Recommended Adhesives for Thermofoil™ Heater Installation

Performance of a Thermofoil heater often depends on the materials and techniques used to install it, but no single adhesive meets the needs of all possible applications. This Application Aid compares several adhesives to help you determine the best alternative for the operating and environmental conditions your heater will encounter.

**Adhesive types**

Mounting methods fall into four categories:

**Films:**
This category includes #12 and #19 pressure-sensitive adhesives (PSA’s), factory applied by Minco. In general, films are preferred for their uniform thickness and lack of bubbles. PSA’s are easy to apply but have limited temperature ranges. Minco #17 is an adhesive film approved for space/vacuum environments but requires a relatively high level of heat and pressure to cure. Ablefilm 550K has the best combination of performance and ease of application but carries a high price.

**Liquid adhesive:**
RTV’s and epoxies work better than PSA for curved surfaces and higher watt ratings, but can often include air bubbles unless given special handling. Bubbles under the heater cause localized overheating and possible heater burnout. Special techniques such as drawing a vacuum on the adhesive after mixing, or perforating heaters between strands, are recommended for critical aerospace applications. Aluminum backing helps spread heat away from remaining bubbles, and is therefore recommended if heaters will operate near the upper limit of their watt density ratings.

**Tape and shrink bands:**
By eliminating the adhesive layer between the heater and heat sink, tape and bands allow fairly high watt densities. They are, however, limited to smooth cylindrical surfaces. Operation in a vacuum may require special installation methods and/or derating of heater power.

**Minco mounting:**
Minco has developed proprietary specialized lamination techniques and equipment to factory mount heaters for best performance. We generally use film type adhesives for Kapton, vulcanization for rubber. We can bond heaters to customer-supplied parts or fabricate complete assemblies in our machine shop.
<table>
<thead>
<tr>
<th>Adhesive</th>
<th>Description</th>
<th>Kapton / FEP insulation</th>
<th>Kapton insulation with aluminum backing</th>
<th>Silicone rubber insulation</th>
<th>Silicone rubber insulation with aluminum backing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No adhesive</td>
<td>Heater only</td>
<td>-200°C to 200°C (-328°F to 392°F)</td>
<td>-200°C to 150°C (-328°F to 302°F)</td>
<td>-45°C to 235°C (-49°F to 455°F)</td>
<td>-45°C to 235°C (-49°F to 455°F)</td>
</tr>
<tr>
<td>Minco #10</td>
<td>0.002” (50µ) PSA film</td>
<td>-32°C to 100°C (-25°F to 212°F)</td>
<td>-32°C to 150°C (-25°F to 302°F)</td>
<td>Not suitable</td>
<td>-32°C to 150°C (-25°F to 302°F)</td>
</tr>
<tr>
<td>Minco #12</td>
<td>0.002” (50µ) PSA film</td>
<td>Not Suitable</td>
<td>-73°C to 150°C (-100°F to 302°F)</td>
<td>-45°C to 177°C (-49°F to 350°F)</td>
<td>-45°C to 204°C (-49°F to 400°F)</td>
</tr>
<tr>
<td>Minco #19</td>
<td>0.002” (50µ) PSA film</td>
<td>-32°C to 100°C (-25°F to 212°F)</td>
<td>-32°C to 150°C (-25°F to 302°F)</td>
<td>Not suitable</td>
<td>-32°C to 150°C (-25°F to 302°F)</td>
</tr>
<tr>
<td>Minco #17</td>
<td>0.001” (25µ) film</td>
<td>-200°C to 150°C (-328°F to 302°F)</td>
<td>-200°C to 150°C (-328°F to 302°F)</td>
<td>Not suitable</td>
<td>-45°C to 150°C (-49°F to 302°F)</td>
</tr>
<tr>
<td>Ablefilm 550K</td>
<td>0.003” - 0.008” (75µ - 200µ) film</td>
<td>-54°C to 150°C (-65°F to 302°F)</td>
<td>-54°C to 150°C (-65°F to 302°F)</td>
<td>Not suitable</td>
<td>-45°C to 150°C (-49°F to 302°F)</td>
</tr>
<tr>
<td>Minco #6</td>
<td>1-part paste RTV</td>
<td>Not suitable</td>
<td>Not suitable</td>
<td>-45°C to 235°C (-49°F to 455°F)</td>
<td>Not suitable</td>
</tr>
<tr>
<td>GE #566</td>
<td>2-part paste RTV</td>
<td>-115°C to 200°C (-175°F to 392°F)</td>
<td>-115°C to 150°C (-175°F to 302°F)</td>
<td>-45°C to 235°C (-49°F to 455°F)</td>
<td>-45°C to 235°C (-49°F to 455°F)</td>
</tr>
<tr>
<td>Minco #15</td>
<td>2-part liquid epoxy</td>
<td>-70°C to 115°C (-94°F to 239°F)</td>
<td>-70°C to 115°C (-94°F to 239°F)</td>
<td>Not suitable</td>
<td>-45°C to 115°C (-49°F to 239°F)</td>
</tr>
<tr>
<td>Lord Adhesives (Crest) 3135 A/B</td>
<td>2-part liquid epoxy</td>
<td>-195°C to 93°C (-320°F to 200°F)</td>
<td>-195°C to 93°C (-320°F to 200°F)</td>
<td>Not suitable</td>
<td>-45°C to 93°C (-49°F to 200°F)</td>
</tr>
<tr>
<td>Minco “BM3”</td>
<td>Mylar Shrink Band</td>
<td>-73°C to 149°C (-100°F to 300°F)</td>
<td>-73°C to 149°C (-100°F to 300°F)</td>
<td>-45°C to 149°C (-49°F to 300°F)</td>
<td>Not suitable</td>
</tr>
<tr>
<td>Minco “BK4”</td>
<td>Kapton Shrink Band</td>
<td>-73°C to 177°C (-100°F to 350°F)</td>
<td>-73°C to 150°C (-100°F to 302°F)</td>
<td>-45°C to 177°C (-49°F to 350°F)</td>
<td>Not suitable</td>
</tr>
<tr>
<td>Minco #20</td>
<td>Silicone Rubber stretch tape</td>
<td>-51°C to 200°C (-60°F to 392°F)</td>
<td>-51°C to 150°C (-60°F to 302°F)</td>
<td>-45°C to 200°C (-49°F to 392°F)</td>
<td>Not suitable</td>
</tr>
</tbody>
</table>

**Special Applications:** Various adhesive manufacturers can supply custom mixed epoxies to meet unique requirements. Some possibilities are: Flame retardant epoxies, flexible epoxies, silver-filled epoxies for high thermal conductivity, low or high viscosity epoxies.

For additional information on heaters for thermal control of spacecraft components refer to “ADHESIVE BONDING OF KAPTON FILM HEATERS”; R.J. Martin, A.E. Hultquist, H.A. Kawayoshi, Lockheed Missile & Space Co., Inc; Space Systems Division, Sunnydale, CA, USA
<table>
<thead>
<tr>
<th>Application Instruction</th>
<th>Thermal conductivity * at 25°C W/(in·°C)</th>
<th>Max. watt density ** at 25°C W/in²</th>
<th>Approvals</th>
<th>Shelf life</th>
<th>Comments</th>
<th>Adhesive</th>
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</thead>
<tbody>
<tr>
<td>EI 138</td>
<td>0.0045</td>
<td>20</td>
<td>GSFC S-311-P-079 listed Low outgassing UL recognized</td>
<td>6 months</td>
<td>Uniform thickness Easy to apply Flat surfaces only</td>
<td>Minco #10</td>
</tr>
<tr>
<td>EI 266</td>
<td>0.0032</td>
<td>33</td>
<td>NASA-RP-1124 listed Low outgassing UL recognized</td>
<td>3 months</td>
<td>Uniform thickness Easy to apply Flat or slightly curved surfaces</td>
<td>Minco #12</td>
</tr>
<tr>
<td>EI 138</td>
<td>0.0045</td>
<td>20</td>
<td>NASA-RP-1124 listed Low outgassing UL recognized</td>
<td>6 months</td>
<td>Uniform thickness Easy to apply Flat surfaces only</td>
<td>Minco #19</td>
</tr>
<tr>
<td>EI 503</td>
<td>0.0058</td>
<td>45</td>
<td>NASA-RP-1124 listed Low outgassing UL recognized</td>
<td>6 months</td>
<td>Uniform thickness Difficult to apply Good option for factory installation</td>
<td>Minco #17</td>
</tr>
<tr>
<td></td>
<td>0.0200</td>
<td>34</td>
<td>NASA-RP-1124 listed Low outgassing</td>
<td>6 months</td>
<td>Uniform thickness Easy to apply Expensive</td>
<td>Ablefilm 550K</td>
</tr>
<tr>
<td>EI 117</td>
<td>0.0052</td>
<td>23</td>
<td>FDA-121.2514 UL recognized</td>
<td>6 months</td>
<td>High temperature capability</td>
<td>Minco #6</td>
</tr>
<tr>
<td></td>
<td>0.0052</td>
<td>16</td>
<td>NASA-RP-1124 listed Low outgassing Mil-A-00509 (salt spray) Mil-A-8623</td>
<td>6 months</td>
<td>Proper mixing is essential High temperature capability</td>
<td>GE #566</td>
</tr>
<tr>
<td>EI 507</td>
<td>0.0223</td>
<td>38</td>
<td>NASA-RP-1124 listed Low outgassing</td>
<td>6 months (freezer)</td>
<td>Easy to use dispenser High thermal conductivity</td>
<td>Minco #15</td>
</tr>
<tr>
<td></td>
<td>0.0036</td>
<td>5</td>
<td>NASA-RP-1124 listed Low outgassing</td>
<td>1 year</td>
<td>Slightly flexible Cryogenic rating</td>
<td>Lord Adhesives (Crest) 3135A/B</td>
</tr>
<tr>
<td>EI 103</td>
<td>N/A</td>
<td>50</td>
<td>NASA-RP-1124 listed Low outgassing</td>
<td>1 year</td>
<td>Easy to apply Removable Smooth cylinders only</td>
<td>Minco “BM3”</td>
</tr>
<tr>
<td>EI 103</td>
<td>N/A</td>
<td>50</td>
<td>NASA-RP-1124 listed Low outgassing</td>
<td>4 months</td>
<td>Easy to apply Removable Smooth cylinders only</td>
<td>Minco “BK4”</td>
</tr>
<tr>
<td>EI 124</td>
<td>N/A</td>
<td>50</td>
<td>NASA-RP-1124 listed Low outgassing</td>
<td>6 months</td>
<td>Easy to apply Smooth cylinders only</td>
<td>Minco #20</td>
</tr>
</tbody>
</table>

* Thermal conductivity ratings are not available for all adhesives. For those without data we assumed a conservative (on the low side) value of 0.0036 W/in/°C.

** Ratings are given for Kapton heaters at 25°C for comparison. The maximum allowable watt density is a function of the heater’s temperature rating, the adhesive’s rating, and the temperature gradient between the heater and the heat sink.
**Minco #10 and #19 PSA**
- Easy to use.
- Uniform 0.002” thickness.
- Meets NASA outgassing limits.
- Minco #10 (3M #966) is specified in NASA / GSFC S-311-P-079.
- Relatively low thermal conductivity and temperature range.
- Widely used on Minco’s standard and custom Kapton heaters.
- May be used on silicone rubber heaters with aluminum backing.
- See watt density chart for Kapton heaters in Minco’s Thermofoil Heater Bulletin.
- Request Engineering Instruction 138 for mounting information.

**Minco #12 PSA**
- Easy to use.
- Uniform 0.002” thickness.
- Widely used on Minco’s standard and custom silicone rubber heaters.
- May be used on Kapton heaters with aluminum backing.
- See watt density chart for rubber heaters in Minco’s Thermofoil Heater Bulletin.
- Request Engineering Instruction 266 for mounting information.

**Minco #17 adhesive film**
- No bubbles.
- Uniform 0.001” thickness.
- Meets NASA outgassing limits.
- Need lamination equipment, requires 100-250 psi at 163°C (325°F) to apply.
- See watt density chart for Kapton heaters in Minco’s Thermofoil Heater Bulletin.
- Request Engineering Instruction 503 for mounting information.

**Minco #6 RTV**
- Wide temperature range.
- Care required to prevent bubbles.
- Only suitable for silicone rubber heaters with 5” maximum distance between center and edge.
- See watt density chart for silicone rubber heaters in Minco’s Thermofoil Heater Bulletin.
- Request Engineering Instruction 117 for mounting information.

**Minco #15 epoxy**
- Easy to mix and dispense; comes in pre-measured packets.
- Good thermal conductivity.
- Meets NASA outgassing limits.
- Care required to prevent bubbles.
- See watt density chart for Kapton heaters in Minco’s Thermofoil Heater Bulletin.
- Request Engineering Instruction 507 for mounting information.

**Minco #3 and #4 shrink bands, #20 stretch tape**
- Easy installation.
- Heater is removable.
- Cylindrical mounting only.
- Special precautions required for vacuum environments.
- See watt density chart for Kapton heaters in Minco’s Thermofoil Heater Bulletin.
- Request Engineering Instruction 103 (shrink bands) or 124 (#20 stretch tape) for mounting information.

**Ablefilm 550K**
- www.ablestik.com
- Easy to apply; requires just 1 psi at 150°C (302°F)
- No bubbles.
- Good thermal conductivity.
- Meets NASA outgassing limits.
- Store in dry ice for maximum shelf life.

**GE 566 RTV**
- www.gesilicones.com
- Wide temperature range down to -115°C (-175°F)
- Meets NASA outgassing limits.
- Care required to prevent bubbles.
- 2-part material, proper mixing is essential.
- Some mounting surfaces require primer.

**Lord (Crest) #3135 A & B**
- www.lordadhesives.com
- Cryogenic rating.
- Care required to prevent bubbles.

**Important notice:**
Any adhesive with a Minco number has been tested by Minco. Other recommendations are based on manufacturers’ data and customer usage. We believe this information to be reliable, but the customer must test these adhesives in their application and assume responsibility for their performance. Minco accepts no liability beyond our standard warranty for consequences of heater or adhesive failure.