FUNCTIONAL MODIFIERS

Compatibilizers are used to promote interfacial adhesion in polymer compounds, which are otherwise immiscible. They usually contain multiple functional groups, with both groups being compatible with one of the phases. These molecules tend to concentrate at the interfaces and stabilize them, thus allowing finer dispersion and compatibility of mutually incompatible pairs.

Coupling agents are chemicals which improve the interfacial properties of mineral fillers and polymers (they reduce the interfacial tension which is disadvantageous rather than advantageous, but simultaneously they reduce the agglomeration tendency of filler particles, thus improving their accessibility to polymer molecules). Coupling agents usually react with the filler surface but exhibit at least one side group which react with the polymer matrix or is at least compatible with it.
## ADVANTAGES OF OUR PROPRIETARY GRAFTING TECHNOLOGIES

<table>
<thead>
<tr>
<th>GRAFT POLYMER PRODUCTS</th>
<th>COMPETITORS PRODUCTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>&gt; 90% Grafting efficiency</strong>&lt;br&gt;Almost no residual chemicals → LOWER VOC</td>
<td><strong>30-50% Grafting Efficiency</strong>&lt;br&gt;A higher amount of leftover reagents → may disrupt polymer processing</td>
</tr>
<tr>
<td><strong>“Blocked Grafting”:</strong> Functional groups such as MAH are activated at higher temperatures (&gt;160°C)&lt;br&gt;The material can be safely stored for at least 36 months.</td>
<td>The material is prone to moisture uptake, hydrolysis occurs, and it is reduced in effectiveness by up to 5 times</td>
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<tr>
<td><strong>HIGH grafting degree, UP to 3%</strong>&lt;br&gt;By grafting higher amounts of MAH, we substantially reduce the quantity required to achieve good compatibility:&lt;br&gt;Up to 60% less compatibilizers required</td>
<td>Grafting degree up to 2%, with many unreacted monomers present</td>
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<td><strong>Very slight MFI reduction when comparing grafted materials to virgin material.</strong>&lt;br&gt;(PE) MFI Decreases from 8 g/10min to 6 g/10min&lt;br&gt;Grafted material retains good flowing capabilities&lt;br&gt;(PP) MFI Decreases from 30 g/10min to 18 g/10min&lt;br&gt;Higher melt strength and stability, almost no chain degradation</td>
<td><strong>Big difference in MFI of grafted materials when comparing to same virgin materials.</strong>&lt;br&gt;(PE) MFI Decrease from 8 g/10min to 0,8g/10min,&lt;br&gt;Worse flowing capabilities than virgin material, making it harder to process&lt;br&gt;(PP) MFI increases from 30 g/10min to 100 g/10min&lt;br&gt;A lot of degradation and chain shortening</td>
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<td><strong>GRAFT POLYMER PRODUCTS</strong></td>
<td><strong>COMPETITORS PRODUCTS</strong></td>
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<tr>
<td><strong>Grafting reaction temperatures are low</strong>, at the melting temperature of polymers (140°C-150°C for polyolefin)</td>
<td>Grafting reaction temperatures are at polymer degradation temperatures (270°C)</td>
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<tr>
<td><strong>No material degradation</strong>, a whiter color of grafted material and <strong>no additional antioxidants are present</strong>.</td>
<td><strong>Grafted material is degraded</strong>, more yellow has additional antioxidants</td>
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<tr>
<td><strong>ONE</strong> step grafting process</td>
<td><strong>Longer</strong> grafting process</td>
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<tr>
<td>Extruder or solid phase reactor, with <strong>no additional process steps</strong></td>
<td>Grafted with two extruders, sometimes grafted in solid phase reactor and extruder (MIX), making the <strong>process more resource consuming</strong></td>
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<td><strong>White grafted material</strong></td>
<td><strong>Yellow grafted material</strong></td>
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<tr>
<td>Doesn’t affect final product color</td>
<td>May influence final material’s color</td>
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The versatility of Grafting Monomers

MALEIC ANHYDRIDE (MAH)
GLYCIDYL METHACRYLATE (GMA)
METHYL METHACRYLATE (MMA)
ACRYLIC ACID (AAc)
BUTYL ACRYLATE (BA)
VINYL ACETATE (VA)
DIETHYL MALEATE (DEM)
ACRYLAMIDE (AAm)
ACRYLONITRILE (ACN)
OTHERS.
<table>
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<tr>
<th>GRAFTABOND™</th>
<th>Reactive Monomer</th>
<th>Grafting Degree [%]</th>
<th>Form</th>
<th>Olefin/PA Blends</th>
<th>Glass Fiber or Mineral Filled Olefins</th>
<th>Natural Fiber Filled Olefins</th>
<th>Metal Adhesion</th>
<th>Polymer Film Adhesion</th>
<th>Non-Halogen FR</th>
<th>Flow Enhancer</th>
<th>Dispersing Agent (Pigments)</th>
<th>Mixed Recyclates PE/PP</th>
<th>ABS</th>
<th>PA</th>
<th>SAN</th>
<th>PVC</th>
<th>WPC</th>
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<th>Polysters (PET,PBT)</th>
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### General Recommendations for different blends:

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<th><strong>Type</strong></th>
<th><strong>Reactive Monomer</strong></th>
<th><strong>Grafting Degree [%]</strong></th>
<th><strong>Form</strong></th>
<th><strong>PET/PE 1/5 of PE</strong></th>
<th><strong>PA/PE 1/5 of minor component</strong></th>
<th><strong>PA/PP 1/5 of minor component</strong></th>
<th><strong>PLA/PP 1/5 of minor component</strong></th>
<th><strong>PLA/PE 5-10 % of chosen grades</strong></th>
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**LEGEND:**
- C - Compatibilizer
- CA - Coupling Agent
- TL - Tie Layer
- IM - Impact Modifier
- CE - Chain Extender

**Olefin = Polyethylene (PE) and polypropylene (PP)**
- **PA = Polyamide**
- **ABS = Acrylonitrile-butadiene-styrene**
- **SAN = Styrene Acrylonitrile**
- **PC = Polycarbonate**

**PET = Polystyrene**
- **PBT = Polybutylene Terephthalate**
- **PVC = Polyvinyl Chloride**
- **PLA = Polylactic Acid**
- **FR = Flame Retardant**
- **WPC = Wood-Plastic Composite**
Where to use...

**AUTOMOTIVE**
- Thermo adhesive film
- Sound deadening foams
- Fuel tank
- Compatibilization of recycled plastics
- Automotive compounds

**PLASTIC COMPOUNDS**
- Impact modifiers for PA, PET, PBT, PPS, POM
- Coupling agents for HFFR and composites
- Compatibility of recycled plastics
- Automotive compounds

**ENERGY**
- Photovoltaic panel
- Cables compounds (LV, MV, HFFR)

**PACKAGING**
- Tie layer for multilayers barrier films and extrusion lamination
- Sealing and Seal/Peel resins
- Oxygen barrier layer

**CONSTRUCTION**
- Additives for bitumen rutting resistance
- Adhesive for pipe coating
- Aluminium panels

**HOT MELT ADHESIVES**
- Deep freeze hot melt adhesives
- High stability hot melt
- EVA binder

**MILITARY AND SPACE**
- Bespoke products across multiple fields
- Innovation lead
**PRODUCT INFORMATION**

**GRAFTABOND™**

**LD-MAH 02030 C**

Maleic Anhydride grafted LDPE

**LD-MAH 00130 TL**

**Special Features and Benefits**

- Designed for LDPE based blends
- Improves mechanical properties: stiffness, tensile and flexural properties, impact strength,
- High Maleic Anhydride content.

**Processing**

- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)

**GRAFTABOND™ LD-MAH 00130 TL**

- Tie layer adhesive for multi-layer barrier films. Compatibilizer for polyethylene/polyamide compounds used in blow molding. Coupling agent for polyethylene filled halogen free flame retardants (HFFR).

**Special Features and Benefits**

- Improves mechanical properties: stiffness, tensile and flexural properties, impact strength,
- Due to low MFI, it is best used for multi-layer barrier systems and compounds for blow molding

**Processing**

- Processable on most thermoplastic processing equipment.
- Preferable for: Coextrusion, extrusion (Compounding), blow molding
GRAFTABOND™ LD-MAH 11530 CA - Coupling agent in filled thermoplastic composites, compounds and alloys.

**Special Features and Benefits**

- Coupling agent for polyethylene compounds with glass, wood and other natural fibers,
- Improves mechanical properties: stiffness, tensile and flexural properties, impact strength,
- Reduces water absorption in natural fiber filled composites,
- High Maleic Anhydride content.

**Processing**

- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)
PRODUCT INFORMATION

GRAFTABOND™

LL-MAH 02030 C

Maleic Anhydride grafted LLDPE

Special Features and Benefits

- Improves mechanical properties: stiffness tensile and flexural properties, impact strength.
- High Maleic Anhydride content.

Processing

- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)

GRAFTABOND™ LL-MAH 00230 TL

- Improve adhesion between layers of polymer packaging systems.
- Compatibilizer for polyethylene/polyamide blends for blow molding.
- Coupling agent for polyethylene filled with halogen free flame retardants (HFFR).

Processing

- Processable on most thermoplastic processing equipment.
- Preferable for: Coextrusion, extrusion (Compounding), blow molding
GRAFTABOND™ HD-GMA02530 C - Compatibilizer in thermoplastic polymer-polymer composites, compounds and alloys. Best when used with PE and polyester (PET, PBT, etc.) compounds.

**Special Features and Benefits**

- Improves mechanical properties: stiffness tensile and flexural properties, impact strength.
- Good flow properties.

**Processing**

- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)
GRAFTABOND™
HD-MAH 02030 C

Maleic Anhydride grafted HDPE

PRODUCT INFORMATION

GRAFTABOND™ HD-MAH 02030 C - Compatibilizer in polyethylene/polyamide compounds, blends and alloys.

Special Features and Benefits

- Improves mechanical properties: stiffness tensile and flexural properties, impact strength.
- High Maleic Anhydride content.

Processing

- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding).

Composite
Without compatibilizers

Composite
With 5% GRAFTABOND™ HD-MAH
**PRODUCT INFORMATION**

*GRAFTABOND™ PO-MAH 00410 IM* - can be used in the following applications:

1. all polyethylene/polyamide blends and
2. Standard toughening agent (golf balls, cable compounds...).

**Processing**

- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)

**GRAFTABOND™ PO-GMA 00515 IM** - can be used in the following applications: Standard toughening agent (golf balls, cable compounds...) of polyolefin-polyester compounds

**Special Features and Benefits**

- Improved flexural properties,
- Excellent notched/unnotched Izod and Charpy impact strength.

**Processing**

- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)
**PRODUCT INFORMATION**

**GRAFTABOND™ PPH-MAH 02030 C** - Compatibilizer for polypropylene/polyamide alloys, and compatibilizer for polypropylene based scrap,

**Processing**
- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)

**GRAFTABOND™ PPH-MAH 70025 CA** - functions as a coupling agent between reinforcing materials (glass fibers, natural and inorganic fillers) and polypropylene. Increase adhesion properties of polypropylene to metal surfaces.

**Special Features and Benefits**
Performance enhancements in glass-filled polypropylene:
- Easy processing of glass reinforced compounds and thin/complex parts, because of its high flow properties,
- Improved tensile and flexural properties,
- Excellent notched/unnotched Izod and Charpy impact strength.
- Improved performance and cost compared to older modifiers.

**Processing**
- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)
PRODUCT INFORMATION

GRAFTABOND™ PPC-GMA 02030 C - functions as a compatibilizer for polypropylene and polyester compounds. Increased adhesion properties of polypropylene to metal surfaces.

Processing

- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)

GRAFTABOND™

PPC-GMA 02030 C

Polypropylene grafted with Glycidyl Methacrylate
PRODUCT INFORMATION

**GRAFTABOND™ CP-MAH 00220 IM** - can be used in the following applications: 1. Toughening agent and plasticizer for PVC. 2. Compatibilizer for PVC alloys and blends. 3. Solid component for solvent borne adhesion promoters.

**Processing**
- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)

**GRAFTABOND™**
**CP-MAH 00020 IM**

Chlorinated Polyethylene grafted with Maleic Anhydride
**PRODUCT INFORMATION**

**GRAFTABOND™ EV-MAH12010 TL** - is designed for hot melt adhesive formulations. It’s compatible with most adhesive resins and waxes. Also suitable to produce thermo-adhesive films for solid substrates (PA, films, Al foils).

**Processing**
- is processable on most thermoplastics processing equipment,
- Preferable for: Coextruding, overmolding
- Purge the equipment after a run is completed.

**GRAFTABOND™ EV-GMA 15025 IM** - is designed for PVC impact modification

**Processing**
- is processable on most thermoplastics processing equipment,
- Preferable for: Compounding PVC transparent films (Extruding)
- Purge the equipment after a run is completed.

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Maleic Anhydride/Glycidyl Methacrylate grafted Ethylene Vinyl Acetate

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Composite without compatibilizers

Composite with 3% **GRAFTABOND™ EVA-MAH**
GRAFTABOND™ EP-MAH 02010 IM

Ethylene-Propylene-Diene-Monomer polymer grafted with Maleic Anhydride

PRODUCT INFORMATION

GRAFTABOND™ EP-MAH 07110 IM - can be used in the following applications: Premium toughening agent and impact modifier for polyamides.

Special Features and Benefits
- Improved flexural properties,
- Excellent notched/unnotched Izod and Charpy impact strength.

Processing
- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)
PRODUCT INFORMATION

**GRAFTABOND™ SB-MAH 00220 IM** - is a great additive for increasing toughness of rigid materials. Excellent compatibility with many polymers and polymer compounds.

**Processing**
- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)

**GRAFTABOND™ SB-MAH 03020 IM** - is a great additive for increasing toughness of rigid materials. Excellent compatibility with many polymers and polymer compounds.

**Processing**
- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)

**GRAFTABOND™ SB-GMA 00330 C** - is a great all-around additive for increasing mechanical properties of any polyester compound.

**Processing**
- Is processable on most thermoplastics processing equipment,
- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)
Market Applications
GRAFTABOND™

SEBS-GMA 02520 IM
SEBS-MAH 02015 IM

Glycidyl
Methacrylate/Maleic
Anhydride grafted Styrene
Ethylene Butylene Styrene
Terpolymer

PRODUCT INFORMATION

GRAFTABOND™ SEBS-GMA 02520 IM - can be used in the following applications: Standard toughening agent (golf balls, cable compounds...) of polyolefin and polyester compounds.

Special Features and Benefits
- Improved flexural properties,
- Excellent notched/unnotched Izod and Charpy impact strength.

Processing
- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding), overmolding (Thermoplastic Elastomer)

GRAFTABOND™ SEBS-MAH 02015 IM - can be used in the following applications: Standard toughening agent (golf balls, cable compounds...) of polyolefin compounds with many different polymers (polyamides, styrene based polymers, different fillers...)

Special Features and Benefits
- Improved flexural properties,
- Excellent notched/unnotched Izod and Charpy impact strength,
- Versatile applications.

Processing
- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding), overmolding (Thermoplastic Elastomer)
PRODUCT INFORMATION

**GRAFTABOND™ EB-MAH 00730 C** - is a great compatibilizer for polyolefin/polyamide blends.

**Processing**

- Is processable on most thermoplastics processing equipment,
- Preferable for: Extrusion (Compounding)
- It is recommended to avoid overheating above 320°C,
- Purge the equipment after a run is completed.

**GRAFTABOND™ EB-MAH 00710 IM** - is a great impact modifier for polyolefin/polyamide blends and polyolefin composites, filled with glass fibers, natural fibers and inorganic fillers.

**Processing**

- GRAFTABOND™ EB-MAH 00710 IM is processable on most thermoplastics processing equipment,
- Preferable for: Extrusion (Compounding)
- It is recommended to avoid overheating above 320°C,
- Purge the equipment after a run is completed.
GRAFTABOND™
EB-GMA 01030 C

- is a great compatibilizer for: Polyolefin-polyester based compounds.

Processing
- GRAFTABOND™ EB-GMA 01030 C is processable on most thermoplastics processing equipment
- Preferable for: Extrusion (Compounding)
- It is recommended to avoid overheating above 320°C
- Purge the equipment after a run is completed

GRAFTABOND™
PO-SAN 00647 IM

- is a great additive for increasing impact strength of soft materials. Excellent compatibility with polymers, containing nitrile or amide groups (e.g. SAN, ABS).

Processing
- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)
**GRAFTABOND™ SAN-MAH 01530 C**

Styrene-Acrylonitrile copolymer grafted with Maleic Anhydride

**GRAFTABOND™ ABS-MAH 01510 C**

Acrylonitrile-butadiene-styrene grafted with Maleic Anhydride

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**PRODUCT INFORMATION**

*GRRAFTABOND™ SAN-MAH 01530 C* - is a great compatibilizer for polymer blends, based on SAN, ABS and other acrylonitrile based polymers.

**Processing**

- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)

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*GRRAFTABOND™ ABS-MAH 01510 C* is a great compatibilizer for increasing mechanical properties of ABS and SAN blends with polyamides, and glass fiber reinforced SAN, ABS and other styrene based polymers.

**Processing**

- Is processable on most thermoplastics processing equipment.
- Preferable for: Extrusion (Compounding)
**PRODUCT INFORMATION**

**GRAFTABOND™ ECO 01030 C** - Increase mechanical properties of plastic scrap materials and mixtures of different polymers (e.g. polyolefins, polyamides and polyesters). Compatibilizer in thermoplastic composites, compounds and alloys with such materials

**Special Features and Benefits**
- Improves mechanical properties: stiffness tensile and flexural properties, impact strength

**Processing**
- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding of recycled materials)

**GRAFTABOND™ ECO-PO/R 00325 C** is designed to provide compatibility to polyolefin based recycled plastic scrap and mixtures. It enhances mechanical and processing properties of all polyolefin blends.

**Special Features and Benefits**
- Increase mechanical properties of plastic scrap materials and mixtures of different polyolefins
- Compatibilizer in thermoplastic composites, compounds and alloys with such materials
- Improves mechanical properties: stiffness tensile and flexural properties, impact strength

**Processing**
- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding of recycled materials)
**PRODUCT INFORMATION**

**GRAFTABOND™ UHHD-MAH 00020 IM** is an alloy of HDPE and UHMWPE, grafted with maleic anhydride. It is a great compatibilizer for polyethylene blends and an excellent toughening agent, due to the UHMWPE.

**Special Features and Benefits**

- Compatibilizer in engineering plastics composites, compounds and alloys as impact modifier.

**Processing**

- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)

**GRAFTABOND™ UHHD-GMA 00020 IM** - Impact modifier in thermoplastic polymer-polymer composites, compounds and alloys. Best when used with PE and polyester (PET, PBT, etc.) compounds excellent impact modifier, due to the UHMWPE.

**Special Features and Benefits**

- Improves mechanical properties: stiffness tensile and flexural properties, impact strength.
- Good flow properties.

**Processing**

- Processable on most thermoplastic processing equipment.
- Preferable for: Extrusion (Compounding)