HT® 424 Adhesive Film

DESCRIPTION

HT® 424 is an aluminum-filled, modified epoxy-phenolic resin coated on a glass carrier. It was developed for bonding metal-to-metal and sandwich composite structures requiring long-term exposure to 300°F (149°C) and short-term exposure to 500°F (260°C). HT 424 has outstanding adaptability to many bonding procedures. Wide variations in bonding temperatures [12 hours at 230°F (110°C) to 40 minutes at 340°F (171°C)] are permissible without sacrificing physical properties. The recommended cure cycle is 40 minute ramp to 340°F (171°C) and 40 minute dwell at 340 ± 10°F (171 ± 5°C) with 40 psi (0.276 MPa).

HT 424 adhesive film may be used with or without a primer. The film-primer system offers the advantage of protecting the clean metal prior to final assembly.

HT 424 adhesive film, 0.135 psf (0.66 kg/m2) meets all the requirements of Federal Specification MMM-A-132 and Military Specification MIL-A-25463, Type II and Type III.

The following products are included in the HT 424 product family:

HT 424 primer – two parts, A and B

HT 424 F primer – one part, supplied at 30% and 90% solids

HT 424 thinner – for diluting the above primers

HT 424 thixotropic paste* – two parts, A and B

HT 424 adhesive foam, Type I* – liquid

HT 424 adhesive foam, Type II* – sheet foam

HT 432 adhesive film* – HT 424 resin on a lighter carrier

HT 435 adhesive film* – no aluminum filler; for use where electrical transparency is required

* Technical information concerning these products may be obtained in their respective brochures

CHARACTERISTICS

Table 1 | HT 424 Adhesive Films – Product Description

Form	Moderately tacky film, glass carrier
Color	Gray
Volatiles	4 – 7.5%
Shelf Life	6 months from date of shipment when stored at or below 0°F (-18°C)
Shop Life	3 days at or below 85°F (29°C) or 12 days at or below 75°F (24°C)

Table 2 | HT 424 Adhesive Films – Availability

Standard Weight	Approximate Thickness
0.080 ± 0.005 psf (0.391 ± 0.025 kg/m^2)	0.010 inch (0.254 mm)
0.100 ± 0.005 psf (0.490 ± 0.025 kg/m^2)	0.012 inch (0.304 mm)
0.135 ± 0.005 psf (0.660 ± 0.025 kg/m^2)	0.015 inch (0.380 mm)
0.170 ± 0.010 psf (0.833 ± 0.050 kg/m^2)	0.019 inch (0.508 mm)

Table 3 | HT 424 Primer, Two Parts – Product Description

Solids	Part A: 19.2 ± 2% Part B: 41.9 ± 3%
Shelf Life	Part A and B: 6 months from date of shipment when stored at or below 85°F (29°C)

Table 4 | HT 424 F Primer, One Part – Product Description

Solids	30% and 90%
Color	Gray
Shelf Life	30% solids: 6 months from date of shipment when stored at or below 40°F (4.4°C) 90% solids: 6 months from date of shipment when stored at or below 0°F (-18°C)

Table 5 | HT 424 Thinner – Product Description

Shelf Life	6 months from date of shipment when stored at or below 85°F (29°C)

PROPERTIES

The mechanical properties of HT 424 adhesive film metal-to-metal bonds on aluminum alloy and stainless steel are reported in Tables 6 and 7, respectively. Test methods of specification MMM-A-132, Type II and Type III were used in the development of this data. The physical properties of HT 424 adhesive film sandwich construction tests of MIL-A-25463 (ASG) Type II and Type III are reported in Tables 9 and 10, respectively.

Table 6 | Properties of HT 424 Adhesive Film, 0.135 psf (0.66 kg/m^2), tested in conformance with MMM-A-132, Type II, 2024-T3 Aluminum

Test Number	Property and Test Condition	Specification Average Requirement	Average Results
1	**Tensile Shear, psi (MPa)** 75 ± 5°F (24 ± 3°C)	2250 (15.52)	3550 (24.48)
3	**Tensile Shear, psi (MPa)** 10 minutes at 300 ± 5°F (149 ± 3°C)	2000 (13.79)	2760 (19.03)
4	**Tensile Shear, psi (MPa)** 192 hours at 300 ± 5°F (149 ± 3°C)	2000 (13.79)	2890 (19.93)
5	**Tensile Shear, psi (MPa)** 10 minutes at 500 ± 5°F (260 ± 3°C)	None	2000 (13.79)
7	**Tensile Shear, psi (MPa)** 10 minutes at -67 ± 5°F (-55 ± 3°C)	2250 (15.52)	3224 (22.24)
8	**Fatigue Strength, psi (MPa)** 75 ± 5°F (24 ± 3°C)	600 (4.14) 10^7 cycles	No failure
9	**Creep-rupture 1600 psi (11.03 MPa)** 192 hours, 75 ± 5°F (24 ± 3°C) maximum deformation	0.015 inch (0.38 mm)	0.003 inch (0.07 mm)
11	**Creep-rupture 800 psi (5.52 MPa)** 192 hours, 300 ± 5°F (149 ± 3°C) maximum deformation	0.015 inch (0.38 mm)	0.010 inch (0.254 mm)
13	**Tensile Shear, psi (MPa),** 75 ± 5°F (24 ± 3°C) After 30 days salt water spray	2100 (14.49)	2960 (20.41)
15	**Tensile Shear, psi (MPa),** 75 ± 5°F (24 ± 3°C) After 7 days immersion in JP-4 fuel (MIL-J-5624) After 7 days immersion in anti-icing fluid (MIL-F-5566) After 7 days immersion in hydraulic oil (MIL-H-5606) After 7 days immersion in standard test fluid Type III (MIL-S-3136) After 30 days immersion in tap water	 2100 (14.49) 2100 (14.49) 2100 (14.49) 2100 (14.49) 2100 (14.49)	 3335 (23.00) 3300 (22.76) 2945 (20.31) 3090 (21.31) 2610 (18.00)

Cure Cycle: 40 minute ramp to 330°F (166°C), 40 minute dwell at 330°F (166°C) with 40 psi (0.276 MPa)

PROPERTIES

Table 7 | Properties of HT 424 Adhesive Film, 0.135 psf (0.66 kg/m²), tested in conformance with MMM-A-132, Type III, 301 Stainless Steel

Test Number	Property and Test Condition	Specification Average Requirement	Average Results
1	**Tensile Shear, psi (MPa)** 75 ± 5°F (24 ± 3°C)	2250 (15.52)	3760 (25.93)
3	**Tensile Shear, psi (MPa)** 10 minutes at 300 ± 5°F (149 ± 3°C)	2000 (13.79)	2680 (18.48)
4	**Tensile Shear, psi (MPa)** 192 hours at 300 ± 5°F (149 ± 3°C)	2000 (13.79)	2880 (19.86)
5	**Tensile Shear, psi (MPa)** 10 minutes at 500 ± 5°F (260 ± 3°C)	1850 (12.76)	2200 (15.17)
7	**Tensile Shear, psi (MPa)** 10 minutes at -67 ± 5°F (-55 ± 3°C)	2250 (15.34)	3560 (24.55)
9	**Creep-rupture 1600 psi (11.03 MPa)** 192 hours, 75 ± 5°F (24 ± 3°C) maximum deformation	0.015 inch (0.38 mm)	0.004 inch (0.01 mm)
13	**Tensile Shear, psi (MPa)** 75 ± 5°F (24 ± 3°C) after 30 days salt water spray	2100 (14.48)	2460 (16.97)
15	**Tensile Shear, psi (MPa),** 75 ± 5°F (24 ± 3°C) After 7 days immersion in JP-4 fuel (MIL-J-5624) After 7 days immersion in anti-icing fluid (MIL-F-5566) After 7 days immersion in hydraulic oil (MIL-H-5606) After 7 days immersion in standard test fluid Type III (MIL-S-3136) After 30 days immersion in tap water	 2100 (14.48) 2100 (14.48) 2100 (14.48) 2100 (14.48) 2100 (14.48)	 3620 (24.97) 3510 (24.21) 3470 (23.93) 3500 (24.14) 3050 (21.03)
*	**Tensile Shear, psi (MPa)** After 30 days in Skydrol 500 at 160 ± 5°F (71 ± 3°C)	None	4000 (27.59)
*	**Tensile Shear, psi (MPa)** After 30 days at 165 ± 5°F (74 ± 3°C), 100% R.H.	None	2850 (19.66)

* Data in addition to requirements of MMM-A-132, Type III

Cure Cycle: 40 minute ramp to 330°F (166°C), 40 minute dwell at 330°F (166°C) with 40 psi (0.276 MPa)

Table 8 | Peel Strength of HT 424 Adhesive Film

Metal-to-Metal Climbing Drum Peel 0.020 inch (0.51 mm) 2024-T3 aluminum	
No primer	11 in lb/in (1.93 kN/m)
HT 424 primer	14 in lb/in (2.45 kN/m)

Climbing Drum Sandwich Peel 0.020 inch (0.51 mm) faces, 3/16", 0.002" aluminum core 3003S	
No primer	25 – 40 in lb/3" width (37.07 – 59.31 Nm/m)
HT 424 primer	30 – 40 in lb/3" width (44.48 – 59.31 Nm/m)

Table 9 | Properties of HT 424 Adhesive Film, 0.135 psf (0.66 kg/m²), tested in conformance with MIL-A-25463, A for Type II Material

Test Number	Property and Test Condition	Specification Average Requirement	Average Results
	Sandwich Peel, in lb/3 in width (Nm/m)		
1	At room temperature	25.5 (37.81)	33 (48.93)
2	At 180°F (82 ± 3°C)	15.0 (22.24)	31 (45.96)
3	At -67°F (-55 ± 3°C)	6.0 (8.90)	35 (51.89)
	Flatwise Tension, psi (MPa)		
4	At room temperature	450 (3.10)	700 (4.83)
5	At 300°F (149 ± 3°C)	350 (2.42)	485 (3.34)
6	At -67°F (-55 ± 3°C)	350 (2.42)	890 (6.14)
	Flexure, pounds (N)		
7	At room temperature	1750 (7784)	2450 (10898)
8	At 300°F (149 ± 3°C)	1500 (6672)	1840 (8184)
9	At -67°F (-55 ± 3°C)	1750 (7784)	2515 (11187)
10	After 192 hours at 300°F (149 ± 3°C)	1200 (5338)	2025 (9007)
	Creep Deflection after 192 hours, inches (mm)		
11	At room temperature, maximum	0.025 (0.635)	0.006 (0.15)
12	At 500°F (260 ± 3°C), maximum	0.050 (1.27)	0.010 (0.254)

Table 10 | Properties of HT 424 Adhesive Film, 0.135 psf (0.66 kg/m²), tested in conformance with MIL-A-25463, A for Type III Material

Test Number	Property and Test Condition	Specification Average Requirement	Average Results
	Sandwich Peel, in lb/3 in width (Nm/m)		
1	At room temperature	25.5 (37.81)	31 (45.96)
2	At 180°F (82 ± 3°C)	15.0 (22.24)	30 (44.48)
3	At -67°F (-55 ± 3°C)	6.0 (8.90)	32 (47.44)
	Flatwise Tension, psi (MPa)		
4	At room temperature	450 (3.10)	616 (4.24)
5	At 300°F (149 ± 3°C)	270 (1.86)	290 (2.00)
6	At -67°F (-55 ± 3°C)	350 (2.42)	760 (5.24)
	Flexure, pounds (N)		
7	At room temperature	1750 (7784)	2180 (9697)
8	At 300°F (149 ± 3°C)	1200 (5338)	1380 (6138)
9	At -67°F (-55 ± 3°C)	1750 (7784)	2270 (10097)
10	After 192 hours at 500°F (260 ± 3°C)	600 (2669)	1200 (5338)
	Creep Deflection after 192 hours, inches (mm)		
11	At room temperature, maximum	0.025 (0.635)	0.004 (0.11)
12	At 500°F (260 ± 3°C), maximum	0.050 (1.27)	0.008 (0.23)

APPLICATION NOTES

Metal Surface Preparation (Aluminum)

A clean, dry, grease-free surface is required for optimum performance.

A recommended procedure for cleaning aluminum skins prior to priming or bonding is as follows:

1. Vapor degrease, alkaline clean, rinse and check for water break
2. Immerse in sodium dichromate-sulfuric acid solution for 10 to 13 minutes at 145 to 155°F (63 to 68°C). This solution is made up as follows:

Sodium dichromate	28.5 grams
Sulfuric acid (conc.)	285.0 grams
Water (distilled or de-ionized)	to make one liter

3. Spray rinse with cold water at or below 75°F (24°C)
4. Immerse in cold water and repeat spray rinse
5. Check for water break and dry in vented oven below 150°F (66°C)

When HT 424 film is used without a primer, extreme care is recommended in handling the prepared surfaces. Surfaces should not be prepared more than 12 hours in advance of assembly operations.

HT 424 Primer Application

Two primers are available for use with HT 424 adhesive film where desired. HT 424 primers are used in the HT 424 high temperature adhesive system to further improve peel strength and to maintain metal cleanliness during production operations. They may be used on both honeycomb core and metal parts.

Table 11 | HT 424 Primers

Primer Designation	Form	Percent Solids	Conditions Indicating End Use
HT 424 primer	Two parts, A and B	30	Unfilled. Mix equal parts by weight of part A and part B. Good high temperature properties. Does not require agitation during application. Dilute 1 part primer to 1.5 parts thinner for spray
HT 424 F primer	One part	30 90	HT 424 F primer is sprayable at 30% solids. Filled. Recommended where optimum properties at high temperature are a prime requirement. Must be agitated during application. Dilute to 30% for spray application.

Note: Both primers may be diluted as necessary with HT 424 thinner.

To prime metal, brush or spray applications are generally used to produce a coating approximately 0.0005 in. (0.010 mm) to 0.001 in. (0.020 mm) thick after curing. Primers are dries as follows:

1. 30 minute air dry
2. 1 hour dry at 150°F (66°C)

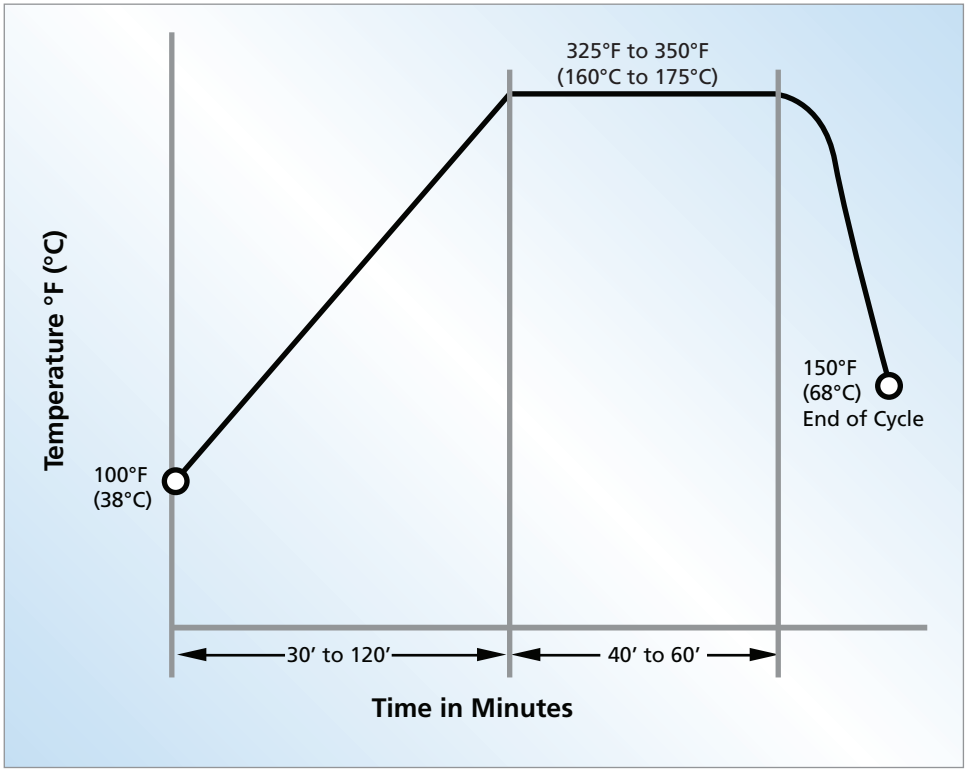
The parts may then be wrapped in paper and stored without fear of contamination.

Bonding Procedure

Assemblies may be bonded at pressures ranging from contact to 100 psi depending upon application. For press, autoclave, pressure diaphragm or vacuum bag, the following curing cycle is recommended for heavier films, i.e., 0.15 to 0.20 psf (0.75 to 1.0 kg/m^2).

1. Apply pressure to assembly
2. Raise temperature, measured by thermocouple at glue line, to 340°F (171°C) in 30 to 120 minutes
3. Cure assembly for 40 minutes at 340 ± 10°F (171 ± 5°C).

Figure 1 | Typical Cure Cycle for HT 424 Adhesive Film



PRODUCT HANDLING AND SAFETY

Cytec Engineered Materials recommends wearing clean, impervious gloves when working with epoxy-phenolic adhesive systems to reduce skin contact and to avoid contamination of the product.

Materials Safety Data Sheets (MSDS) and product labels are available upon request and can be obtained from any Cytec Engineered Materials Office.

DISPOSAL OF SCRAP MATERIAL

Disposal of scrap material should be in accordance with local, state, and federal regulations.

CONTACT INFORMATION

GLOBAL HEADQUARTERS for AEROSPACE MATERIALS

Tempe, Arizona
tel 480.730.2000
fax 480.730.2088
email custinfo@cytec.com

NORTH AMERICA

Anaheim, California
tel 714.630.9400
fax 714.666.4345

Orange, California
tel 714.639.2050
fax 714.532.4096

Cytec Carbon Fiber
Piedmont, South Carolina
tel 864.277.5720
fax 864.299.9373

Greenville, Texas
tel 903.457.8500
fax 903.457.8598

Winona, Minnesota
tel 507.454.3611
fax 507.452.8195

Havre de Grace, Maryland
tel 410.939.1910
fax 410.939.8100

D' Aircraft Products
Anaheim, California
tel 714.632.8444
fax 714.632.7164

EUROPE

Wrexham, United Kingdom
tel +44 1978.665200
fax +44 1978.665222

Östringen, Germany
tel +49 7253.934111
fax +49 7253.934102

ASIA

Shanghai, China
tel +86 21.5746.8018
fax +86 21.5746.8038