Starting Formulation

SF 4009 Adhesive Formulations EPON and Epikure Adhesive Formulations for Thermoplastic Substrates

EPON™ Resins 8132, 828, 58005, 862, 58003 / EPIKURE™ Curing Agent 30055, 3125, 3163, and 3164

Introduction These adhesive systems are designed for use in ambient or elevated temperature bonding of thermoplastic substrates such as Nylon 11, polyethylene terephthalate, polyvinyl chloride, and polyurethane.

Features
- Good adhesion to thermoplastic substrates
- Solvent-free, no volatile by-products

Mixing Instructions Processing data are presented in Table 1. All of the starting point formulations discussed in this bulletin utilize Cab-O-Sil M-5 as the thixotropic agent (see Table 1). The Cab-O-Sil M-5 should be dispersed into a portion of the base resin (EPON Resin 8132, EPON Resin 828, EPON Resin 862) using a high shear dispersing technique. Add the remaining base resin and any other resins in the formulation to the resulting dispersion and mix using conventional mixing equipment, until a uniform consistency is attained.

This formulation is a basic starting point and can be modified with other filler types, such as aluminum powder, talc, alumina, silica, wollastonite, or calcium carbonate. Addition of a sufficient quantity of filler can adjust the combining ratio to a convenient level. Modification with silane coupling agents improves bonds to concrete and glass. Pigment may be incorporated into either or both portions for the purpose of color-coding.

Processing Properties Table 1 / Processing Properties

<table>
<thead>
<tr>
<th>Formulation number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resin, parts by weight (by volume)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPON Resin 8132</td>
<td>75</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>(82)</td>
<td></td>
<td></td>
<td></td>
<td>(109)</td>
<td>(109)</td>
<td>(109)</td>
</tr>
<tr>
<td>EPON Resin 828</td>
<td>25</td>
<td>75</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>(26)</td>
<td>(77)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPON Resin 58005</td>
<td>–</td>
<td>25</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(28)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPON Resin 862</td>
<td>–</td>
<td>–</td>
<td>75</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(76)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPON Resin 58003</td>
<td>–</td>
<td>–</td>
<td>25</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(28)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PON Resin 58135</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>100</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(105)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

® and ™ Licensed trademarks of Hexion Inc.

DISCLAIMER

The information provided herein was believed by Hexion Inc. ("Hexion") to be accurate at the time of preparation or prepared from sources believed to be reliable, but it is the responsibility of the user to investigate and understand other pertinent sources of information, to comply with all laws and procedures applicable to the safe handling and use of the product and to determine the suitability of the product for its intended use. All products supplied by Hexion are subject to Hexion’s terms and conditions of sale. Hexion MAKES NO WARRANTY, EXPRESS OR IMPLIED, CONCERNING THE PRODUCT OR THE MERCHANTABILITY OR FITNESS THEREOF FOR ANY PURPOSE OR CONCERNING THE ACCURACY OF ANY INFORMATION PROVIDED BY Hexion, except that the product shall conform to Hexion’s specifications. Nothing contained herein constitutes an offer for the sale of any product.
### Resin viscosity @ 25 °C, P

<table>
<thead>
<tr>
<th>Speed (rpm)</th>
<th>0.3</th>
<th>0.6</th>
<th>1.5</th>
<th>3</th>
<th>6</th>
<th>12</th>
<th>30</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>1360</td>
<td>1320</td>
<td>1300</td>
<td>1290</td>
<td>407</td>
<td>396</td>
<td>32.9</td>
<td>30.6</td>
</tr>
</tbody>
</table>

### Curing agent, parts by weight (by volume)

<table>
<thead>
<tr>
<th>Curing Agent</th>
<th>Formulation</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPI-CURE Curing Agent 3055</td>
<td>42</td>
<td>42</td>
<td>46</td>
<td>42</td>
<td>50</td>
<td>86</td>
<td>138</td>
<td>86</td>
</tr>
<tr>
<td>EPI-CURE Curing Agent 3125</td>
<td>(53)</td>
<td>(53)</td>
<td>(58)</td>
<td>(53)</td>
<td>(62)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPI-CURE Curing Agent 3163</td>
<td>50</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPI-CURE Curing Agent 3164</td>
<td>138</td>
<td>138</td>
<td>(169)</td>
<td>(169)</td>
<td>(106)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Curing Agent Viscosity @ 25 °C

<table>
<thead>
<tr>
<th>Speed (rpm)</th>
<th>2</th>
<th>2</th>
<th>2</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>330</td>
<td>1490</td>
<td>82</td>
<td>82</td>
</tr>
</tbody>
</table>

### Gel Time @ 25 °C

<table>
<thead>
<tr>
<th>Speed (rpm)</th>
<th>100 gram mass</th>
<th>Thin film Gel Time @ 25 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>109</td>
<td>20.5</td>
</tr>
</tbody>
</table>

1. Brookfield DV-II
2. Shyodu Gel Timer
3. Gardco Circular Drying Time Recorder, 0.2 mm film

**Application Instructions**

Surfaces to be bonded should be clean and free of dust, dirt, grease, or other extraneous material. Mix the adhesive components and apply immediately by spreading a thin film over the surface to be bonded. Maintain light pressure during cure to achieve the best bond. For the data presented, the surfaces were wiped with acetone or methyl ethyl ketone in order to remove dust, dirt, oils, etc.

The initial cure step may be carried out at room temperature or at elevated temperature. If initially cured at room temperature, an elevated temperature post cure should be evaluated depending on the requirements of the desired application. An elevated temperature cure will decrease the cure time significantly and will reduce the need for an additional post cure. Data are presented in Table 2 for both room and elevated temperature cure schedules. The cure schedule used was 30 minutes at 140 °C (280 °F).
Room Temperature Cure
Cure Schedule 7 days @ 25 °C (77 °F)
Lap shear strength 1, psi
CARILON® P-1000 2
Average 1012 884 950 832 691 621 499
Standard Deviation 193 216 189 166 43 81 33
Polyvinylchloride (PVC) 3
Average 691* 677* 754* 776 308 549 529
Standard Deviation 199 77 37 136 31 55 61
Polyurethane 4
Average 479 435 759 573 718 906 730
Standard Deviation 252 83 103 168 70 122 150
Polyethylene terephthalate (PET) 5
Average 255 254 487 506 525 800 632
Standard Deviation 68 29 139 81 75 52
Elevated Temperature Cure
Cure Schedule 30 minutes @ 140 °C (284 °F)
Lap shear strength 1, psi
CARILON® P-1000 2
Average 1396* 1401* 1359* 688 784 886 388
Standard Deviation 119 187 169 230 128 27 54
Polyvinylchloride (PVC) 3
Average 1216* 1281* 939* 951* 661* 969* 674*
Standard Deviation 346 193 434 220 111 123 98
Polyurethane 4
Average 319 550 385 407 307 583 429
Standard Deviation 75 39 124 49 103 77
Polyethylene terephthalate (PET) 5
Average 768 653 890 796 964 1244 848
Standard Deviation 125 160 117 113 79 106 44
Nylon 6
Average 434 – 414 444 650 725 466
Standard Deviation 105 – 168 67 188 27 57
Glass Transition Temperature 7, °C 60 86 75 70 50 45 40
1 ASTM D 3163 96 AT 25 °C, Average of 5 Specimens, Solvent Wiped
2 CARILON® P-1000 was supplied by Shell Chemical Company

© and ™ Licensed trademarks of Hexion Inc.

DISCLAIMER
The information provided herein was believed by Hexion Inc. ("Hexion") to be accurate at the time of preparation or prepared from sources believed to be reliable, but it is the responsibility of the user to investigate and understand other pertinent sources of information, to comply with all laws and procedures applicable to the safe handling and use of the product and to determine the suitability of the product for its intended use. All products supplied by Hexion are subject to Hexion’s terms and conditions of sale. HEXION MAKES NO WARRANTY, EXPRESS OR IMPLIED, CONCERNING THE PRODUCT OR THE MERCHANTABILITY OR FITNESS THEREOF FOR ANY PURPOSE OR CONCERNING THE ACCURACY OF ANY INFORMATION PROVIDED BY HEXION, except that the product shall conform to Hexion’s specifications. Nothing contained herein constitutes an offer for the sale of any product.
3 Polyvinylchloride (PVC), Type 1, was supplied by McMaster-Carr Supply Company
4 Polyurethane was supplied by McMaster-Carr Supply Company and had a Shore Durometer reading of 75 and a tensile strength of 7500 psi
5 Polyethylene terephthalate (PET) was supplied by McMaster-Carr Supply Company
6 Nylon was supplied by ElfAtochem as Rilsan® Polyamide 11 Resin
7 Dynamic Mechanical Analysis, Rectangular Torsional Geometry, 1 °C/min

* All samples failed in tensile mode within the bond line.

Storage Recommendations regarding storage conditions can be obtained by visiting our website at www.hexion.com

General Information
These are starting formulations and are not proven in the user’s particular application but are simply meant to demonstrate the efficacy of the products and to assist in the development of the user’s own formulation. It is the user’s responsibility to fully test and qualify the formulation, along with the ingredients, methods, applications or equipment identified herein (“Information”), by the user’s knowledgeable formulator or scientist, and to determine the appropriate use conditions and legal restrictions, prior to use of any Information.

Safety, Storage & Handling
Please refer to the MSDS for the most current Safety and Handling information.

Exposure to these materials should be minimized and avoided, if feasible, through the observance of proper precautions, use of appropriate engineering controls and proper personal protective clothing and equipment, and adherence to proper handling procedures. None of these materials should be used, stored, or transported until the handling precautions and recommendations as stated in the Material Safety Data Sheet (MSDS) for these and all other products being used are understood by all persons who will work with them. Questions and requests for information on Hexion, Inc. (“Hexion”) products should be directed to your Hexion sales representative, or the nearest Hexion sales office. Information and MSDSs on non-Hexion products should be obtained from the respective manufacturer.

Contact Information
For product prices, availability, or order placement, please contact customer service:
www.hexion.com/Contacts/

For literature and technical assistance, visit our website at www.hexion.com