GRAFT POLYMER
COMBINE INCOMPATIBLE

IMPACT MODIFIERS FOR POLYAMIDE TOUGHTENING

2021

INTRODUCTION

Polyamide thermoplastic resins propose an excellent balance of processibility and performance properties and are used widely. The most popular are PA 6 and PA 6.6. Still, some end-use applications for these resins demand increased impact performance at normal or low temperatures. For these applications, improved grades of polyamide can be used.

Grafted polymers, GRAFTABOND LPO-MAH 00110 IM, GRAFTABOND EP-MAH 00110 IM , and GRAFTABOND PO-MAH 00110 IM, allow customizing properties in polyamide compounds, including fluidity in processing, impact resistance, and mechanical strength. These new grades have been produced to complete Graft Polymer's range of impact modifiers.

Two innovative MAH-grafted grades are a chain of reactive polymers that couple excellent processability, as well as the necessary reactivity with polyamides. Graft Polymer impact modifiers include reactive terpolymers and grafted polymers that are widely used to improve the impact strength as well as the melt flow of PA compounds.

Graft Polymer modifiers are used in toughened polyamide resins, ranging from general-purpose toughness to intermediate and super toughness.

CATEGORIES OF TOUGHENERS

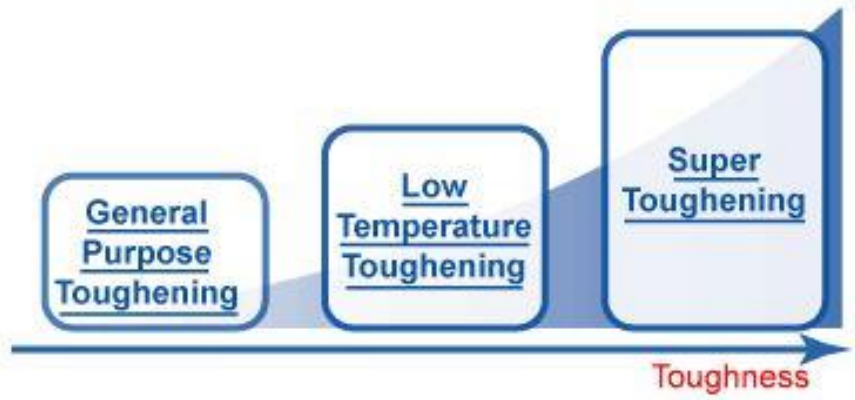
Different levels of polyamide toughness can be achieved using different types of the impact modifier.

General-purpose toughener – gives impact strength measured by notched Izod test of about 100 to 210 J/m or about 2 to 4 ft-lb/in. at the test temperature.

Intermediate toughener – gives impact strength measured by notched Izod test of about 160 to 320 J/m or about 3 to 6 ft-lb/in. at the test temperature.

Super toughener – issues in no break in the notched Izod test, with impact strength typically greater than 800 J/m or greater than 15 ft-lb/in. at the test temperature.

The impact strength measured by notched Izod testing depends on test temperature. Thus, a polyamide modifier can provide super-toughness at room temperature and achieve general-purpose toughness at -40°C(-40°F) test temperatures.



MORPHOLOGY OF GP IMPACT MODIFIERS FOR PA

GRAFTABOND LPO-MAH 00110 IM, GRAFTABOND EP-MAH 00110 IM and GRAFTABOND PO-MAH 00110 IM are “In situ” formation of Core-Shell morphology impact modifiers.

Figure 1 presents the structure of a core-shell of Graft Polymer Impact Modifiers for PA.

Figure 2 shows the formation process of the core-shell structure of GRAFTABOND LPO-MAH 00110 IM, GRAFTABOND EP-MAH 00110 IM and GRAFTABOND PO-MAH 00110 IM in polyamide matrix during melt blending.

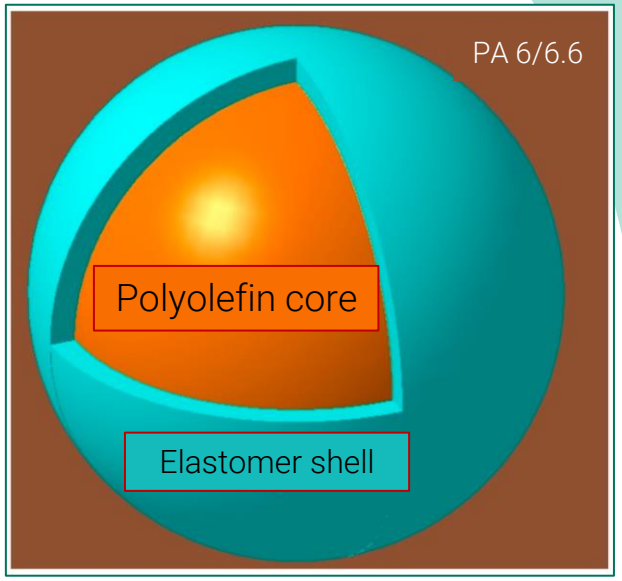


Figure 1

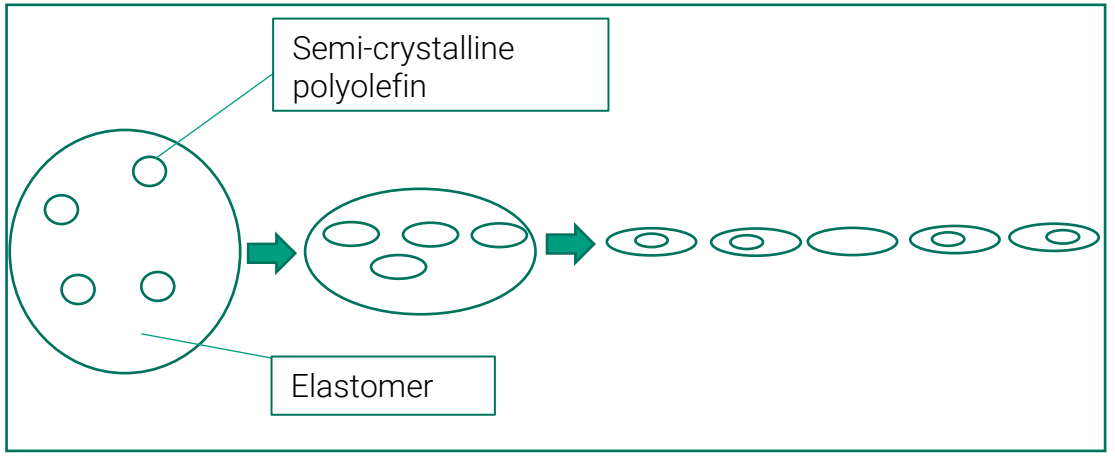
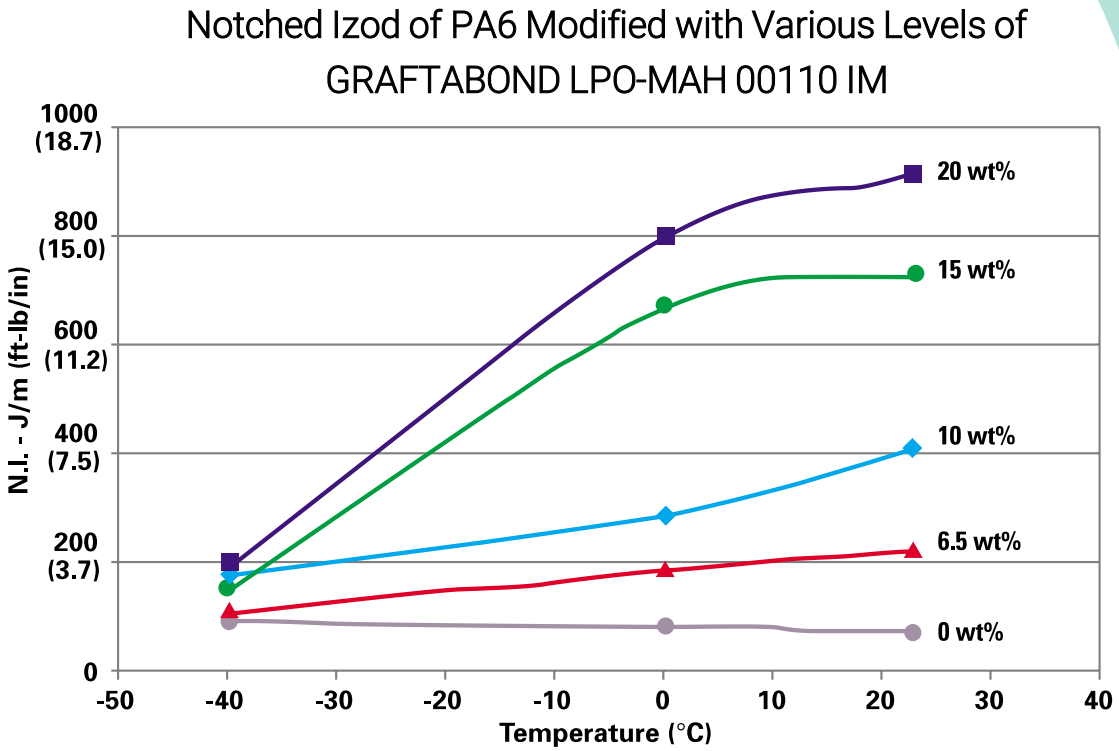


Figure 2

IMPACT MODIFICATION OF PA6

GRAFTABOND LPO-MAH 00110 IM is recommended for toughening PA6. The level of toughening depends on the amount of modifier used. A wide range of toughness, from general-purpose to super-toughness, can be obtained by changing the amount of IM (see Picture 1). Super-tough properties can be achieved at 15 wt% of GRAFTABOND LPO-MAH 00110 IM.

Advantages of using Graft Polymer modifiers include its food compliance, its low color, excellent surface finish, and short cycle time.



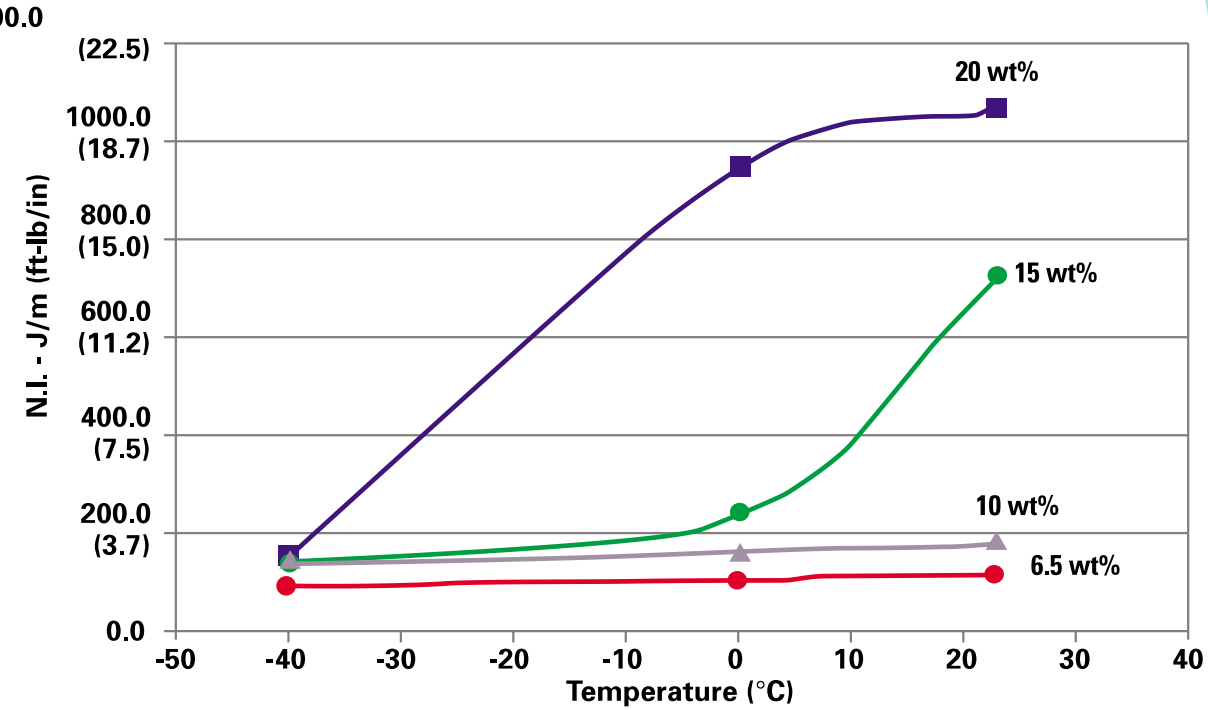
Picture 1

IMPACT MODIFICATION OF PA6.6

For PA6.6 impact modification, GRAFTABOND EP-MAH 00110 IM, GRAFTABOND LPO-MAH 00110 IM is recommended.

GRAFTABOND EP-MAH 00110 IM gives good properties for PA6.6 due to its relatively high level of high functionality. The level of toughening with various amounts of GRAFTABOND EP-MAH 00110 IM for PA6.6 is shown on Picture 2.

Notched Izod of PA 6.6 Modified with Various Levels of GRAFTABOND EP-MAH 00110 IM

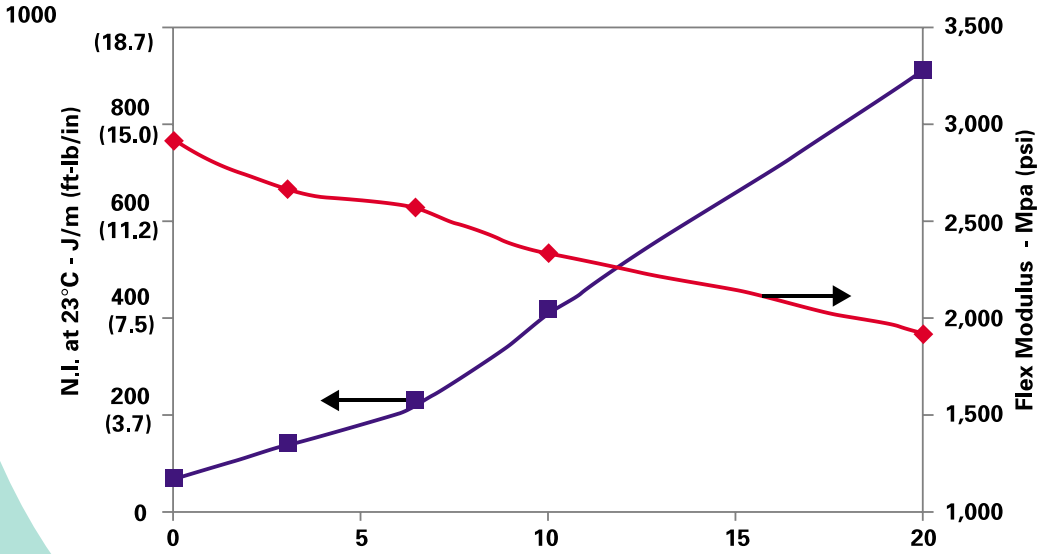


Picture 2

IMPACT MODIFIER INFLUENCE ON OTHER PROPERTIES

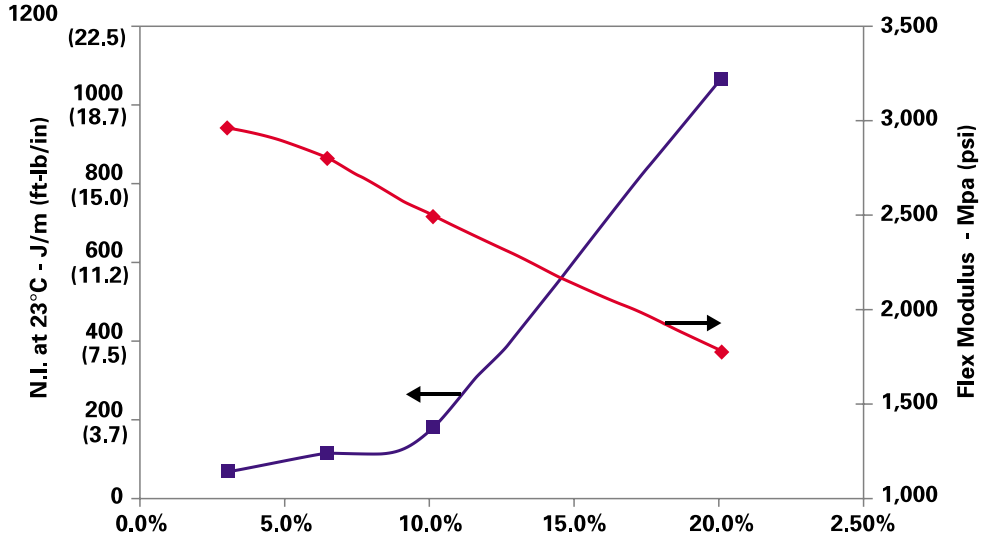
The **stiffness** of modified polyamide decreases in 1000 as more toughener was added. It can be seen in properties such as flex modulus and tensile strength, which direct to decrease as the toughener level increases. Pictures 5 and 6 shows the relationship between flex modulus and toughener level for PA6 and PA6.6.

Notched Izod & Flex Modulus PA6 Modified with GRAFTABOND LPO-MAH 00110 IM



Picture 5

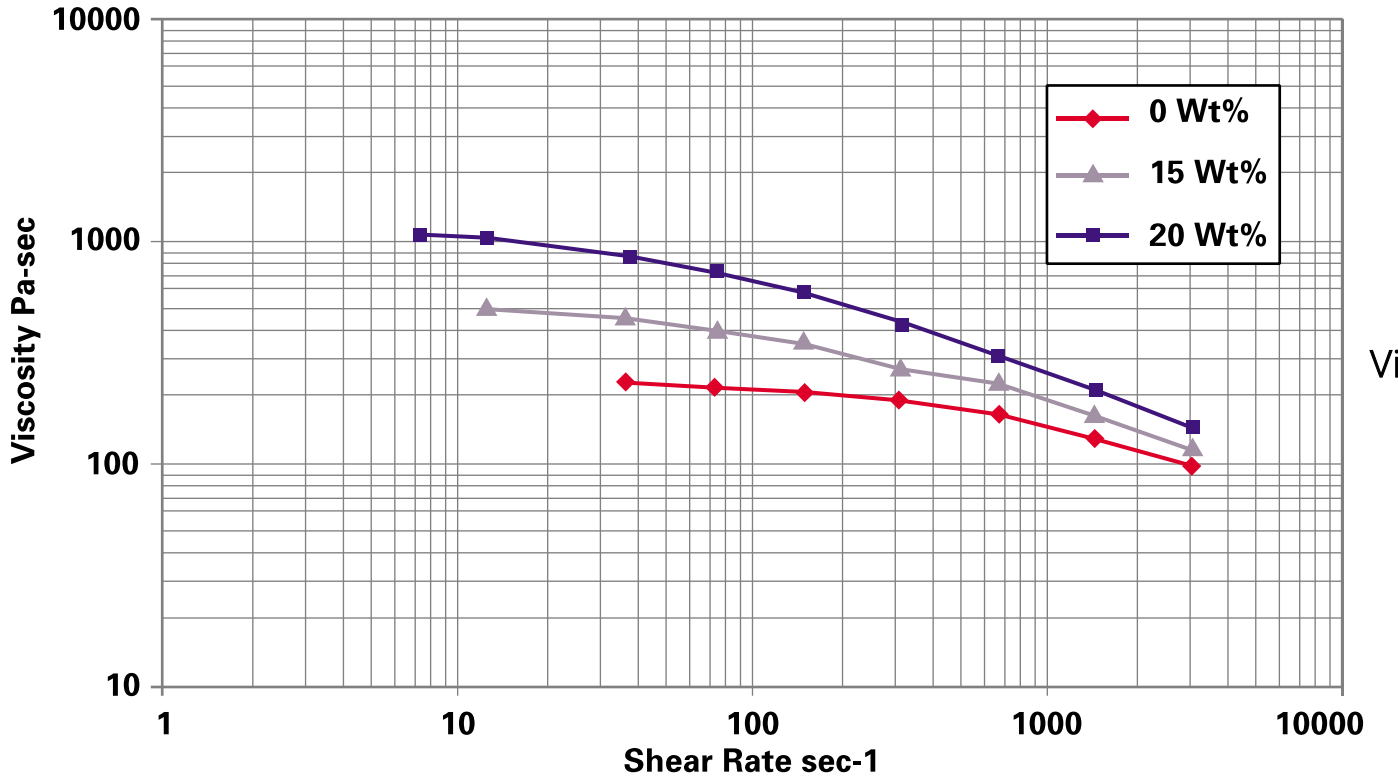
Notched Izod & Flex Modulus PA6 Modified with GRAFTABOND EP-MAH 00110 IM



Picture 6

IMPACT MODIFIER INFLUENCE ON OTHER PROPERTIES

Modified polyamide normally has a higher **viscosity** than untoughened grades, which may require that processors adjust injection molding conditions. Picture 7 shows how viscosity changes concerning the toughener level.



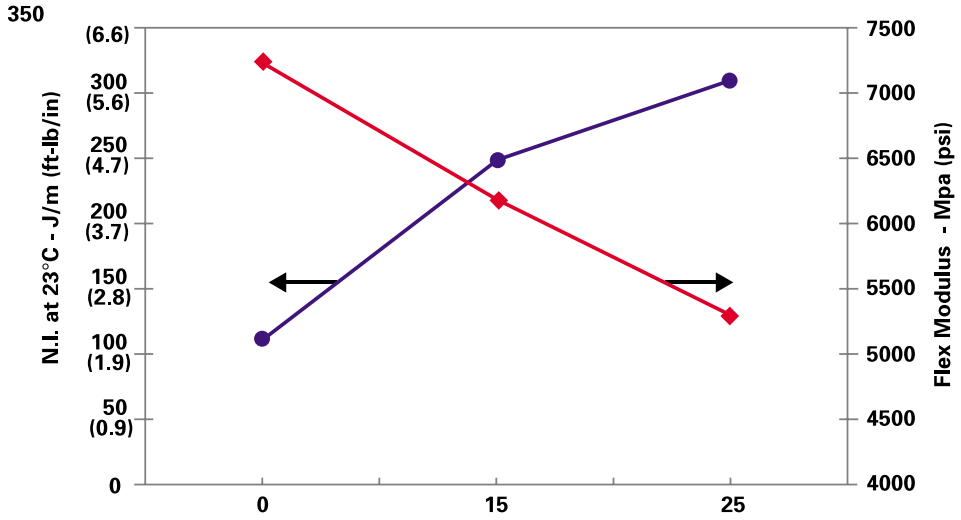
Picture 7

Viscosity vs Shear rate at 260°C of PA6 for Various Levels of GRAFTABOND LPO-MAH 00110 IM

GLASS-FIBER REINFORCED POLYAMIDE

Glass fibers can improve polyamide stiffness. However, properties such as elongation and impact strength decreased by adding glass fiber. Using impact modifiers in glass-fiber reinforced polyamide can improve its elongation and impact strength.

Picture 8 shows the impact strength of PA6 with 30% glass fiber for a various dosage of GRAFTABOND LPO-MAH 00110 IM. As mentioned above, flex modulus decreases with higher toughener levels. The same trend in physical properties operates for lower levels of glass.



Picture 8

Notched Izod & Flex Modulus 33% Glass Filled PA6 Modified with GRAFTABOND LPO-MAH 00110 IM

GRAFTABOND EP-MAH 00110 IM

Impact modifier for polyamides blends

Special Features and Benefits:

- Improved flexural properties
- Excellent notched/unnotched Izod and Charpy impact strength
- Enhanced impact strength at low temperatures

Dosage: 5-20%

Recommended to follow proper processing rules for testing IM for Polyamides:

1) Drying of PA before extrusion blending at 100 C (3 h minimum)
2) Drying of PA blend (with IM mixed) after extrusion. At 100 C (3 h) before injecting specimens
3) Conditioning of Injected Specimens at ROOM temperature within (3 days minimum)

It is reasonable to test 3 points of dosage 5%, 10%, 15% to determinate the best IM and dosage in your mix.

GRAFTABOND LPO-MAH 00110 IM & GRAFTABOND PO-MAH 00110 IM

Impact modifiers for polyamides blends based on PE

Special Features and Benefits:

- Improved flexural properties
- Excellent notched/unnotched Izod and Charpy impact strength
- Enhanced impact strength at low temperatures

Dosage: 5-20%

Recommended to follow proper processing rules for testing IM for Polyamides:

1) Drying of PA before extrusion blending at 100 C (3 h minimum)
2) Drying of PA blend (with IM mixed) after extrusion. At 100 C (3 h) before injecting specimens
3) Conditioning of Injected Specimens at ROOM temperature within (3 days minimum)

It is reasonable to test 3 points of dosage 5%, 10%, 15% to determinate the best IM and dosage in your mix.

BUSINESS MODEL: INNOVATIONS

GRAFT / BLOCK POLYMERS

POLYMERIC NANO ALLOYS

CROSSLINKING

POROUS

SYNTHESIS

INNOVATIVE TECHNOLOGIES

- Flow induced crystallization
- Solid Phase Grafting
- Solution Grafting
- Fillers Treatments
- Powders Hybridization
- Hot ozonolysis/plasma modification
- Nitroxide Mediated Polymerization
- Micro/Nano Porous polymer carries

To support its unique modification technologies, GP has built the **R&D** center including **Laboratory** and **Synthesis facilities**

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