Low-VOC, liquid, amine-functional siloxane crosslinking resin

Amine-functional polymers have had broad utility in the coatings industry for nearly a century. Second only to the composite wood industry, the coatings industry employs amine resins in the synthesis or curing of nearly every paint resin binder system, including urethane, epoxy, polyester, alkyd and acrylic systems. *Dow Corning®* 3055 Resin offers a distinct option from the traditional organic amine polymers. Used as the sole amine source, or in combination with organic amine crosslinkers, *Dow Corning®* 3055 Resin provides the benefits of siloxane chemistry: flexibility, thermal and UV durability along with acid and water resistance. And with < 1% residual solvent, *Dow Corning®* 3055 Resin allows formulating of low-VOC, high performance coatings. Particular attention has been given in this document to the modification of epoxy resins; however, with the active amine functionality, *Dow Corning®* 3055 Resin can also be used for any high-performance coatings based on Urethane, Carboxy functional Polyester, Alkyd and Acrylate resins.

The Next Generation of Silicon-based Hybrids

Traditional polysiloxane hybrids rely on alkoxo-functional materials, such as silane monomers to crosslink organic polymers via organic reactivity and a secondary cure mechanism of hydrolysis and condensation of alkoxo groups (see Figure 1).

Figure 1. Cure Mechanism of Silane-based Polysiloxane Coatings
Dow Corning® 3055 Resin simplifies the chemistry (see Figure 2). Essentially all silylalkoxy groups are eliminated. Only amine functionality remains to participate in the crosslinking and curing of the coating. This elegant technology eliminates the need for catalysts (titanate for hydrolysis and tin for condensation), along with the reliance on ambient moisture. Further Dow Corning® 3055 Resin eliminates the generation of volatile by-products, which contribute to VOCs, mass loss and post-cure embrittlement.

1. Flexibility

Mandrel flexibility of Bis-A and Bis-F epoxies improves with Dow Corning® 3055 Resin at addition levels as low as 6%.

Figure 3. Improved mandrel flexibility of the epoxy coating with addition of Dow Corning® 3055 Resin

Differentiated Performance with Dow Corning® 3055 Resin in Combination with Epoxy Resins

Used alone or in combination with organic amine crosslinkers, Dow Corning® 3055 Resin improves the physical properties and long term performance of the epoxy coatings. For example, wet adhesion of the epoxy formulation improved with only 6% Dow Corning® 3055 Resin addition. Other performance also starts to improve at as low as 6% Dow Corning® 3055 Resin in formulation. At higher usage level (30-60%), Dow Corning® 3055 Resin can meet the harsh requirements needed for specialty applications.

2. Thermal Stability

Graph 1 shows the improved thermal stability provided by varied levels of Dow Corning® 3055 Resin. Similar results were obtained with Bis-F, Novolac and Cycloaliphatic epoxies.

Potential Dow Corning® 3055 Resin Applications

- Industrial/protective coatings
- Primer
- Metal containers
- Coil coatings
- Wood and metal furniture
- Prefinished wood
- Appliances
- Machinery and equipment
- Electrical insulation
- Automotive
- Land transportation
- General metal and miscellaneous OEM
3. Acid Resistance

Acid resistance is improved in Bis-A, Bis-F, Novolac and Cycloaliphatic epoxy resins with the inclusion of Dow Corning® 3055 Resin starting at 24% in the formulation.

Figure 4. Improved chemical resistance of an epoxy coating formulated with Dow Corning® 3055 Resin

<table>
<thead>
<tr>
<th>#</th>
<th>Chemical</th>
<th>Epoxy + Dow Corning® 3055 Resin (56% Si)</th>
<th>Epoxy + Organic Amine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acetic acid (10%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Formic acid (10%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Hydrochloric acid (36%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Nitric acid (50%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Phosphoric acid (50%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Sulfuric acid (50%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Ammonium hydroxide (20%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Potassium hydroxide (20%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Sodium hydroxide (20%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Five drops of chemical were added to each resin sample, and the samples were then covered with a watch glass for 24 hours.

4. Water Absorption

Water absorption of the epoxy coating decreases with higher use of Dow Corning® 3055 Resin.

Chart 2. Bis-A Epoxy with Dow Corning® 3055 Resin and organic amine.

Because it imparts improved thermal, weathering and chemical resistance properties, Dow Corning® 3055 Resin also offers potential opportunities for performance improvement in applications outside of traditional protective coatings, including fire-resistant and intumescent coatings, composite polymers, industrial adhesives, and high-temperature coatings.
More Than Resins

Our innovative, silicon-based resin and additive technologies can help you infuse your products with high-value performance attributes that will give you a competitive advantage in the marketplace. As a leader and innovator with a long history of success in the industry, Dow Corning’s performance-enhancing coating technology platforms are well-aligned to the needs of the increasingly competitive global coatings market. Consider what adding the following enabling technologies could do to improve your products’ performance and support your business goals:

- Gloss enhancement
- Mar resistance and slip
- Impact deadening
- UV resistance
- Feel and touch
- Heat and temperature resistance
- Water resistance
- Anti-fouling

For More Information

Visit dowcorning.com/powerup or email us at coatings@dowcorning.com to learn how Dow Corning’s innovative coatings technology platforms can help you power up your product line. A complete list of phone numbers can be found at dowcorning.com/ContactUs.