Polymer Modification (Hydrophilic)
INTRODUCTION

Thermoplastic polymers such as polyamide, polyolefin or polyester are widely used for a variety of applications because of their good properties. One important characteristic of polyolefins is their hydrophobicity, which can be an advantage in many applications, but a disadvantage in others. The low surface energy of those polymers results in poor adhesion by coatings of all kinds – poor paintability, printability, and dyeability can cause problems in many applications. Low hydrophilicity can result in static problems as well.

Through grafting or copolymerization, ELASTAMINE® Polyetheramine based on PEG dominant backbone can improve the desired hydrophilicity, surface energy and polarity of thermoplastics.

FEATURES

• Increased surface energy
• Increased polarity
• Increased hydrophilicity

APPLICATIONS

(A) Use in Polyolefins

One chemical route to improvement of surface energy is grafting of a hydrophilic polymer onto the polyolefin. Use of an anhydride group as a linking point is a convenient approach – the availability of maleated polyolefins, and the reactivity of the anhydride group with amines, makes this a useful tactic, as long as the polyolefins and amines have suitable properties. Huntsman’s ELASTAMINE® family of polyetheramines includes hydrophilic monoamines that are well-suited to this purpose.

Chemistry

The utility of this concept has been proven with maleated polypropylene and ELASTAMINE® polyethermonoamines.

The reaction and product (amine-maleated polypropylene adduct, AMAPPA) are shown in diagram 1.

<table>
<thead>
<tr>
<th>Applications</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface modification of polyolefins</td>
<td>Improved paintability</td>
</tr>
<tr>
<td>Hydrophilic polyolefins</td>
<td>Improved dyeability</td>
</tr>
<tr>
<td>Colored plastics, fibers or films</td>
<td>Improved printability</td>
</tr>
<tr>
<td>Compatibilization of polymer alloys</td>
<td>Improved antistatic properties</td>
</tr>
<tr>
<td></td>
<td>Improved Interpolymer adhesion</td>
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</tbody>
</table>
Examples of application of this technology fall into two general categories:
1. Modification of the polyolefin to make the surface inherently more polar (paintable, printable, etc.),
2. Preparation of dispersions that can serve as primers for polyolefin surfaces to improve adhesion to coatings.

While polyolefin modification generally involves grafting of a polyetheramine onto a polyolefin backbone, modification of condensation polymers such as polyamides (nylons) usually is by including the polyetheramine as a comonomer. Incorporation of a polyetheramine in a thermoplastic polyester polymerization results in a polyesteramide that can have enhanced hydrophilicity-related properties.

**B) Use in Polyamide**

<table>
<thead>
<tr>
<th>Applications</th>
<th>Benefits</th>
</tr>
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<tbody>
<tr>
<td>• Modification of Polyamide with enhanced moisture wicking ability</td>
<td>• Amine end groups are much more reactive than alcohol end groups</td>
</tr>
<tr>
<td>• Water-soluble Nylon bags</td>
<td>• Improved hydrolysis resistance</td>
</tr>
<tr>
<td>• Modification of polyamide with increased Vapor permeability</td>
<td>• Flexibility from polyether backbone</td>
</tr>
<tr>
<td>• Compatibilization of polymer alloys</td>
<td>• Hydrophilicity, polarity and improved antistatic properties from polyethyleneglycol backbone</td>
</tr>
<tr>
<td></td>
<td>• Improved moisture transport in fiber and film applications</td>
</tr>
</tbody>
</table>
C) Use in Thermoplastic Polyester

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Backbone</th>
<th>Approx molecular weight</th>
<th>Functionality</th>
<th>Colour, Pt-Co</th>
<th>Water, wt%</th>
<th>Viscosity, cSt</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE-600</td>
<td>PEG (mostly)/PPG</td>
<td>600</td>
<td>Diamine</td>
<td>75 max</td>
<td>0.35 max</td>
<td>72 (20°C)</td>
</tr>
<tr>
<td>RE-900</td>
<td>PEG (mostly)/PPG</td>
<td>900</td>
<td>Diamine</td>
<td>100 max</td>
<td>0.35 max</td>
<td>119 (25°C)</td>
</tr>
<tr>
<td>RE1-1000</td>
<td>PEG (mostly)/PPG</td>
<td>1000</td>
<td>Monoamine</td>
<td>75 max</td>
<td>0.25 max</td>
<td>Room temp solid, mp ~30°C</td>
</tr>
<tr>
<td>RE1-2007</td>
<td>PEG (mostly)/PPG</td>
<td>2,000</td>
<td>Monoamine</td>
<td>75 max</td>
<td>0.25 max</td>
<td>283 (25 °C)</td>
</tr>
</tbody>
</table>

* Properties are for reference only. Please approach Huntsman Corporation for actual specifications.
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