Starting Formulation

SF 7011

General Purpose Electric Molding Compounding

EPON™ Resin 1002F

Introduction
This general purpose electrical molding compound provides good mechanical and electrical properties for transfer or compression molding of electrical and electronic components. The combination of tetrachlorophthalic anhydride and 3,3′,4,4′-benzophenone tetracarboxylic dianhydride provides acceptable cured state properties at a low press cycle temperature of 150 °C.

Formula

<table>
<thead>
<tr>
<th>Material</th>
<th>Supplier</th>
<th>Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPON Resin 1002F</td>
<td>Hexion</td>
<td>100.0</td>
</tr>
<tr>
<td>Tetrachlorophthalic Anhydride, (TCPA)</td>
<td>Monsanto Co.</td>
<td>22.7</td>
</tr>
<tr>
<td>3,3′,4,4′-Benzophenone Tetracarboxylic Dianhydride, (BTDA)</td>
<td>Allco Chemical Co.</td>
<td>11.2</td>
</tr>
<tr>
<td>Zinc Stearate</td>
<td>Witco Chemical Corp.</td>
<td>6.0</td>
</tr>
<tr>
<td>Carnauba Wax</td>
<td>Frank B. Ross Co., Inc.</td>
<td>1.3</td>
</tr>
<tr>
<td>Carbon Black</td>
<td>Columbian Chemical Co.</td>
<td>1.3</td>
</tr>
<tr>
<td>Fused Silica, GP-111</td>
<td>Cambell Chemical Co.</td>
<td>317.4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>459.9</td>
</tr>
</tbody>
</table>

Compounding
Grind components not supplied in powder form to a particle size finer than 50 mesh using a hammermill. All anhydrides need to be approximately 325 mesh. Add raw materials in the order given and blend to a homogeneous mix. A Twin-Shell blender equipped with an intensifier bar works well for this step. Charge the loose powder in the feed hopper of a single or double screw extruder, or a 2-roll mill, between 71 and 88 °C. Granulate to between 8 and 50 mesh for general purpose use or press into preforms after granulating for subsequent molding.

Typical Handling

Table 1 / Handling Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Units</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Granular</td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td>Black</td>
<td></td>
</tr>
<tr>
<td>Gel Time</td>
<td>sec.</td>
<td>60</td>
</tr>
<tr>
<td>at 150 °C</td>
<td>sec.</td>
<td>28</td>
</tr>
<tr>
<td>Specific Gravity at 25 °C</td>
<td>g/ml</td>
<td>1.76</td>
</tr>
</tbody>
</table>

Molding Conditions
Satisfactory cures can be achieved in 1 to 4 minutes at 120 to 180 °C in a transfer press. A press cycle time of less than 2 minutes is practical for parts molded in the temperature range of 150 to 180 °C. A useful transfer pressure range is 500 to 2,000 psi.
## Typical Molding Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Units</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spiral Flow per EMMI 1-66, 1,000 psi at 180 °C</td>
<td>in</td>
<td>46</td>
</tr>
<tr>
<td>Hot Hardness upon ejection from 180 °C mold</td>
<td>Shore D</td>
<td>75</td>
</tr>
</tbody>
</table>

## Typical Cured State Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Units</th>
<th>As Molded</th>
<th>Post Cured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Deflection Temperature</td>
<td>°C</td>
<td>115</td>
<td>130</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>psi</td>
<td>11,000</td>
<td>10,500</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>psi</td>
<td>20,000</td>
<td>18,500</td>
</tr>
<tr>
<td>Molded Density</td>
<td>gm/cc</td>
<td>1.76</td>
<td>1.76</td>
</tr>
<tr>
<td>Mold Shrinkage</td>
<td>cm/cm</td>
<td>0.006</td>
<td>0.006</td>
</tr>
</tbody>
</table>

### Electrical

#### Volume Resistivity

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Units</th>
<th>As Molded</th>
<th>Post Cured</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 °C</td>
<td>ohm•cm</td>
<td>$1.0 \times 10^{16}$</td>
<td>$4.0 \times 10^{16}$</td>
</tr>
<tr>
<td>66 °C</td>
<td>ohm•cm</td>
<td>$2.8 \times 10^{15}$</td>
<td>$5.7 \times 10^{15}$</td>
</tr>
<tr>
<td>93 °C</td>
<td>ohm•cm</td>
<td>$1.6 \times 10^{14}$</td>
<td>$4.2 \times 10^{14}$</td>
</tr>
<tr>
<td>130 °C</td>
<td>ohm•cm</td>
<td>$5.2 \times 10^{12}$</td>
<td>$8.7 \times 10^{12}$</td>
</tr>
<tr>
<td>150 °C</td>
<td>ohm•cm</td>
<td>$4.5 \times 10^{11}$</td>
<td>$5.5 \times 10^{11}$</td>
</tr>
<tr>
<td>180 °C</td>
<td>ohm•cm</td>
<td>$4.0 \times 10^{10}$</td>
<td>$4.8 \times 10^{10}$</td>
</tr>
</tbody>
</table>

#### Dielectric Constant

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 °C</td>
<td>3.79</td>
</tr>
<tr>
<td>40 °C</td>
<td>3.80</td>
</tr>
<tr>
<td>60 °C</td>
<td>3.81</td>
</tr>
<tr>
<td>80 °C</td>
<td>3.86</td>
</tr>
<tr>
<td>100 °C</td>
<td>3.91</td>
</tr>
<tr>
<td>120 °C</td>
<td>4.23</td>
</tr>
<tr>
<td>140 °C</td>
<td>4.35</td>
</tr>
<tr>
<td>160 °C</td>
<td>4.36</td>
</tr>
<tr>
<td>180 °C</td>
<td>4.39</td>
</tr>
</tbody>
</table>

#### Dissipation Factor

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 °C</td>
<td>0.002</td>
</tr>
<tr>
<td>40 °C</td>
<td>0.002</td>
</tr>
<tr>
<td>60 °C</td>
<td>0.002</td>
</tr>
<tr>
<td>80 °C</td>
<td>0.004</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Temperature</th>
<th>Loss Factor 1</th>
<th>Loss Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 °C</td>
<td>0.004</td>
<td>0.002</td>
</tr>
<tr>
<td>100 °C</td>
<td>0.009</td>
<td>0.004</td>
</tr>
<tr>
<td>120 °C</td>
<td>0.025</td>
<td>0.020</td>
</tr>
<tr>
<td>140 °C</td>
<td>0.020</td>
<td>0.020</td>
</tr>
<tr>
<td>160 °C</td>
<td>0.040</td>
<td>0.016</td>
</tr>
<tr>
<td>180 °C</td>
<td>0.076</td>
<td>0.036</td>
</tr>
</tbody>
</table>

Loss Factor

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Loss Factor 1</th>
<th>Loss Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 °C</td>
<td>0.009</td>
<td>0.007</td>
</tr>
<tr>
<td>40 °C</td>
<td>0.007</td>
<td>0.006</td>
</tr>
<tr>
<td>60 °C</td>
<td>0.008</td>
<td>0.006</td>
</tr>
<tr>
<td>80 °C</td>
<td>0.015</td>
<td>0.009</td>
</tr>
<tr>
<td>100 °C</td>
<td>0.034</td>
<td>0.015</td>
</tr>
<tr>
<td>120 °C</td>
<td>0.106</td>
<td>0.081</td>
</tr>
<tr>
<td>140 °C</td>
<td>0.085</td>
<td>0.084</td>
</tr>
<tr>
<td>160 °C</td>
<td>0.173</td>
<td>0.087</td>
</tr>
<tr>
<td>180 °C</td>
<td>0.335</td>
<td>0.151</td>
</tr>
</tbody>
</table>

1 Values were obtained by testing bars molded from dielectrically heated preforms at 175 °C for 3 minutes at 1,000 psi.

2 Bars were postcured for 4 hours at 175 °C.

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