

FM[®] 1000

FM[®] 1000 is a modified polyimide-epoxy unsupported adhesive film and is especially developed for bonding metals, structural plastic laminates and various composite structural plastic sandwiches. FM[®] 1000 film adhesive is serviceable over a temperature range of -423°F to 200°F (-250°C to 95°C).

Primers are not generally required for use with FM[®] 1000 adhesives to increase strength; however, two primers are available for use where processing requires “tacking” of the FM[®] 1000 film in place or for protection of clean details. BR[®] 1009-8 tack primer is used for room temperature tacking while BR[®] 1009-49 tack primer is used for “heat-tacking” at 175°F (80°C)

FM[®] 1000 film adhesive, with and without primer, has been tested extensively against the requirements of Federal Specification MMM-A-132. FM[®] 1000 has a typical cure cycle of 60 minutes at 340° ± 10°F (170°C ± 6°C) at 40 psi (0.28 MPa).

Typical applications for FM[®] 1000 include metal-to-metal bonding, composite-to-composite bonding, and composite structural plastic sandwich bonding.

Features and Benefits

- Exceptional lap shear and peel strength
- Wide service temperature range; -423°F to 200°F (-250°C to 95°C)
- Designed for use in metal-to-metal and honeycomb sandwich structures
- Qualified to MMM-A-132, Type 1, Class 1

CHARACTERISTICS

Table 1 | Physical Properties of FM[®] 1000 film adhesive

Shelf Life	Six months from date of shipment at or below 85°F (30°C)
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Table 2 | Product Availability

Product Form	Nominal Weight ¹	Nominal Thickness	Color
	psf (gsm)	in (mm)	
Unsupported Elastomeric Film	0.015 (75)	0.003 (0.075)	White
	0.030 (150)	0.005 (0.13)	
	0.050 (250)	0.009 (0.23)	
	0.060 (290)	0.010 (0.27)	

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

Table 3 | Physical Properties of BR[®] 1009-8 room temperature tacking primer

Shelf Life	Six months from date of shipment at or below 85F (30C) – DO NOT REFRIGERATE
Solids ASTM D 3530	20% sprayable

Table 4 | Physical Properties of BR[®] 1009-49 heat tacking primer

Shelf Life	Six months from date of shipment at or below 85F (30C) – DO NOT REFRIGERATE
Solids ASTM D 3530	10% and 20% sprayable
Thinner	BR [®] 1009-49 thinner

PROPERTIES

Table 5 | Mechanical Properties, FM[®] 1000, 0.06 psf (290 gsm)¹

Property	Test Temp	Value	Substrate
T-Peel ASTM D 1876	^{°F (°C)}	lb/in (kN/m)	0.020 in (0.51 mm) 2024-T3 clad aluminum
	75 (24)	60 (10.5)	
Wide Area Lap Shear ASTM D 3165		psi (MPa)	0.063 in (1.60 mm) 2024-T3 clad aluminum
	75 (24)	6295 (29)	
Fatigue Strength ASTM D 3166	^{°F (°C)}	Cycles	0.063 in (1.60 mm) 2024-T3 clad aluminum
	75 (24)	No Failure After 10 ⁷ Cycles	
Climbing Drum Peel ASTM D 1781	^{°F (°C)}	in-lb/in (Nm/m)	0.020 in (0.51 mm) and 0.063 in (1.60 mm) 2024-T3 clad aluminum
	-67 (-55)	102 (454)	
	75 (24)	200 (890)	
Flatwise Tension ASTM C 297	^{°F (°C)}	psi (MPa)	Skin: 0.020 in (0.51 mm) 2024-T3 clad aluminum Core: 7.9-1/4-0.004N-5052
	75 (24)	1200 (8)	

¹Cured for 60 minutes at 350°F (175°C), 25 psi (0.17 MPa)

Table 5 (cont.) | Mechanical Properties, FM[®] 1000, 0.06 psf (290 gsm)¹

Property	Test Temp	Exposure Duration	Exposure Condition	psi (MPa)	Substrate
	°F (°C)				
Tensile Shear ASTM D 1002	-67 (-55)	10 Minutes	-	7400 (51)	0.063 in (1.60 mm) 2024-T3 clad aluminum
	75 (24)	-	-	7090 (49)	
	75 (24)	30 Days	Salt water Spray	6150 (42)	
	75 (24)	30 Days	Immersion in tap water	5490 (38)	
	75 (24)	30 Days	Immersion in Skydrol 500 at 160°F (70°C)	5440 (38)	
	75 (24)	30 Days	95%-100% R.H at 165°F (74°C)	4195 (29)	
	75 (24)	7 Days	Immersion in JP-4 fuel (MIL-J-5624)	6410 (44)	
	75 (24)	7 Days	Immersion in anti-icing fluid (MIL-F-5566)	6625 (46)	
	75 (24)	7 Days	Immersion in hydraulic oil (MIL-H-5606)	6620 (43)	
	75 (24)	7 Days	Immersion in hydrocarbon (TT-S-735)	6690 (47)	
	180 (82)	10 Minutes	-	3670 (25)	
	250 (121)	10 Minutes	-	2200 (15)	
	°F (°C)			in (mm)	
Creep-Rupture ASTM E 139	75 (24)	192 Hours	800 psi (5.5 MPa)	0.003 (0.102)	0.063 in (1.60 mm) 2024-T3 clad aluminum
	180 (82)	192 Hours	1600 psi (11 MPa)	0.004 (0.076)	
	°F (°C)	-	Nominal Weight	in-lb/3 in (Nm/m)	Skin: 0.020 in (0.51 mm) 2024-T3 clad aluminum Core: 7.9-1/4-0.004N-5052
Honeycomb Sandwich Peel ASTM D 1781	75 (24)	-	0.06 psf (290 gsm)	175 (260)	
	75(24)	-	0.08 psf (391 gsm)	270 (400)	

¹Cured for 60 minutes at 350°F (175°C), 25 psi (0.17 MPa)

Table 6 | Effect of curing temperature, FM[®] 1000, 0.06 psf (290 gsm)

Property	Cure Temp	Test Temp	psi (MPa)	Substrate
	^{°F} (^{°C})	^{°F} (^{°C})		
Lap Shear ASTM D 1002	315 (157)	75 (24) 180 (82)	6880 (47) 3770 (26)	0.063 in (1.60 mm) 2024-T3 clad aluminum
	335 (168)	75 (24) 180 (82)	7000 (48) 4120 (28)	
	350 (175)	75 (24) 180 (82)	7090 (49) 4210 (29)	

Table 7 | Effect of heat-up rate, FM[®] 1000, 0.06 psf (290 gsm)

Property	Heat-up Rate	Test Temp	psi (MPa)	Substrate
	Minutes	^{°F} (^{°C})		
Lap Shear ASTM D 1002	0	75 (24) 180 (82)	7100 (49) 4020 (28)	0.063 in (1.60 mm) 2024-T3 clad aluminum
	30	75 (24) 180 (82)	7200 (50) 3900 (27)	
	60	75 (24) 180 (82)	7080 (48) 4300 (30)	
Honeycomb Sandwich Peel ASTM D 1781			in-lb/3 in (Nm/m)	Skin: 0.020 in (0.51 mm) 2024-T3 clad aluminum Core: 7.9-1/4-0.004N-5052
	0	75 (24)	210 (311)	
	30	75 (24)	185 (274)	
	60	75 (24)	190 (282)	

Table 8 | Effect BR[®] 1009-8 primer air dry time with FM[®] 1000 adhesive film, 0.06 psf (290 gsm)

Property	Air Dry Time	Test Temp	in-lb/in (kN/m)	Substrate
	Minutes	°F (°C)		
T-Peel ASTM D 1876	10	75 (24)	67 (12)	0.020 in (0.51 mm) 2024-T3 clad aluminum
	30	75 (24)	80 (14)	
	60	75 (24)	71 (12.5)	
			in-lb/3 in (Nm/m)	
Honeycomb Sandwich Peel ASTM D 1781	10	75 (24)	190 (282)	Skin: 0.020 in (0.51 mm) 2024-T3 clad aluminum Core: 7.9-1/4-0.004N-5052
	30	75 (24)	180 (267)	
	60	75 (24)	190 (282)	
			psi (MPa)	
Lap Shear ASTM D 1002	10	75 (24) 180 (82)	7290 (50.2) 3620 (25)	0.063 in (1.60 mm) 2024-T3 clad aluminum
	30	75 (24) 180 (82)	7200 (50) 3500 (24)	
	60	75 (24) 180 (82)	7430 (51) 3740 (26)	

Table 9 | Physical properties with BR[®] 1009-8 primer with FM[®] 1000 adhesive film, 0.06 psf (290 gsm)¹

Property	Test Temp	Exposure Duration	Exposure Condition	psi (MPa)	Substrate
	°F (°C)				
Tensile Shear ASTM D 1002	-67 (-55)	10 Minutes	-	6840 (47)	0.063 in (1.60 mm) 2024-T3 clad aluminum
	75 (24)	-	-	7200 (50)	
	75 (24)	30 Days	Salt water Spray	6215 (43)	
	75 (24)	30 Days	Immersion in tap water	6095 (42)	
	75 (24)	30 Days	Immersion in Skydrol 500 at 160°F (70°C)	5025 (34)	
	75 (24)	30 Days	95%-100% R.H at 165°F (74°C)	5360 (37)	
	75 (24)	7 Days	Immersion in JP-4 fuel (MIL-J-5624)	6980 (49)	
	75 (24)	7 Days	Immersion in anti-icing fluid (MIL-F-5566)	6695 (46)	
	75 (24)	7 Days	Immersion in hydraulic oil (MIL-H-5606)	6960 (48)	
	75 (24)	7 Days	Immersion in hydrocarbon (TT-S-735)	6995 (48)	
	180 (82)	10 Minutes	-	3500 (24)	
	°F (°C)			in (mm)	
Creep-Rupture ASTM E 139	75 (24)	192 Hours	800 psi (5.5 MPa)	<0.015 (0.38)	0.063 in (1.60 mm) 2024-T3 clad aluminum
	180 (82)	192 Hours	1600 psi (11 MPa)	<0.015 (0.38)	
	°F (°C)			Cycles	
Fatigue Strength ASTM D 3166	75 (24)	-	-	No Failure After 10 ⁷ Cycles	0.063 in (1.60 mm) 2024-T3 clad aluminum

¹Primer air dried for 30 minutes at room temperature. Cure – 30 minutes to 350°F (175°C), 60 minutes at 350°F (175°C), 25 psi (0.17 MPa)

Table 10 | Physical properties with BR[®] 1009-49 primer with FM[®] 1000 adhesive film, 0.06 psf (290 gsm)¹

Property	Test Temp	Exposure Duration	Exposure Condition	psi (MPa)	Substrate
	°F (°C)				
Tensile Shear ASTM D 1002	-67 (-55)	10 Minutes	-	6740 (47)	0.063 in (1.60 mm) 2024-T3 clad aluminum
	75 (24)	-	-	6590 (45)	
	75 (24)	30 Days	Salt water Spray	6185 (43)	
	75 (24)	30 Days	Immersion in tap water	6125 (42)	
	75 (24)	30 Days	Immersion in Skydrol 500 at 160°F (70°C)	5810 (40)	
	75 (24)	30 Days	95%-100% R.H at 165°F (74°C)	5165 (35)	
	75 (24)	7 Days	Immersion in JP-4 fuel (MIL-J-5624)	5985 (41)	
	75 (24)	7 Days	Immersion in anti-icing fluid (MIL-F-5566)	5895 (40)	
	75 (24)	7 Days	Immersion in hydraulic oil (MIL-H-5606)	6345 (44)	
	75 (24)	7 Days	Immersion in hydrocarbon (TT-S-735)	6120 (42)	
	180 (82)	10 Minutes	-	3400 (23)	
	°F (°C)			in (mm)	
Creep-Rupture ASTM E 139	75 (24)	192 Hours	800 psi (5.5 MPa)	>0.015 (0.38)	0.063 in (1.60 mm) 2024-T3 clad aluminum
	180 (82)	192 Hours	1600 psi (11 MPa)	>0.015 (0.38)	
	°F (°C)			Cycles	
Fatigue Strength ASTM D 3166	75 (24)	-	-	No Failure After 10 ⁷ Cycles	0.063 in (1.60 mm) 2024-T3 clad aluminum

¹Cure – 30 minutes to 350°F (175°C), 60 minutes at 350°F (175°C), 25 psi (0.17 MPa)

PROCESSING

Guidelines for Thawing Out

On Removal of sealed film adhesive from 0°F (-18°C) storage, ensure that the material is allowed to thaw fully to room temperature prior to unsealing. This avoids condensation. Typically an 82 ft. (25m) roll of film adhesive, 0.060 psf (290 gsm) requires 6 hours to thaw.

Recommended Cure Cycle

Autoclave Cure Cycle Apply full vacuum, 24 in Hg (0.081 MPa) minimum.
Apply 40 psi (0.28 MPa) pressure. Vent Vacuum at 20 psi (0.14 MPa)
Heat from 75°F (24°C) to 340°F ± 10°F (170°C ± 6°C).
Hold at 340° ± 10°F (170°C ± 6°C) for 60 minutes
Cool under pressure below 140°F (60°C).

Handling Information

Both primers will gel on exposure to low temperature. The material may be returned to fluid state as follows:

1. Loosen lid on primer container. Replace lid without tightening.
2. Place container in 120°F (50°C) preheater water bath and hold until primer becomes fluid.
3. Stir primer for 15 minutes using slotted cover to reduce solvent loss.

Surface Preparation

Aluminum Skins

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 at 155°F ± 5°F (68°C ± 3°C).

Clad- 10 minutes

Bare- 5 minutes

Solution contents:

- a. Sodium dichromate (Fed-O-S-595A)- 34 grams
 - b. Sulfuric acid (Fed-O-A-115, Class A, Grade 2)- 304 grams
 - c. Water- To make 1 liter
 - d. Dissolve 1.5 grams of 2024 clad 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 (66°C).

RECOMMENDED CONSUMABLES

Table 11 below provides a list of consumable processing materials recommended for use with FM[®] 1000 film adhesive.

Table 11 | Processing Materials

Product Category	Product Name
Sealant Tape	SM514BY, SM 5127, SMS5126
Release Film	A6200, A5000
Release Fabric	200 TFP, 200TFNP
Breather/Bleeder Fabric	RC3000-10, A3000-4
Peel Ply	60001, 60002, 51789
Bagging Film	HS 8171, SV3000
Adhesive Tape	Flashtape 1, Flashtape 2

HEALTH & SAFETY

Please refer to the product SDS for safe handling, personal protective equipment recommendations and disposal considerations.

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