TECHNICAL DATASHEET

FM® 73 Toughened Epoxy Film

Description:

FM® 73 film adhesive is a toughened, general purpose aerospace epoxy designed to provide excellent structural performance from -67°F to 180°F (-55°C to 82°C). FM® 73 film adhesive is formulated to provide outstanding durability in bonding metals and is also suitable for bonding many structural composite systems.

Extensive testing has proven that FM® 73 adhesive easily meets the requirements set forth in specifications MMM-A-132A, type I, class 2 and MIL-A-25463B, type I, class 2 as well as more stringent requirements. To achieve maximum environmental resistance and bonding durability, the use of BR® 127 corrosion inhibiting primer is recommended in bonding metallic components.

Features and benefits:

- **Demonstrates excellent peel strength and structural performance from -67°F to 180°F (-55°C to 82°C)**
- **Resistant to prebond humidity exposure**
- **Good moisture and corrosion resistance in high humidity**
- **Shop life of 30 days at 75°F (24°C)**
- **Easily meets the requirements of specifications MMM-A-132, type I, class 2 and MIL-A-25463B, type I, class 2**

For more information, contact:
Cytec Engineered Materials
Technical Service
1300 Revolution Street
Havre de Grace, MD 21078
410 939-1910

This information is provided for informational purposes only and without legal responsibility.
Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

Cytec ENGINEERED MATERIALS
CREATING A MATERIAL ADVANTAGE

General information

FM® 73 adhesive is manufactured as a supported film with both knit or mat carriers, or as an unsupported film. FM® 73 adhesive supported with a knit carrier offers optimum mechanical performance while the random mat version, FM® 73M adhesive, provides superior handling characteristics. FM® 73M adhesive can be supplied in a one-side tacky (OST) version which allows for the bonding of large metal parts without concerns of trapping air during lay-up. In addition, FM® 73M OST adhesive film can be manufactured in widths of up to 72 inches to accommodate large part fabrication.

A shop life in excess of 30 days at conditions of 75°F (24°C) or below, allows the user a great deal of freedom in material handling and inventory control.

The recommended cure cycle is 60 minutes at 250°F (120°C) and 40 psi (0.28 MPa). This cycle can be varied over a broad range from four hours at 200°F (95°C) to ten minutes at 350°F (177°C) with minimum pressure to assure proper mating of details.

Product description

Product number	Nominal weight[1] psf (gsm)	Nominal thickness inches (mm)	Color	Carrier
FM® 73 film adhesive	0.045 (210) 0.060 (300) 0.085 (420)	0.007 (0.18) 0.010 (0.25) 0.015 (0.38)	Yellow Yellow Yellow	Polyester knit; Both sides tacky
FM® 73M film adhesive	0.030 (150) 0.045 (210) 0.060 (300) 0.085 (420)	0.005 (0.13) 0.007 (0.18) 0.010 (0.25) 0.015 (0.38)	Dark green Yellow Yellow Yellow	Polyester mat; Both sides tacky
FM® 73M OST film adhesive	0.030 (150) 0.060 (300) 0.085 (420)	0.005 (0.13) 0.010 (0.25) 0.015 (0.38)	Dark green Yellow Yellow	Polyester mat; One side tacky
FM® 73U film adhesive	0.020 (100) 0.030 (150)	0.0035 (0.09) 0.005 (0.13)	Green Yellow	Unsupported

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

This information is provided for informational purposes only and without legal responsibility.
Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

Cytec ENGINEERED MATERIALS
CREATING A MATERIAL ADVANTAGE

Handling properties

Volatiles:	1.25% maximum
Outgassing properties: **(after complete cure)**	0.78% TWL and 0.00% CVCM (NASA Reference Publication 1124, Rev. 8/87)
Shop life:	30 days at or below 75°F (24°C)
Shelf life:	Twelve months from date of shipment at recommended storage conditions
Recommended storage:	Store at or below 0°F (-18°C)

BR 127 Corrosion Inhibiting Primer Description

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

The following products are recommended for use with FM® 73 film adhesives:

BR® 127 corrosion inhibiting primer
FM® 410 foam adhesive for honeycomb splicing and bonding to spars
BR® 626 potting compound as insert or edge filling material for honeycomb sandwich construction
CYCOM® 919 advanced composite
CYCOM® 950 advanced composite
CYCOM® 5919 advanced composite

Note: Advanced composite laminating materials for structural honeycomb sandwich and structural laminates where co-curing with FM® 73 film adhesive is desired.

This information is provided for informational purposes only and without legal responsibility.
Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

Cytec ENGINEERED MATERIALS
CREATING A MATERIAL ADVANTAGE

Mechanical performance[1]: Metal-to-metal

Property[2] and test condition	FM® 73M film adhesive 0.03 psf (150 gsm)		FM® 73M OST film adhesive 0.03 psf (150 gsm)		FM® 73M film adhesive 0.06 psf (300 gsm)	
Tensile shear, psi (MPa)						
-67°F (-55°C)	5890	(40.6)	6130	(42.3)	6340	(43.7)
75°F (24°C)	5770	(39.8)	6200	(42.8)	6680	(46.1)
180°F (82°C)	4050	(27.9)	3760	(25.9)	4400	(30.4)
250°F (120°C)	1650	(11.4)	1480	(10.2)	1430	(9.9)
Federal standard MMM-A-132A						
Blister detection, psi (MPa)						
-67°F (-55°C)	5290	(36.5)	5100	(35.2)	5210	(36.0)
75°F (24°C)	4860	(33.5)	4700	(32.4)	4890	(33.7)
180°F (82°C)	3650	(25.2)	3580	(24.7)	3760	(25.9)
250°F (120°C)	1590	(11.0)	1570	(10.8)	1670	(11.5)
Federal standard MMM-A-132A						
Climbing drum metal-to-metal peel, in-lb/in. (Nm/m)						
-67°F (-55°C)	55	(220)	61	(270)	68	(300)
75°F (24°C)	66	(290)	73	(330)	87	(390)
180°F (82°C)	85	(380)	91	(410)	130	(570)
250°F (120°C)	37	(170)	45	(200)	47	(210)
ASTM-D-1781-76						
Floating roller peel, lbs/in. (KN/m)						
-67°F (-55°C)	56	(9.8)	51	(8.9)	44	(7.7)
75°F (24°C)	64	(11.2)	63	(11.0)	73	(12.8)
180°F (82°C)	55	(9.6)	49	(8.6)	76	(13.3)
250°F (120°C)	31	(5.4)	32	(5.6)	29	(5.1)
ASTM-D-3167-76						

1. Typical average results with BR® 127 primer; recommended cure cycle:
   30 minutes to 250°F (120°C)
   60 minutes at 250°F ± 5°F (120°C ± 3°C); 40 ± 5 psi (0.28 ± 0.03 MPa)
   FPL etch was used for cleaning aluminum skins prior to bonding.

2. Materials:
   Tensile shear: 0.063 in. (1.60 mm) 2024-T3 clad
   Blister detection: 0.064 in. (1.63 mm) 2024-T3 bare
   Climbing drum peel: 0.020 in. to 0.040 in. (0.51 mm to 1.03 mm) 2024-T3 clad
   Floating roller peel: 0.025 in. to 0.063 in. (0.64 mm to 1.60 mm) 2024-T3 bare

This information is provided for informational purposes only and without legal responsibility.
Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

Cytec ENGINEERED MATERIALS
CREATING A MATERIAL ADVANTAGE

Mechanical performance[1]: Metal-to-metal, cont.

Property[2] and test condition	FM® 73M OST film adhesive 0.06 psf (300 gsm)		FM® 73 film adhesive 0.06 psf (300 gsm)		FM® 73 film adhesive 0.085 psf (425 gsm)	
Tensile shear, psi (MPa)						
-67°F (-55°C)	6680	(46.1)	6650	(45.9)	6770	(46.7)
75°F (24°C)	6580	(45.4)	6500	(44.9)	6840	(47.2)
180°F (82°C)	4540	(31.3)	4340	(30.0)	4770	(32.9)
250°F (120°C)	1430	(9.9)	1040	(7.2)	810	(5.6)
Federal standard MMM-A-132A						
Blister detection, psi (MPa)						
-67°F (-55°C)	5420	(37.4)	5460	(37.7)	5290	(36.5)
75°F (24°C)	4900	(33.8)	5100	(35.2)	5050	(34.8)
180°F (82°C)	4350	(30.0)	4080	(28.2)	4120	(28.4)
250°F (120°C)	1400	(9.7)	1410	(9.7)	1240	(8.6)
Federal standard MMM-A-132A						
Climbing drum metal-to-metal peel, in-lb/in. (Nm/m)						
-67°F (-55°C)	65	(290)	73	(330)	88	(390)
75°F (24°C)	83	(370)	95	(420)	150	(650)
180°F (82°C)	130	(580)	130	(560)	160	(690)
250°F (120°C)	50	(220)	68	(300)	70	(310)
ASTM-D-1781-76						
Floating roller peel, lbs/in. (KN/m)						
-67°F (-55°C)	58	(10.2)	66	(11.6)	52	(9.1)
75°F (24°C)	65	(11.4)	65	(11.4)	79	(13.8)
180°F (82°C)	95	(16.6)	96	(16.9)	110	(20.0)
250°F (120°C)	47	(8.2)	55	(9.6)	59	(10.4)
ASTM-D-3167-76						

1. Typical average results with BR® 127 primer; recommended cure cycle:
   30 minutes to 250°F (120°C)
   60 minutes at 250°F ± 5°F (120°C ± 3°C); 40 ± 5 psi (0.28 ± 0.03 MPa)
   FPL etch was used for cleaning aluminum skins prior to bonding.

2. Materials:
   Tensile shear: 0.063 in. (1.60 mm) 2024-T3 clad
   Blister detection: 0.064 in. (1.63 mm) 2024-T3 bare
   Climbing drum peel: 0.020 in. to 0.040 in. (0.51 mm to 1.03 mm) 2024-T3 clad
   Floating roller peel: 0.025 in. to 0.063 in. (0.64 mm to 1.60 mm) 2024-T3 bare

This information is provided for informational purposes only and without legal responsibility.
Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

Cytec ENGINEERED MATERIALS
CREATING A MATERIAL ADVANTAGE

Mechanical performance[1]: Metallic structural sandwich

Property[2] and test condition	FM® 73M film adhesive 0.06 psf (300 gsm)		FM® 73M OST film adhesive 0.06 psf (300 gsm)		FM® 73 film adhesive 0.06 psf (300 gsm)	
Sandwich peel, in.lbs/3 in. (Nm/m)						
-67°F (-55°C)	50	(74)	46	(68)	53	(79)
75°F (24°C)	86	(130)	83	(120)	95	(140)
180°F (82°C)	38	(56)	33	(49)	41	(61)
250°F (120°C)	4	(6)	4	(6)	5	(8)
MIL-A-25463B						
Flatwise tensile, psi (MPa)						
-67°F (-55°C)	1500	(10.4)	1450	(10.0)	1680	(11.6)
75°F (24°C)	1050	(7.3)	1080	(7.4)	1300	(8.9)
180°F (82°C)	720	(5.4)	660	(4.6)	660	(4.6)
250°F (120°C)	88	(0.6)	72	(0.5)	72	(0.5)
MIL-A-25463B						

Property[2] and test condition	FM® 73M film adhesive 0.085 psf (425 gsm)		FM® 73M OST film adhesive 0.085 psf (425 gsm)		FM® 73 film adhesive 0.085 psf (425 gsm)	
Sandwich peel, in.lbs/3 in. (Nm/m)						
-67°F (-55°C)	70	(100)	75	(110)	87	(130)
75°F (24°C)	120	(180)	128	(190)	145	(220)
180°F (82°C)	40	(59)	55	(82)	65	(96)
250°F (120°C)	6	(9)	6	(9)	8	(10)
MIL-A-25463B						
Flatwise tensile, psi (MPa)						
-67°F (-55°C)	1580	(10.9)	1680	(11.6)	1730	(11.9)
75°F (24°C)	1450	(10.0)	1400	(9.7)	1400	(9.7)
180°F (82°C)	830	(5.7)	780	(5.5)	880	(6.0)
250°F (120°C)	72	(0.5)	70	(0.5)	80	(0.6)
MIL-A-25463B						

1. Typical average results with BR® 127 primer;
   recommended cure cycle:
   30 minutes at 250°F (120°C)
   60 minutes at 250°F ± 3°F (120°C ± 3°C); 40 ± 5 psi (0.28 ± 0.03 MPa)
   FPL etch was used for cleaning aluminum skins prior to bonding.
2. Materials
   Skins: 0.020 (0.5 mm) 2024-T3 clad
   Core: .25 in. (6.35 mm) 0.004 NP 5052

This information is provided for informational purposes only and without legal responsibility.
Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

Cytec ENGINEERED MATERIALS
CREATING A MATERIAL ADVANTAGE

Mechanical performance after environmental exposure[1]

Product description	FM® 73M film adhesive 0.03 psf (150 gsm)	FM® 73M film adhesive 0.06 psf (300 gsm)	FM® 73 film adhesive 0.06 psf (300 gsm)
Tensile shear, psi (MPa) after:			
30 days at 120°F (50°C) and 95 - 100% R.H.	4960 (34.2)	4990 (34.4)	5140 (35.5)
30 days salt spray	4790 (33.1)	4930 (33.9)	5240 (36.1)
7 days immersion in JP-4 fuel (MIL-J-5624)	4780 (33.0)	4980 (34.4)	5270 (36.3)
7 days immersion in hydrocarbon fluid (TT-S-735)	4880 (33.6)	5040 (34.8)	5230 (36.1)
7 days in Skydrol**, 500	4770 (32.9)	5060 (34.9)	5140 (35.5)

Federal standard MMM-A-132A

1. **Fluid exposure coupons are individual blister detection coupons with cut edges exposed and tested at 75°F ± 5°F (24°C ± 3°C)**

** Product of Monsanto Chemical Company

This information is provided for informational purposes only and without legal responsibility.
Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

Cytec ENGINEERED MATERIALS
CREATING A MATERIAL ADVANTAGE

KGR stress strain data

The heart of Cytec Engineered Materials' 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 shear 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 Engineered Materials 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 (250°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 has been 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 condition. 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 extensometer for help in your own work, please contact a Cytec Engineered Materials representative.

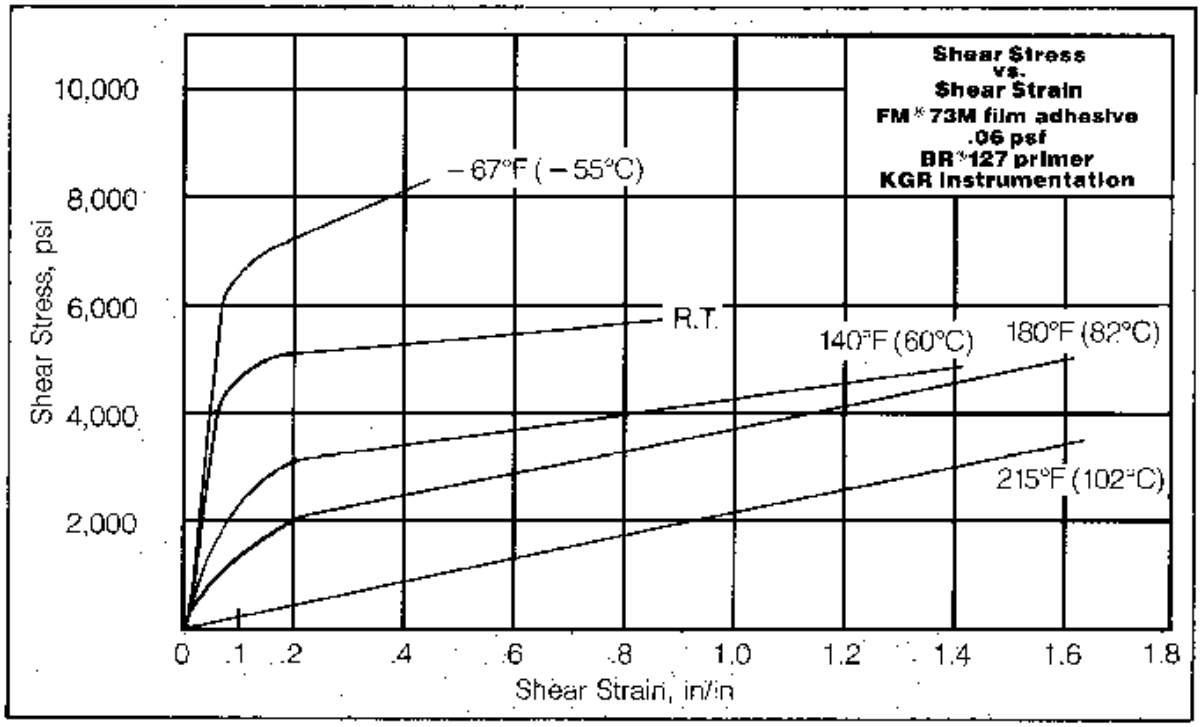
This information is provided for informational purposes only and without legal responsibility.
Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

Cytec ENGINEERED MATERIALS
CREATING A MATERIAL ADVANTAGE

KGR-1 stress strain data for FM® 73M film adhesive, 0.06 psf (300 gsm) with BR® 127 corrosion inhibiting primer with no prebond or postbond exposure

f = Shear stress, psi (MPa) ℜ = Shear strain, in/in **G** = Shear modulus, psi (MPa)

	Linear limit (LL)			Knee		Ultimate failure (UL)	
Test temperature	τ	ɤ	**G**	τ	ɤ	τ	ɤ
–67°F (-55°C)	3350 (23.1)	0.026	131,000 (904)	7220 (49.8)	0.097	8080 (55.7)	0.447
75°F (24°C)	2510 (17.3)	0.021	122,000 (842)	4690 (32.4)	0.062	5930 (40.9)	0.873
140°F (60°C)	1460 (10.1)	0.022	65,900 (455)	2620 (18.1)	0.073	5060 (34.9)	1.430
180°F (82°C)	980 (6.8)	0.028	37,800 (261)	1600 (11.0)	0.064	5150 (35.5)	1.623

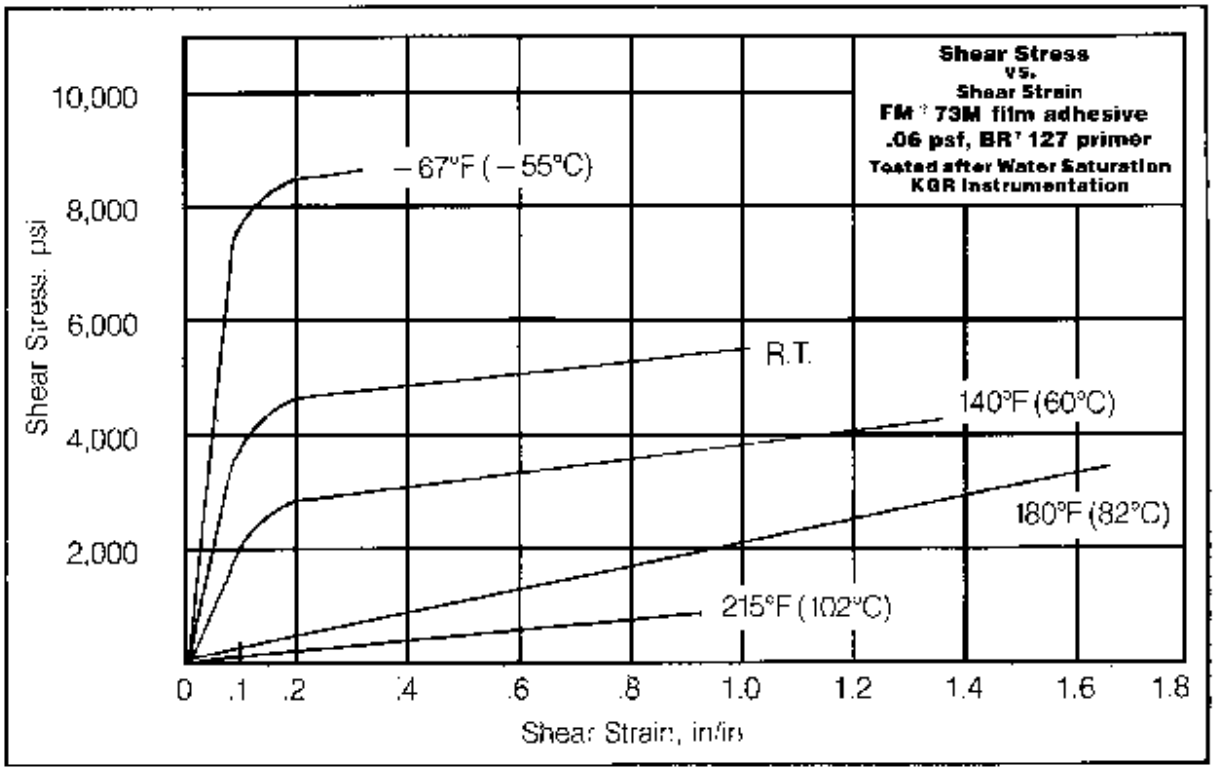


This information is provided for informational purposes only and without legal responsibility.
Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

KGR-1 stress strain data for FM® 73M film adhesive, 0.06 psf (300 gsm) with BR® 127 corrosion inhibiting primer postbond exposure of 100% R.H. at 140°F (60°C) until saturated

f = Shear Stress, psi (MPa) ℜ = Shear Strain, in/in G = Shear Modulus, psi (MPa)

	Linear limit (LL)			Knee		Ultimate failure (UL)	
Test temp.	**f**	**ℜ**	**G**	**f**	**ℜ**	**f**	**ℜ**
–67°F (-55°C)	3440 (23.7)	0.028	123,000 (849)	8070 (55.7)	0.100	8700 (60.0)	0.315
75°F (24°C)	2100 (14.5)	0.022	95,000 (655)	4200 (29.0)	0.081	5210 (35.9)	0.970
140°F (60°C)	1290 (8.9)	0.026	53,200 (368)	—	—	4210 (929.0)	1.420
180°F (82°C)	—	—	—	—	—	3540 (24.4)	1.620
215°F (102°C)	—	—	—	—	—	910 (6.3)	0.930



This information is provided for informational purposes only and without legal responsibility.
Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

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 described below:

1. Vapor degrease, alkaline clean, rinse and check for water break.
2. Immerse in sodium dichromate-sulfuric acid solution at 155°F ± 5°F (68°C ± 3°C).
   Clad: 10 minutes Bare: 5 minutes

   Chromic acid is highly corrosive; all contact with skin and tissues must be prevented. Wear impervious apron, boots, and gloves, as well as splashproof goggles and face shield when preparing and/or using chromic acid solutions. If air-borne concentrations of chromic acid exceed 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.

   To prepare this solution:
   - Dissolve sodium dichromate 34 grams (FED-)-S-595A)
   - In water 700 ml
   - Add sulfuric acid 304 grams (FED-O-A-115, Class A, Grade 2)
   - Mix well and add additional water to make one liter. Dissolve 1.5 grams of 2024 clad aluminum per liter.
3. Spray rinse with 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 (65°C). NOTE: Deionized water is recommended.

   In addition to the FPL etch cleaning method for aluminum, the phosphoric acid anodizing surface treatment* is now being used by a large number of aircraft manufacturers due to the improved surface bond durability provided by phosphoric acid anodizing surface treatment. FM® 73 film adhesive with BR® 127 corrosion inhibiting primer bonds well to both surface treatments.

*Boeing Patent 4,085,012; April 18, 1978

This information is provided for informational purposes only and without legal responsibility.
Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

Cytec ENGINEERED MATERIALS
CREATING A MATERIAL ADVANTAGE

Primer application

Although not mandatory, BR® 127 corrosion inhibiting primer is recommended for use with FM® 73 film adhesive in 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.

1. Allow material to warm to room temperature prior to opening container; thoroughly mix before and agitate during application.

2. Spray or brush coat to a dry primer thickness of 0.0001 inch (0.0025 mm) nominal with a 0.0003 inch (0.005 mm) maximum thickness. For protective coating applications, increase primer thickness to 0.0004 to 0.0010 inch (0.0102 – 0.025 mm).

3. Air dry 30 minutes minimum prior to oven cure.

4. Oven cure 30 minutes at 250°F ± 10°F (120°C ± 6°C).

Bonding procedure

Primer assemblies, which have been dried and wrapped with a protective covering such as kraft paper, may be stored at 75°F (24°C) for six months and longer without fear of degradation of the final bond.

Before bonding, detail parts and adhesive film must be properly assembled. Patterns of FM® 73 film adhesive should be cut as required before removal of the protective covering which is easily stripped from the film at room temperature. Apply the film adhesive smoothly to the parts. For additional tack, warm to approximately 110°F (43°C) with a heat gun or tack table.

After assembly of the details, apply pressure and cure, using the standard cure cycle below:

Heat up in 30 minutes to 250°F (120°C)
Hold 60 minutes at 250°F ± 5°F (120°C ± 3°C)
40 ± 5 psi (0.28 ± 0.03 MPa)

This information is provided for informational purposes only and without legal responsibility.
Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

Cytec ENGINEERED MATERIALS
CREATING A MATERIAL ADVANTAGE

Important notice

The information and statements herein are we believe to be reliable but are not to be construed as a warranty or representation for which Cytec Engineered Materials assumes legal responsibility. Users should undertake sufficient verification and testing to determine the suitability for their own particular purpose of any information or products referred to herein. NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE IS MADE. Nothing herein is to be taken as permission, inducement or recommendation to practice any patent invention without a licence.

.

contact us

Cytec Engineered Materials Inc. North American Facilities

Anaheim, California
714 630-9400 • Fax 714 666-4345

Havre de Grace, Maryland
410 939-1910 • Fax 410 939-8100

Greenville, Texas
903 457-8500 • Fax 903 457-8598

Winona, Minnesota
507 454-3611 • Fax 507 452-8195

Orange, California
714 639-2050 • Fax 714 639-2033

D Aircraft Products, Inc.
Anaheim, California
714 632-8444 • Fax 714 632-7164

Cytec Carbon Fibers LLC
Piedmont, South Carolina
800 222-2448 • Fax 864 299-9333

GLOBAL HEADQUARTERS
Tempe, Arizona
480 730-2000 • Fax 480 730-2390

Cytec Engineered Materials, Ltd.
United Kingdom

Wrexham, UK
+44 1978 665200
Fax +44 1978 665222

Cytec Engineered Materials (GmbH)
Germany

Ostringen, Germany
+49 7523 912800
Fax +49 7523 912899

Cytec ENGINEERED MATERIALS
CREATING A MATERIAL ADVANTAGE