PLASTICS I PERFORMANCE ADDITIVE

UPGRADE YOUR PERFORMANCE WITH GENIOPLAST® PELLET S
Plastics manufacturers and compounders are facing new challenges concerning the quality, productivity and profitability of thermoplastics. As a committed partner to the plastics industry, WACKER is constantly exploring new and innovative approaches. A perfect example is our line of GENIOPLAST® silicone-based plastic additives.
GENIOPLAST® offers a novel solution for continuous compounding and masterbatch production. These innovative performance additives not only improve the processing, surface quality, and mechanical properties of plastic compounds – they also optimize your production process.

Better Properties with No Side Effects: GENIOPLAST® Pellet S reduces melt viscosity and improves the flow characteristics of the thermoplastic compounds. By lowering extruder torque and die pressure, it saves energy or produces significantly more compound for the same amount of energy. GENIOPLAST® Pellet S reduces undesirable die drool and other extruder deposits particularly in compounds containing mineral fillers. This reduces downtime and cleaning time while boosting productivity. Moreover, this special material does not negatively affect the mechanical properties of the compounds and often enhances them. Parts molded with compounds containing GENIOPLAST® Pellet S demonstrate better surface quality. The coefficient of friction is reduced and the surface becomes smoother, thereby improving antifriction properties as well as scratch and abrasion resistance.

Two Grades for All Your Needs
GENIOPLAST® Pellet S provides solutions for general molding uses. In addition, WACKER makes available GENIOPLAST® Pellet P Plus for food-contact applications.

<table>
<thead>
<tr>
<th>Product</th>
<th>Typical Uses</th>
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</thead>
<tbody>
<tr>
<td>GENIOPLAST® Pellet S</td>
<td>Wire and cable, automotive interiors, business machines housing and drive parts, color concentrates and mineral-filled compounds, footwear</td>
</tr>
<tr>
<td>GENIOPLAST® Pellet P Plus</td>
<td>Rigid and flexible packaging, caps and closures, disposables, food processing equipment</td>
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<tr>
<td>(Food compliant)</td>
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**GENIOPLAST® Pellets**

This unique combination of high-viscosity silicone gum and a specially modified silica provides optimum efficiency together with universal compatibility in thermoplastics. GENIOPLAST® Pellet S provides the unique processing benefit and improves the surface quality. In contrast to many other additives GENIOPLAST® Pellet S does not negatively affect the physical properties such as tensile and impact strength. In mineral-filled compounds GENIOPLAST® Pellet S actually enhances impact strength and provides a synergistic effect with the flame-retardant additives.

**GENIOPLAST® Enhances Productivity**

<table>
<thead>
<tr>
<th>Addition of 0.1 – 1%</th>
<th>Addition of 1.0 – 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improves the processing and flow for the compounder and the downstream processor</td>
<td>Improves the surface properties of parts</td>
</tr>
<tr>
<td>Reduces extruder torque and die pressure</td>
<td>Improves smoothness and gloss</td>
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<tr>
<td>Significantly increases throughput</td>
<td>Reduces coefficient of friction</td>
</tr>
<tr>
<td>Reduces deposits</td>
<td>Increases scratch and abrasion resistance</td>
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<tr>
<td></td>
<td>Improves physical properties of compounded parts</td>
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Technical polyolefin compounds are extremely versatile and are increasingly used in areas such as cables, automotive applications, appliances, consumer electronics and packaging. GENIOPLAST® makes a contribution in all of these applications.

**GENIOPLAST® in Cable Compounds**

Today, new and better cable compounds for data transmission, telecommunication and low-voltage cables are being developed on the basis of polyethylene (PE) or ethylene copolymers. These compounds are rendered flame retardant by means of halogen-free flame-retardant fillers, such as aluminum hydroxide (ATH). In halogen-free flame-retardant cable compounds (HFFR), GENIOPLAST® Pellet S significantly improves processing, flow, surface, and mechanical properties as shown in the following charts. Furthermore, deposits on the die and in the extruder itself are reduced and flame-retardant properties are synergistically improved.

**PE-EVA/ATH**

| Additive: | GENIOPLAST® Pellet S |
| Dosage: | 1 – 3% |
| Application: | FR Cable Compounds |
| Benefit: | Higher throughput  
No die drool  
Reduced melt viscosity  
Better flow  
Improved flame retardancy |

**GENIOPLAST® in Automotive Compounds**

Ease in processing of polypropylene (PP) compounds for use in automotive interiors is essential. Consistent and efficient polymer flow in filling the mold cavity and demolding the part are a prerequisite. Furthermore, the surfaces must exhibit good abrasion resistance which is demonstrated in the following charts. GENIOPLAST® Pellet S also significantly improves the processing, flow, surface and mechanical properties in mineral-filled PP compounds.

**A Wealth of Potential Applications**

The use of GENIOPLAST® in polyolefin compounds is not limited to cables, appliances and automotive interiors. The combination of benefits that GENIOPLAST® imparts to polyolefin compounds as a performance additive also improves compounds for other technical applications, such as for pipe, extruded film and sheet as well as wood and bio-plastic compounds. Likewise FDA-compliant GENIOPLAST® Pellet P Plus enhances compounds for flexible and rigid food packaging and caps and closures.
ENGINEERING COMPOUNDS

GENIOPLAST® in Polycarbonate Blends
Polycarbonate blends (PC/ABS) are primarily used in the electrical and electronics sectors to manufacture housing parts for PCs, laptops, printers, copiers, as well as video and audio equipment. Important factors are good processing properties, good demolding and scratch-resistant surfaces.

GENIOPLAST® in Polyacetal
Polyacetal (polyoxymethylene, POM) is an engineering polymer primarily used in vehicle construction and in the manufacture of moving parts in electrical/electronics. POM is known for its good anti-friction and wear characteristics, as well as chemical resistance. It is therefore often used as an alternative to metals.

GENIOPLAST® Pellet S is successfully used in PC/ABS, POM and polyamide (PA) compounds for automotive and electrical / electronic applications, as well as in ABS compounds for appliances. As a high-performance additive for engineering polymers, it can also improve the properties of your compound. The following charts illustrate how GENIOPLAST® Pellet S significantly improves processing and surface properties in various materials.
ABS/Talc (40%)

Nylon 6/6

Nylon 6/6 Glass Filled (35%)

ABS

PC/ABS

POM Mineral Filled (30%)

PPE/HIPS

- Improvement in Taber Abrasion [%]
- Decrease in CoF [%]
- Increase of Spiral Flow [%]
- Decrease in Torque [%]
- Increase of Melt Flow Index [%]

- Base Polymer
- +1.0% GENIOPLAST® Pellet S
- +3.0% GENIOPLAST® Pellet S

- Tensile Strength [%]
- Elongation at Break [%]
- Impact Strength [%]
- Shore D Hardness [%]
- Vicat A Softening Temp [%]

- Throughput Increase [%]
- Decrease in Torque [%]
- Increase of Melt Flow Index [%]
THERMOPLASTIC ELASTOMERS

Thermoplastic elastomers consist of styrene block copolymers, polyolefins blends, elastomeric alloys, thermoplastic polyurethanes, copolyester and polyamides. Due to the unique combination of “thermoplastic” and “elastomeric” properties, these materials are often used in applications such as automotive parts, shoe soles and medical disposables.

GENIOPLAST® in 2-Component Molding
This is a technique in which two different plastic materials are joined in the molten state in order to maximize the adhesion between them. This adhesion is critical to the functionality and integrity of the part.

Many process additives interfere with the connection of the melt fronts of the materials due to their immiscibility in one or both materials. Thanks to its universal compatibility GENIOPLAST® Pellet S has been shown to have little or no negative effect in this regard.

<table>
<thead>
<tr>
<th>TPE-S (SBS, SEBS)</th>
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<tbody>
<tr>
<td>Additive:</td>
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<tr>
<td>Dosage:</td>
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<tr>
<td>Application:</td>
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<tr>
<td>Benefit:</td>
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2-Component Injection Molding – Cohesion Properties PA 66/TPU

**Test Specimen**

- PA 6.6
- TPU (Modified and Unmodified)

**TPE/SBS**

- Improvement in Taber Abrasion [%]
- Decrease in CoF [%]
- Decrease in Die Pressure [%]
- Decrease in Torque [%]
- Increase of Melt Flow Index [%]
- Tensile Strength [%]
- Elongation at Break [%]

- SBS +1.0% GENIOPLAST® Pellet S

**TPE/HSBC**

- Improvement in Taber Abrasion [%]
- Decrease in CoF [%]
- Decrease in Die Pressure [%]
- Decrease in Torque [%]
- Increase of Melt Flow Index [%]
- Tensile Strength [%]
- Elongation at Break [%]

- HSBC +1.0% GENIOPLAST® Pellet S

**TPO/Talc (20%)**

- Improvement in Taber Abrasion [%]
- Decrease in CoF [%]
- Decrease in Die Pressure [%]
- Increase of Melt Flow Index [%]
- Tensile Strength [%]
- Elongation at Break [%]
- Impact Strength [%]
- Shore D Hardness [%]

- TPO/Talc (20%) +1.0% GENIOPLAST® Pellet S

**TPU**

- Improvement in Taber Abrasion [%]
- Decrease in CoF [%]
- Decrease in Die Pressure [%]
- Decrease in Torque [%]
- Increase of Melt Flow Index [%]
- Tensile Strength [%]
- Elongation at Break [%]
- Shore D Hardness [%]

- TPU +1.0% GENIOPLAST® Pellet S

**TPU/FHF**

- Improvement in Taber Abrasion [%]
- Decrease in CoF [%]
- Decrease in Die Pressure [%]
- Increase of Melt Flow Index [%]
- Tensile Strength [%]
- Elongation at Break [%]
- Shore D Hardness [%]

- TPU/FHF +1.0% GENIOPLAST® Pellet S
CASE STUDY: SCRATCH AND MAR

Some of the measures of a flawless surface are no visible defects or scratches and consistent color and gloss. Automotive designers continually devise techniques to overcome these challenges such as using contrasting colors on adjoining parts, and using textured surfaces to provide a consistent gloss and mask imperfections resulting in a blemish free surface.

GENIOPLAST® Pellet S is used in many applications to improve the surface properties. This section examines the use of GENIOPLAST® Pellets in a typical automotive compound consisting of 20% talc-filled polypropylene. Adding 3% GENIOPLAST® Pellet S significantly improves the scratch and mar in automotive trim. In order to quantify the measurement of scratch and mar we use ΔL values. ΔL is the change in the lightness of the color which is affected by the reflection of light from the scratch pattern. After subjecting the sample to an Erichsen Scratch Test, the control has a ΔL value of 5.3 while adding 3% GENIOPLAST® Pellet S reduces the ΔL to 1.5.

Upon further examination of the scratch it is apparent that, due to the lower coefficient of friction, the depth of the scratch is not as severe and the surface of the damaged area is much smoother compared to the control samples. These two properties result in less scattering of the reflected light and which provides lower ΔL value and gives the appearance of a less severely damaged surface.
There are many options commercially available to compounders to reduce scratch visibility. WACKER compared several of these materials against the effectiveness and permanency of GENIOPLAST® Pellet S.

The upper chart illustrates the initial effectiveness of GENIOPLAST® Pellet S compared to other available materials. While all materials improve the ΔL value (lower number is better), silicone is one of the most effective.

Parts molded with GENIOPLAST® Pellets will provide the same surface benefit over a prolonged period of time.

The second chart shows GENIOPLAST® Pellet S permanence after 7 days heat aging. Pellet S is non-migratory and provides the same level of benefit as in the 2-day room temperature chart while the organo-modified silicone and organic amide have migrated and their effectiveness is diminished.

For long term use and benefit the choice is clear – GENIOPLAST® Pellet S.

GENIOPLAST® Pellet S provides long term benefit.

Fogging is another challenge designers must overcome when developing new parts. Due to the high molecular weight, GENIOPLAST® Pellet S outperforms other commonly used materials and provides superior performance.
Flame Retardancy in HFFR Cable Compounds

Material: PE/EVA-ATH HFFR systems
Additive: GENIOPLAST® Pellet S
Dosage: 1 – 3%
Application: Processing, flow, FR
Benefit: • Higher throughput, no die drool
• Better surface properties
• Better flame retardancy
• Higher LOI, reduced dripping

The trend toward Halogen Free Flame Retardants (HFFR) has placed new processing demands on the wire and cable manufacturers. The new compounds are heavily loaded and can create issues with die drool, poor surface quality, and pigment/filler dispersion. Incorporating GENIOPLAST® Pellet S significantly improves the material flow, extrusion process, and creates a synergistic effect with the flame-retardant fillers.

Adding 0.1 – 1% of GENIOPLAST® Pellet S
• Improved processing flow
• Less extruder torque
• Lower die pressure
• Reduced die drool and melt fracture
• Faster throughput
• Better melt flow

Adding 1 – 5% of GENIOPLAST® Pellet S
• Improved surface lubricity and slip
• Lower coefficient of friction
• Better abrasion resistance
• Better surface touch and feel
• Better mechanical properties
• Better synergy with flame retardants

<table>
<thead>
<tr>
<th>Flame Retardancy in HFFR Cable Compounds</th>
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</thead>
<tbody>
<tr>
<td>Material: PE/EVA-ATH HFFR systems</td>
</tr>
<tr>
<td>Additive: GENIOPLAST® Pellet S</td>
</tr>
<tr>
<td>Dosage: 1 – 3%</td>
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<td>• Better flame retardancy</td>
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<tr>
<td>• Higher LOI, reduced dripping</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Without Additive</th>
<th>+0.5% GENIOPLAST® Pellet S</th>
<th>+1.0% GENIOPLAST® Pellet S</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDPE/ATH (60%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOI [% O2]</td>
<td>26</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>UL 94</td>
<td>V-1</td>
<td>V-0</td>
<td>V-0</td>
</tr>
<tr>
<td>PP/MDH (60%)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>LOI [% O2]</td>
<td>26</td>
<td>30</td>
<td>32</td>
</tr>
<tr>
<td>UL 94</td>
<td>V-0</td>
<td>V-0</td>
<td>V-0</td>
</tr>
</tbody>
</table>

CASE STUDY: WIRE AND CABLE
In polyolefin based HFFR compounds containing flame retardant filler, such as aluminium hydroxide (ATH) or magnesium hydroxide (MDH), GENIOPLAST® Pellet S acts as char former and can reduce heat release and smoke generation. This benefit is demonstrated in the cone calorimetry graph and data.

<table>
<thead>
<tr>
<th></th>
<th>Reference</th>
<th>+2% GENIOPLAST® Pellet S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of Ignition [s]</td>
<td>68</td>
<td>61</td>
</tr>
<tr>
<td>Peak Heat Release Rate [kW/m²]</td>
<td>203</td>
<td>151</td>
</tr>
<tr>
<td>Total Heat Released [MJ/m²]</td>
<td>110</td>
<td>102</td>
</tr>
<tr>
<td>Total Smoke Released [m²/m²]</td>
<td>866</td>
<td>313</td>
</tr>
<tr>
<td>Burning Time [s]</td>
<td>1217</td>
<td>1820</td>
</tr>
</tbody>
</table>

**Cone Calorimetry**

- **EVA-LLDPE/ATH (60%)**
- **+2% GENIOPLAST® Pellet S**

**Combustion Residue: Reference**

**Combustion Residue: +2% GENIOPLAST® Pellet S**
EXPERTISE AND SERVICE NETWORK ON FIVE CONTINENTS

WACKER is one of the world’s leading and most research-intensive chemical companies, with total sales of €5.3 billion. Products range from silicones, binders and polymer additives for diverse industrial sectors to bioengineered pharmaceutical actives and hyperpure silicon for semiconductor and solar applications. As a technology leader focusing on sustainability, WACKER promotes products and ideas that offer a high value-added potential to ensure that current and future generations enjoy a better quality of life based on energy efficiency and protection of the climate and environment. Spanning the globe with 5 business divisions, we offer our customers highly-specialized products and comprehensive service via 25 production sites, 22 technical competence centers, 12 WACKER ACADEMY training centers and 50 sales offices in Europe, North and South America, and Asia – including a presence in China. With a workforce of some 17,000, we see ourselves as a reliable innovation partner that develops trailblazing solutions for,
and in collaboration with, our customers. We also help them boost their own success. Our technical centers employ local specialists who assist customers worldwide in the development of products tailored to regional demands, supporting them during every stage of their complex production processes, if required.

WACKER e-solutions are online services provided via our customer portal and as integrated process solutions. Our customers and business partners thus benefit from comprehensive information and reliable service to enable projects and orders to be handled fast, reliably and highly efficiently.

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All figures are based on fiscal 2015.
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