processing

The talcs are compounded using a Coperion Werner & Pfleiderer ZSK 26 Mega Compounding twin-screw co-rotating extruder (ø = 40 mm, L/D = 48). Standard screw design used for compounding fillers in PP. Both talcs are introduced in the PP melt via a side-feeder so as to obtain optimum performances. Injection moulding was performed on an Arburg press 75T using standard parameters for filled compounds and a mold temperature maintained at 40°C.

Mechanical properties:
Specimens have been tested at Imerys Talc’s application laboratory in Toulouse, France, in accordance with:
- Flexural modulus - ISO 178
- CLTE - internal method
- Shrinkage - internal method
- HDT - ISO 75 A
- Notched Charpy impact strength at 23°C (kJ/m²) - ISO 179 1e A
- Notched Charpy Impact strength at -20°C (kJ/m²) - ISO 179 1e A
- Tensile strength - ISO 527 1e A
- Impact strength at 23°C and ISO 180

Short Glass Fiber Study

- Materials used
  Commercial grades:
  - PC copolymer – ExxonMobil PP01020 – ExxonMobil (1%)
  - Hostanox SE10 (0.1%) – Clariant
  - Hostanox 03 (0.1%) – Clariant
  - Luzenac HAR®
  - Luzenac 40µm top cut talc
  - Luzenac 10µm top cut talc
  - PP homopolymer – ExxonMobil PPU0180F
  - PP copolymer – ExxonMobil PPU 0009F
  - Short glass fiber – EC 13-968 – OCV
  - PP copolymer Sabic P108MF10, PP copolymer ExxonMobil 7043 L1,
- General study
- Performance in polypropylene
- Experimental data
  - MFI (230°C/2.16kg) = 10 g/10 min.
  - PP copolymer Sabic P108MF10, PP copolymer ExxonMobil 7043 L1,
- Flexural modulus - ISO 178
- CLTE - internal method
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- Flexural modulus - ISO 178
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In the automotive industry, current trends are towards mass-producibility of polypropylene-based parts, particularly in the realms of weight reduction and zero-gap design. Because conventional jet milling technologies, also known as micronization technologies, have reached their full potential for both grinding and delaminating talc, Imerys Talc has developed a range of high aspect ratio talcs to meet the demands of the automotive industry. By virtue of its superior performance, HAR® is opening new possibilities for talc usage as a reinforcing medium in polypropylene.

**Introduction**

HAR® talc particles are exceptionally lateral and, unlike short glass fiber (SGF), their aspect ratio is not impaired during the extrusion process. As a result, the stiffness and toughness properties of HAR® talc-reinforced composites are close to those of SGF. By virtue of its superior performance, HAR® is opening new possibilities for talc usage as an alternative to SGF in applications where market specifications are less stringent about whiteness. No bonding additives are required for processing, even in polymers such as polyethylene or polypropylene.

**HAR® talc performance in 20% in PP copolymer**

<table>
<thead>
<tr>
<th>Property</th>
<th>HAR® talc</th>
<th>SGF</th>
<th>SGF</th>
<th>SGF</th>
<th>SGF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural modulus (MPa)</td>
<td>2700</td>
<td>3190</td>
<td>3300</td>
<td>3500</td>
<td>3600</td>
</tr>
<tr>
<td>CLTE (10^-6 K^-1)</td>
<td>89</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Stiffness (%)</td>
<td>1.09</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
</tr>
<tr>
<td>HDT (°C)</td>
<td>68</td>
<td>73</td>
<td>73</td>
<td>73</td>
<td>73</td>
</tr>
<tr>
<td>Charpy unnotched (kJ/m²)</td>
<td>5.9</td>
<td>6.2</td>
<td>6.2</td>
<td>6.2</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Tests show that HAR® talc is the best option for automotive parts such as zero-gap bumpers. In a formulation using 90% PP copolymer and 10% HAR® talc, HAR® talc demonstrated 15% lower CLTE levels compared to very fine talc.

**HAR® talc durability**

HAR® talc is free flowing and highly stable. The spherical shape of the HAR® powder also provides excellent flow properties, which can be quantified using an AT4 powderometer based on Freeman technology. The equipment provides powder flowability levels as well as information on how the powder is affected by processing (rotation, segregation, etc.).

**Whiteness**

Two HAR® talc grades of different whiteness are available with similar technical performance in polymers:

- White HAR®: HAR® T84: 82 < Y < 84
- Medium white HAR®: HAR® T84: 82 < Y < 84

Tests performed using Minolta CR300 Illuminant D65.

**Processing recommendations**

Certain precautions have to be taken when compounding HAR® talc as the exceptional whiteness of the talc particles makes them fragile. The use of an anti-static to introduce the HAR® talc directly into the PP melt is a best method. A very fine talc is made to the master hoppers with the PP pellets in a mill which levels the mechanical properties such as stiffness, HDT and CLTE.

The following figure illustrates the results obtained using different fillers and talc grades on a homogenous co-rotating extruder. The talc content in the PP compound formulation is 12%. A very fine talc is used as a reference.

**HAR® talc versus short glass fiber in polypropylene**

HAR® talc particles are exceptionally lateral and, unlike short glass fiber (SGF), their aspect ratio is not impaired during the extrusion process. As a result, the stiffness and toughness properties of HAR® talc-reinforced composites are close to those of SGF. By virtue of its superior performance, HAR® is opening new possibilities for talc usage as an alternative to SGF in applications where market specifications are less stringent about whiteness. No bonding additives are required for processing, even in polymers such as polyethylene or polypropylene.
Introduction

In the automotive industry, current trends are focused on polymeric composites, particularly in the realm of weight reduction and zero-gap design. Because conventional jet milling technologies, also known as micronization technologies, have reached their full potential for both grading and deagglomeration, Harza Talc has developed a range of high aspect ratio talcs to meet the demands of the automotive industry. These talcs are produced using an innovative, patented deagglomeration process. HAR talcs have a higher aspect ratio than other conventionally micronized grades, and provide improved mechanical properties when compounded in polypropylene versus conventional talcs or fillers, without impeding theductility of the molded parts. HAR talcs are supplied in micron-sphere dispersed form and have excellent flow properties for easy handling and high compounding throughput.

Performance in polypropylene

HAR talc and a reference talc were compounded using a twin-screw co-rotating extruder and then introduced in the PP melt via a side-feeder as to obtain optimum performance (see HAR® processing recommendations). All properties related to aspect ratio were improved with HAR® talc: Residual modulus increased by 20%, CLTE decreased by 20%, stiffness increased by 20%, impact strength increased by 50%, and dimensional stability.

Figure 1. Laminarity of HAR® talc versus conventional talc

Tests show that HAR® talc is the best option for automotive parts such as zero-gap bumpers. In a formulation using 50% PP copolymer, impact strength was increased by 50%, stiffness by 20%, CLTE by 50%, and impact strength by 40%.

Figure 2. HAR® talc performance at 20% in PP copolymer

HAR® talc versus short glass fiber in polypropylene

HAR® talc particles are exceptionally slender and, unlike short glass fiber (SGF), their aspect ratio is not impaired during the extrusion process. As a result, the stiffness and toughness properties of HAR® talc-reinforced composites are close to those of SGF. By virtue of its superior performance, HAR® is opening new possibilities for talc usage as an alternative to SGF in applications where market specifications are less stringent aboutwhiteness. No bonding additives are required for processing.

Figure 3. HAR® talc performance at 20% in PP copolymer

Compared to needle-like SGF, the protruding and homogenous dispersion of HAR® talc particles within the polypropylene matrix makes for a better aesthetic effect and dimensional stability.

Figure 4. Influence of processing conditions on HAR® talc performance

Product characteristics

Tapped density and flow properties

Although HAR® talc exhibits a lower initial tapped density than very fine talc grades, the tapped density remains constant during transportation, handling and conveying. Densified HAR® talc powder is highly stable and free flowing. Initial tapped density is not the only important parameter. The density measured just before feeding the extruder is also crucial, as well known that densified products can become destructured during transport, handling and conveying. The different flow stream operations can be simulated using simple equipment such as 150mm die testing devices.

Figure 5. CLTE performance of HAR® talc versus conventional talc grades (% change in CLTE)

HAR® talc durably

HAR® talc is free flowing and highly stable. The spherical shape of the HAR® powder also provides excellent flow properties, which can be quantified using an AT4 powder rheometer based on Freeman technology. The equipment provides powder flowability levels as well as information on how the powder is affected by processing (aeration, segregation etc.).

Whiteness

Two HAR® talc grades of different whiteness are available with similar technical performance in polymers:

- White HAR® talc: HAR® 902B - Y ≤ 0.82
- Medium white HAR® talc: HAR® 84 - Y ≤ 0.64

Tests performed using Minolta CR300 Illuminant D65/2.

Processing recommendations

Certain precautions have to be taken when compounding HAR® talc as the exceptional lamellarity of their particles makes them fragile. The use of a side-feeder to introduce the HAR® talc directly into the PP melt is the best method. If HAR® talc is added to the main hopper with the PP pellets it is micro milled which impairs the mechanical properties such as stiffness, HDT and CLTE.

HAR® talc is free flowing and highly stable. The spherical shape of the HAR® powder also provides excellent flow properties, which can be quantified using an AT4 powder rheometer based on Freeman technology. The equipment provides powder flowability levels as well as information on how the powder is affected by processing (aeration, segregation etc.).

For optimal performance, HAR® talc should be introduced in the PP melt via a side-feeder.

For more detailed results, see “Guidelines for the processing of High Aspect Ratio (HAR) talcs filled polypropylene compounds”.

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Image 1233x560 to 1901x1113

The feed sequence has significant impact on the final result:

- When feed downstream directly into the PP melt via the side-feeder, HAR® talc: demonstrates high stiffness performance compared to the very fine reference talc: 5% stiffness modulus increase, without impeding impact strength. Redeposition in the polymer matrix is excellent.
- When HAR® talc is fed upstream with the polypropylene pellets, the flexural modulus is lowered. The decrease is about 230 MPa, i.e., more than 10%.

The feed sequence also affects the influence of the talc: the powder also...
**Introduction**

In the automotive industry, current trends are towards more cost-effective and lightweight polymeric products, particularly in the realm of weight reduction and zero gap design. Because conventional jet milling technologies, also known as micronisation technologies, have reached their full potential for both grading and dispersing talcs, in the last 20 years, a new technology has developed a range of high aspect ratio talcs to meet the demands of the automotive industry. These talcs are produced using an innovative, patented process known as HAR® technology. **HAR®** talcs have a higher aspect ratio than other conventionally micronised grades, and provide improved mechanical properties when compounded into the polymeric matrix: this is true for both injection moulded and extruded products. The feed sequence also alters the impact strength of high aspect ratio talc filled polypropylene pellets, the flexural modulus is improved with HAR® talc. Figure 7 shows that the final results:

**HAR® talc** is free flowing and highly stable. The spherical shape of the HAR® powder also provides excellent flow properties, which can be quantified using an FT4 powder rheometer based on Freeman technology. This equipment provides powder flowability levels as well as information on how the powder is affected by processing (rotation, segregation etc.).

**Whiteness**

Two HAR® grade talcs of different whitenesses are available with similar technical performance in polymers:

- **Medium whiteness**: HAR® T84: Y < 92
- **Medium white**: HAR® T84: Y < 84

**Tests performed using Microf CFT3000 Illuminant D50**.

**Processing recommendations**

Certain precautions have to be taken when compounding HAR® talcs as the exceptional lamellarity of their particles makes them fragile. The use of an air-feeder to introduce the HAR® talc directly into the PP melt is not a best method. HARR® talc is fed upstream with the PP pellets to the extruder. The talc content in the PP copolymer formulation is around 12%. A very true talc is used as a reference.

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**Figure 1. Lamellarity of HAR® talc versus conventional talc**

**Figure 2. HAR® talc performance at 20% in PP copolymer**

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**Figure 3. 90% Talc: flexural modulus**

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**Figure 4. 90% Talc: flexural modulus**

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**Figure 5. CLTE performance of HAR® talc versus conventional talc grades**

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**Figure 6. HAR® talc performance at 20% in PP copolymer**

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**Figure 7. Influence of processing conditions on HAR® talc performance**

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**Figure 8. Influence of processing conditions on HAR® talc performance**
**Processing**

The talcs are compounded using a Coperion Werner & Pfleiderer ZSK 40 megacompounder twin-screw co-rotating extruder (N = 40 mm, L/D = 49). 300 to 1200 rpm. Standard screw design is used for compounding fillers in PP. Both talcs are introduced in the PP melt via a side-feeder so as to obtain optimum performance.

Injection moulding was performed on an Arburg press 75T using standard parameters for filled compounds and a mold temperature maintained at 40°C.

**Mechanical properties:**

Specimens have been tested at Imerys Talc’s application laboratory in Toulouse, France, in accordance with:

- Flexural modulus – ISO 178
- CLTE – internal method
- Shrinkage – internal method
- HDT – ISO 75 A
- Nonched Charpy impact strength at 23°C (kJ/m²) – ISO 179 1e A
- Notched Charpy impact strength at –20°C (kJ/m²) – ISO 179 168
- Low impact strength at 23°C – ISO 180

**Impact strength at 23°C**

Materials used

Commercial grades:

- PP copolymer – ExxonMobil PPU0180F
- PP homopolymer – ExxonMobil PPU0009F
- Short glass fiber – EC 13-968 – OCV
- Hostanox 03 (0.1%) – Clariant
- Luzenac HAR®
- Luzenac 10µm top cut talc
- Luzenac 40µm top cut talc
- Hostanox 03 (0.1%) – Clariant
- Irgafos 168

**Flexural modulus and HDT**

- PP copolymer Sabic P108MF10, MFI (230°C/2.16kg) = 10 g/10 min.
- PP copolymer Sabic P108MF10, MFI (230°C/2.16kg) = 8 g/10 min.
- PP copolymer ExxonMobil 7043 L1, MFI (230°C/2.16kg) = 10 g/10 min.

**CLTE study**

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  - Short glass fiber – EC 13-968 – OCV
  - Luzenac 40µm top cut talc
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  - Luzenac HAR®
  - Hostanox 03 (0.1%) – Clariant
  - Hostanox 03 (0.1%) – Clariant
  - Irgafos 168

- Compounding

  Twin-screw extruder: Coperion Mega Compounds ZSK 26
  Injection moulding press: Billion 142 tonnes

- **Mechanical properties**

  Conditioning before tests: ISO 291
  Specimens tested at Imerys Talc’s application laboratory in Toulouse, France, in compliance with:
  - Flexural modulus ISO 178
  - Unnotched Charpy impact ISO 179
  - CLTE internal method

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### Experimental data

**Performance in polypropylene**

- **General study**
  - PP copolymer ExxonMobil 7543 L1: MFI (230°C/2.16kg) = 8g/10 min.

- **Processing**
  - The talcs are compounded using a Coperion Werner & Pfleiderer ZSK 40 co-rotating single-screw extruder (1+40 mm, L/D = 40), with a throughput of 330 to 500 kg/h. Standard screw design is used for compounding fibres in PP. Both talcs are introduced in the PP melt via a side-feeder so as to obtain optimum performance.

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### Short Glass Fiber Study

- **Materials used**
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    - Short glass fiber – EC 13-968 – OCV

- **Compounding**
  - Twin-screw extruder: Coperion Mega Compounder ZSK 26

- **Mechanical properties**
  - Conditioning before tests: ISO 291

- **Flexural modulus ISO 178**
  - U-notched Charpy impact ISO 179

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