SMA® Resins For High Gloss and Thermal Resistant Overprint Varnishes

SMA® Resins are a family of low molecular weight copolymers of Styrene and Maleic Anhydride that can be used as hard resins in overprint varnish formulations. The different resins within this product line have a variety of chemical structures and exhibit a number of outstanding properties, including high acid equivalent values, outstanding thermal stability and high Tg. SMA® 1000, 2000, 3000 and 4000 are base resins with styrene/maleic anhydride ratios equal to 1, 2, 3 and 4, respectively, while SMA® 1440, 17352, 2625 and 3840 are partially esterified derivatives of SMA® base resins which contain ester, carboxylic acid and anhydride functionality.

In addition to supplying SMA® Resins in solid form, Sartomer Company produces aqueous solutions of the ammonium salts of most resin grades to facilitate their use in water-based formulations. These ammonium salt solutions are soluble in all proportions with water. However, they are sensitive to strongly acid conditions and will precipitate at pH below 7.

SMA® Resins are currently used in a variety of application areas in the graphic arts industry. This brochure is designed to assist you in gaining the maximum benefit from including SMA® Resins in your water-based overprint varnish formulations.

Benefits From Using SMA® Resins

This document describes the enhancement in properties that can be achieved when SMA® Resins are added to overprint varnish formulations. To illustrate this, gloss, water resistance, heat resistance, hot scuff resistance, and dry rub resistance properties have been compared for formulations made with SMA® Resins or styrene/acrylate resins.

Two latex emulsions, Joncryl 90 (Johnson Polymer) and Neocryl BT44 (Zeneca), serve as standards for this study. SMA® 1000, 2000 and 17352 were compared to styrene/acrylate resins as the post-addition hard resins. Solids contents of the overprint varnishes were kept constant at approximately 33%. The ratio (hard resin / hard resin + latex) was also kept constant at 30%. Additional information about film application, testing procedures, and formulations is described in the Appendix.

The results from the comparison between SMA® post addition formulations and the standard styrene/acrylate resins are summarized in Table 1.

All of the SMA®-containing formulations exhibit gloss properties similar to the styrene/acrylate resin formulations. As expected, formulations with SMA® 1000 exhibit the highest gloss of the SMA®-based formulations, but also the lowest water resistance, since this resin has the highest acid value for a SMA® Resin.

The main benefit gained by the post-addition of SMA® Resins is found in the greatly improved heat resistance of these overprint varnish formulations. Even at room temperature, SMA® Resin-based formulations have slightly better scuff resistance. At higher temperatures, the full advantages of SMA® post addition are realized, as good scuff resistance properties are maintained up to 190°C. Furthermore, these examples should only serve as starting points for your formulations work, since, by using higher quantities of SMA®, it may be possible to obtain larger improvements in both gloss and thermal resistance.
As shown in Table 1, using the right SMA® Resin can give you the balance of properties you need for your particular application. For example, use SMA® 1000 for the highest gloss and best thermal resistance, or use SMA® 17352 or SMA® 2000 for high gloss, excellent thermal resistance and the best water resistance.

**Conclusions**

SMA® Resins can enhance properties of styrene-acrylate emulsion overprint varnishes when they are added as a post addition hard resin. In particular, SMA® Resins are of proven benefit in preparing overprint varnishes where high thermal properties are required.

### Table 1: Effect of Hard Resin Addition to Neocryl BT 44 Emulsion

<table>
<thead>
<tr>
<th>Formulation (wt%)</th>
<th>SMA® 1000</th>
<th>SMA® 2000</th>
<th>SMA® 17352</th>
<th>Styrene/Acrylic resin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neocryl BT 44</td>
<td>49</td>
<td>49</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>Hard Resin Solution</td>
<td>23</td>
<td>44</td>
<td>44</td>
<td>28</td>
</tr>
<tr>
<td>Dowanol DPM</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>IPA</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PE Wax</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Water</td>
<td>21</td>
<td></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>OPV solid content (%)</td>
<td>33</td>
<td>32.5</td>
<td>32.5</td>
<td>34.5</td>
</tr>
<tr>
<td>Viscosity Zahn Cup 2 (s)</td>
<td>25</td>
<td>33</td>
<td>33</td>
<td>25</td>
</tr>
<tr>
<td>Properties: Gloss 2A</td>
<td>84</td>
<td>76</td>
<td>80</td>
<td>86</td>
</tr>
<tr>
<td>Gloss 3NT-3</td>
<td>66</td>
<td>61</td>
<td>64</td>
<td>70</td>
</tr>
<tr>
<td>Water resistance (2h)</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Scuff Resistance</td>
<td>4.5</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Heat resistance (190 °C)</td>
<td>4</td>
<td>4.5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Hot Scuff 150 °C</td>
<td>4.5</td>
<td>4.5</td>
<td>4.5</td>
<td>3</td>
</tr>
<tr>
<td>190 °C</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

* Solids contents of SMA® 1000H, SMA® 2000H, and SMA® 17352HD are 38%, 20%, and 20%, respectively.

### Appendix

**Latexes and SMA® Resins Studied:**
The latexes studied were styrene acrylate emulsions designed for waterbased, high gloss and heat resistant overprint varnishes:

- Joncryl 90 (Johnson Polymer):
  - ES=44%, MFT> 86 °C, Tg=110 °C
- Neocryl BT 44 (Zeneca):
  - ES=45%, MFT= 75 °C, Tg= 98 °C

The SMA® Resins studied were SMA® 1000, 2000, and 17352:

- SMA® 1000
  - Acid number = 480, Tg= 154 °C
- SMA® 2000
  - Acid number = 355, Tg= 133 °C
- SMA® 17352
  - Acid number = 270, Tg= 124 °C

**Formulations:**
Standard formulations were prepared with a coalescing aid (cosolvent, IPA), coalescing agent (Dowanol DPM, from Dow) and a polyethylene wax (Jonwax 35 from Jonhson Polymer) to improve the scuff resistance.

- **Formulation:** Latex + Resin (30% based on solid) + IPA (1%) + Dowanol (1%) + PE Wax (5%) + Water

**Film Application:**
The films were applied on Leneta 2A or Leneta 3NT3 charts with a Pamarco applicator and dried at room temperature for 2 hours.

**Testing Procedures:**
Gloss: Percent reflectance determined at 60°C by an average of 10 readings with a glossmeter (Model 540 from Erichsen).
Water resistance: 4 drops of water were applied for 10 minutes and wiped off with a tissue. The resulting spots were rated from 1 to 5, 5 being perfect film integrity and 1 being total removal. The drying times and temperatures were varied.

Heat resistance: Sample strips were tested face to face by placing them under a heated bar at 190°C for 5 seconds. The damage was rated from 1 to 5, with 5 being no sticking or damage to the film.

Hot Scuff resistance: Performed with a Sutherland Ink Rub Tester. 20 rubs were performed at 110°C, 150°C or 190°C. The damage was rated from 1 to 5.

Scuff (Dry Rub resistance): Using a Sutherland Ink Rub Tester with a 4 pound weight, the surface of the film was rubbed for 40 cycles and rated 1 to 5 on extent of damage.