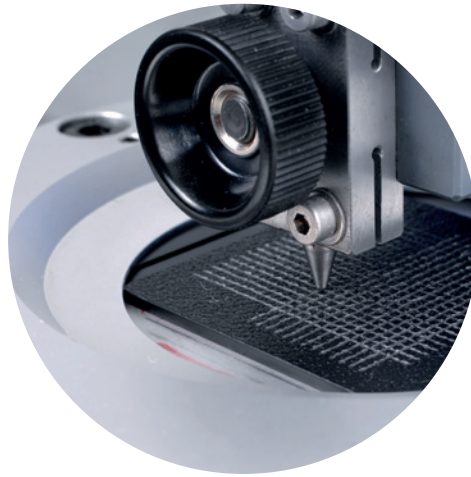
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*Cone
Calorimeter*



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Erichsen Scratch pattern

Please do not hesitate to contact us to discuss your special requests. We will be pleased to support you with your formulation challenges. Our extensive additives and applications knowledge complements the excellent capabilities of our Plastics Technology Center in Essen, Germany that has been specifically designed to help run trials with you.

PROPERTIES WE EVALUATE	TEST METHOD/EQUIPMENT AVAILABLE TO SUPPORT YOU
Scratch and mar resistance	Erichsen Scratch Tester, Five Finger Scratch Tester, Corckmaster
Melt flow properties and viscosity	Melt Flow Path, Melt Flow Index, Anton Paar Viscosimeter up to 400°C, Brabender Lab Kneader
Flame resistance (UL 94, cone)	UL 94 flame chamber, lowest oxigene index, cone calorimeter
Impact and notched impact test	Izod and charpy method at room temperature
Tensile/flexural/tier strength, elongation	Zwick universal testing machine
Hardness	Shore Hardness Tester
Shark skin	Blown and Cast Film Line from Brabender
COF modification	Erichsen Coat Master
Color and gloss evaluation	X-rite Model SP62, BYK micro-TRI-gloss
Electrical properties	PTL M 31 - CTI measuring device according IEC 60112
Heat conductivity	C3 Hotdisk TPS2200
Filter pressure value	Filter Pressure Equipment for Brabender Lab Station
Surface tension	Krüß Bubble Pressure Tensiometer
Antistatic	Fetronic HM 307 (high impedance measurement equipment) with annular electrode
Antifog	Hot and Cold Fog Test

Europe | Middle East | Africa

Evonik Operations GmbH
Goldschmidtstraße 100
45127 Essen
Germany
Phone +49 201 173-2665
Fax +49 201 173-1990
www.evonik.com

Asia | Pacific

Evonik Specialty Chemicals Co., Ltd.
55, Chundong Road
Xinzhuan Industry Park
Shanghai, 201108
PR China
Phone +86 21 6119-1125
Fax +86 21 6119-1406

The Americas

Evonik Corporation
P.O. Box 34628
Richmond, VA 23234
USA
Phone +1 804 727-0700
Fax +1 804 727-0855

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