CYTEC

TECHNICAL DATA SHEET AEROSPACE MATERIALS

FM® 300 Epoxy Film Adhesive

DESCRIPTION

FM® 300 is a modified epoxy film adhesive available with three different moisture-resistant polyester carriers. It is designed for bonding metal-to-metal and sandwich composite structures. To achieve ultimate environmental resistance in bonding aluminum details, use pre-cured BR® 127 primer with FM 300 film adhesive.

Extensively used as a surface finished ply on composites material outside layers, FM 300 film adhesive has unique properties which drastically reduce, and in some cases virtually eliminate, time-consuming sanding and filling operations.

FM 300 film adhesive has high elongation and toughness with high ultimate shear strength. This makes it particularly suitable for redistributing the high shear stress concentrations of graphite epoxy- to-metal bonds, and allows it to accommodate the low interlaminar shear strength of the composite. It is particularly good in fatigue resistance in these joints. In properly designed and processed joints, the tight-knit tricot carrier provides a degree of electrical isolation between metal and graphite composites to reduce galvanic corrosion.

FEATURES & BENEFITS

- Superior metal-to-metal peel strength, composite-to-composite bonding and composite-to-metal joints
- Extensively used as surfacing ply for composite materials
- Service temperature from -67°F to 300°F (-55°C to 150°C)
- Excellent moisture and corrosion resistance in high humidity environments with no significant reduction in mechanical properties
- Allows x-ray inspection of assemblies due to natural opacity of adhesive formulations
- Available in a wide range of film thicknesses tailored to specific applications
- Industry wide acceptance

SUGGESTED APPLICATIONS

- Metal-to-metal bonding
- Composite-to-composite bonding
- Composite-to-metal bonding
- Composite surfacing

CHARACTERISTICS

Table 1 | Product Description for FM 300 Adhesive Films

Product Number	Weight, psf (gsm)[1]	Nominal Thickness, inches (mm)	Color	Carrier	Characteristics
FM 300 film adhesive	0.08 (390) 0.10 (490)	0.013 (0.32) 0.015 (0.38)	Blue Blue	Tight knit	Enhanced bondline thickness control. Good blend of structural and handling properties
FM 300K film adhesive	0.05 (244) 0.08 (390)	0.008 (0.20) 0.013 (0.32)	Green Green	Wide open knit	Highest overall performance
FM 300M film adhesive	0.03 (150) 0.08 (390)	0.005 (0.13) 0.013 (032)	Green Green	Random mat	Provides the best bondline and flow control. Reduces tendency to trap air during lay-up.
FM 300U film adhesive	0.03 (150) 0.055 (268)	0.005 (0.13) 0.008 (0.20)	Green Green	Unsupported film	Can be reticulated

[1] Weight tolerance equals nominal weight ± 0.005 psf (± 25 gsm)

Table 2 | Handling Properties of FM 300 Adhesive Films

Properties	Description
Volatiles	1.0% maximum
Outgassing properties (after complete cure)	0.92% TWL and 0.07% CVCM (NASA reference publication 1124, Rev. 8/87)
Recommended storage	Supported grades: store at or below 0°F (-18°C) Unsupported grades: store at 40°F (4.5°C)
Shelf life	Supported Grades: 12 months from date of shipment Unsupported Grades: 4 months from date of shipment
Shop life	10 days at 90°F (32°C) 30 days at 70°F (21°C)

Table 3 | Product Description: BR® 127 corrosion inhibiting primer

Properties	Description
Color	Yellow
Solids	10% ± 1% sprayable
Density	7.3 lbs/gal (875 g/liter)
Shop life	5 days at 90°F (32°C)
Shelf life	12 months from date of shipment at recommended storage
Recommended	Store at or below 0°F (-18°C)

PROPERTIES

Table 4 | Mechanical Properties[1]

Sample Description[2] Product Number	FM 300 0.08 psf (390 gsm)	FM 300K 0.05 psf (244 gsm)	FM 300K 0.08 psf (390 gsm)	FM 300M 0.03 psf (150 gsm)	FM300M 0.08 psf (390 gsm)
Tensile shear, psi (MPa)					
-67°F (-55°C)	5080 (35.0)	–	5460 (37.7)	–	4930 (34.0)
75°F (24°C)	5145 (35.5)	5340 (36.8)	5850 (40.3)	4325 (29.8)	5275 (36.4)
250°F (120°C)	3995 (27.6)	3575 (24.7)	4200 (28.9)	3360 (23.2)	4040 (27.9)
300°F (150°C)	2910 (20.0)	2965 (20.4)	3155 (21.8)	2310 (15.9)	2955 (20.4)
Floating roller peel, in-lb/in (kN/m)					
-67°F (-55°C)	28 (4.9)	–	28 (4.9)	–	29 (5.1)
75°F (24°C)	29 (5.1)	23 (40)	28 (4.9)	26 (4.6)	29 (5.1)
250°F (120°C)	–	–	–	–	–
300°F (150°C)	25 (4.4)	–	26 (4.6)	27 (4.7)	26 (4.6)
Honeycomb sandwich peel, in-lb/3 in (Nm/m)					
-67°F (-55°C)	–	25 (37)	40 (58)	–	–
75°F (24°C)	–	22 (32)	45 (66)	11 (16)	–
250°F (120°C)	–	–	–	–	–
300°F (150°C)	–	22 (32)	28 (41)	–	–
Flatwise tensile, psi (MPa)					
-67°F (-55°C)	1350 (9.3)	–	1075 (7.4)	–	1600 (11.0)
75°F (24°C)	1095 (7.6)	–	1030 (7.1)	435 (3.0)	1390 (9.6)
250°F (120°C)	–	–	–	–	–
300°F (150°C)	345 (2.4)	340 (2.3)	470 (3.2)	125 (0.86)	513 (3.5)

[1]FM 300, FM 300K and FM 300M film adhesives with BR 127 primer: Typical average results.
[2] Metal: Tensile shear 0.063 in. (1.63 mm) 2024-T3 clad, honeycomb skins 0.020 in. (0.51 mm) 2024-T3 clad, honeycomb 3/16 in. (4.76 mm) 0.002 (0.65 mm) NP5052, floating roller peel 0.025/0.063 2024-T3 clad

Table 5 | Humidity and Fluid Exposure[1]

Sample Description[2] Product Number	FM 300 0.08 psf (390 gsm)	FM 300K 0.08 psf (390 gsm)	FM 300M 0.08 psf (390 gsm)
Tensile shear, psi (MPa) after 30 days at 120°F (50°C), 95 – 100% RH[3]	5185 (35.8)	6225 (42.9)	5535 (38.2)
Tensile shear, psi (MPa) after 7 days immersion in:			
JP-4 fuel	5030 (34.7)	6240 (43.0)	5550 (38.3)
Anti-icing fluid	4915 (33.9)	6275 (43.3)	5250 (36.2)
Hydraulic oil	5100 (35.2)	6130 (42.3)	5350 (36.9)
Hydrocarbon fluid	5155 (35.6)	6095 (42.0)	5125 (35.3)
Tensile shear, psi (MPa) after 200 hours in Skydrol[4] hydraulic fluid at 150°F (66°C)	4935 (34.0)	6350 (43.8)	4860 (33.5)

[1] FM 300, FM 300K and FM 300M film adhesive with BR 127 primer: Typical average results
[2] Metal: Tensile shear 0.063 in. (1.63 mm) 2024-T clad
[3] Tested at 75°F (24°C)
[4] A product of Solutia, Inc.

Table 6 | Effect of Humidity Exposure on Film Prior to Bonding[5]

Property	Test Condition	Control (no exposure)	15 Day Exposure at 54% RH
Tensile shear, psi (MPa)	Tested at 75°F (24°C)	4800 (33.1)	4900 (33.8)
		4700 (32.4)	4800 (33.1)
		4650 (32.1)	5200 (35.9)
	Tested at 300°F (150°C)	3400 (23.5)	2600 (17.9)
		3300 (22.8)	2900 (20.0)
Floating roller peel, lbs/in (kN/m)	Tested at 75°F (24°C)	28 (4.9)	28 (4.9)
		29 (5.1)	29 (5.1)
Honeycomb sandwich peel, in-lb/3 in. (Nm/m)	Tested at 75°F (24°C)	75 (110)	75 (110)
		68 (100)	69 (100)

[5] Sample: FM 300K film adhesive, 0.08 psf (390 gsm) with BR 127 primer

Metal:
Tensile shear	0.063 in. (1.63 mm) 2024-T3 clad
Honeycomb skins	0.020 in (0.51 mm) 2024-T3 clad
Honeycomb	3/16 in. (4.76 mm) 0.002 (0.65 mm) NP 5052
Floating roller peel	0.025/0.063 2024-T3 clad

Cure cycle: 60 minutes to 350°F (175°C)
60 minutes at 350°F (175°C)
40 psi (0.28 MPa)

Table 7 | 300°F (150°C) Heat Aging Studies[1]

Hours exposure	Tensile shear psi (MPa) tested at 75°F (24°C)	Tensile shear psi (MPa) tested at 300°F (149°C)	Honeycomb sandwich peel in-lb/3 in (Nm/m) tested at 75°F (24°C)	Flatwise tensile, psi (MPa) tested at 75°F (24°C)
Control	6070 (41.8)	2980 (20.6)	64 (94)	1380 (9.5)
1440	4460 (30.8)	3720 (25.6)	35 (52)	–
2880	4700 (32.4)	3400 (23.5)	41 (60)	960 (6.6)
4320	4300 (29.7)	3430 (23.7)	26 (39)	1000 (6.9)
5040	3910 (27.0)	3530 (24.4)	23 (34)	990 (6.8)
5760	3210 (22.1)	3450 (23.8)	20 (30)	950 (6.6)
7200	3580 (24.7)	3450 (23.8)	20 (30)	–
7920	3270 (22.6)	2960 (20.4)	17 (25)	780 (5.4)

[1] Sample: FM 300K film adhesive, 0.08 psf (390 gsm) with BR 127 primer

Metal: Tensile shear 0.063 in. (1.63 mm) 2024-T3 clad
Honeycomb skins 0.020 in (0.51 mm) 2024-T3 clad
Honeycomb 3/16 in. (4.76 mm) 0.002 (0.65 mm) NP 5052

Cure cycle: 60 minutes to 350°F (175°C)
60 minutes at 350°F (175°C)
40 psi (0.28 MPa)

KGR Stress Strain Data

The heart of Cytec is new technology for structural adhesives is the KGR-1 extensometer. This instrument provides the basic, definitive property of a structural adhesive – its shear stiffness. KGR-1 records the entire stress strain curve for the adhesive in environments reproducible in the laboratory.

This technology benefits both the designer and the adhesive formulator. The designer and stress analyst use this technology to predict the service performance of the adhesive bond, including strength, creep and fatigue in environments reproducible in the laboratory.

Until Cytec developed the KGR-1, test methods to obtain shear stiffness were either inaccurate or too costly to allow sufficient data for statistical confidence. A measure of the difficulty in obtaining this stiffness is that movements of one quarter of a micron (0.00001 inches) must be detected with clarity and reliability. KGR-1 does this over a temperature range of -67°F (-55°C) to 500°F (260°C) in hostile environments reproducible in the laboratory.

The economy of operation of KGR-1 makes stiffness data affordable to the designer. This economy allows statistical confidence necessary for practical analysis. In addition to stiffness, KGR-1 provides the shear stress strain relationship over the entire non-linear range up to and including ultimate failure.

It is established that fatigue life and residual static strength are dependent on strain at ultimate stress. The larger the strain, the longer the fatigue life and the higher the residual static strength (the strength after the joint has seen the required fatigue loads). This data defines limits for creep and fatigue conditions. It is possible to perform proper stress analysis of bonded aircraft primary structure. Accurate predictions are now possible for the bond performance over the life of the aircraft.

Apart from its value to the designer, KGR-1 technology is invaluable to the formulator of structural adhesives. Stress strain properties beyond the linear range define the adhesive's performance in fatigue and toughness.

If you are interested in acquiring a KGR-1 exensometer for help in your own work, please contact a Cytec representative.

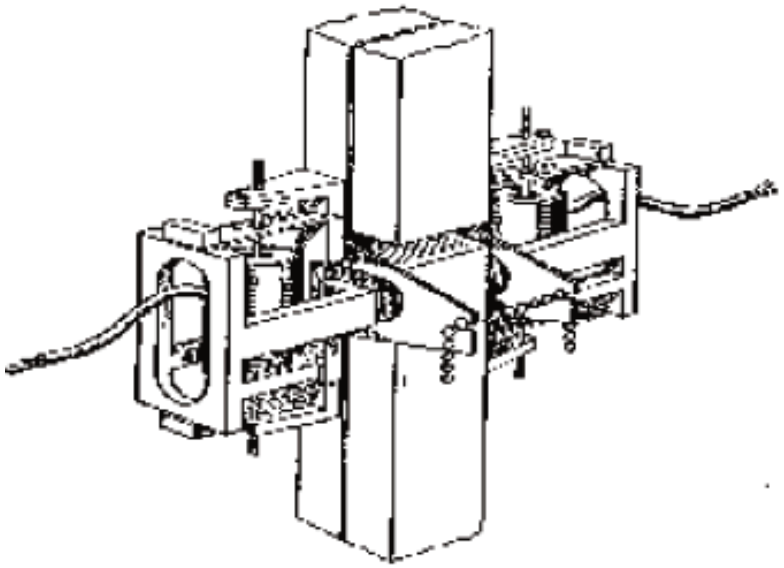
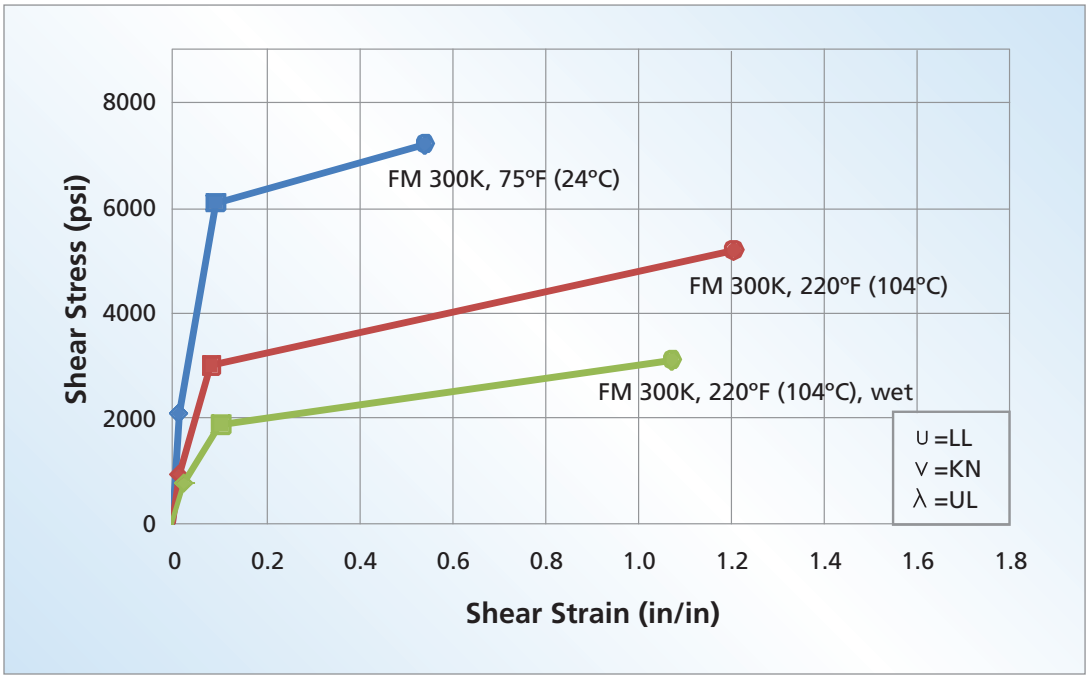


Table 6 | KGR-1 Stress Strain Data for FM 300K Adhesive Film, 0.06 psf (290 gsm) with BR® 127 Primer
[*f* = Shear Stress, psi (MPa), = Shear Strain, in/in, G = Shear Modulus, psi (Mpa)]

Test Temperature	Linear Limit (LL)			Knee (KN)		Ultimate Failure (UL)	
	f	Σ	G	*f*	Σ	*f*	Σ
75°F (24°C)	2060 (14.2)	0.0156	131,500 (907.5)	6100 (42.1)	0.0932	7210 (49.8)	0.5446
220°F (104°C)	916 (6.32)	0.0150	64,700 (446.2)	3000 (20.8)	0.0835	5190 (35.8)	1.2073
220°F (104°C)[1]	745 (5.14)	0.0273	27,500 (189.8)	1880 (13.0)	0.1047	3100 (21.4)	1.0744

[1] Postbond exposure to 100% RH at 140°F (60°C) until saturated

Figure 9 | Shear Stress vs. Shear Strain for FM 300K Film Adhesive in Various Environments KGR-1 Instrumentation



APPLICATION NOTES

Preparation of 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 the FPL cleaning method:

1. Vapor degrease, alkaline clean, rinse and check for water break
2. Prepare a sodium dichromate/sulfuric acid solution as follows:
   a. Mix the following ingredients:

Sodium Dichromate	34 grams	FED-O-S-595A
Water	700 ml	Deionized water recommended
Sulfuric Acid	304 grams	FED-O-A-115, Class A, Grade 2

   b. Add additional water to make one liter

   This solution will dissolve 1.5 grams of 2024 clad aluminum per liter.

   NOTE: Chromic acid is highly corrosive. All contact with skin and tissues must be prevented. Wear impervious apron, boots and gloves as well as splash-proof goggles and face shield when preparing and/or using chromic acid. If airborne concentration of chromic acid exceeds the 8-hr TWA established by OSHA, respirators approved by NIOSH must be worn.

   Chromic acid solutions should be prepared and handled only in fume hoods or other adequately ventilated areas even when the TWA is not exceeded. Traces of chromyl chloride may occur in the vapors above heated chromic acid solutions prepared from chlorinated water.
3. Immerse aluminum part in sodium dichromate/sulfuric acid solution at 155 ± 5°F (68 ± 3°C) for 10 minutes (clad aluminum) or 5 minutes (bare aluminum)
4. Spray rinse with water at or below 75°F (24°C)
5. Immerse in cold water
6. Repeat spray rinse checking for water break
7. Dry in a vented oven below 150°F (65°C)

In addition to the FPL etch cleaning method for aluminum, the phosphoric acid anodizing (PAA) surface treatment1 is now being used by a large number of aircraft manufacturers due to the improved surface bond durability provided by the PAA treatment.

Primer Application

Although not mandatory, BR 127 corrosion inhibiting primer is recommended for use with FM 300 adhesive in the bonding of aluminum details. BR 127 primer offers superior durability and resistance to hostile environments within the bond line and also may be used as a protective coating outside the bonded areas. Apply BR 127 as follows:

1. Allow BR 127 material to warm to room temperature prior to opening container
2. Thoroughly mix before application and agitate during application
3. Spray or brush coat to a dry primer thickness of 0.0001 inch (0.0025 mm) nominal with a 0.0002 inch (0.0050 mm) maximum thickness
4. Air dry 30 minutes minimum prior to using
5. Oven dry 30 minutes at 250 ± 10°F (120 ± 6°C)

[1] Boeing patent 4,085,012; April 18, 1978

Bonding Procedure

Bond FM 300 film adhesive at pressures ranging from 15 – 100 psi (0.10 – 0.69 MPa) depending upon the application. For press, autoclave, pressure diaphragm or vacuum bag curing use the following cure cycle:

1. Heat up to 350°F (175°C) in 30 – 60 minutes
2. Hold at 350°F (175°C) for 60 minutes

Compatibility

The cure temperature, pressure and gel time of FM 300 film adhesive make it compatible for co-cure or simultaneous autoclave runs with FM® 61 and FM® 96 film adhesives as well as BR 127 primer.

PRODUCT HANDLING AND SAFETY

Cytec Industries recommends wearing clean, impervious gloves when working with epoxy resin 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 location supplying aerospace materials.

DISPOSAL OF SCRAP MATERIAL

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

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