MAGNIFIN® Magnesium Hydroxides
Halogen-Free Flame Retardants for Polyamide
**MAGNIFIN® Use in Polyamide**

Polyamides are used predominantly in the electrical sector, where their ease of processing, favorable physical and electrical properties, high heat stability, and good chemical resistance - as well as their high surface quality - are key benefits. In the electrical sector polyamide is normally glass fiber-reinforced and flame retarded.

**Applications**
- Medium-voltage components
- Insulation components
- Switch components
- Switch casings
- Electromagnetic switches
- Terminal blocks
- Plug connectors
- Multiple plug sockets

MAGNIFIN flame retardant - a fine particle-sized, high purity magnesium hydroxide - is a genuine alternative to the conventional flame-retarding additives used in reinforced polyamides.

**MAGNIFIN® Flame-Retarding Effect**

MAGNIFIN’s flame-retarding effect is based on the endothermic decomposition of magnesium hydroxide into magnesium oxide and water vapor, which are both completely non-toxic, non-corrosive decomposition products. As MAGNIFIN flame retardant decomposes, considerable amounts of heat are consumed and withdrawn from combustion.

For MAGNIFIN flame retardant the reaction has a total heat consumption of 1316 J/g Mg(OH)₂.

\[
\text{Mg(OH)}_2 \rightarrow \text{MgO + H}_2\text{O}
\]

The heat consumption protects the plastic material against rapid thermal decomposition and prevents the formation of flammable by-products. The water vapor formed during decomposition displaces the oxygen and functions as protective gas. A heat-resistant covering layer consisting of carbonized products and active magnesium oxide is formed on the surface of the plastic material, inhibiting further combustion. By absorbing soot particles, MAGNIFIN flame retardant also reduces smoke density.

**MAGNIFIN® Characteristics of MAGNIFIN Flame-Retarded Polyamide**

Flame retardants (FR) for polyamide include halogen containing, phosphorus-based, or melamine compounds as well as magnesium hydroxide such as MAGNIFIN. MAGNIFIN flame retardant allows processors to produce flame retarded polyamide without halogen or phosphorous-containing compounds. Today’s existing products contain approximately 10 to 20% glass fiber, with about 30 to 55% of MAGNIFIN flame retardant. With optimized magnesium hydroxides such as MAGNIFIN H-5 IV or H-10 IV flame retardants, processors can even produce light-colored, glass fiber reinforced polyamide compounds. Because MAGNIFIN flame retardants are white powders, they do not affect the color of the finished product, a true advantage for electrical and electronic applications. The tailor-made surface modifications used in MAGNIFIN H-5 IV or H-10 IV flame retardants lead to higher compatibility with the polymer, which results in improved compound and product performance. In addition, MAGNIFIN-based PA compounds are easy to process. The special surface modification of the magnesium hydroxide by amino silane groups in MAGNIFIN H-5 IV flame retardant allows good flow characteristics despite high additive loading levels. Compared to uncoated MAGNIFIN H-5 flame retardant, H-5 IV shows improved mechanical properties such as an improved E-modulus, increased tensile strength, elongation at break, and impact strength. PA compounds flame retarded with MAGNIFIN comply with obligations for coding and the marking of parts as they can be marked by tampon and laser printing.

Table 1 gives an overview of the characteristics of polyamide compounds flame retarded with MAGNIFIN. The testing was done dry as molded. The formulations shown in Table 1 are not optimized, however, they can be used as starting formulations for further optimization. The reinforcing effect of MAGNIFIN allows significant reduction of the glass fiber level while maintaining comparable modulus values. As an example, for a typical UL94 V0 (1.6 mm) formulation one needs only 10% glass fiber compared to the typical 30% glass fiber used with other flame retardants. PA 6-compounds flame retarded with MAGNIFIN H-5 IV pass the glow-wire test, in accordance with IEC 60695-2-12 at 960°C and achieve a glow-wire ignition temperature (GWIT) of 775°C according to IEC 60695-2-13. MAGNIFIN is the only flame retardant which allows users to achieve a UL94 V0 compound having the highest CTI (comparative tracking index) value of 600 V in a glass fiber-reinforced formulation which can be made in all colors. In addition, in contrast to traditional flame retardants for polyamide, MAGNIFIN ensures extremely low levels of smoke density.
Table 1: MAGNIFIN in Polyamide PA6

<table>
<thead>
<tr>
<th>Glass fibers loading level (%)</th>
<th>PA6 (unfilled)</th>
<th>PA6 + MAGNIFIN H-5 IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAGNIFIN loading level (%)</td>
<td>0  25</td>
<td>30  30</td>
</tr>
<tr>
<td>Glass fibers loading level (%)</td>
<td>10 10</td>
<td>10  20</td>
</tr>
<tr>
<td>UL94 (1.6 mm sample thickness)</td>
<td>UL94 Fail V2 V2 V2 V2 V0</td>
<td></td>
</tr>
<tr>
<td>Glow Wire Flammability Index @960°C (1.6 mm)</td>
<td>IEC 60695-2-12 Fail Fail Pass Pass Pass Pass</td>
<td></td>
</tr>
<tr>
<td>Comparative Tracking Index IEC 112</td>
<td>V 525 600 600 600 600 600</td>
<td></td>
</tr>
<tr>
<td>Tensile Modulus IEC 527</td>
<td>MPa 4500 6800 7200 10000 8490 12300</td>
<td></td>
</tr>
<tr>
<td>Tensile Strength ISO 527</td>
<td>MPa 103 115 118 150 114 121</td>
<td></td>
</tr>
<tr>
<td>Elongation at Break ISO 527</td>
<td>% 3.4 3.2 2.9 2.7 2.2 1.7</td>
<td></td>
</tr>
<tr>
<td>Heat Distortion Temperature (HDT) ISO 180</td>
<td>kJ/m² 30 48 44 50 37 28</td>
<td></td>
</tr>
</tbody>
</table>

**MAGNIFIN®**
Production of MAGNIFIN PA Compounds

The granules can be processed on a Buss Ko-kneader or a twin-screw extruder. A suitable temperature control system and an adequate use-specific screw configuration are crucial for producing the correct blend in both types of machine. Assistance is available upon request.

**Recommendations for the Buss kneader:**
- Two, or possibly three, feeding ports with gravity controlled dosing and split feed, i.e. addition of polymer via the first port together with approx. 60% of the MAGNIFIN; the remaining MAGNIFIN flame retardant being added via the second port. Any glass fiber is added at the third port.
- L/D ratio min. 11
- Presence of an outlet for venting or, even better, vacuum degassing
- Precise temperature control

**Recommendations for the twin-screw extruder:**
- Co-rotating screws
- L/D ratio min. 32
- Two, or possibly three, dosing ports with gravity-controlled dosing. All polymer is added via first port. The second port is preferably a forced side-feeder, used for adding the entire MAGNIFIN quantity. Any glass fiber should be mixed in at the third port.
- Precise temperature control
- Presence of an outlet for venting or, even better, vacuum degassing

Processing can be carried out on all commercially available injection molding machines, at temperatures of between 270°C and 320°C. Due to the relatively high filler content of the polyamide compounds, we recommend the selection of high injection pressure and high injecting speeds. The mold temperature should stay between 70°C and 90°C. The injection-molded articles demonstrate outstanding surface quality.

Halogen-Free Flame Retardants for Polyamide
J.M. Huber Corporation, headquartered in Edison, New Jersey (U.S.), operates a portfolio of companies with a focus on its core engineered materials businesses. Founded in 1883, today Huber is one of the largest family-owned companies in the U.S. The diversified, multinational company creates products that are used in a broad range of consumer and industrial applications, including oral care, personal care, food, beverage, pharmaceuticals, plastics and building materials.

Individually, Huber’s businesses play a leading role in the industries they serve. Together, they form a global company with revenue of about $2 billion and approximately 4,500 employees in more than 20 countries. While our businesses serve many different customers and markets, they all share a commitment to adhere to our core values, the Huber Principles, everywhere we operate.

This document presents information on applications of MAGNIFIN® MDH flame retardants for commonly used polyamide compounds.

If your compound differs from those presented here, or you have additional product or processing questions, please contact us.