ALPOLIC®/fr LT

Technical Manual

Section 2 Characteristics

Contents

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1. General

As mentioned in the previous section, ALPOLIC/fr LT is an Aluminum Composite Material (ACM) composed of aluminum sheets and the fire-retardant core material. We are going to introduce various properties of ALPOLIC/fr LT in this section. These properties are summarized in a compact style in “Appendix 1: Summary of Specification Data” in Section 4.

2. Physical properties

(1) Summary of physical properties

The following table is a summary of physical properties of ALPOLIC/fr LT.

	ASTM	Unit	ALPOLIC/fr LT
Specific gravity	-	-	1.84
Weight	-	kg/m^2 psf	5.5 1.13
Linear thermal expansion/ contraction coefficient	D696	1/°C 1/°F	24×10^{-6} 13×10^{-6}
Thermal conductivity	D976	W/(m·K) BTU/(ft·hr·°F)	0.31 0.17
Deflection temperature	D648	°C °F	110 230

(2) Panel weight

The following table shows the comparison of weight between various materials of typical thicknesses.

Material	Specific gravity	Unit weight of typical thickness	
		Typical thickness mm (inch)	Weight kg/m^2 (psf)
ALPOLIC/fr LT	1.84	3.0 (0.12”)	5.5 (1.13)
Aluminum sheet	2.71	2.0 (0.08”)	5.4 (1.11)
Steel sheet	7.9	1.2 (0.05”)	9.5 (1.95)
Stainless steel (304)	7.9	1.2 (0.05”)	9.5 (1.95)
Granite	2.9	8.0 (0.31”)	23.0 (4.71)
Glass	2.5	3.0 (0.12”)	7.5 (1.54)
Acrylic sheet	1.2	4.0 (0.16”)	4.8 (0.98)
Gypsum board	0.86	12.5 (0.49”)	10.8 (2.21)

(3) Thermal expansion/contraction

ALPOLIC/fr LT has the same expansion/contraction ratio as aluminum metal. The following table shows the expansion/contraction of various building materials.

Material	Linear expansion/contraction coefficient		Expansion/contraction per 1 meter with 25°C change	Expansion/contraction per 3 ft with 45°F change
	1/°C	1/°F	mm	inch
ALPOLIC/fr LT	24×10^{-6}	13×10^{-6}	0.6 mm	0.021”
Aluminum	24×10^{-6}	13×10^{-6}	0.6 mm	0.021”
Steel	12×10^{-6}	6.7×10^{-6}	0.3 mm	0.011”
Stainless steel (304)	17×10^{-6}	9.6×10^{-6}	0.4 mm	0.016”
Concrete	12×10^{-6}	6.7×10^{-6}	0.3 mm	0.011”
Glass	9×10^{-6}	5.0×10^{-6}	0.2 mm	0.008”
Acrylic sheet	70×10^{-6}	39×10^{-6}	1.8 mm	0.063”

(4) Thermal conductivity

ALPOLIC/fr LT has lower thermal conductivity than metals like aluminum and steel. However, actual heat resistance depends on the overall heat flow through the wall system or heat transmission, as discussed in the next chapter.

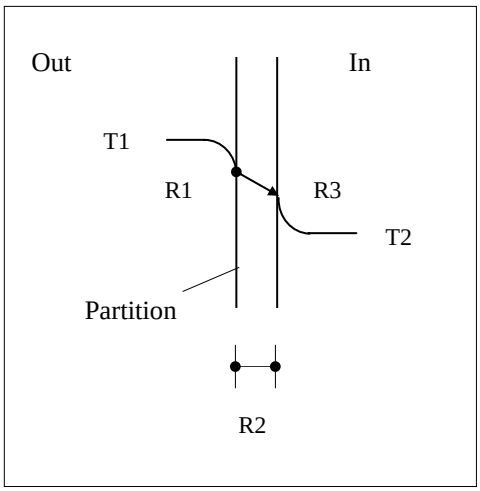
Material	Thermal conductivity, W/(m·K)	Material	Thermal conductivity, W/(m·K)
ALPOLIC®/fr 303	0.31	Brick	0.28
Aluminum	210	Glass	1
Steel	45	Gypsum board	0.13
Stainless steel (304)	17	Rock wool / Glass wool	0.04
Concrete	1.6		

(5) Heat transmission

In interior partitions as shown in the diagram, the heat transmission through the partition is the sum of R1 (heat transmission of interface), R2 (heat flow inside partition by thermal conductance) and R3 (heat transmission of interface). Thus, calculating each of R1, R2 and R3 will give us the overall heat transmission. The following table is a calculated result with several materials.

Material	Thickness (mm)	Rt (m^2·K/W)
ALPOLIC®/fr LT	3	0.25
Aluminum	2	0.24
Plywood	12	0.32
Gypsum board	12	0.34

Heat Transmission



Note: Rt is the sum of R1, R2 and R3 and shows the total resistance of heat transmission through the partition.

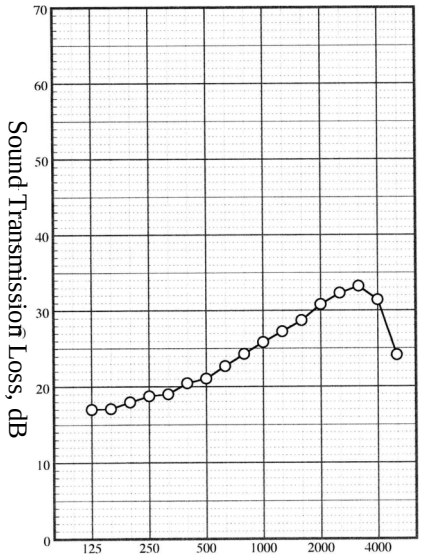
As shown above, ALPOLIC/fr LT 3 mm has about 70% of thermal insulation effect of plywood 12 mm and gypsum board 12 mm.

(6) Deflection temperature

The deflection temperature of ALPOLIC/fr LT is 110°C (230°F). Therefore, non-burdened ALPOLIC/fr LT resists boiling water for short time. However, in a practical heating work, we recommend the following guideline:
If the heating duration is shorter than 30 min, keep 90°C (194°F) at maximum.
If the heating duration is longer than 30 min, keep 70°C (158°F) at maximum.

(7) Sound transmission loss

Compared to steel sheet, aluminum sheet, plywood, ALPOLIC/fr LT has a large sound insulation per unit weight. The chart shows airborne sound insulation measured in accordance with the following method:
JIS A1416 (ISO140-3): Acoustics-Method for laboratory measurement of airborne sound insulation of building elements.



3. Mechanical properties

(1) Mechanical properties as ACM

ALPOLIC/fr LT has the following mechanical properties as a composite panel.

	ASTM	Unit	ALPOLIC/fr LT
Tensile strength	E8	MPa or N/mm^2	30
		psi	4352
0.2% proof stress	E8	MPa or N/mm^2	27
		psi	3916
Elongation	E8	%	4
Flexural elasticity, E	C393	MPa or N/mm^2	33×10^3
		psi	4787×10^3
Flexural rigidity, E×I	C393	Nmm^2/mm	74×10^3
		$lbs.inch^2/inch$	655
Shear strength with punching shear test	D732	N/mm^2	21
		psi	3046

(2) Mechanical properties of aluminum skin (1100-H14)

Aluminum skin (1100-H14) used for ALPOLIC/fr LT has the following mechanical properties which are often used for structural calculation of ALPOLIC/fr LT panels. Refer to "Panel Strength" in this section and "Appendix 6: Panel Strength" in Section 4.

	ASTM	Unit	Aluminum 1100-H14
0.2% proof stress	E8	MPa or N/mm^2 psi	118 17×10^3
Flexural elasticity	E8	GPa or kN/mm^2 psi	69 10×10^6

(3) Rigidity and panel weight

Based on the above mechanical properties, we can calculate the flexural rigidity (bending strength) of ALPOLIC/fr LT. The following table shows the rigidity of ALPOLIC/fr LT in comparison with other materials of the same rigidity. ALPOLIC/fr LT has high rigidity with a lightweight. ALPOLIC/fr LT consists of two sheets of 0.3mm thick aluminum, but the rigidity is equivalent to 2.4 mm thick solid aluminum sheet and 1.6 mm thick steel sheet.

Material	Thickness of equivalent rigidity	Modulus of elasticity, E	Flexural rigidity, E×I	Panel weight	Weight ratio (ALPOLIC =100)
Unit	mm (inch)	MPa or N/mm^2 (psi)	Nmm^2/mm ($lbs\cdot inch^2/inch$)	kg/mm^2 (psf)	%
ALPOLIC/fr LT	3 mm (0.118")	33×10^3 (4787)	74×10^3 (657)	5.5 (1.13)	100
Aluminum	2.4 mm (0.094")	69×10^3 (9951)	79×10^3 (700)	6.5 (1.33)	118
Steel	1.6 mm (0.063")	210×10^3 (29881)	70×10^3 (622)	12.6 (2.58)	230
Stainless steel	1.7 mm (0.067")	190×10^3 (27995)	79×10^3 (699)	13.4 (2.75)	244
Acrylic sheet	6.6 mm (0.26")	3.2×10^3 (464)	77×10^3 (679)	7.9 (1.62)	144

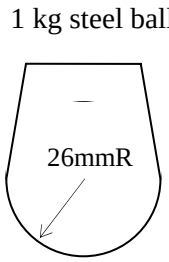
4. Impact resistance

We obtained the following data with Du-pont method

Steel ball weight kg (lbs)	Height mm (inch)	Dent depth mm (inch)
0.3 (0.7)	300 (11.8")	1.0 (0.04")
0.5 (1.1)	500 (19.7")	2.0 (0.08")
1.0 (2.2)	300 (11.8")	2.3 (0.09")
1.0 (2.2)	500 (19.7")	3.1 (0.12")

Du-pont test instrument

In addition to the above test, we held another impact test using a 1 kg steel ball, in accordance with JIS A 5703. The test includes other interior sheet materials for comparison. Refer to the test report attached in “Appendix 4: Impact Test with Steel Ball” in Section 4. As shown in the report, ALPOLIC/fr LT never shows crack, break and fracture by the impact of the steel ball.



5. Bendable limit

ALPOLIC/fr LT is bendable by means of a press brake or a 3-roll bender. The minimum bendable radii of respective bending methods are as follows.

Bending method	Condition		Minimum bendable radius (mm)
Press brake	Bending direction	Traverse	50
		Parallel	80
3-roll bender	Roll length	500 mm	120
		1000 mm	150
		2000 mm	180
		2500 mm	200

Note 1: “Traverse and Parallel” in press-brake means the direction toward the roll (coating) direction.
Note 2: In 3-roll bending, the exact bendable limit varies depending on the bending roll diameter and type of bending machine. The above values are rough suggestion based on a typical machine.

6. Fire Performance

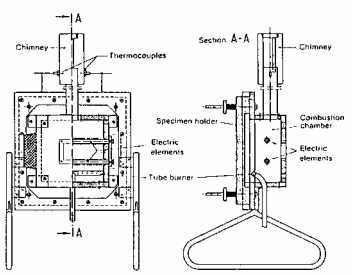
ALPOLIC/fr LT is a fire safe material. It passes the following fire tests:

Country	Test Standard	Specimen thickness	Results & classification
United Kingdom	BS476 Part 6 BS476 Part 7	3 mm	Class 0 Class 1
USA	Tunnel Test (ASTM E-84)	3 mm	Class A / Class 1
	Interior Room Corner Test (UBC 26-3)	3 mm	Passed
Japan	Heat Release Test for Non-combustible Material (ISO5660-1) and Toxicity Gas Test	3 - 6 mm	Passed Certificate No. NM-0209

For reference, we are outlining each test below:

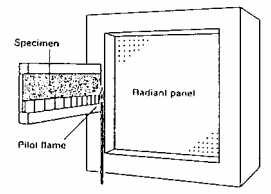
BS476 Part 6: Fire propagation for products

This test is applicable to those materials that could pass Class 1 of BS476 Part 7 test. The index converted from temperature data of the effluent gas from specimen in combustion chamber must be lower than a specific value. The material, which passes this test, becomes Class 0.



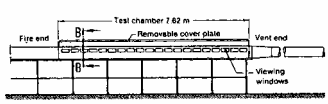
BS476 Part 7: Surface flame spread of products

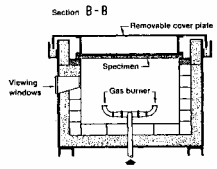
This test focuses on the classification of materials by the surface spread of flame. The length of flame-spread of specimen exposed vertically to a heat radiation panel is measured. Based on the length, materials are classified into Class 1 - 4.



Tunnel test (ASTM E84): Surface burning characteristics of building material

This test focuses on the surface burning characteristics. Through the test, spread length of fire and density of effluent gas take measured, to convert to flame-spread index. Based on this index, the material is classified to three classes (I to III in UBC & NBC or A to C in SBC).



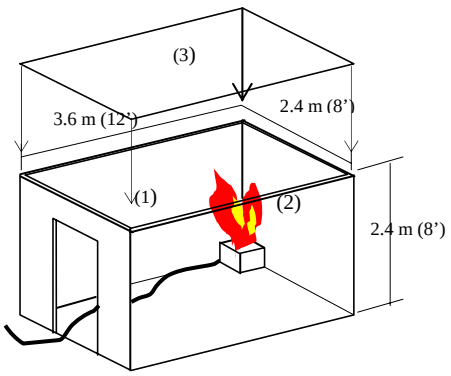


Interior room corner test (UBC 26-3):

Main purpose of this test is to examine the potentiality of “Flashover” of the interior materials. In the event that a fire takes place at a room corner, the flame will grow slowly until the fire reaches a critical point called flashover. When the fire reaches the flashover point, the fire suddenly expands toward the opening door. The flashover is hazardous and sometimes lethal. This test simulates this situation, to reveal the potentiality of flashover of the interior materials.

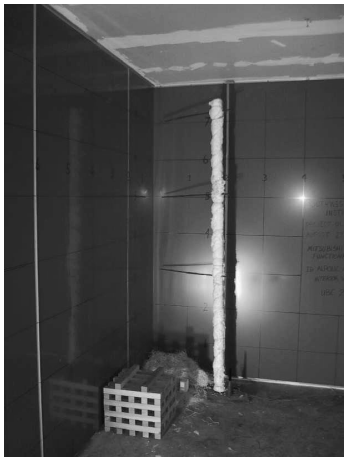
Testing conditions:
Heater: Gas burner or 30lb wood crib
Time: 15 min
The interior is finished with the testing material
(1) Side wall, (2) Front wall, (3) Ceiling: Optional

Interior room corner test (UBC 26-3)



Interior room corner test (UBC 26-3)

Before test



7 minutes after ignition

14 minutes after ignition

Heat release test (ISO 5660-1) and Toxicity gas test in Japan:
ALPOLIC®/fr LT passes Japan's heat release test (ISO 5660-1) and toxicity gas test. ALPOLIC/fr LT has an approval as non-combustible material for interior and exterior of buildings in Japan with Certificate No. NE-209.

Heat release test (ISO 5660-1)

7. Non-permeability

ALPOLIC/fr LT is non-permeable. Under humid atmospheric conditions, it does not absorb moisture at all. The following is the test result of the freezing and thawing cycle test, which confirms the complete non-permeability of ALPOLIC/fr LT.

(1) Freezing and thawing test
Exposure cycle: -20°C×1.0hrs for freezing and +10°C×1.5hrs for thawing
(2) Test result
After 300 cycles, the sample does not show any change in weight, thickness and appearance.

Note: If you use ALPOLIC/fr LT in a humid condition like in a bathroom where the edge of the panel may be always wet, it is important to design the fixing detail to drain the moisture and to keep the edge dry. Please consult our office about practical methods of suitable fixing details.

8. Coating performance

(1) Coating type and coating system

The finishes of stock colors include four coating types: Solid Color, Metallic Color, Stone and Timber Finishes. Each type has the following coating system:

Solid and **Metallic** Colors: 2-coat / 2-bake system consisting of primer and top coating.

Stone and **Timber** Colors: Coated with a unique image transfer process. The coating consists of primer, image transfer layer and top coating.

Matte finish is produced with a unique coating, in which microscopic wrinkles emerge over the entire coated surface during baking of the paint. Thus, Matte finishes have uniform and fine wrinkles over the surface.

Note 1 Custom colors: In addition to the above stock colors, **custom colors** are available subject to the minimum quantity and color match. Please contact distributors or our office for custom color request.

Note 2 Option coatings: Furthermore, we are ready to supply ALPOLIC303/fr products coated with such distinctive paints as fluorocarbon coating, high cross-link polyester coating and conductive fluorocarbon coating. Refer to “Appendix 2: Optional Coatings” in Section 4.

(2) Coating performance

The above polyester coatings meet the following performance:

Test item	Test method	Performance
Paint thickness		17 microns min.
Gloss:	60° specular gloss (ASTM D523-89)	Matte to 90%
Pencil hardness:	(ASTM D522-88)	>= H
Adhesion (Cross-cut)	Adhesion (Cross-cut)	100/100 (Cross-cut)
Impact resistance:	Du-pont method, 0.5kg, 1/2 inch, 50cm, Backside impact test	No picking off
Water resistance: Boiling water resistance Humidity resistance:	50°C, tap water, 24 hrs. 98-100°C, pure water, 4 hrs. 240 hrs, 98% RH, 50°C (ASTM D2247-87)	100/100 (Cross-cut) 100/100 (Cross-cut) No blister, no pick off
Alkali resistance: Acid resistance: Salt spray resistance: Solvent resistance:	1%NaOH, 20°C, 24hrs. 5%H_2SO_4, 20°C, 24hrs. 1000 hrs, salt fog, 35°C MEK, 20°C, 24hrs.	No blister, no pick off No blister, no pick off No blister, no pick off No blister, no pick off
Detergent resistance: Pollution resistance:	Detergent “Surf”, 25g/30L, 20°C, 24hrs. Lip stick, eye shadow, 24 hrs. After wiping off with IPA.	No blister, no pick off No blister, no pick off
Accelerated weathering test:	QUV, 500 hrs.	No blister, no pick off

9. Panel strength

When ALPOLIC/fr LT panels are used outdoors, the panels must withstand the wind load. When wind

blows toward panels, the wind will push the panel with a positive pressure. To the contrary, a negative wind load will cause suction on the panels. We normally confirm the adequacy of the panel strength by calculating the strength under given conditions.

(1) Calculation to check the possibility of permanent deformation

For calculation, we assume that the strength of ALPOLIC/fr LT panels lies on its aluminum skins. Namely, if the stress exerted in aluminum skins is smaller than the permissible value, permanent deformation will not occur. In this calculation, the permissible value is given as 0.2% proof stress (or yield strength) of aluminum skin divided by a safety factor. 0.2% proof stress depends on aluminum alloy and hardening condition, and the following aluminum alloy is used in ALPOLIC/fr LT:

	Alloy and hardening	0.2% proof stress (Yield strength)
ALPOLIC/fr LT	1100 H14	118 MPa (N/mm^2), or 170×10^2 psi

The panel strength depends on the following environmental and geometrical factors, in addition to the permissible stress of aluminium skin:

A. Wind load
B. ALPOLIC303/fr thickness (3mm)
C. Supporting condition
D. ALPOLIC panel size

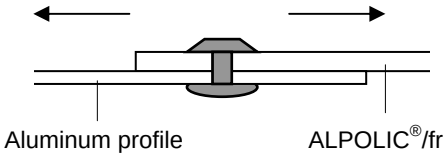
The actual calculation method is outlined in “Appendix 6: Panel Strength” in Section 4. If the calculated stress becomes larger than the permissible limit, further study is required to lessen the stress. One solution is to reinforce the panel with stiffener. If you need a structural calculation, please contact distributors or our office.

(2) Calculation of panel deflection

Panel deflection will be also checked, if the maximum deflection is specified in the project. The calculation method of panel deflection is outlined in “Appendix 6: Panel Strength” in Section 4.

10. Strength of junction holes

When suction pressure loads on ALPOLIC/fr LT panel, the junction hole of rivet or screw must withstand the tension. Otherwise, the junction hole will be torn off and the panel will be removed.



In actual installation work, the position of junction hole is important. When the hole is positioned in the proximity of panel edge, its strength will be lessened and may be unsatisfactory. Normally, the distance from hole-center to panel edge (e) should be larger than twice of hole-diameter (D). Namely, $e > 2\times D$. Refer to “Appendix 7: Strength of Junction Holes” in Section 4.