Co-Binders
TEGO® AddBond – TEGO® VariPlus
TEGO® AddBond
Polyester resins as co-binders

Adhesion is a key topic in coatings systems. The demands made on adhesion-promoting products are highly sophisticated. Besides excellent compatibility with other formulation components, such resins must be able to optimize adhesion on all types of substrates. TEGO® Add-Bond products provide formulators with a range of polyester resins which improve adhesion of solventborne, waterborne and radiation-curing coatings and printing inks regardless of the way they dry or cure. The resins can be used in physically drying, oxidatively drying, heat-curing and radiation-curing systems.

How are polyester resins manufactured?

TEGO® AddBond resins are polyester resins with a special structure. They are manufactured by the polycondensation of special-purpose carboxylic acids and polyols (fig. 1). Aqueous secondary dispersions are obtained by neutralizing carboxyl groups with amines (fig. 2). Such solvent-free dispersions have a good storage life. The TEGO® AddBond resins are resistant to hydrolysis. They always contain free carboxyl and hydroxyl groups. Their hydrophilic and hydrophobic characteristics are designed to make a maximum contribution to improving adhesion and enhancing corrosion protection.
What do polyester resins achieve?

With the exception of TEGO® AddBond LTH, which is a solid resin, all other products in the TEGO® AddBond range are supplied as solutions (table 1). Since TEGO® VariPlus 3350 UV is also a polyester resin, it is listed here. This resin is dissolved in tripropylene glycol diacrylate, a UV-reactive solvent. TEGO® AddBond DS 1300 is an aqueous secondary dispersion which does not contain any organic solvents. All other products are dissolved in an organic solvent.

TEGO® AddBond resins contribute to improved adhesion on numerous substrates. They are effective on metals, minerals and various plastics and are thus often used in primers or one-coat finishes. They also improve intercoat adhesion so they are highly recommended for use in multicoat finishes. In effect-finishes, they improve cohesion within the film. The adhesion promoting properties of TEGO® AddBond products, complemented by excellent resistance to hydrolysis, significantly improve the anticorrosion performance of coatings. TEGO® AddBond resins help to enhance gloss, flexibility and hardness.

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**Some properties of TEGO® AddBond products**

<table>
<thead>
<tr>
<th>Product</th>
<th>Supply form</th>
<th>Viscosity (23°C, mPa·s)</th>
<th>Softening temperature (°C)</th>
<th>Acid value (mg KOH/g)</th>
<th>Hydroxyl value (mg KOH/g)</th>
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</thead>
<tbody>
<tr>
<td>TEGO® AddBond LTH</td>
<td>solid</td>
<td>600 – 1500</td>
<td>90 – 102</td>
<td>12 – 20</td>
<td>– 25</td>
</tr>
<tr>
<td>TEGO® AddBond LTW</td>
<td>60% in xylene</td>
<td>350 – 650</td>
<td>soft resin</td>
<td>20 – 30</td>
<td>– 30</td>
</tr>
<tr>
<td>TEGO® AddBond LTW-B</td>
<td>60% in n-butyl acetate</td>
<td>350 – 650</td>
<td>soft resin</td>
<td>20 – 30</td>
<td>– 30</td>
</tr>
<tr>
<td>TEGO® AddBond 2220 ND</td>
<td>60% in SOLVESSO 150</td>
<td>1500 – 2700</td>
<td>soft resin</td>
<td>18 – 22</td>
<td>– 30</td>
</tr>
<tr>
<td>TEGO® AddBond 2325</td>
<td>60% in n-butyl acetate</td>
<td>300 – 700</td>
<td>– 60</td>
<td>– 18</td>
<td>– 16</td>
</tr>
<tr>
<td>TEGO® VariPlus 3350 UV</td>
<td>50% in TPGDA</td>
<td>– 8000</td>
<td>– 60</td>
<td>– 18</td>
<td>– 16</td>
</tr>
<tr>
<td>TEGO® AddBond 1270</td>
<td>70% in sec-butanol</td>
<td>4000 – 9000</td>
<td>soft resin</td>
<td>56 – 65</td>
<td>– 25</td>
</tr>
<tr>
<td>TEGO® AddBond DS 1300</td>
<td>45% in water</td>
<td>– 150</td>
<td>– 55</td>
<td>–</td>
<td>– 60</td>
</tr>
<tr>
<td>TEGO® AddBond HS</td>
<td>75% in n-butyl acetate</td>
<td>1500 - 2500</td>
<td>soft resin</td>
<td>20 - 30</td>
<td>– 100</td>
</tr>
</tbody>
</table>

1 60% in xylene 2 solid resin

Table 1

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Figure 3: Use of TEGO® AddBond LTW in coil coatings
TEGO® AddBond resins are used as co-binders in numerous paints and lacquers such as can coatings and coil coatings, automotive OEM or refinish coatings, industrial coatings, anti-corrosion paints, road marking paints, printing inks, adhesives, hot embossing foils and UV coatings.

Figs. 3 to 7 show typical examples of applications. TEGO® AddBond LTW and LTW-B improve adhesion of can coatings and coil coatings (fig. 3). These resins exhibit a flexibilizing effect and enhance the coating’s processing properties.

An additional important area of application is automotive OEM or refinish coatings. TEGO® AddBond LTW and LTW-B are widely used in solventborne finishes. TEGO® AddBond 1270 is used in brake disc lacquers. TEGO® AddBond DS 1300 is used, for example, to improve the adhesion of waterborne paints on plastic fenders (fig. 4).

TEGO® AddBond products are also used in anti-corrosion paints, TEGO® AddBond LTH and LTW in solventborne coatings, and TEGO® AddBond DS 1300 in waterborne coatings (fig. 5).
TEGO® AddBond products improve adhesion in numerous paints and lacquers for plastics substrates such as polyamide, polyvinylchloride, polycarbonate, ABS, ABS/polycarbonate, Noryl or HIPS. The TEGO® AddBond products LTH, LTW, LTW-B, 2325 and 1270 are recommended for solventborne finishes, DS 1300 and 1270 for waterborne finishes and TEGO® AddBond LTH and TEGO® VariPlus 3350 UV for radiation-curing coatings. The flexible TEGO® AddBond LTW ensures good substrate wetting, improved adhesion and excellent cohesion of effect pigment finishes (fig. 6). Because of its high compatibility with acrylic resins and reactive thinners, TEGO® VariPlus 3350 UV is recommended for use in radiation-curing coatings, printing inks and adhesives (fig. 7). TEGO® AddBond LTH is also used in some UV formulations. Both resins enhance not only adhesion but also reduce volume shrinkage during curing.
Numerous coatings and printing inks are available commercially. Physically-drying coatings, air-drying paints, stoving enamels and radiation-curing systems are used in diverse fields and applied to very different substrates. TEGO® VariPlus resins are frequently used to enhance the property profile of such systems. These non-saponifiable, neutral, hard resins have a low molecular weight, low inherent color and exhibit good light and heat resistance. Their outstanding compatibility with the most important main binders and their good solubility in the solvents commonly used in these systems make them highly versatile.

How are ketone-aldehyde resins and the special resins derived from them manufactured?

Ketone-aldehyde resins are manufactured by an aldol condensation of a ketone with an aldehyde. The resulting chemical structures and their properties depend substantially on the ketone used. If acetophenone or trimethylcyclohexanone are used, resins with exclusively keto groups are obtained (fig. 1). It is possible to manufacture ketone resins containing hydroxyl groups by using suitable reaction conditions and cyclohexanone.

Figure 1: Typical structures of TEGO® VariPlus resins based on ketone-aldehyde chemistry
Another possibility for obtaining alcohol groups is by hydrogenating the keto group. In this way, the ketone-aldehyde resin TEGO® VariPlus AP is made into the polyol resin TEGO® VariPlus SK (fig. 2). The polyurethane-polyol resin TEGO® VariPlus 1201 TF is manufactured by reacting the hydroxyl groups of TEGO® VariPlus SK with a special light-resistant polyisocyanate using an organotin-free catalyst.

Resins for waterborne applications can be manufactured by various means. Water-insoluble resins, for example, are rendered water-dispersible by neutralization of the carboxyl groups. These polyurethane-polyol dispersions are resistant to hydrolysis (fig. 3).

How do ketone-aldehyde resins and special resins derived from them perform?

As a result of their chemical structure and the production process, the ketone-aldehyde resins are very light in color and transparent compared with natural resins. The inherent color and resistance to light and heat of the special resins obtained by chemical modification of the ketone-aldehyde resins are also substantially improved. The solubility of TEGO® VariPlus resins in organic solvents is very good. The polarity determines the solubility in very polar (alcohols) or very non-polar (aromatic-free white spirit) solvents. With one exception, all TEGO® VariPlus resins are hard solids. The glass transition temperature ranges from -47°C to +130°C.

While most resins are supplied as solids, TEGO® VariPlus 1201 TF is supplied in an organic solvent. As an aqueous secondary dispersion with excellent stability, TEGO® VariPlus DS 50 is free from organic solvents. TEGO® VariPlus UC is the only solvent-free, liquid resin with a low glass transition temperature of -47°C.
As a result of the optimized process, the formaldehyde content of products based on acetophenone is below the limits of detectability.

Because of their low molecular weights and high softening or melting temperatures, resins in the TEGO® VariPlus range are not film-forming. They are thus combined with other binders to improve the properties of coatings.

TEGO® VariPlus resins influence in all sorts of ways the properties of solvent-borne, waterborne and radiation-curing coatings, printing and other inks as well as of adhesives:

- faster drying and set times
- lower VOC content
- higher hardness
- higher gloss
- improved adhesion
- improves ability to be used in primers
- better heat resistance
- better chemical resistance
- better mechanical resistance
- better corrosion protection
- better block resistance
- higher pigment loading and higher color intensities through improved pigment wetting
- lower pigment paste viscosities

### Physical properties of TEGO® VariPlus resins

<table>
<thead>
<tr>
<th>Product</th>
<th>Supply form</th>
<th>Color value Gardner</th>
<th>Softening temp./ Melting temp. (°C)</th>
<th>Tg (°C)</th>
<th>OH-value (mg KOH/g)</th>
</tr>
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<tbody>
<tr>
<td>TEGO® VariPlus AP</td>
<td>solid</td>
<td>≤ 3</td>
<td>– 75</td>
<td>– 50</td>
<td>– 5</td>
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<tr>
<td>TEGO® VariPlus TC</td>
<td>solid</td>
<td>≤ 3</td>
<td>– 65</td>
<td>– 40</td>
<td>– 10</td>
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<tr>
<td>TEGO® VariPlus CA</td>
<td>solid</td>
<td>≤ 2</td>
<td>– 102</td>
<td>– 75</td>
<td>– 200</td>
</tr>
<tr>
<td>TEGO® VariPlus SK</td>
<td>solid</td>
<td>≤ 1</td>
<td>– 115</td>
<td>– 90</td>
<td>– 325</td>
</tr>
<tr>
<td>TEGO® VariPlus 1201 TF</td>
<td>49% in EA</td>
<td>≤ 2</td>
<td>– 163&lt;sup&gt;1&lt;/sup&gt;</td>
<td>– 130&lt;sup&gt;1&lt;/sup&gt;</td>
<td>– 200&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>TEGO® VariPlus DS 50</td>
<td>33% in water</td>
<td>–</td>
<td>– 150&lt;sup&gt;1&lt;/sup&gt;</td>
<td>– 120</td>
<td>– 190</td>
</tr>
<tr>
<td>TEGO® VariPlus UC</td>
<td>liquid</td>
<td>&lt; 7</td>
<td>–</td>
<td>– 47</td>
<td>– 40</td>
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<tr>
<td>TEGO® VariPlus UC W 40</td>
<td>40% in water</td>
<td>–</td>
<td>–</td>
<td>– 47</td>
<td>– 40</td>
</tr>
</tbody>
</table>

<sup>1</sup> solid resin

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Figure 4: Use of TEGO® VariPlus 1201 TF in printing inks
Besides their widespread use in printing inks (rotogravure, flexographic, screen printing, UV and specialist printing processes) and hot embossing foils, TEGO® VariPlus resins are proven co-binders in coatings and adhesives. They are used in wood finishes, coatings for plastics, anti-corrosion paints, concrete paints, road marking paints, industrial finishes, packaging coatings, paper coatings, writing inks, pigment pastes, liquid adhesives and hot melt adhesives.

Figures 4 to 7 show typical applications. TEGO® VariPlus 1201 TF imparts printing inks with very good adhesion, excellent gloss, and good block resistance during rapid drying. Because of its very good pigment wetting, it is also used in pigment pastes to achieve high color intensity and good transparency.

Ballpoint pen pastes owe their special rheological properties to the unique structure of TEGO® VariPlus SK. This resin prevents drying out and leakage of the ink while ensuring rapid setting after writing.
Used as a resin in the top coat of hot embossing foils, TEGO® VariPlus CA has a positive influence on a range of properties such as gloss, flexibility and fastness. It is also used in the adhesive film of these coated foils because it enhances adhesion.

Because of its high glass transition temperature and special chemical structure, TEGO® VariPlus DS 50 improves the resistance of waterborne coatings for plastics to water, solvents and chemicals as well as their film hardness and gloss. Substrate adhesion is also optimized.

TEGO® VariPlus TC has proved itself as a grind paste resin in pigment concentrates because of its universal solubility in organic solvents, compatibility with binders and excellent pigment wetting.

TEGO® VariPlus UC represents a new generation of pigment paste resins developed specifically for solventborne, extremely high-solids pigment concentrates with high pigment loadings. TEGO® VariPlus UC W 40 makes this resin accessible for use in waterborne (including universal) pigment preparations.