Turning Liquids into Solids for the Plastics Industry

Evonik Nutrition & Care GmbH
Technical Service Compounding
Polymer Processing Industry Value Chain and their Needs – We can now address all of them

<table>
<thead>
<tr>
<th>Polymer and Additive Manufacturer</th>
<th>Masterbatcher</th>
<th>Compounder</th>
<th>Converter</th>
<th>TIER and OEM Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Antistatic</td>
<td>Color MB and liquid colorants</td>
<td>• Antistatic agent</td>
<td>Moulder, film manufacturer, foam manufacturer or cable companies</td>
<td></td>
</tr>
<tr>
<td>• Melt flow improver</td>
<td>• Dispersants</td>
<td>• Antifogging additive</td>
<td></td>
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<tr>
<td>• Slip agents</td>
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<tr>
<td>• Chain extender</td>
<td>• Antiblocking additives</td>
<td>• Antistatic agent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Processing aids (PPA, OMS, ..)</td>
<td>• UV stabilizer</td>
<td>• Antifogging additive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Dispersants</td>
<td></td>
<td>• Slip agents</td>
<td></td>
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</tr>
<tr>
<td>• Polymers</td>
<td></td>
<td>• Slip agents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pigments, Fillers, FR</td>
<td></td>
<td>• UV stabilizer</td>
<td></td>
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</tbody>
</table>

Additive MB

<table>
<thead>
<tr>
<th>Additive MB</th>
<th>Compounder</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Antistatic agent</td>
<td>• Antiscratch additives</td>
</tr>
<tr>
<td>• Antifogging additive</td>
<td>• Mold release agents</td>
</tr>
<tr>
<td>• Slip agents</td>
<td>• Impact modifier</td>
</tr>
<tr>
<td>• Antiblocking additives</td>
<td>• Nucleator</td>
</tr>
<tr>
<td>• UV stabilizer</td>
<td>• Chain extender</td>
</tr>
</tbody>
</table>

| | • Dispersants |
| | • Haptic enhancers |
| | • Flame retardant |
| | • Foaming agent |
Polymer Processing Industry Value Chain and the Evonik I&P Products

Polymer and Additive Manufacturer
- TEGOMER®
- TEGOPREN®
- TEGIN®
- TEGO® STS, SMO, SMO 85
- TEGO® Sorb
- ACCUREL®

Masterbatcher
- Color MB and liquid colorants
  - TEGOMER® E525, P121, P 122
  - TEGO® STS, SMO, SMO 85
  - TEGO® Sorb

Compounder
- Additive MB
  - TEGOMER® Grades
  - TEGOPREN® Grades
  - TEGIN®
  - TEGO® Sorb
  - ACCUREL®

Converter
- Compounder
  - TEGOMER® Grades
  - TEGOPREN® Grades
  - TEGO® Sorb
  - ACCUREL®

TIER and OEM Companies
- Consumer
Positioning Evonik Additive Groups in Packaging Applications by Function

Mold Release
ACCUREL® Si
TEGOMER® H-Si 6441P / M-Si 2650
TEGOPREN® 6846

Antistatics
ACCUREL® SF / ACCUREL® GA
TEGIN® 90

Acid / Oxygen Scavenger
TEGOMER® P 122 / E525 as Dispersant

Foam Cell Stabilizer
ACCUREL® GA
ACCUREL® WF

PPA's
TEGOMER® 6810 (for PE)
TEGOMER® 6850 (for PP)

Haptic Enhancer
ACCUREL® GA
TEGIN® 90

Anti-blocking and Slip Additives
ACCUREL® Si / ACCUREL® SF
TEGOMER® H-Si 6441P

Colorants
TEGOMER® P 122 / E 525 as Dispersants

Antifog Agents
ACCUREL® AF, ACCUREL® GA
TEGO® STS

Odor absorber for Recycled Plastics
TEGO® Sorb PY 50 for film manufacture, recycler and compounding
TEGO® Sorb PY88
TEGO® Sorb PY30
ACCUREL® Product Portfolio

**ACCUREL® Direct**
- Direct conversion of liquid, waxy or meltable additives in highly loaded masterbatches for an easy handling

**ACCUREL® MP**
- Porous polymer granules of all thermoplastics
- Loading capacity up to 70%

**ACCUREL® XP**
- Micro porous powder or granules
- Loading capacity up to 80%
ACCUREL® Product Portfolio

- **ACCUREL®Direct**
  - Direct conversion of thermoplastic polymers and additives into high concentrates with up to 80% additive content
  - Masterbatches of thermally sensitive additives (ethoxylated amines, fatty acid amides, siloxanes, GMS, antioxidants, …)

- **ACCUREL®XP**
  - Porous polymer granules of all thermoplastic polymers

- **ACCUREL®MP**
  - Micro porous polymers from PP, HDPE, LDPE, LLDPE, …

- **Additive loading on ACCUREL®MP/XP porous polymers**
  - Additive loading on porous carriers
  - Physical absorption and capillary forces keeps the additive inside
Additive Loading on ACCUREL®XP Porous Polymer - Example

- Example 35 wt.
- Example 65 wt.
- Example 100 wt.

- Viscosity 30,000 cSt
- free flowing granule

Turning liquids into solid
Benefits of highly filled Masterbatches vs. Conventional Masterbatches

- Up to 70% less foreign polymer in final product
- Less influence on crystallinity
- Lower storage volume
- Lower transportation costs
- Easier to dose

If 2% active additive needs to be used:

<table>
<thead>
<tr>
<th></th>
<th>ACCUREL®XP</th>
<th>Conventional MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Additive</td>
<td>80%</td>
<td>25%</td>
</tr>
<tr>
<td>Polymer</td>
<td>20%</td>
<td>75%</td>
</tr>
</tbody>
</table>

- Reduction of 0.5% polymer by 30%
- 1.6% polymer
Benefits in Logistics – Cost savings in Transportation and Storage

Conventional MB with 15% additive content

ACCUREL® Direct
60% additive content

∥ 10 tons net per container →

34 tons resin required to carry 6 tons additive

4 tons resin required to carry 6 tons additive

- Converters need the additive whereas the resins can be purchased often locally at lower costs
- Cost savings at freight charges with high concentrates
- Less warehouse space required.
What kind of Additives can be loaded?

- Liquid, waxy or low melting additives
- Antistatic or antifogging additives such as glycerol esters, glycerin, ethoxylated amines/alcohols, …
- Flame retardants, Antioxidants, Plasticizer
- Reactive agents such as silanes, peroxides, TAIC
- Fragrances
- Antimicrobials
- Flame retardants
- UV stabilizers
- Silicone oils (up to 30,000 cSt viscosity)
- Enzymes
- Lubricants
- Hydrophilic/hydrophobic substances, e.g. water or water-based dispersions
Which Markets can we address with ACCUREL®, TEGOPREN® and TEGOMER® Additives?
Evonik Additives and highly filled Additive Masterbatches for Film Processing and Sheets

**PP Film**
- Antifog
- Antistatic
- Antiblock
- Slip
- PPA

  - General packaging
  - Food packaging
  - Metallized films
  - Cover films
  - Synthetic paper

**LDPE / LLDPE**
- UV protection
- Slip
- Antifog
- Antistatic
- Antiblock
- PPA

  - Greenhouse films
  - General packaging
  - Electronic packaging
  - Bubble films
  - Food packaging
  - Waste bags

**PET Film**
- Slip
- Antiblock

  - Food packaging
  - Bottles
  - Barrier films
Evonik Additives and highly filled Additive Masterbatches for Foam Production

PE Foam
- Thermal insulation
- Sound dumping
- Packaging Trays
- Mechanical shock absorber

• Antistatics
• Mold release
• Foam cell stabilizer
• Surface modifiers

PS Foam
- Molded parts
- Extruded profiles
- Block Foam

• Mold release
• External lubricant
• Antistatics
• Foam cell stabilizer

PU Foam
- Thermal insulation
- Mechanical shock absorber

• Dispersants for colorizing
• Foam cell stabilizer
Evonik Additives and highly filled Additive Masterbatches for Fiber Production

PP Fiber
- Haptic Enhancer
- Lubricant
- Antistatic
- Odor absorber
- Melt flow enhancer
- • Carpet fibers
  • Non-woven
  • Fabrics

PA Fiber
- Lubricant
- Antistatic
- Melt flow enhancer
- • Fabrics
  • Carpet fibres
  • Composite reinforcement

PET Fiber
- Antistatic
- Melt flow enhancer
- Chain extender
- • Geo textiles
  • Non-wovens
  • Fabrics
Evonik Additives and highly filled Additive Masterbatches for Compounding, Cable Compounding and Additive Masterbatches

Cable Compounding
- PP
  - Dry Silanes
  - Lubricant
- EVA
  - Dispersants
- PP
  - FR and Synergists
  - Coupling agents
- • Cable Compounds
- • Bedding Compounds
- • Jacketing Compounds
- • X-linked Cables
- • HFFR Cables

General Compounding
- PA
  - FR and synergists
- PC/ABS
  - Antiscratch
- PS, PET
  - Demolding
- Polyolefins and others
  - Melt flow enhancer and processing aids
- • Injection molded parts
- • Profile extrusion
- • Films and sheets

Masterbatter
- All Polymers
- Full Evonik Portfolio
  - ACCUREL®
  - TEGOMER
  - TEGOPREN
- • Color Masterbatches
- • Additive Masterbatches
- • Combi Masterbatches
### ACCUREL® grades for various polymers

<table>
<thead>
<tr>
<th>Major Products for various Polymers for Masterbatcher, Compounder and Converter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Slip Agent</strong>&lt;br&gt;COF reduction</td>
</tr>
<tr>
<td>ACCUREL® SF660</td>
</tr>
<tr>
<td><strong>Antifogging Agent</strong></td>
</tr>
<tr>
<td><strong>Antistatic Agent</strong></td>
</tr>
<tr>
<td><strong>Antiblock Agent</strong></td>
</tr>
<tr>
<td><strong>Mold release Agent</strong></td>
</tr>
<tr>
<td><strong>Foam Cell Stabilizer</strong>&lt;br&gt; <strong>Foaming Agent</strong></td>
</tr>
<tr>
<td><strong>Flame Retardant</strong></td>
</tr>
<tr>
<td><strong>Haptic Enhancer</strong>&lt;br&gt;<strong>1.</strong></td>
</tr>
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</table>
### Standard ACCUREL® Grades

#### ACCUREL® XP grades for various polymers

<table>
<thead>
<tr>
<th>ACCUREL®</th>
<th>Polymer</th>
<th>Standard Loading capacity [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>XP100-60</td>
<td>PP</td>
<td>40</td>
</tr>
<tr>
<td>XP100-84</td>
<td>PP</td>
<td>70</td>
</tr>
<tr>
<td>XP200</td>
<td>HDPE</td>
<td>60</td>
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<tr>
<td>XP300</td>
<td>PVOH</td>
<td>60</td>
</tr>
<tr>
<td>XP315</td>
<td>LLDPE</td>
<td>30</td>
</tr>
<tr>
<td>XP400</td>
<td>LDPE</td>
<td>50</td>
</tr>
<tr>
<td>XP500</td>
<td>EVA</td>
<td>50</td>
</tr>
<tr>
<td>XP550</td>
<td>EMA</td>
<td>30</td>
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<tr>
<td>XP601</td>
<td>PC</td>
<td>60</td>
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<tr>
<td>XP650</td>
<td>PMMA</td>
<td>50</td>
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<tr>
<td>XP700</td>
<td>PA6</td>
<td>65</td>
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<td>XP712</td>
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<td>65</td>
</tr>
<tr>
<td>XP800</td>
<td>PS</td>
<td>60</td>
</tr>
<tr>
<td>XP850</td>
<td>SBC</td>
<td>50</td>
</tr>
<tr>
<td>XP851</td>
<td>SAN</td>
<td>50</td>
</tr>
<tr>
<td>XP880</td>
<td>ABS</td>
<td>50</td>
</tr>
<tr>
<td>XP900</td>
<td>PET</td>
<td>40</td>
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<tr>
<td>XP950B</td>
<td>Bio Polyester</td>
<td>50</td>
</tr>
<tr>
<td>XP951B</td>
<td>PLA</td>
<td>60</td>
</tr>
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### Which Additives can be loaded?

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Test Capabilities for ACCUREL® Grades in Film Application
New Capabilities – Film extrusion

Blown-film process

Cast-film process
New Capabilities - Evaluation of Antifogging Performance in Packaging Films

The Cold ‘Fog’ Test

The Hot ‘Fog’ Test

Level 1-5 often also named as Level A-E
New method: Cold and Hot Fogging Test – Visual Appearance

In dependence on the age of the film (new films versus stored films) the performance of the additives may vary. Currently there is only new film samples evaluated.

PP film: left: without additive, right: 2% TEGIN 90 Pellets applied as MB