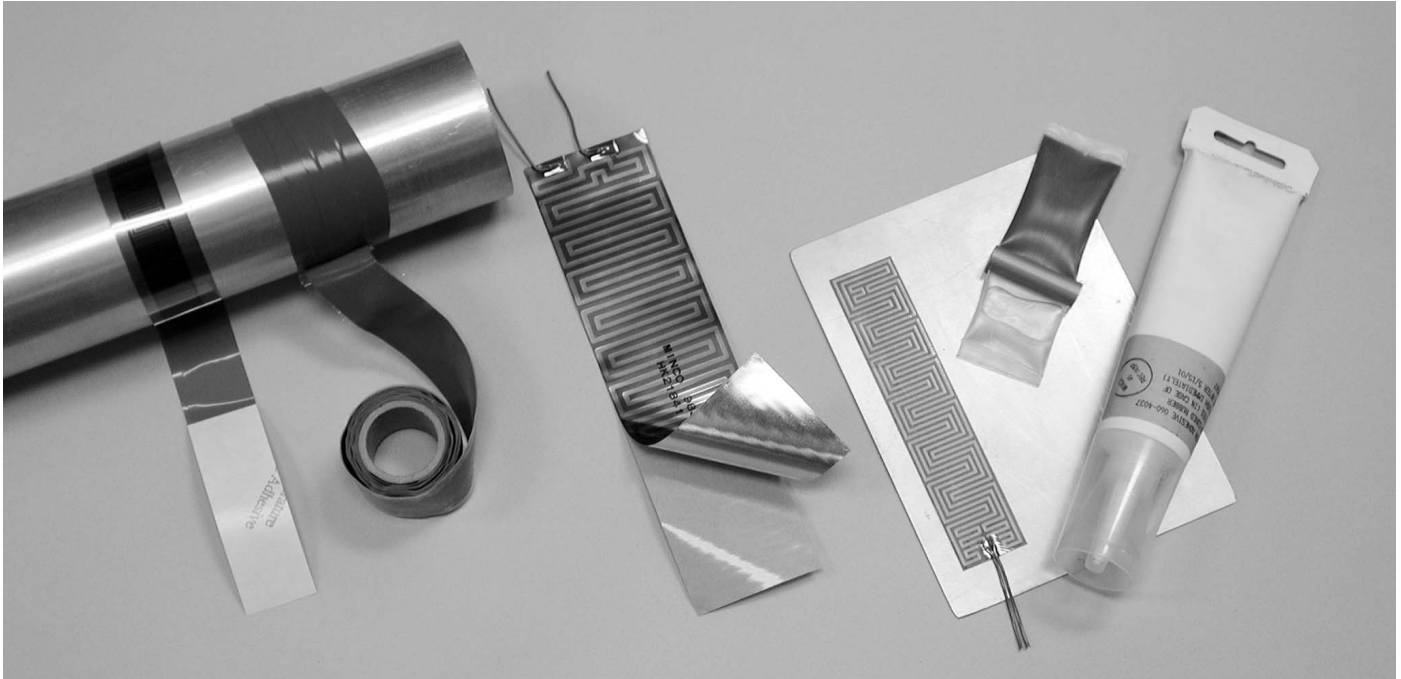


## Recommended Adhesives for Thermofoil™ Heater Installation



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.

Adhesive	Description	Suitability & temperature range			
		Kapton / FEP insulation	Kapton insulation with aluminum backing	Silicone rubber insulation	Silicone rubber insulation with aluminum backing
No adhesive	Heater only	-200°C to 200°C (-328°F to 392°F)	-200°C to 150°C (-328°F to 302°F)	-45°C to 235°C (-49°F to 455°F)	-45°C to 235°C (-49°F to 455°F)
Minco #10	0.002" (50μ) PSA film	-32°C to 100°C (-25°F to 212°F)	-32°C to 150°C (-25°F to 302°F)	Not suitable	-32°C to 150°C (-25°F to 302°F)
Minco #12	0.002" (50μ) PSA film	Not Suitable	-73°C to 150°C (-100°F to 302°F)	-45°C to 177°C (-49°F to 350°F)	-45°C to 204°C (-49°F to 400°F)
Minco #19	0.002" (50μ) PSA film	-32°C to 100°C (-25°F to 212°F)	-32°C to 150°C (-25°F to 302°F)	Not suitable	-32°C to 150°C (-25°F to 302°F)
Minco #17	0.001" (25μ) film	-200°C to 150°C (-328°F to 302°F)	-200°C to 150°C (-328°F to 302°F)	Not suitable	-45°C to 150°C (-49°F to 302°F)
Ablefilm 550K	0.003" - 0.008" (75μ - 200μ) film	-54°C to 150°C (-65°F to 302°F)	-54°C to 150°C (-65°F to 302°F)	Not suitable	-45°C to 150°C (-49°F to 302°F)
Minco #6	1-part paste RTV	Not suitable	Not suitable	-45°C to 235°C (-49°F to 455°F)	Not suitable
GE #566	2-part paste RTV	-115°C to 200°C (-175°F to 392°F)	-115°C to 150°C (-175°F to 302°F)	-45°C to 235°C (-49°F to 455°F)	-45°C to 235°C (-49°F to 455°F)
Minco #15	2-part liquid epoxy	-70°C to 115°C (-94°F to 239°F)	-70°C to 115°C (-94°F to 239°F)	Not suitable	-45°C to 115°C (-49°F to 239°F)
Lord Adhesives (Crest) 3135 A/B	2-part liquid epoxy	-195°C to 93°C (-320°F to 200°F)	-195°C to 93°C (-320°F to 200°F)	Not suitable	-45°C to 93°C (-49°F to 200°F)
Minco "BM3"	Mylar Shrink Band	-73°C to 149°C (-100°F to 300°F)	-73°C to 149°C (-100°F to 300°F)	-45°C to 149°C (-49°F to 300°F)	Not suitable
Minco "BK4"	Kapton Shrink Band	-73°C to 177°C (-100°F to 350°F)	-73°C to 150°C (-100°F to 302°F)	-45°C to 177°C (-49°F to 350°F)	Not suitable
Minco #20	Silicone Rubber stretch tape	-51°C to 200°C (-60°F to 392°F)	-51°C to 150°C (-60°F to 302°F)	-45°C to 200°C (-49°F to 392°F)	Not suitable

**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

Application Instruction	Thermal conductivity * at 25°C W/(in·°C)	Max. watt density ** at 25°C W/in <sup>2</sup>	Approvals	Shelf life	Comments	Adhesive
						No adhesive
EI 138	0.0045	20	GSFC S-311-P-079 listed Low outgassing UL recognized	6 months	Uniform thickness Easy to apply Flat surfaces only	Minco #10
EI 266	0.0032	33		3 months	Uniform thickness Easy to apply Flat or slightly curved surfaces	Minco #12
EI 138	0.0045	20	NASA-RP-1124 listed Low outgassing UL recognized	6 months	Uniform thickness Easy to apply Flat surfaces only	Minco #19
EI 503	0.0058	45	NASA-RP-1124 listed Low outgassing UL recognized	6 months	Uniform thickness Difficult to apply Good option for factory installation	Minco #17
	0.0200	34	NASA-RP-1124 listed Low outgassing	6 months	Uniform thickness Easy to apply Expensive	Ablefilm 550K
EI 117	0.0052	23	FDA-121.2514 UL recognized	6 months	High temperature capability	Minco #6
	0.0052	16	NASA-RP-1124 listed Low outgassing Mil-A-00509 (salt spray) Mil-A-8623	6 months	Proper mixing is essential High temperature capability	GE #566
EI 507	0.0223	38	NASA-RP-1124 listed Low outgassing	6 months (freezer)	Easy to use dispenser High thermal conductivity	Minco #15
	0.0036	5	NASA-RP-1124 listed Low outgassing	1 year	Slightly flexible Cryogenic rating	Lord Adhesives (Crest) 3135A/B
EI 103	N/A	50	NASA-RP-1124 listed Low outgassing	1 year	Easy to apply Removable Smooth cylinders only	Minco "BM3"
EI 103	N/A	50	NASA-RP-1124 listed Low outgassing	4 months	Easy to apply Removable Smooth cylinders only	Minco "BK4"
EI 124	N/A	50		6 months	Easy to apply Smooth cylinders only	Minco #20

\* 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](http://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](http://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](http://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.**

**MINCO**  
ISO 9001

### Minco Products, Inc. (Main Office)

7300 Commerce Lane  
Minneapolis, MN 55432-3177  
U.S.A.  
Tel: 1-763-571-3121  
Fax: 1-763-571-0927

Stock order desk:  
Tel: 1-763-571-3123  
Fax: 1-763-571-9142



Internet:  
[sales@minco.com](mailto:sales@minco.com)  
[www.minco.com](http://www.minco.com)

### Minco S.A.

Usine et Service  
Commercial, Z.I.  
09310 Aston, France  
Tel: (33) 5 61 03 24 01  
Fax: (33) 5 61 03 24 09

### Minco EC

Hirzenstrasse 2  
CH-9244 Niederuzwil  
Switzerland  
Tel: (41) 71 952 79 89  
Fax: (41) 71 952 79 90