

# **ALPOLIC<sup>®</sup>/fr LT**

## **Technical Manual**



Mitsubishi Chemical Functional Products, Inc.

URL <http://www.alpolic.com>

MARCH 2005

# **ALPOLIC®/fr LT**

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## Section 1 Outline

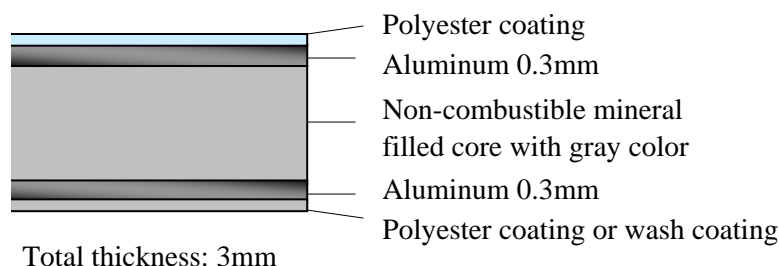
Introducing ALPOLIC®/fr LT, the new lightweight champion of Aluminum Composite Material (ACM). This material is perfect for use on interior walls, columns, ceilings and partitions in shops, offices and factories, and for such light outdoor applications as soffits, awnings, parapets, signs and much more.

### 1. Material composition

ALPOLIC®/fr LT is composed of a non-combustible mineral core with a small amount of low-density polyethylene sandwiched between two skins of 0.3 mm thick aluminum. The core, indispensable for fire safety of interior application, is gray in color, with a touch of carbon black for an aesthetically pleasing cut edge.

ALPOLIC®/fr LT's effective sides are finished with polyester coatings and covered with translucent protective films. The Reversible Series has effective surfaces front and back, while the Single, Stone, and Timber Series feature the effective surface on the front and a wash coating on back.

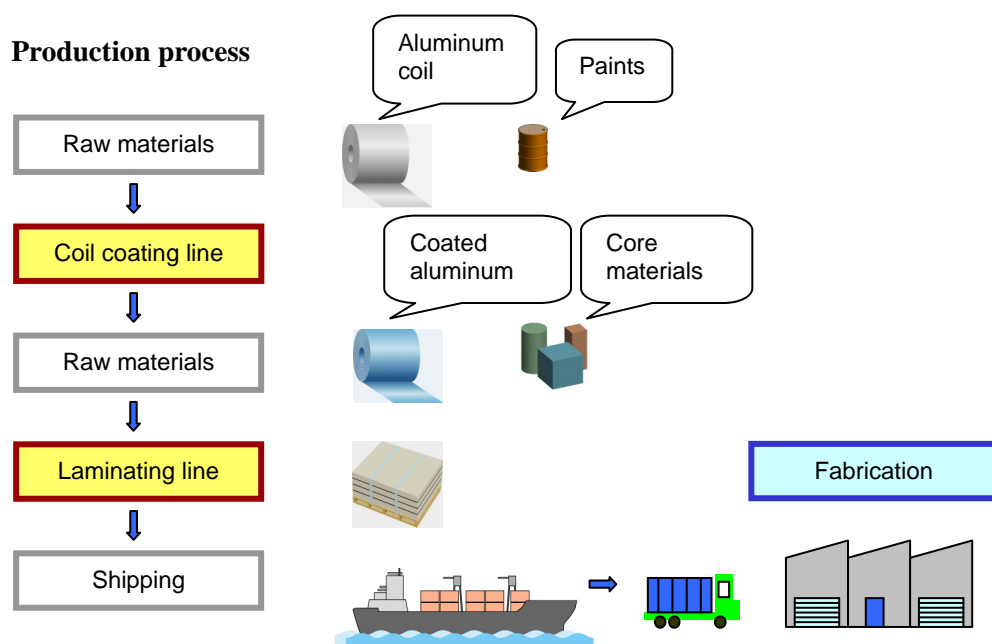
#### Composition of ALPOLIC®/fr LT



### 2. Production process

The production process of ALPOLIC/fr LT consists of two lines: a coil coating line and a laminating line. In the coil coating line, polyester paints are applied to continuous aluminum coils. In the laminating line, the mineral-filled fire retardant core is laminated between these coated coils, resulting in the finished composite material.

After laminating, the finished product is packed in wooden cases. Standard products are warehoused for stock, and custom products are immediately shipped to the customer. Thus, ALPOLIC/fr LT products are shipped as flat panels to be processed in local workshops according to project specifications.



### 3. Features

ALPOLIC/fr LT has all the features you've come to expect from other ALPOLIC ACMs, and then some. Fire safety is an imperative issue for interior materials, and ALPOLIC/fr LT passes the fire tests required for interior materials in the USA and Japan.

ALPOLIC/fr LT is available as a stock item in our full range of standard and metallic colors, as well as in stone and timber-patterned finishes produced with our unique image transfer process.










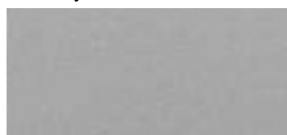









ALPOLIC/fr LT offers the rigidity of heavy-gauge sheet metal in a lightweight material with superior flatness, vibration damping, durability, and ease of maintenance. It is amazingly formable, so it can be easily cut, bent, grooved or shaped with ordinary woodworking and metal working tools.

The panel's twin sheets of 0.3 mm aluminum deliver the rigidity equivalent to an aluminum sheet of 2.4 mm thickness or a steel of 1.6 mm, and offer a weight reduction of 15% for aluminum and 57% for steel of the same rigidity.

### 4. Surface finishes

ALPOLIC/fr LT is available as a stock item in Reversible, Single, Stone and Timber finishes as follows:

## Finishes of stock products:

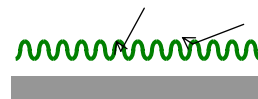
<b>N1 Pure White-G90</b>  84%, 4%, 7.8BG9.4/0.2	<b>N1 Anodized Silver-G75</b>  32%, 6%, 1.2G8.2/0.1	<b>N2 White-G30</b>  75%, 2%, 2.1PB8.9/0.4	<b>N2 Champagne Metallic-G 30</b>  35%, 3%, 0.2Y7.8/0.2
<b>N3 Light Beige-G30</b>  70%, 3%, 6.2Y8.8/0.7	<b>N3 Silver Metallic-G30</b>  36%, 3%, 3.1G7.7/0.1	<b>N4 Black-G30</b>  1%, 2%, 5.3PB2.6/0.3	<b>N4 Gray-G30</b>  43%, 2%, 0.6B7.2/0.2
<b>N5 Off White-Matte</b>  73%, 1%, 8.3Y8.8/0.7	<b>N6 Gray Metallic-Matte</b>  27%, 1%, 5.4YR6.1/0.3	<b>S1 Black Granite-G80</b>  2%, 3%, 5.5R3.2/0.4	<b>S2 White Granite-G80</b>  33%, 3%, 10.0YR6.8/1.3
<b>S3 Red Granite-G80</b>  5%, 3%, 1.4YR3.7/1.6	<b>S4 Pink Granite-G80</b>  35%, 3%, 6.8YR6.8/1.3	<b>S6 Venetian Marble-G80</b>  57%, 4%, 1.5Y8.2/0.9	<b>S5 White Marble-G80</b>  56%, 4%, 3.8G8.0/0.1
<b>S7 Sandstone-Matte</b>  67%, 1%, 0.3Y8.6/2.0	<b>T1 Maple-Matte</b>  35%, 1%, 6.3YR6.6/5.9	<b>T2 Walnut-Matte</b>  18%, 0%, 4.1YR5.0/5.3	

**Legend:** Top of color indicates color code, color name and gloss ratio respectively. For example, N1 Pure White-G80 shows N1 Pure White with 80% gloss. Bottom of color indicates diffuse reflectivity, specular (mirror) reflectivity and Munsell number respectively. Values of patterned colors are quite approximate values.

**Note:** Due to the limitation of photo, the above color does not show the exact colors. Refer to the Color Chart.

**Reversible surfaces** (N1 to N4) have effective sides on both front and back. **Stone** (S1 to S7) and **Timber** (T1, T2) are coated with a unique image transfer process. **Matte** finish is produced with a new coating technology in which microscopic wrinkles emerge over the entire surface during baking in the coil coating line. All the finishes are coated with polyester paints in ALPOLIC's continuous coil coating line.

**Matte finish:** Due to the differing speed of hardening between the outer and inner layers, microscopic wrinkles emerge over the entire surface. The wrinkled surface results in a matte appearance due to irregular light reflection.

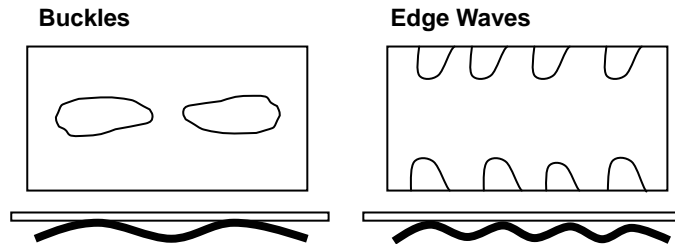




## 5. Flatness

ALPOLIC/fr LT is as flat as it gets. Generally speaking, ensuring the flatness of interior material is very difficult. Solid aluminum sheet, for example, has a slight distortion stemming from its rolling process: buckles, edge waves and overall warping are common. ALPOLIC/fr LT is extremely flat due to the thinness of the aluminum sheets and our lamination process.

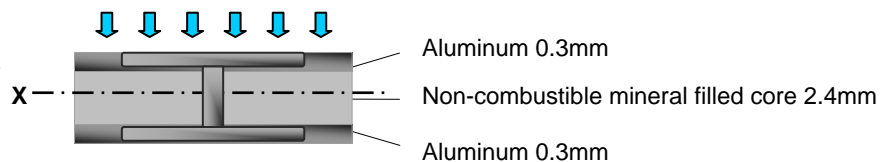
### Flatness of aluminum sheet (Excerpt from ISO standard)



## 6. Rigidity and weight

ALPOLIC/fr LT is highly rigid compared to aluminum and other metal sheets. As shown in the diagram below, two sheets of aluminum skin behave like a strong H-section when pressure is applied on ALPOLIC panel. Consisting of 2 sheets of 0.3mm thick aluminum, ALPOLIC/fr LT delivers the rigidity equivalent to an aluminum sheet of 2.4 mm thickness or a steel sheet of 1.6 mm, and is lighter than any other solid metals or plastic materials of the same rigidity.

### Rigidity of ACM (Aluminum Composite Material)



### Comparison of flexural rigidity of various materials

Material	Thickness of equivalent rigidity, mm (inch)	Weight kg/m <sup>2</sup> (psf)	Weight ratio (ALPOLIC=100)
ALPOLIC®/fr LT	3.0 (0.118")	5.5 (1.13)	100
Aluminum sheet	2.4 (0.094")	6.5 (1.33)	118
Steel sheet	1.6 (0.063")	12.6 (2.59)	230
Stainless steel (304)	1.7 (0.067")	13.4 (2.75)	244
Acrylic sheet	6.6 (0.260")	7.9 (1.62)	144

## 7. Fire safety

ALPOLIC/fr LT is a fire-safe interior material, passing all mandatory requirements for interior materials in the United States and Japan. Though the core material does contain a small amount of combustible polyethylene, the main ingredient of the mineral does not permit the proliferation of

flame and restricts the development of the smoke detrimental to the evacuation activities. Refer to Section 2 “Characteristics” for details of each fire test.

#### ALPOLIC/fr LT passes the following fire tests:

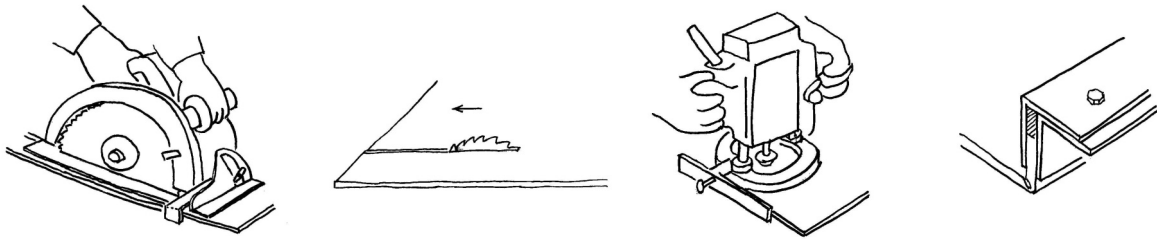
Country	Test standard	Results & classification
United Kingdom	BS476 Part 6	Class 0
	BS476 Part 7	Class 1
USA	Tunnel Test (ASTM E-84)	Class A/Class 1
	Interior Room Corner Test (UBC 26-3)	Passed
Japan	Heat Release Test for Non-combustible Material (ISO5660-1) and Toxicity Gas Test	Passed. Certificate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

#### Interior Room Corner Test



### 8. Workability

The amazing workability of ALPOLIC/fr LT is one of its most compelling features. It can be cut with circular saws. It can be folded after grooving with a router. It can be bent with a 3-roll bender and press brake, and the core material can be welded with hot-melt adhesive. For details, refer to Section 3 “Fabrication and installation.”



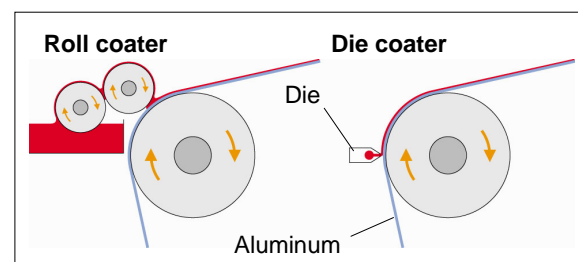
### 9. Coating quality

#### (1) Consistent color quality

Consistent color quality is maintained through the continuous application of paints to the aluminum coil in the coil coating line. The “Die Coating” process that occurs on this line employs a unique technology developed by Mitsubishi Chemical that ensures a smooth, fine coating.

#### (2) Coating type

Stock colors can be classified into the following types:



Roll Coater, widely used in aluminum industry, affords to produce an adequate quality with a reasonable efficiency. But Die Coater excels Roll Coater, permitting direct coating on aluminum surface that ensures more smooth and fine finishes without grain lines.

Coating type	Finish
Solid Color	Pure White-G90, White-G30, Light Beige-G30, Black-G30, Gray-G30, Off White-Matte
Metallic Color	Anodized Silver-G75, Champagne Metallic-G30, Silver Metallic-G30, Gray Metallic-Matte
Stone	Black Granite-G80, White Granite-G80, Red Granite-G80, Pink Granite- G80, White Marble-G80, Venetian Marble-G80, Sandstone-Matte
Timber	Maple-Matte, Walnut-Matte

**Note:** Numbers following the color name, such as G30, show the gloss in %.

Each finish is coated with polyester paint in ALPOLIC's continuous coil coating line.

**Solid** and **Metallic Colors** are the product of a 2-coat / 2-bake system consisting of primer and top coating.

**Stone and Timber Finishes** are created with a unique image transfer process consisting of primer, image-transfer layer and top coating.

**Matte** finish is produced by a unique method in which microscopic wrinkles emerge uniformly over the surface during the baking stage in the coil coating line.

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

### (3) Paint performance

The above polyester coatings are resistant to corrosion and moisture in interior applications, and sufficiently show a reasonable weather-ability in outdoor applications such as soffits, parapets, awnings and signs.

However, as widely known, the polyester coatings have less weather-ability than fluorocarbon coatings. With outdoor use, it is possible for polyester coatings to show gradual color fading, a gloss change and a chalking within 3-5 years depending on the intensity of the UV. If such degradation is unacceptable, re-coating may be required. If you require a coating warranty for your project (not available on our polyester-coated products), we recommend ALPOLIC's line of optional fluorocarbon-coated products.

### (4) Optional coatings

Apart from the above polyester paints, we can supply ALPOLIC/fr LT in the following distinctive paints as an option. Refer to respective specifications in Section 4.

### Paint options

Optional coating	Characteristics	Suitable application
Fluorocarbon coating (Lumiflon-based)	Ultra-weather-ability Coating warranty is available.	Outdoor (awnings, parapets, signs)
Conductive fluorocarbon coating	Electric-conductive ( $3 \times 10^{7-8}$ ohms)	Interior walls and partitions in factory
High cross-link polyester coating	High hardness (4H) High reflectivity (80%)	Interior lining of tunnels

### (5) Touch-up paint

We can use commercial touch-up paints when we need to repair scratches during fabrication and installation, but please be aware that touched-up portions, especially on patterned (Stone and Timber) and Matte Finishes, may not completely match the original finish in appearance. Refer to Section 3 for detail.

### 10. Thermal expansion/contraction

ALPOLIC/fr LT has the same linear thermal expansion coefficient as aluminum metal, so movement will not occur between aluminum and ALPOLIC/fr LT due to thermal expansion/contraction.

#### Thermal expansion/contraction:

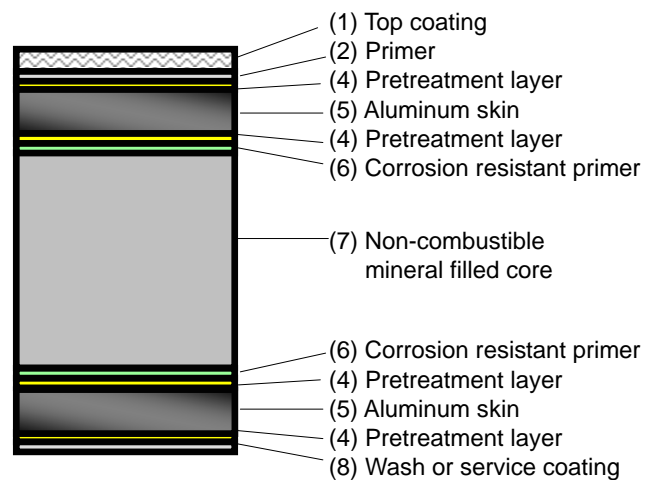
Material	Linear thermal expansion coefficient, /°C	Elongation or shrinkage per 1 meter per 25°C	Linear thermal expansion coefficient, in/in/°F
ALPOLIC303/fr	$24 \times 10^{-6}$	0.6 mm	$13 \times 10^{-6}$
Aluminum	$24 \times 10^{-6}$	0.6 mm	$13 \times 10^{-6}$
Steel	$12 \times 10^{-6}$	0.3 mm	$7 \times 10^{-6}$
Stainless steel (304)	$17 \times 10^{-6}$	0.4 mm	$10 \times 10^{-6}$
Concrete	$12 \times 10^{-6}$	0.3 mm	$7 \times 10^{-6}$
Glass	$9 \times 10^{-6}$	0.2 mm	$5 \times 10^{-6}$
Acrylic sheet	$70 \times 10^{-6}$	1.8 mm	$39 \times 10^{-6}$

Since the thermal expansion of steel and concrete is smaller, a certain amount of movement will take place between these materials and ALPOLIC/fr LT. This movement is normally very small (0.5mm/m or 0.02"/3') in case of indoor applications, but it must be relieved with a suitable method such as spacing between panels. In outdoor applications, the larger temperature change will result in movement that is nearly twice of the interior.

### 11. Prevention from edge corrosion

When used in a corrosive atmosphere, corrosion normally takes place at the cut edge and tends to penetrate inside, finally resulting in de-lamination between the aluminum skin and the core material. To protect the cut edge from this type of corrosion, ALPOLIC/fr LT features a corrosion resistant primer behind aluminum skins. Although protected by the primer, to enhance long-term durability we still recommend that the cut edge is not exposed to corrosive or outdoor atmosphere. If the cut edge is continuously exposed to moist conditions, a suitable corrosion protection will be necessary in design or fixing details.

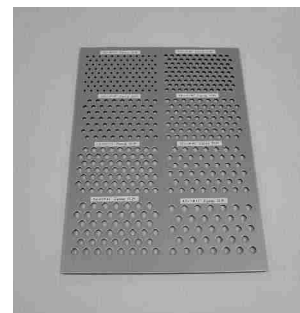
#### Cross-section of ALPOLIC®/fr LT



## 12. Perforated panel

ALPOLIC/fr LT Perforated Panel has a pattern of holes at regular intervals. This provides ventilation and permits vision through the panel, making it suitable for balconies, staircases and partitions. Refer to Section 4 for details.

#### Perforated panel



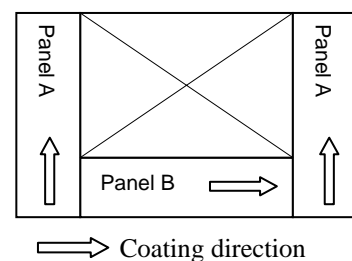
## 13. Recycling

Scraps of ALPOLIC/fr LT generated from ALPOLIC plants and from nominated fabricators' workshops are collected for recycling at the ALPOLIC plants.

## 14. General notes

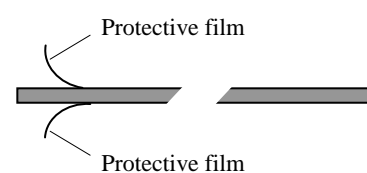
### (1) A note on coating direction

In Metallic Colors, Stone and Timber, slight color differences will be noticeable if the panels are installed in different directions (like Panel A and B in the diagram). Install panels in the same direction as marked in the protective film. In our Solid Colors, any color difference due to coating direction is negligible.



### (2) A note on protective film

Effective surfaces are protected with protective film. Do not remove this film during handling, fabrication and installation. Remove film immediately after installation in order to avoid any problems due to



degradation of the protective film. With Reversible Panels, peel off the film from both sides. Note that, unlike the protective film applied to ALPOLIC/fr for outdoor applications, this protective film does not resist UV indefinitely.

### **(3) A note on cleaning**

Do not use strong organic solvents, such as MEK (Methyl Ethyl Ketone), MIBK (Methyl Iso Butyl Ketone), Triclene and paint thinner. Do not use strong alkali, strong acid or abrasive cleaners. Use of these solvents and cleaners may result in the paint becoming swollen or removed.



To prevent scratching the coated surface, make sure that cleaning sponges and rags are grit-free. Avoid over cleaning or excessive rubbing.

Refer to Section 3 “Fabrication and installation” for the details of cleaning method.

### **ISO 9001:2000 Certified**

ALPOLIC/fr LT, through the design, development, manufacture and sales, is managed with ISO 9001:2000.

### **ISO 14000:**

ALPOLIC/fr LT is produced in the plant that has ISO14000 certificate.

# **ALPOLIC®/fr LT**

## **Technical Manual**

### **Section 2 Characteristics**

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## Section 2 Characteristics

### 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 <sup>2</sup> psf	5.5 1.13
Linear thermal expansion/ contraction coefficient	D696	1/°C 1/°F	24×10 <sup>-6</sup> 13×10 <sup>-6</sup>
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 <sup>2</sup> (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	$24 \times 10^{-6}$	$13 \times 10^{-6}$	0.6 mm	0.021"
Aluminum	$24 \times 10^{-6}$	$13 \times 10^{-6}$	0.6 mm	0.021"
Steel	$12 \times 10^{-6}$	$6.7 \times 10^{-6}$	0.3 mm	0.011"
Stainless steel (304)	$17 \times 10^{-6}$	$9.6 \times 10^{-6}$	0.4 mm	0.016"
Concrete	$12 \times 10^{-6}$	$6.7 \times 10^{-6}$	0.3 mm	0.011"
Glass	$9 \times 10^{-6}$	$5.0 \times 10^{-6}$	0.2 mm	0.008"
Acrylic sheet	$70 \times 10^{-6}$	$39 \times 10^{-6}$	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.

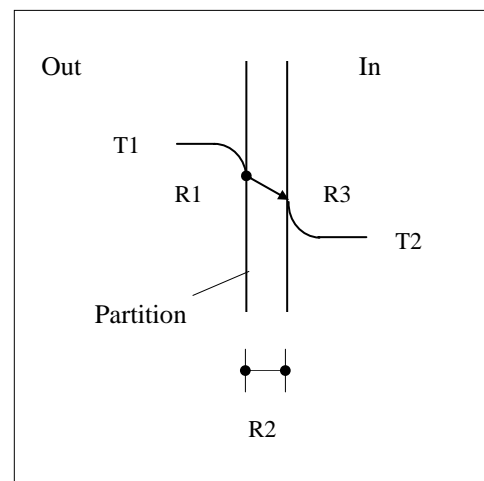
Material	Thermal conductivity, W/(m·K)	Material	Thermal conductivity, W/(m·K)
ALPOLIC®/fr 303	0.31	Brick	0.28
Aluminum	210	Glass	1
Steel	45	Gypsum board	0.13
Stainless steel (304)	17	Rock wool / Glass wool	0.04
Concrete	1.6		

### (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 <sup>2</sup> ·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.

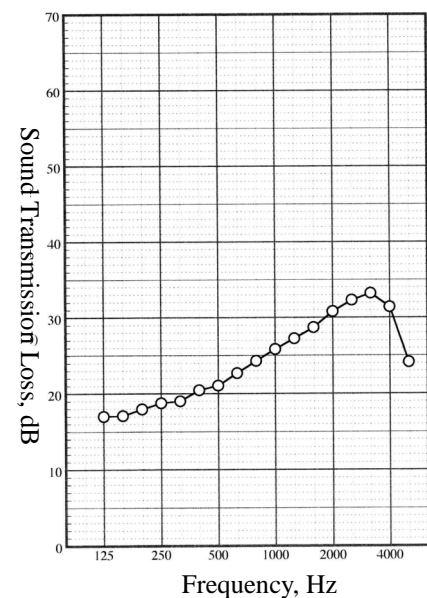
#### (7) Sound transmission loss

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 <sup>2</sup> psi	30 4352
0.2% proof stress	E8	MPa or N/mm <sup>2</sup> psi	27 3916
Elongation	E8	%	4
Flexural elasticity, E	C393	MPa or N/mm <sup>2</sup> psi	33×10 <sup>3</sup> 4787×10 <sup>3</sup>
Flexural rigidity, E×I	C393	Nmm <sup>2</sup> /mm lbs.inch <sup>2</sup> /inch	74×10 <sup>3</sup> 655
Shear strength with punching shear test	D732	N/mm <sup>2</sup> psi	21 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 <sup>2</sup> psi	118 17×10 <sup>3</sup>
Flexural elasticity	E8	GPa or kN/mm <sup>2</sup> psi	69 10×10 <sup>6</sup>

## (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.

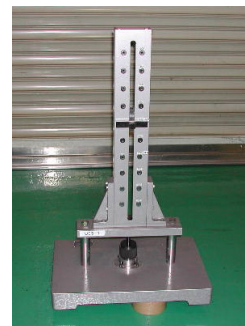
Material	Thickness of equivalent rigidity	Modulus of elasticity, E	Flexural rigidity, E×I	Panel weight	Weight ratio (ALPOLIC =100)
Unit	mm (inch)	MPa or N/mm <sup>2</sup> (psi)	Nmm <sup>2</sup> /mm (lbs·inch <sup>2</sup> /inch)	kg/mm <sup>2</sup> (psf)	%
ALPOLIC/fr LT	3 mm (0.118")	33×10 <sup>3</sup>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

## 4. Impact resistance

We obtained the following data with Du-pont method

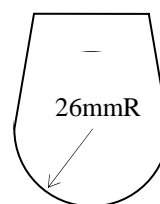
Steel ball weight kg (lbs)	Height mm (inch)	Dent depth mm (inch)
0.3 (0.7)	300 (11.8")	1.0 (0.04")
0.5 (1.1)	500 (19.7")	2.0 (0.08")
1.0 (2.2)	300 (11.8")	2.3 (0.09")
1.0 (2.2)	500 (19.7")	3.1 (0.12")

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.

1 kg 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

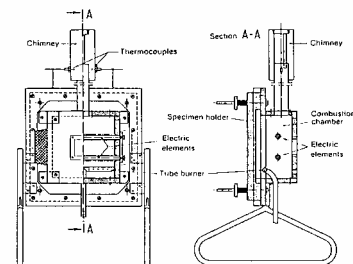
ALPOLIC/fr LT is a fire safe material. It passes the following fire tests:

Country	Test Standard	Specimen thickness	Results & classification
United Kingdom	BS476 Part 6	3 mm	Class 0
	BS476 Part 7		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:

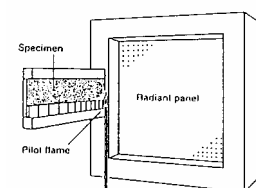
### **BS476 Part 6: Fire propagation for products**

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.



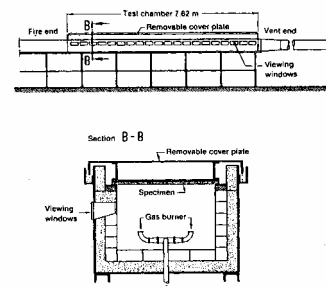
### **BS476 Part 7: Surface flame spread of products**

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:

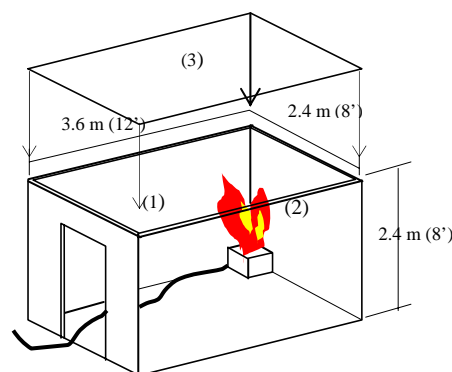
Heater: Gas burner or 30lb wood crib

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:  $-20^{\circ}\text{C} \times 1.0\text{hrs}$  for freezing and  $+10^{\circ}\text{C} \times 1.5\text{hrs}$  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:	50°C, tap water, 24 hrs.	100/100 (Cross-cut)
Boiling water resistance	98-100°C, pure water, 4 hrs.	100/100 (Cross-cut)
Humidity resistance:	240 hrs, 98% RH, 50°C (ASTM D2247-87)	No blister, no pick off
Alkali resistance:	1% NaOH, 20°C, 24hrs.	No blister, no pick off
Acid resistance:	5% H <sub>2</sub> SO <sub>4</sub> , 20°C, 24hrs.	No blister, no pick off
Salt spray resistance:	1000 hrs, salt fog, 35°C	No blister, no pick off
Solvent resistance:	MEK, 20°C, 24hrs.	No blister, no pick off
Detergent resistance:	Detergent “Surf”, 25g/30L, 20°C, 24hrs.	No blister, no pick off
Pollution resistance:	Lip stick, eye shadow, 24 hrs. After wiping off with IPA.	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 <sup>2</sup> ), or 170×10 <sup>2</sup> 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

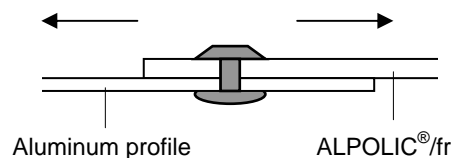
The actual calculation method is outlined in “Appendix 6: Panel Strength” in Section 4. If the calculated stress becomes larger than the permissible limit, further study is required to lessen the stress. One solution is to reinforce the panel with stiffener. If you need a structural calculation, please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



# **ALPOLIC®/fr LT**

## **Technical Manual**

### **Section 3 Fabrication & installation**

#### **Contents**

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4	Joining method	31
5	Surface processing	33
6	Examples of installation method	35
7	Repair coating method	42
8	Cleaning method	42

## Section 3 Fabrication & installation

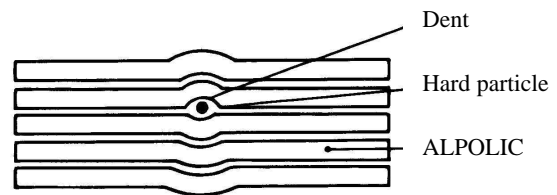
### 1. General

ALPOLIC/fr LT can be processed with woodworking and aluminium working machines and tools. It can be cut with a circular saw, can be folded after grooving with a router, and can be bent with a 3-roll bender or a press brake. We can use several methods for junction between aluminium extrusions and ALPOLIC/fr LT panels. We are going to introduce these processing methods as well as some examples of installation methods.

The product information such as available panel size and its tolerance, which is required for fabrication and installation works, is summarized in “Appendix 1: Summary of Specification Data” in Section 4. In this section, ALPOLIC/fr LT is often referred to simply as ALPOLIC

### 2. Notes on handling

ALPOLIC is a rigid material, but it is possible that the panel is damaged with edge deformation by physical impact or dent caused by inclusion of hard particles. Especially, inclusion of hard particles such as grains of sand and cutting chips between ALPOLIC panels will cause a dent, as shown in the diagram. Refer to the following notes through all stages during fabrication and installation.



#### (1) Unpack and pack

- Unpack and pack wooden crates in a clean place.
- Remove dusts and chips from ALPOLIC and packing paper. The hard particles, such as sand and cutting chips, caught between panels will cause a dent on the panel.
- Do not handle ALPOLIC on a floor. Handle it on a worktable.
- Handle ALPOLIC carefully by two persons facing the effective surface upward, to avoid possible rubbing of ALPOLIC surface during picking up and piling down panels.

#### (2) Transport

- Lay the packed ALPOLIC horizontally and do not place heavy goods on it.
- Mark clearly “Handle with Care”, “Keep Dry”, “No Hooks” and “This Side Up” on the packing.

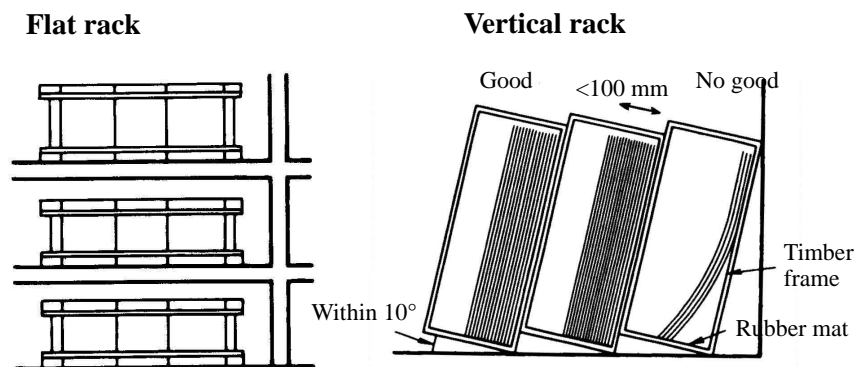
#### (3) Fabrication

- Prior to fabrication, clean out the worktable, temporary stand and both sides of ALPOLIC.

- b. Especially, take notice of the cutting chips generated from saws, routers and drills, as well as those chips and particles caught between ALPOLIC and tools.

#### (4) Storing

- a. Store ALPOLIC panels indoors with flat rack or vertical rack systems.
- b. In flat rack system, pile the same size of panels on a strong palette. Do not pile up different sizes together.
- c. In vertical rack system, lean panels closely against an inclined backing material with  $10^\circ$  or less. Total thickness of leaning panels should not exceed 100 mm thick. Use veneer for backing cover and place rubber mat on the bottom. Avoid scratches during pulling a panel out from the rack and restoring it back.



#### (5) Protective film

It is possible that the protective film of ALPOLIC degrades with direct sunlight and moisture, which finally results in a glue-remaining and elasticity-losing problem of the film. Store the panels in dry atmosphere. Remove the film immediately after the installation is completed. Especially, in Reversible Series in which protective films are applied on both sides of the panel, make sure that each film is peeled off from front and back, although the film is translucent (half-transparent) and it may be slightly hard to notice it.

### 3. Processing method

#### (1) Summary


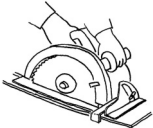
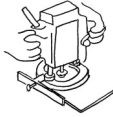

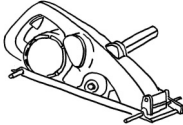
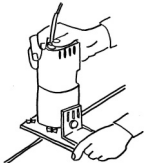

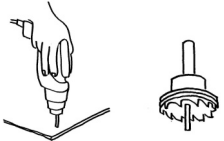
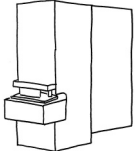
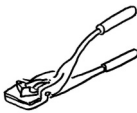

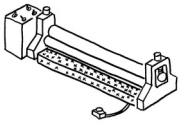
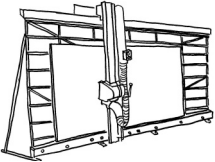
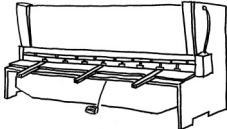
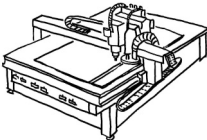
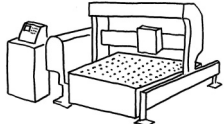
We can use wide variety of machines and tools to process ALPOLIC/fr LT panels. We can classify these machines into conventional ones and modern automated ones. Generally, automated machines enable high efficiency especially in analogous works with large quantity. To the contrary, conventional machines and tools are versatile and flexible. The former requires a costly investment for the machine, and the latter requires a good skill for a quality work. Main machines and tools are as shown in the following table.

### Conventional tools and machines

Processing	Tools or machines	No.
Cut	Table saw	1
	Hand circular saw	2
	Hand router	3
	Hand jigsaw	4
Groove	Grooving machine	5
	Hand router	3
Chamfer	Hand trimmer	6
	Plane	7
Make hole	Hand drill	8
Punch	Punching machine	9
Notch	Notching tool	10
Bend	Press brake	11
	3-roll bender	12

### Efficient and automated machines

Processing	Tools or machines	No.
Cut	Panel saw	13
	Square shear	14
	CNC router	15
Groove	Panel saw	13
	CNC router	15
Perforate	Turret Puncher	16

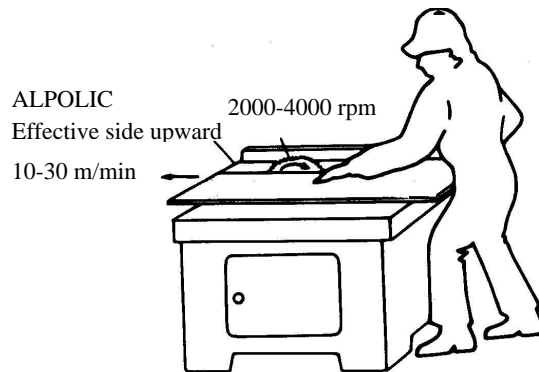
1. Table saw 	2. Hand circular saw 	3. Hand router 	4. Hand jigsaw 
5. Grooving machine 	6. Hand trimmer 	7. Plane 	8. Hand drill 
9. Punching machine 	10. Notching tool 	11. Press brake 	12. 3-roll bender 
13. Panel saw 	14. Square shear 	15. CNC router 	16. Turret puncher 

## (2) Saw cutting

Various types of circular saws including table saw, hand circular saw and panel saw can cut ALPOLIC. Suitable saw blade is carbide-tipped blades for aluminum or plastic use

Example of suitable saw blade:

Blade diameter	255 mm
Number of teeth	80 to 100
Cut width	2.0 to 2.6 mm
Rake angle	10°
Tip	Carbide



Operating conditions

Rotation of saw blade	2000-4000 rpm
Feed speed	10-30 m/min

### Notes on saw cutting:

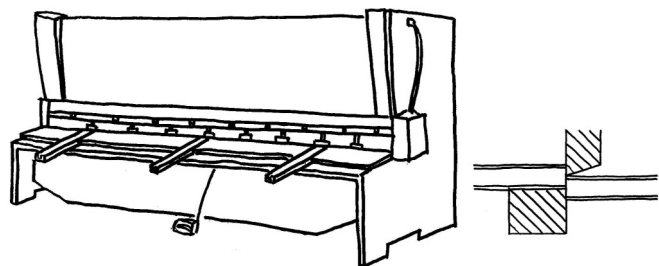
- Do the cutting operation with facing the effective side upward to prevent the panel from scratch and the protective film from peeling off.
- Remove cutting chips from ALPOLIC carefully after cut, to avoid dent during storing or assembling.
- Sharpen or replace the saw blade, when it becomes dull. Dull blade will result in large burr or distortion at cut edge.

## (3) Shear cutting

Square shear permits an efficient sizing work. Generally, the most suitable clearance and rake angle are as follows:

Clearance	0.04 - 0.1 mm
Rake angle	1°

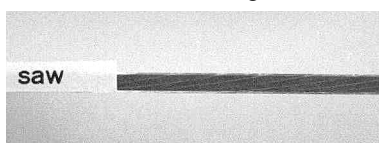
Shear cutting



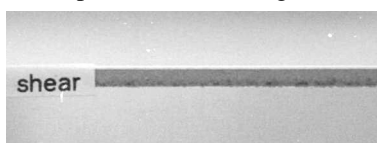
## (4) Trimming

In saw cutting, burr appears on both sides of edges. In shear cutting, either droop or burr appears on each edge. If we install the panel with exposed cut edge, we have to take notice of the edge conditions.

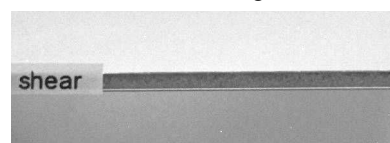
Burr after saw cutting



Droop after shear cutting



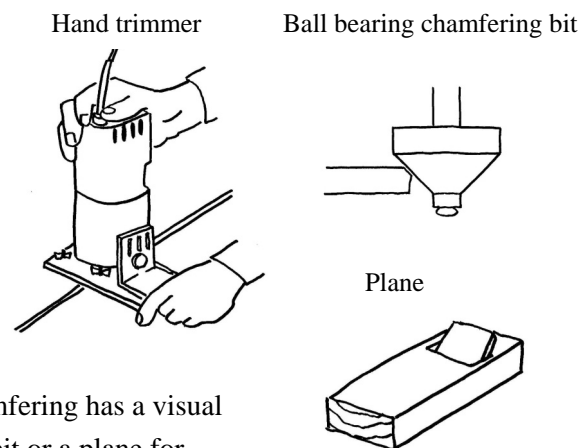
Burr after shear cutting



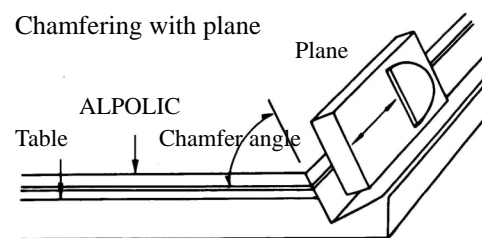
Namely, in saw cutting we should keep the saw blade sharp to have a sharp cut. In shear cutting we should adjust the clearance of die properly.

Generally, the condition of edge is more important in interior than in exterior. Sometimes we have to trim the edge after cutting. For trimming, we use trimmer, plane or sandpaper.

In Solid and Metallic Colors, deep trimming like chamfering has a visual effect. Use a trimmer with a ball bearing chamfering bit or a plane for woodworks. In working with plane, a guide ruler will help to ensure a uniform edge.

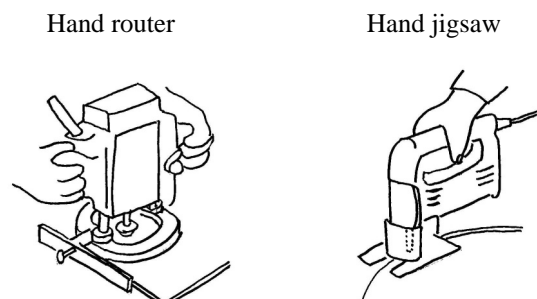


In Stone and Timber Finishes, on the other hand, deep trimming is not suitable, because deep trimming harms the appearance of Stone and Timber. If it is possible to hurt a finger with cut edges in Stone and Timber Finishes, make the edge dull with fine sandpaper. Normally, droop edge by shear cutting is mild enough to ensure the safety of edges.



## (5) Curving cut

Hand router and trimmer can cut ALPOLIC in curving lines. Guide template will help you to stabilize this work. Jigsaw is also useful for cutting complex shapes.

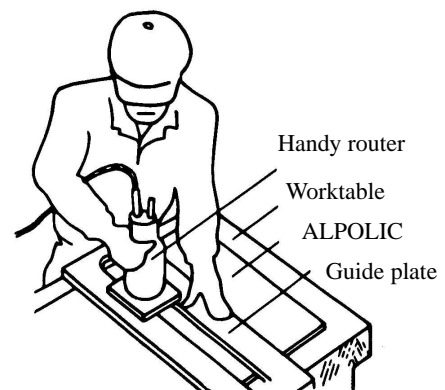


### Notes on the use of guide plate:

- Put an appropriate guide plate (template) on the effective side of ALPOLIC to do the routing work through the guide plate.
- Particles caught between the template and the effective surface of ALPOLIC may cause dent or scratch.

## (6) U-grooving

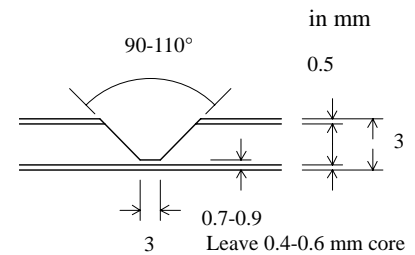
We can fold ALPOLIC after U-grooving in the backside. Two types of machines are available for U-grooving. One is a circular cutter type and the other is a router type. The former includes hand grooving machines and panel saws, and the latter includes hand routers and CNC routers.



### U-groove shape

The diagram shows one of the typical U-groove shapes suitable for folding ALPOLIC panels. It is important to leave 0.4-0.6 mm of core. We recommend 110° groove for 90° bending.

Typical U-groove shape



### Handy grooving machine

Hand grooving machine can groove ALPOLIC. An example of the suitable cutter blades and operating conditions are as follows:

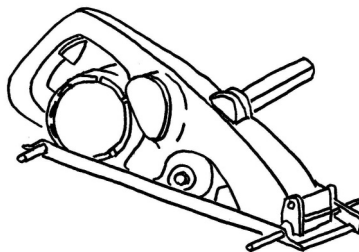
Cutter blade:

Outside diameter	110-120 mm
Number of teeth	4
Material	Carbide tip

Operating conditions

Rotation	5,000-9,000 rpm
Feeding speed	5-20 m/min

Hand grooving machine



Grooving cutter



### Handy router

Hand router can groove straight lines and curving lines. Use a custom router bit having the groove shape shown in the above drawing. The suitable bit and operating conditions are as follows:

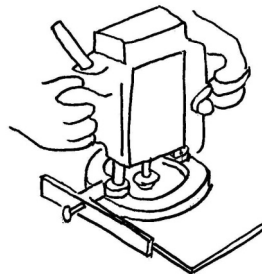
Router bit:

Number of teeth	2-4
Material	Carbide tip

Operating conditions:

Rotation	20,000-30,000 rpm
Feeding speed	3-5 m/min

Handy router



Router bit



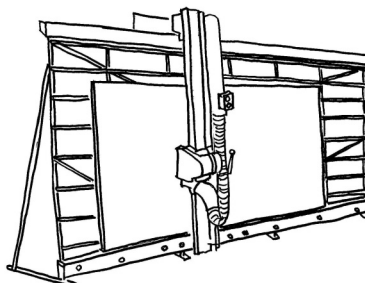
### Panel saw

Efficient grooving work is possible with panel saw. Typical conditions are as follows:

Cutter blade:

Outside diameter	220 mm
Number of teeth	8
Material	Carbide tip

Panel saw and grooving cutter

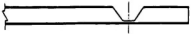
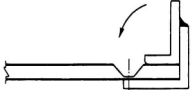
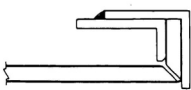
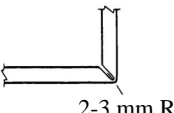
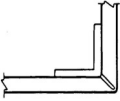


Operating conditions:

Rotation	2,500-5,000 rpm
Feeding speed	30 m/min

## (7) Folding

After U-grooving, we can fold ALPOLIC with folding jig. The typical folding procedures are as follows.

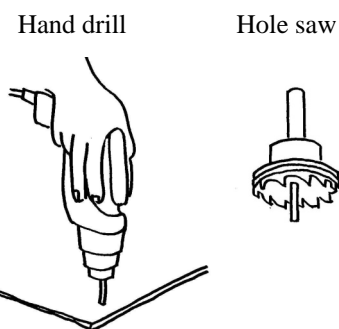
1. U-groove Leave 0.2-0.4 mm core.	2. Folding jig Folding jig is made of aluminum or steel angle.	3. Fold Use a little longer jig than folding length.	4. Roundness Suitable roundness is 2-3 mm R.	5. Support Support with aluminum angle, if necessary.
				

### Notes on folding:

- Fold ALPOLIC panels on a flat and steady worktable. If we fold the panel with warping, the folded line will not be straight.
- The folded corner should have a suitable roundness of 2-3 mm in radius. If the roundness is too small, the coating may have a crack on the folded corner. This tendency becomes apparent when we carry out the folding work at low temperature. Have a folding work at 10°C or higher.
- Folding after U-grooving entails slight elongation. The elongation is 0.5-1.0mm depending on the roundness of the folding corner. Therefore, the position of grooving lines must be pre-adjusted when the fabrication drawings are prepared..

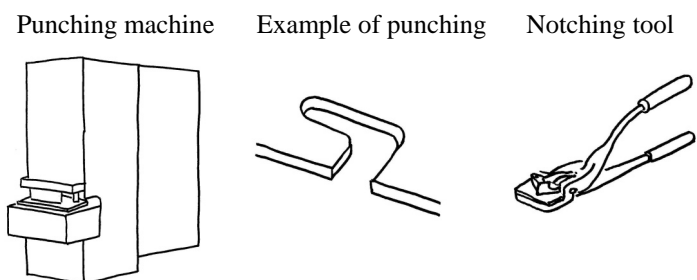
## (8) Making hole with drill

We can make holes with a hand drill and a drill press, equipped with drill bit, hole-saw and circle cutter. Use drill bit for metal. Making a hole from the effective side will reduce the burr.



## (9) Punching and notching

We use punching machine for notching and cutting out. The suitable clearance between punch and die is 0.1mm or smaller (material thickness × approx. 2%). Small droop will appear at punched edge.



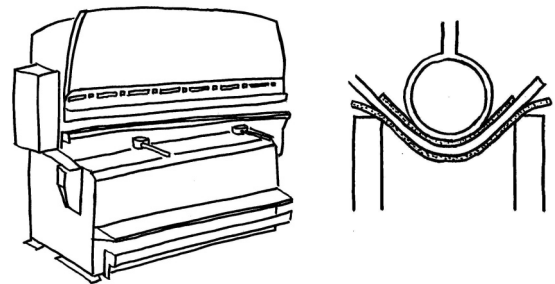


### (10) Bending with press brake

We can bend ALPOLIC/fr LT with press brake. The minimum bendable radius with press brake is as follows:

Bending direction	Minimum bendable radius
Traverse	50 mm
Parallel	80 mm

Bending with press brake



#### Notes on press brake bending:

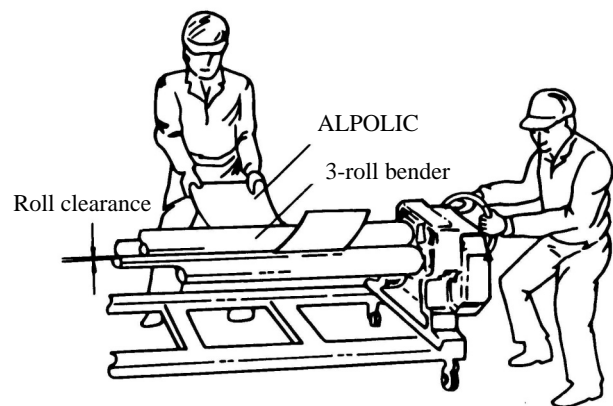
- “Traverse” and “Parallel” show the bending direction toward the rolling (coating) direction, printed on the protective film.
- The minimum bendable radius means the limit with which visible wrinkles appear on the aluminum surface of ALPOLIC.
- Use the top die (punch) with the similar radius to the desired radius. If the radius of the top die is too small, it is possible that the bending radius becomes partially smaller than the above limit.
- Use a urethane pad for the bottom die, or place a rubber mat between ALPOLIC and the bottom die.
- Use a scratch-free top die. Polish and wipe the top die. Do the bending work without peeling off the protective film.

### (11) Bending with 3-roll bender

We can use manual or electric-drive 3-roll bender for bending ALPOLIC. The minimum bendable limit is normally 250 mm in radius, but it depends on the length of the bender and the type of the machine. The following is an example of relationship between the length of bender and the minimum bendable limit.

Roll length (mm)	Minimum radius (mm R)
500	120
1000	150
2000	180
2500	200

Bending with 3-roll bender

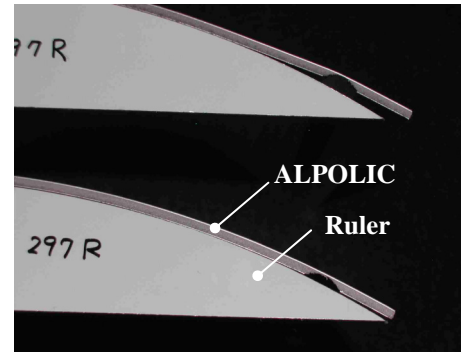


#### Notes on 3-roll bending:

- Prior to bending operation, wipe the roll surface carefully.
- Remove the burr at ALPOLIC edge that may cause dent with rolling.
- Remove the cut particles stuck on ALPOLIC and rectify the wrinkles of protective film, which may cause dent.
- Do not tighten ALPOLIC with rolls. If the roll clearance is rigid in the machine, adjust the clearance to panel thickness plus approx. 0.5 mm.

- e. If notch is required in a curving panel, make the notch after bending. Making the notch before bending will result in a distorted curving.
- f. When bending to small radius, gradual bending is necessary by adjusting the elevation of bending roll.
- g. We can reduce the straight portion near edge by means of a subsidiary sheet material, but it remains to some extent. If a consistent curving line is needed near the edge, we have to do additional edge bending after the regular bending.

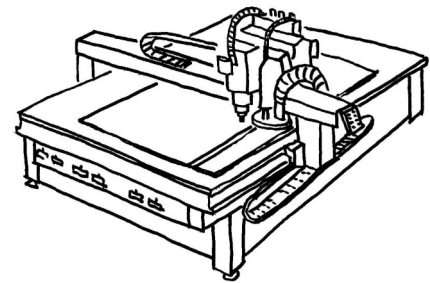
**Before (top) and after edge bending**



### (12) CNC router

CNC router can cut and groove ALPOLIC panels. As a series of processing is controlled by a computer program, CNC router is suitable for repetition of the same processing. The suitable bit and operating conditions are the same as hand routers.

CNC router

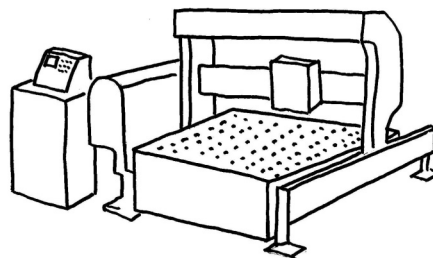


### (13) Turret puncher

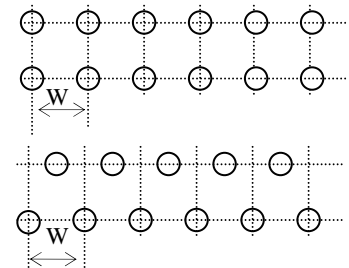
Turret puncher, also computer-controlled, can be used for perforation of the ALPOLIC.

The suitable clearance between punch and die is 0.1mm or smaller (material thickness  $\times$  approx. 2%). Small droop will appear at punched edge.

Turret puncher



Example of perforated pattern



### (14) Others

**Water-jet cutting:** Plunge cut (piercing at the starting point) in water-jet cutting may cause a certain extent of de-lamination between aluminum skin and core material. Therefore, we have to plunge at a disposable area or start at panel edge. After penetrating through the panel, water jet can cut ALPOLIC.

**Laser cutting:** According to our test, we so far conclude that ALPOLIC is not suitable for laser cutting, because the fume generated from ALPOLIC might harm the sophisticated optical instrument of laser system.

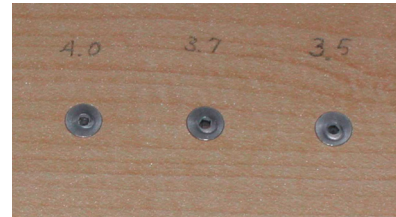
## 4. Joining method

### (1) Rivet and bolt/nut

We often use rivets, bolt/nut and tapping screws for junction between ALPOLIC and aluminum extrusions. Use aluminum blind rivet. We can do riveting work from one direction. Use bolt/nut and tapping screw made of aluminum or stainless steel.

A hole of 3mm in diameter withstands approx. 400 N per point. Refer to “Strength of Junction Hole” in Section 4 for the strength data of hole for your strength design. The strength of junction hole depends on the position of the hole. The junction hole positioned quite near to panel edge will not show sufficient strength. An equation  $e > 2D$  indicates a suitable relationship between the hole diameter (D) and the distance from the hole center to panel edge (e). Refer to Section 4 for details.

Countersunk rivet



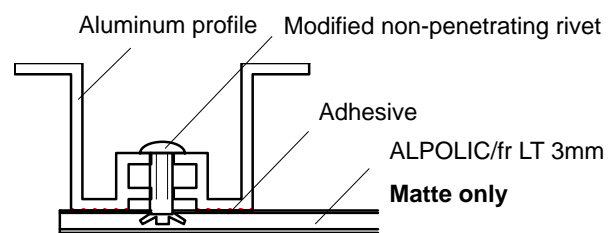
In the installation of interior, countersunk rivets and screws will be used more often than round-head ones. The strength may lessen with countersunk rivets and screws.

### (2) Modified non-penetrating rivet

In **Matte** finish products, a non-penetrating rivet is applicable to joining an aluminum profile to ALPOLIC/fr LT. Refer to “Appendix 5: Modified Non-Penetrating Rivet” in Section 4.

**Note:** This method is applicable only to **Matte** Finish products. If we apply this method to other finishes, the fastened trace is visible from front side.

Modified non-penetrating rivet



### (3) Adhesives

We can use commercial adhesives for joining and assembling of ALPOLIC. We can use wide variety of adhesives for ALPOLIC, except for some types of adhesives that may corrode aluminum metal. For example, vinyl acetate type, widely used for timber and styrene foam, corrodes aluminum metal. Main adhesives applicable to an adhesion between ALPOLIC and other materials are as follows.

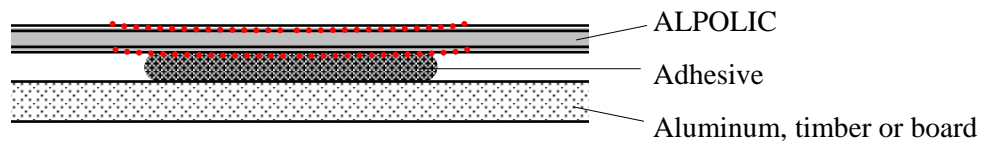
#### Adhesives applicable to ALPOLIC

Adhesive type		Epoxy	Chloroprene	Silicone RTV	Cyano-acrylate
Example of commercial brand		Araldite	Contact Cement	All Purpose Silicone	Aron Alpha
Suitable material to be adhered	Metal	S	S	S	S
	Timber	S	S	S	S
	Gypsum board	S	S	No	No
	Styrene foam	S	No	No	No

S: Suitable No: Not suitable

#### Notes on adhesives:

- Prior to adhesion work, remove all the foreign matters such as dust, particle, grease, water, etc. from the area to be adhered.
- Select the most appropriate adhesive that ensures the necessary adhesion power in the atmospheric conditions. The adhesion power depends on the surface conditions of the substrate. Follow the adhesive manufacturer's instructions.
- When ALPOLIC is adhered to different material, it is possible that ALPOLIC shows a deflection due to the thermal expansion difference or dimension change of the material. Pre-test the adhesive before fabrication and installation.
- Some adhesives may cause a distortion after hardening due to shrinkage of the adhesive, as shown in the diagram. Therefore, pre-testing is necessary for some types of adhesives. Generally, some of epoxy adhesives, polyurethane adhesives and silicone adhesives may show this kind of distortion. This distortion is usually very slight and sometimes it is not visible in low gloss and matte finishes.



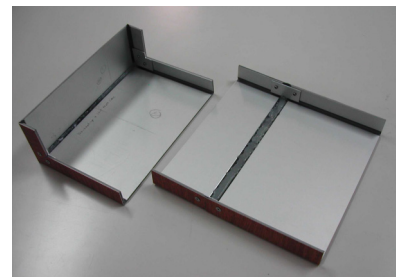
Apart from the above adhesives, we have successfully used the following adhesives for fabrication and assembling work of ALPOLIC. These adhesives, however, are only locally available in Japan. If you are interested in these adhesives, contact our office.

Brand name	Adhesive type	Manufacturer	Remarks
Diabond SG350	Acrylic	Nogawa Chemical	2-part, 5-15 min curing
Super X No.8008	Silyl-modified	Cemedine	1-part, 1-2 hrs curing

#### (4) Welding of core

One end of ALPOLIC/fr LT can be adhered to another end of ALPOLIC by welding the core with hot melt adhesive (glue). Prior to heating a glue stick, we have to pre-heat the core surface for good adhesion. Normally, mechanical reinforcement is necessary after welding.

Welding of core with hot melt glue



#### (5) Double-sided tape

Double-sided tape like 3M's VHB tape is effective in joining ALPOLIC to other materials. VHB tape simplifies the joining work and the thicker ones allow a movement of the adhered two materials to some extent.

#### (6) Hook/loop fastener

Hook/loop fasteners like Vercro tape is useful for guide signs and displays. This type of fastener is

removable and restorable.

## (7) Sealant

In order to ensure waterproofing of joints between panels, normally a sealing material is used. The sealing material shall meet the performance required for the atmospheric conditions. Silicone, modified silicone, polysulfide and polyurethane sealant are used. General performance of these sealing materials is as follows. Regarding the joint design such as joint width and thickness, please follow the sealant manufacturer's specifications.

General performance		Sealing Materials			
		Silicone	Modified silicone	Polysulfide	Polyurethane
Restoring ability		A	A-B	B	B
Degradation	Due to aging	VS	S-M	M	M
	Due to temperature	VS	S-M	M-L	M
Shrinkage after filling		S	S	S	S
Serviceable temperature (long-term)		-40/120°C -40/248°F	-30/90°C -22/194°F	-20/80°C -4/176°F	-20/70°C -4/158°F
Weather-ability		A	A-B	A-B	B
Fatigue resistance		A	A-B	B	A-B

**Note 1:** A: Excellent

B: Good

C: Normal

VS: Very small

S: Small

M: Medium

L: Large

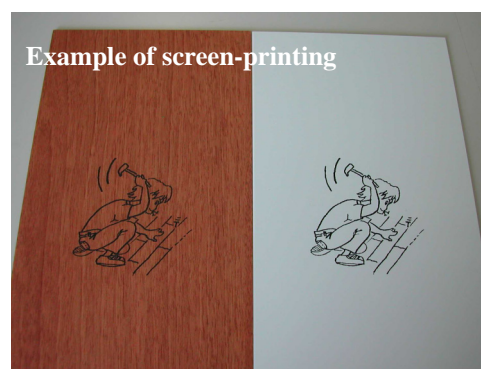
**Note 2:** The above is excerpt from Sealing Material Handbook, Japan Sealant Manufacturers' Association.

## 5. Surface processing

### (1) Screen-printing

In screen-printing, 1-component vinyl type or 2-component polyurethane type inks are suitable for all the finishes of ALPOLIC/fr LT. We obtain normal adhesion with these inks after drying at 80°C for 30 min and curing at room temperature for 24 hrs. The typical printing procedures are as follows:

- Remove all dust and dirt with soft cloth. Oily dirt, if remaining, causes printing defects.
- Cure or dry under proper conditions. Follow instructions from ink manufacturer.



### Notes on screen-printing:

- Keep the curing temperature below 90°C (194°F) for less than 30 min. If the curing temperature is higher, deflection of the panel may occur.
- Select the ink suitable for the atmospheric conditions where the panel is located.

## **(2) Cutting film**

Various types of cutting films are applicable to the ALPOLIC/fr LT surface. If you are going to fold the area where the film is applied, the film may change the color at the folded corner. Confirm with pre-testing.

## **(3) Digital print with ink jet printer**

Various types of decorative films and wallpapers printed with ink jet printers can be applied on ALPOLIC/fr LT. Confirm the fire approval conditions of the film. Direct digital print is also possible with special ink jet printers.

(1) Internal wall cladding with hanging system

section

6

5

3

4

1

2

10

50-60

The drawing consists of two views of a mechanical assembly, oriented vertically. The top view shows a cross-section of a component with a flange (1) and a central hole (3). A pin (4) is inserted into the hole. A vertical line (5) represents a wall or boundary. A horizontal line (6) is shown to the right. The bottom view shows a similar assembly with a flange (1) and a central hole (3). A pin (4) is inserted into the hole. A vertical line (5) represents a wall or boundary. A horizontal line (6) is shown to the right.

- Note:

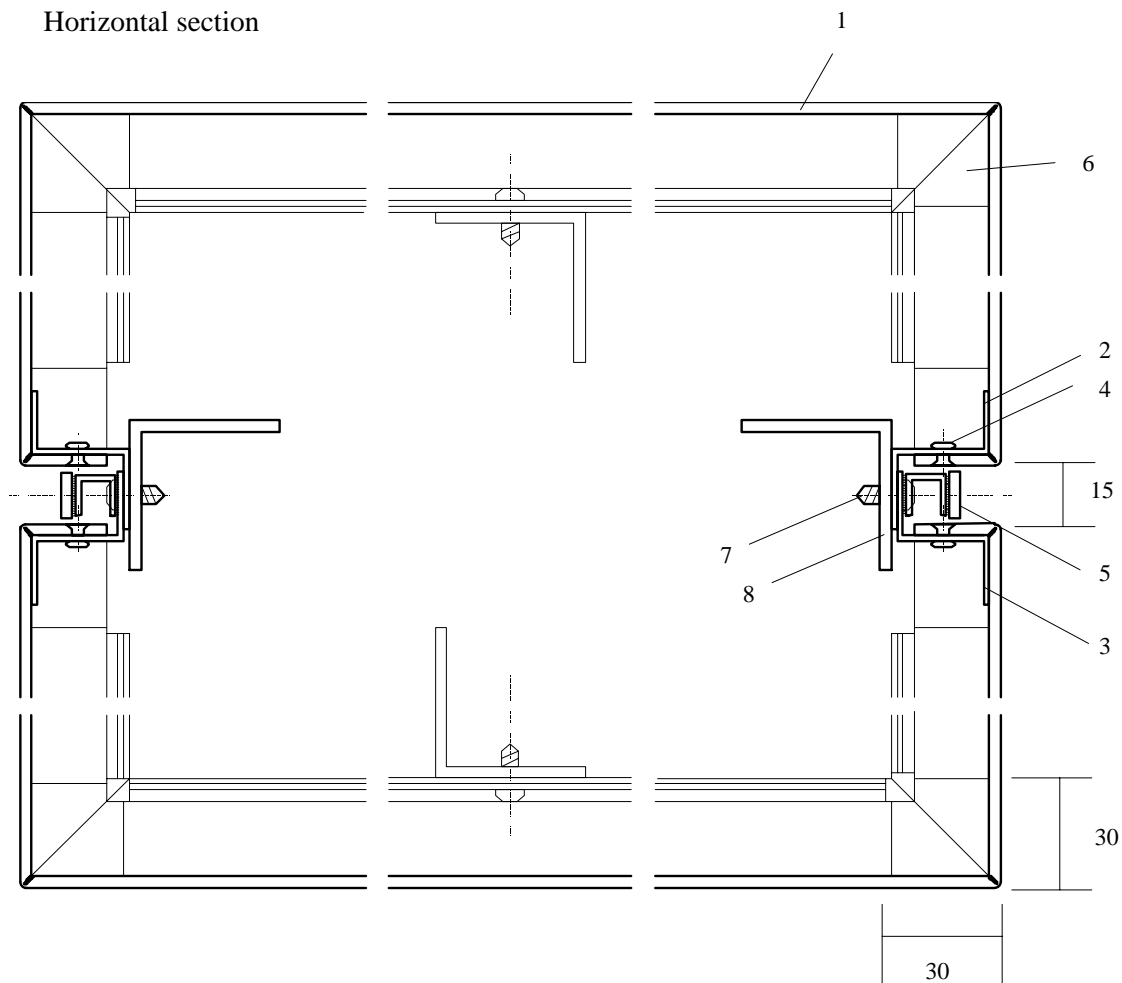
In renovation projects, “Stud Detector” will help you to find out the position of studding concealed behind gypsum board. Stud Detector is a small tool working with an electromagnetic sensor.

Data embodied herein is intended only for estimate by technically skilled persons, with any use thereof to be at their own discretion and risk.

Mitsubishi Chemical shall have no responsibility or liability for results from such use or infringement of any patent or other proprietary right.

## (2) Column cover with Z-shaped flange system

Horizontal section



1. ALPOLIC/fr LT 3mm
2. Z-shaped flange (Large)
3. Z-shaped flange (Small)
4. Aluminum rivet, countersunk, 3mm diameter
5. Joint cover adhered to aluminum C-10×10 with VHB tape
6. Corner support plate, aluminum sheet
7. Tapping screw, M4
8. Sub-frame, aluminum L-30×30mm

### Note:

Two Z-shaped flanges are overlapped and fixed to the sub-frame. Conceal the joint with joint cover slip of the same panel. Use countersunk rivet for assembling the panel.

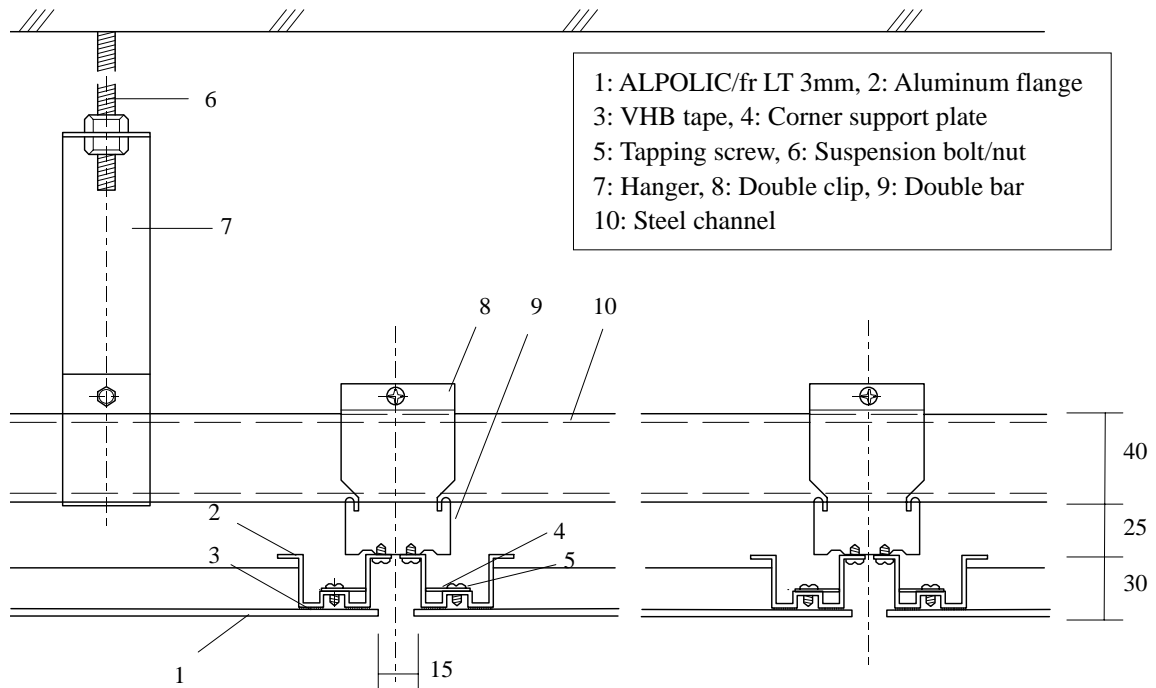
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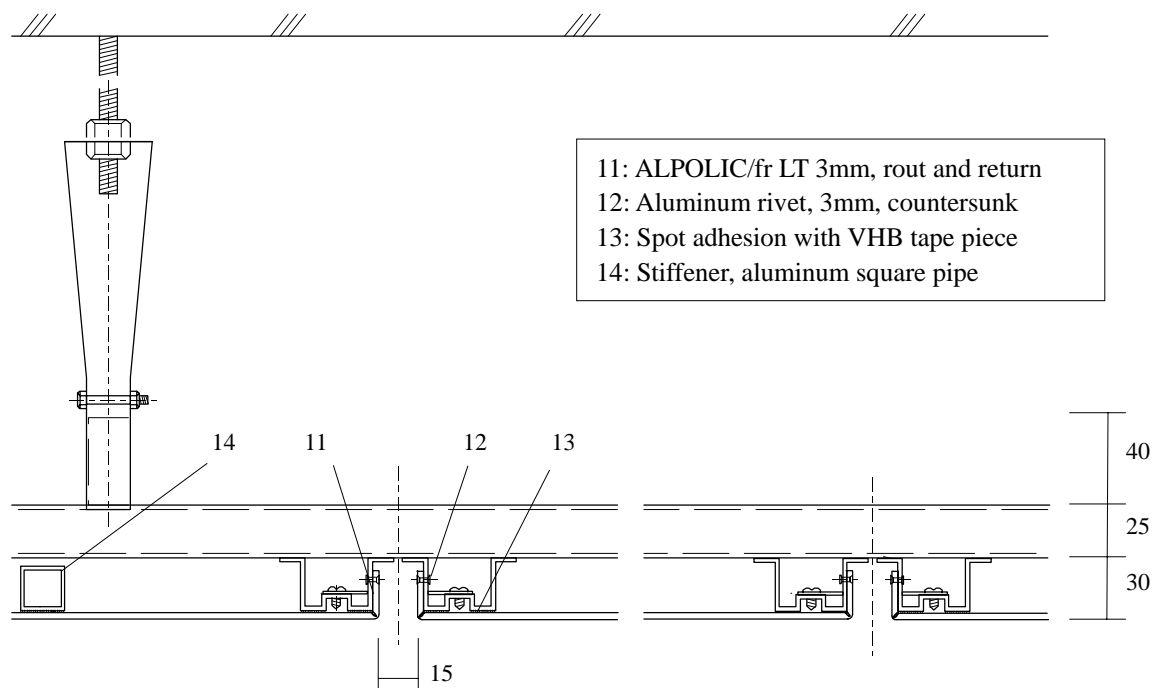


### (3) Ceiling installed on lightweight suspension bar system

#### Section of the longer panel side



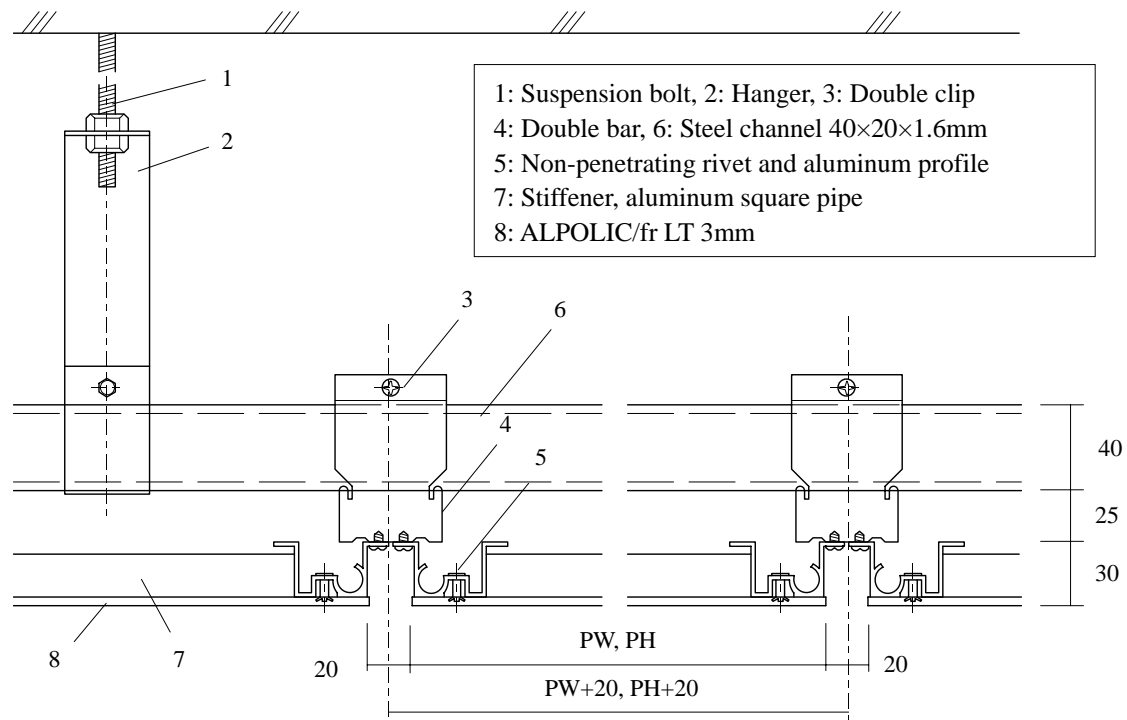
#### Section of the shorter panel side



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#### (4) Ceiling panel fixed with non-penetrating rivet



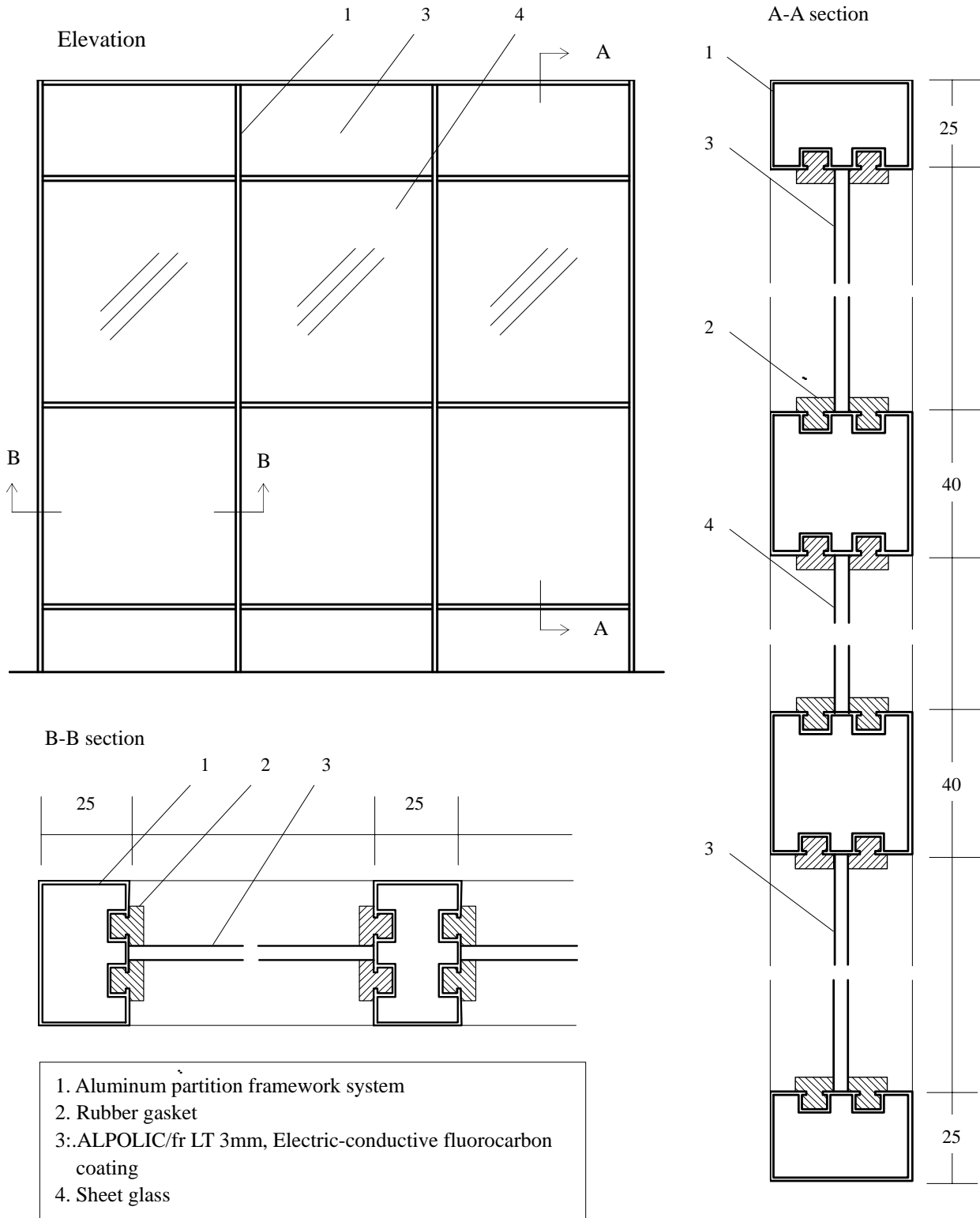
##### Note:

1. Non-penetrating rivet is used in this method. Non-penetrating rivet is applicable **only to Matte Finish**. If this rivet is applied to products other than Matte Finish, the trail of concealed rivet is visible from front.
2. The design strength of the non-penetrating rivet is 160 N per piece not including safety factor. Refer to “Appendix 5: Modified Non-Penetrating Rivet” in Section 4.

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(5) Partition of factory (Electric-conductive fluorocarbon coating)

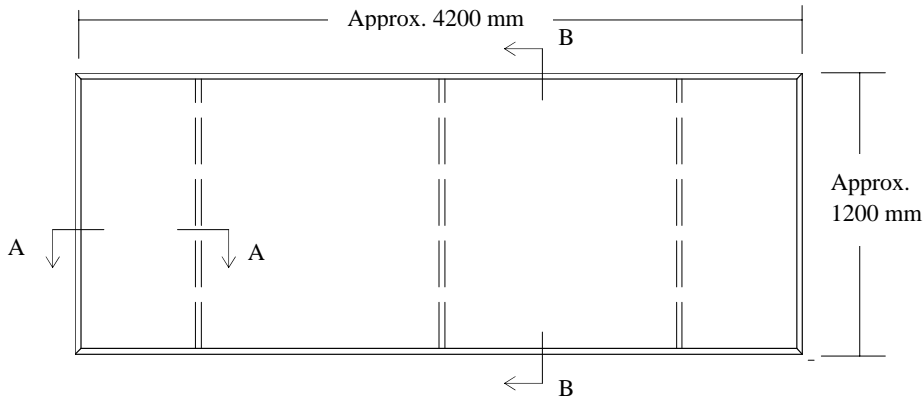


Data embodied herein is intended only for estimate by technically skilled persons, with any use thereof to be at their own discretion and risk.

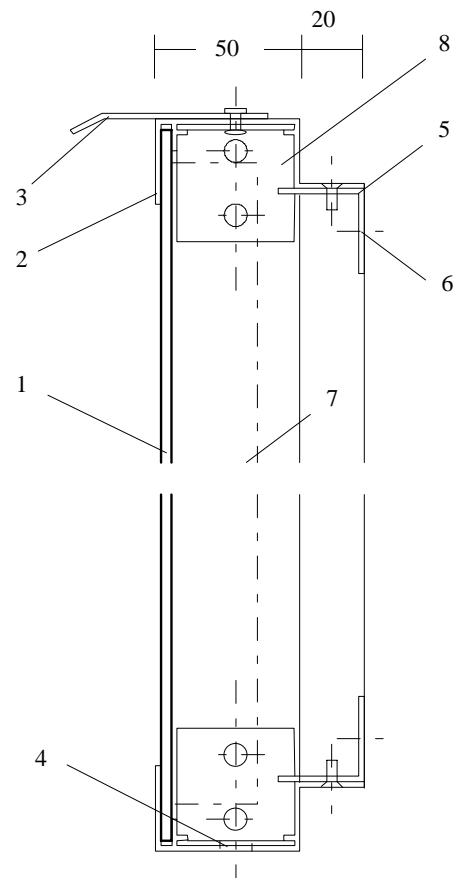
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(6) Corporate shop front signboard  
Example of installation method for ceiling

Elevation

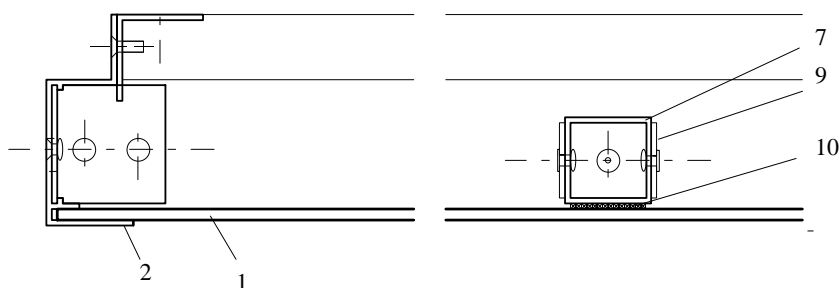


B-B section



1. ALPOLIC/fr LT 3mm having signs (logotype, letterings) by Scotchcal film
2. Aluminum flange coated with the same color of ALPOLIC
3. Water drip
4. Drain hole
5. Steel sub-structure, L-30×30, coated
6. Anchor
7. Stiffener, aluminum square pipe, 30×30×2
8. Corner support plate, aluminum L-40×40
9. Aluminum channel (top & bottom only)
10. VHB tape

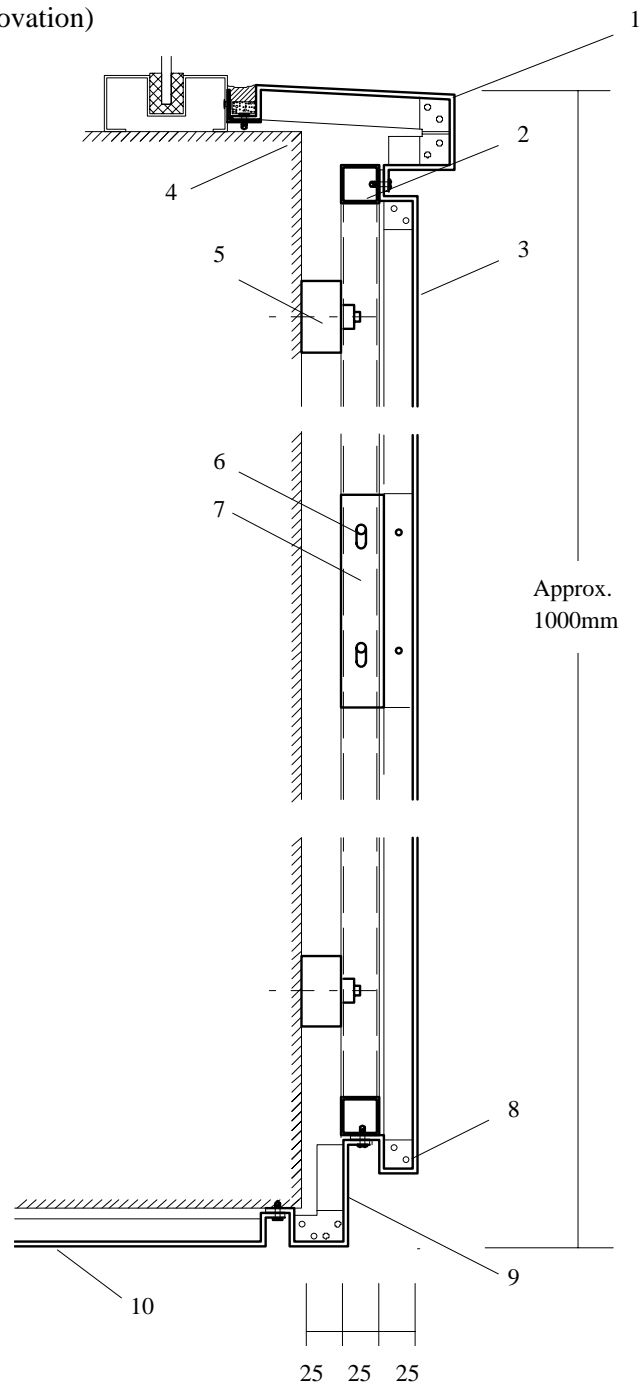
A-A section



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(7) Parapet and soffits (renovation)



1: ALPOLIC/fr LT 3mm, water drip  
 2: Aluminum sub-structure  
 3: ALPOLIC/fr LT 3mm, parapet  
 4: Existing external wall  
 5: Level-adjustment and anchor

6: Suspension bolt  
 7: Aluminum support plate  
 8: Aluminum L-shaped support plate  
 9: ALPOLIC/fr LT 3mm, water drip  
 10: ALPOLIC/fr LT 3mm, eaves

Data embodied herein is intended only for estimate by technically skilled persons, with any use thereof to be at their own discretion and risk.

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## 7. Touch-up coating method

Commercial or custom acrylic paints are suitable for repair coating of all finishes of ALPOLIC/fr LT. Typical procedures are as follows.

- Clean the surface and remove dirt, if any.
- Stir the paint well. Apply paint with brush or pencil-type container.
- Dry and cure at room temperature, as in the instructions from the manufacturer.

Normally acrylic paints show good adhesion after cured, however the touched-up portion may show a slightly different appearance. As appearance of coating depends on coating method, even an exactly matched paint may show a slightly different appearance to some extent.

In Stone and Timber Finishes, use an intermediate solid color diluted with clear paint for touch-up. The suitable dilution rate is, depending on the color, 10-90% of clear content. Munsell Number attached to each color may become a guide to find the intermediate color.

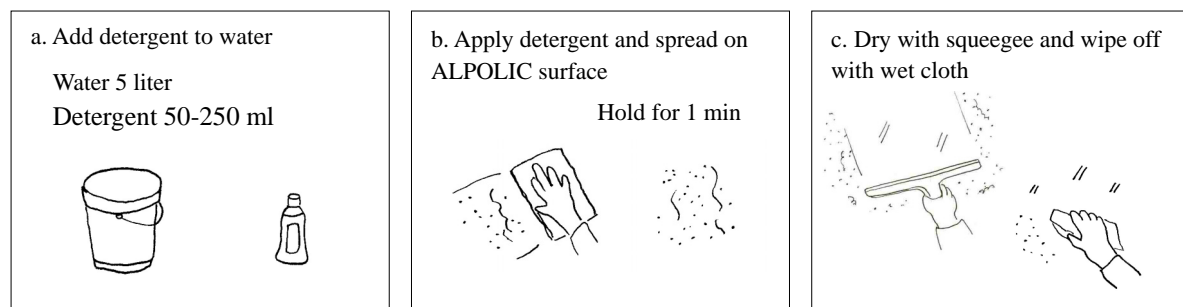
## 8. Cleaning method

### (1) General cleaning

Firstly, try water rinse using soft sponge with modest pressure to remove the stain. If the stain remains after dry, then use neutral detergents or household cleaners diluted with water. Typical cleaning procedures are as follows.

- Dilute a detergent or a cleaner to 1-5% with water.
- Apply the solution and spread on ALPOLIC surface with soft rags or sponges. Wait for 1 minute, then the foam will blacken.
- Dry the solution with a squeegee and wipe the remaining solution with wet cloth containing clean water.

According to our test, dilute Magiclean is suitable for all finishes of ALPOLIC/fr. Magiclean is a household detergent with pH 8 from Kao Corp. If you use other detergent, pre-test it in a small area.



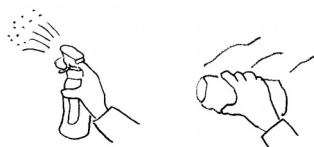
### (2) Stubborn stain

According to our test, alkali cleaners such as Sharpshooter and Windex are applicable to strong stain,

however Metallic Colors of ALPOLIC/fr LT requires good rinsing with water afterward. It is because no water rinsing may cause a color change in the future due to remaining alkali in Metallic Colors. In Solid Colors, Stone and Timber Finishes, rinsing with water is unnecessary especially.

Note: Sharpshooter is a versatile cleaner from 3M (alkali, pH12), and Windex is a glass cleaner from Johnson (alkali, pH11). As these are alkali solutions, prevent eye and skin contact. Follow manufacturer's safety instructions.

1. Apply Sharpshooter or Windex with sprayer, soft cloth or sponge.



2. Rinse with wet cloth containing clean water.



If you use other strong cleaners or stain removers, pre-test in a small area. Generally, strong acid and alkali may cause a gloss change, color change, or swelling of coating film. Do not use cleaners containing abrasives. Do not use strong solvents and paint thinners.

# **ALPOLIC®/fr LT**

## **Technical Manual**

### **Section 4 Appendices**

#### **Contents**

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Appendix 4	Impact test with steel ball	53
Appendix 5	Modified non-penetrating rivet	55
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Appendix 7	Strength of junction holes	61



## Summary of Specification Data - ALPOLIC®/fr LT

### 1. General

ALPOLIC®/fr LT is an Aluminum Composite Material (ACM) with a sufficient fire safety, which is used on interior walls, columns, ceilings and partitions of shops, offices and factories. Its application is not only on interior field, but also on light outdoor field including soffits, awnings, parapets and signs. Besides, this material is applicable to such civil works as internal linings of tunnels.

ALPOLIC®/fr LT is manufactured by Mitsubishi Chemical Functional Products, Inc. and furnished by approved dealers or distributors of the manufacturer.

### 2. Product composition

ALPOLIC®/fr LT is composed of a non-combustible mineral core with a small amount of low-density polyethylene sandwiched between two skins of 0.3mm thick aluminium.

Composition	Skin material:	0.3mm thick aluminum (1100-H14)
	Core material:	Non-combustible mineral filled core with gray color.

The effective sides are finished with polyester coatings. “Reversible” has effective sides on both top and back. “Single, Stone and Timber” have an effective side on top and a wash coating on back. Refer to “6 Paint Finish” below. The effective sides are protected with a translucent self-adhesive / peel-off film.

### 3. Product dimension and tolerance

- (1) Panel thickness: 3 mm
- (2) Panel size in stock: The available panel size depends on the finishes as shown below.

Type	Finish	Code	Stock size, mm (in)	Remarks
Reversible	Pure White-G90 / Anodised Silver-G80	N1	1270×3099 (55"×122") 1575×3099 (62"×122")	Both top and back are effective sides.
	White-G30 / Champagne Metallic-G30	N2		
	Light Beige-G30 / Silver Metallic-G30	N3		
	Black-G30 / Gray-G30	N4		
Single	Off White-Matte	N5	1270×3099 (55"×122")	Top is effective side and back is wash coating.
	Gray Metallic-Matte	N6		
Stone	Black Granite-G80	S1	1270×3099 (55"×122") 1575×3099 (62"×122")	
	White Granite-G80	S2		
	Red Granite-G80	S3		
	Pink Granite-G80	S4		
	White Marble-G80	S5		
	Venetian Marble-G80	S6		
	Sandstone-Matte	S7		
Timber	Maple-Matte	T1	1270×3099 (55"×122")	
	Walnut-Matte	T2		

**Note:** Custom width is available between 914mm and the above width. Custom length less than 5000mm can be accepted. Please contact distributors or our sales office for the minimum quantity and the lead-time of the custom size products.

(3) Product tolerance

Width:	±2.0mm
Length:	±4.0mm
Thickness:	±0.2mm
Bow:	Maximum 0.5% of the length and/or width
Squareness:	Maximum 5.0mm (diagonal difference)
Surface defect:	The surface shall not have irregularities such as roughness, buckling and other imperfections in accordance with our visual inspection rules.
Panel edge:	ALPOLIC®/fr LT is supplied with a cut edge out of aluminum sheet displacement and core protrusion.

**4. Principal properties**

- (1) Panel weight: 5.5 kg/m<sup>2</sup> (1.13 psf)  
(2) Thermal expansion:  $24 \times 10^{-6}$  m/m/°C ( $13 \times 10^{-6}$  in/in/°F)  
(3) Mechanical properties as a composite material, ALPOLIC®/fr LT

Tensile strength (ASTM E8)	30 MPa or N/mm <sup>2</sup> , 3.0 kg/mm <sup>2</sup> , 4300 psi
Yield strength (ASTM E8)	27 MPa or N/mm <sup>2</sup> , 2.7 kg/mm <sup>2</sup> , 3900 psi
Elongation (ASTM E8)	4 %
Flexural Elasticity (ASTM C393)	33 GPa or kN/mm <sup>2</sup> , 3400 kg/mm <sup>2</sup> , $4.8 \times 10^6$ psi

(4) Mechanical properties of skin aluminum (1100-H14):

Yield strength (ASTM E8)	118 MPa or N/mm <sup>2</sup> , 12.0 kg/mm <sup>2</sup> , 17000 psi
Modules of elasticity (ASTM C393)	70 GPa or kN/mm <sup>2</sup> , 7000 kg/mm <sup>2</sup> , $10.2 \times 10^6$ psi

**5. Summary of fire tests**

ALPOLIC®/fr LT comprising of 0.3 mm thick skin has passed the following fire tests:

Country	Test Standard	Specimen Thickness	Results & Classification
United Kingdom	BS476 Part 6	3 mm	Class 0
	BS476 Part 7		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

## 6. Paint finish

### (1) Finish type

The finishes can be classified into the following coating types:

Coating type	Finish
Solid Color	Pure White-G90, White-G30, Light Beige-G30, Black-G30, Gray-G30, Off White-Matte
Metallic Color	Anodized Silver-G75, Champagne Metallic-G30, Silver Metallic-G30, Gray Metallic-Matte
Stone	Black Granite-G80, White Granite-G80, Red Granite-G80, Pink Granite- G80, White Marble-G80, Venetian Marble-G80, Sandstone-Matte
Timber	Maple-Matte, Walnut-Matte

Custom colors and custom gloss are available, subject to minimum quantities and color match. Please contact distributors or our office for custom color request.

### (2) Coating system

Each finish type has the following coating system of polyester paint:

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

Stone and Wood 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.

All these coatings are produced in the manufacturer's continuous coil coating line.

### (3) Paint performance

The coating meets 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:	50 °C, tap water, 24 hrs.	100/100 (Cross-cut)
Boiling water resistance	98-100°C, pure water, 4 hrs.	100/100 (Cross-cut)
Humidity resistance:	240 hrs, 98% RH, 50°C (ASTM D2247-87)	No blister, no pick off
Alkali resistance:	1% NaOH, 20°C, 24hrs.	No blister, no pick off
Acid resistance:	5% H <sub>2</sub> SO <sub>4</sub> , 20°C, 24hrs.	No blister, no pick off
Salt spray resistance:	1000 hrs, salt fog, 35°C	No blister, no pick off
Solvent resistance:	MEK, 20°C, 24hrs.	No blister, no pick off
Detergent resistance:	Detergent "Surf", 25g/30L, 20°C, 24hrs.	No blister, no pick off
Pollution resistance:	Lip stick, eye shadow, 24 hrs. After wiping off with IPA.	No blister, no pick off
Accelerated weathering test:	QUV, 500 hrs.	No blister, no pick off

#### (4) Optional coatings

Apart from the above polyester coatings, we can supply ALPOLIC/fr LT products coated with the following distinctive paints as option. Refer to Appendix 2.

Optional coating	Characteristics	Suitable application
Fluorocarbon coating (Lumiflon-based)	Ultra-weather-ability Coating warranty is available.	Outdoor (awnings, parapets, signs)
Conductive fluorocarbon coating	Electric-conductive ( $3 \times 10^{7-8}$ ohms)	Interior walls and partitions in factory
High cross-link polyester coating	High hardness (4H) High reflectivity (80%)	Internal lining of tunnels

#### 7. Perforated panel

ALPOLIC/fr LT Perforated Panel has a pattern of holes at regular intervals. This provides ventilation and permits vision through the panel, making it suitable for balconies, staircases and partitions. Refer to Appendix 3.

### Optional Coatings

ALPOLIC/fr LT is coated with polyester paints in standard, but we can supply ALPOLIC/fr LT products coated with the following distinctive paints as an option.

Optional coating	Characteristics	Suitable application
Fluorocarbon coating (Lumiflon-based)	Ultra-weather-ability Coating warranty is available.	Outdoor (awnings, parapets, signs)
Conductive fluorocarbon coating	Electric-conductive ( $3 \times 10^{-8}$ ohms)	Interior walls and partitions in factory
High cross-link polyester coating	High hardness (4H) High reflectivity (80%)	Internal lining of tunnels

#### 1. Lumiflon-based fluorocarbon coating

Lumiflon-based fluorocarbon coating can realize the ultra-weatherability. The coating resists a long-term exposure to outdoor conditions and complies with AAMA 2605-98 issued by the AAMA (American Architectural Manufacturers Association).

Four types of finishes are available: Solid Colors, Metallic, Sparkling Colors and Stone Series. The gloss can be adjusted between 20 and 80%. In these finishes, the paints are applied in the manufacturer's coil coating lines. The coating system of each finish is:

A. "Solid Colors" are a two-coat two-bake system.

The total dry film thickness is 25 microns (0.98 mils) minimum and consists of a conversion coating, an inhibitive primer and a Lumiflon-based fluorocarbon coating.

B. "Metallic Colors" and "Sparkling Colors" are a three-coat three-bake system.

The thickness is 32 microns (1.26 mils) minimum and consists of a conversion coating, an inhibitive primer, a Lumiflon-based metallic coating and a clear coating.

C. "Stone Series" is coated with a unique image transfer process.

The thickness is 45 microns (1.77 mils) minimum and consists of a conversion coating, an inhibitive primer and a Lumiflon-based fluorocarbon coating including the image transfer layer.

Refer to the Color Chart of Lumiflon-based fluorocarbon coating.

Lumiflon-based fluorocarbon coating has a coating warranty of 10 years in standard.

#### 2. Conductive fluorocarbon coating

ALPOLIC/fr LT coated with conductive fluorocarbon paint is used on interior walls, partitions and ceilings of clean rooms and warehouses. With an electric-conductive surface, the panel also has high rigidity and fire safety. The conductive paint can be applied on both sides of the panel, if necessary.

Principal coating performance:

- |                                  |                          |
|----------------------------------|--------------------------|
| (1) Pencil hardness:             | 3H                       |
| (2) Surface electric resistance: | $3 \times 10^{7-8}$ ohms |
| (3) Chemical resistance:         |                          |
| Sulfuric acid, 5% $H_2SO_4$ :    | No change                |
| Sodium hydroxide, 1% NaOH:       | No change                |

### **3. High cross-link polyester coating**

The high cross-link polyester coating permits high surface hardness of 4H as well as sufficient surface reflectivity of 80%. Therefore, it is suitable for the area where the panel might be scratched during maintenance work, such as an internal lining of tunnels. The paint is applied in manufacturer's continuous coil coating lines, which ensures uniform coating quality of the product.

Principal coating performance:

- |                           |  |
|---------------------------|--|
| (1) Coating system:       | Two-coat two-bake system, total dry film thickness is 30 $\mu$ minimum |
| (2) Pencil hardness:      | 4H with ASTM D522-88   |
| (3) Surface reflectivity: | 80% in diffuse reflection (white color)                                |

### ALPOLIC/fr LT Perforated Panel

ALPOLIC/fr LT Perforated Panel has a pattern of holes at regular intervals. This provides ventilation and permits vision through the panel, making it suitable for balconies, staircases, partitions and ceilings.

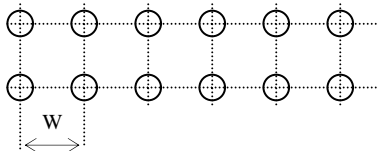
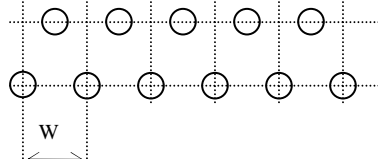
#### 1. Panel size

Maximum width: 1270mm (55")

Maximum length: Approx. 3000mm (118")

Practical examples of sizes: 1000×300mm, 1000×500mm, 1000×700mm, 1000×1000mm

#### 2. Examples of perforation pattern

Direction	Pattern	Hole diameter	Interval (W)	Perforation ratio
Square		20mm	40mm	19.6%
60° Zigzag		5mm	10mm	22.6%
		6mm	10mm	32.6%
		7mm	10mm	44.4%
		7mm	12mm	30.8%
		8mm	12mm	40.2%
		8mm	16mm	22.6%
		10mm	15mm	40.2%
		15mm	25mm	32.6%

#### 3. Panel strength:

Panel strength is lessened after perforation. Namely, the permissible load of ALPOLIC/fr LT becomes smaller dependent on the perforation ratio. The following table shows the maximum limit of uniformly-distributed load, like a wind load, without causing permanent deformation.

Maximum uniformly-distributed load (kPa):

Supporting condition		4-side simply supported					4-side fixed				
Perforation ratio		0%	10%	20%	30%	40%	0%	10%	20%	30%	40%
Panel size mm×mm	1000×300	8.1	6.5	4.0	2.4	1.6	11.5	9.2	5.8	3.5	2.3
	1000×500	2.9	2.3	1.5	0.9	0.6	4.2	3.3	2.1	1.3	0.8
	1000×700	2.3	1.9	1.2	0.7	0.5	2.4	1.9	1.2	0.7	0.5
	1000×1000	1.8	1.4	0.9	0.5	0.4	1.7	1.3	0.8	0.5	0.3

**Notes on fabrication and installation**

- (1) Effective surfaces are protected with protective films. Remove protective film immediately after installation. With Reversible Panels, peel off the film from both sides.
- (2) Align the coating direction in case of Metallic Colors, Stone and Timber Finishes, to avoid slight color difference due to coating direction.
- (3) Use aluminum or stainless steel rivet or screw for junction. If aluminum skin has a contact with other metals under humid atmosphere, the corrosion of the aluminum might be accelerated with galvanic corrosion.
- (4) On re-coating on ALPOLIC/fr LT Perforated Panel, use air-curing type paint and dry it at 90°C or lower, to prevent the core material from overheating.



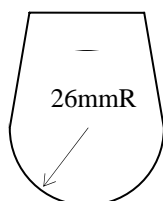
## Impact Test with Steel Ball

We held this test to check the impact resistance of ALPOLIC/fr LT. As the test result shows, ALPOLIC/fr LT never shows crack, break and fracture by the impact of steel ball.

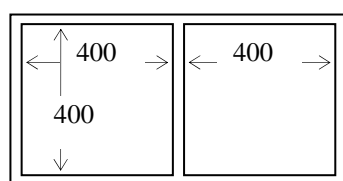
## 1. Testing method

- (1) Testing standard: JIS A 5703 “Plastic laminated or printed boards for inside use”
- (2) Specimen: 450×900 mm, placed in a specimen holder shown below.
- (3) Steel ball: 1 kg weight shown below
- (4) Procedures: Steel ball is dropped onto a specimen from 1 or 2 meters height.
- (5) Evaluation: After the test, the specimen is evaluated on the following items:
  - a. Break or fracture by impact
  - b. Deformation of the entire area (H)
  - c. Deformation of the dropping point (h)

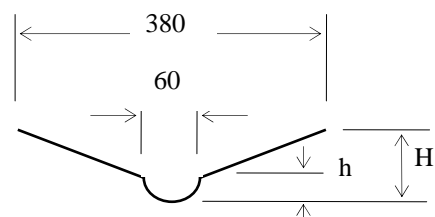
1 kg weight



Specimen holder



Evaluation of deformation



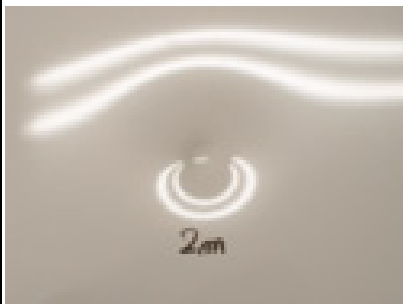



## 2. Test result

Material	Thickness (mm)	Weight (kg/m <sup>2</sup> )	Fracture	Deformation (mm)			
				2	4	6	8
ALPOLIC/fr LT	3	5.5	No	○	△	○	△
Aluminum sheet, anodized	1.2	3.2	No	○	△	○	△
	2	5.4	No	○	△	○	△
Steel sheet, vinyl coated	0.8	4.8	No	○	△	○	△
	1.0	7.9	No	○	△	○	△
Veneer	6	3.0	Yes/Back (1m)	○	△	○	△
	15	7.5	No	○	△	○	△
Gypsum board	12	8.9	Yes/Both (1m)	Not available			
Calcium silicate board	8	10.3	Yes/Both (2m)	○	△	○	△
Acrylic sheet	3	3.6	Yes/Both (1m)	Not available			

Dropping height ○: 1 m △: 2 m Deformation —○—△ : H .....○.....△ : h

**Note:** In fracture column in the table, “Back” indicates that the specimen fractured in the back. “Both” indicates that fracture was found both in back and front. “Not available” means that it is impossible to measure the deformation value due to fracture.

### 3. Appearance of specimen (examples)

		
ALPOLIC/fr LT 3 mm N1 Pure White-G90 Impact: 1kg × 2 m	ALPOLIC/fr LT 3 mm T2 Walnut-Matte Impact: 1kg × 2 m	Aluminum sheet 1.2 mm Anodized Impact: 1kg × 2 m
		
Aluminum sheet 2.0 mm Anodized Impact: 1kg × 2 m	Veneer 15 mm Impact: 1kg × 2 m	Acrylic sheet 3 mm Impact: 1kg × 1 m

## Modified Non-Penetrating Rivet

### 1. General

The non-penetrating rivet method permits a fixing aluminum profiles to ALPOLIC panels as an alternative method of those by adhesives and double-sided tapes. This rivet, unlike adhesives or double-sided tapes, fulfills a mechanical fixing. Therefore, it is suitable for the area where a reliable fixing is required even in the event of fire or other accidents.

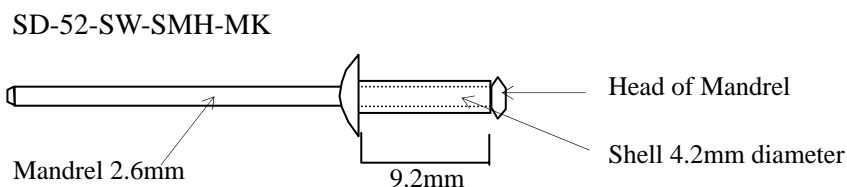
It is important that this method is not applicable to all ALPOLIC panels, but applicable only to the low-gloss finishes, because the trail of concealed rivet is visible from front if the surface is glossy. Especially on ALPOLIC/fr LT, this method is applicable only to **Matte Finish** products. Namely, we can apply this method to the following gloss levels:

ALPOLIC type	Applicable gloss level
ALPOLIC/fr LT 3mm	Matte Finish only
ALPOLIC/fr 4mm, 6mm	30% gloss or less

### 2. Installation method

#### (1) Rivet

Use the rivet, SD-52-SW-SMH-MK, as shown in the diagram.

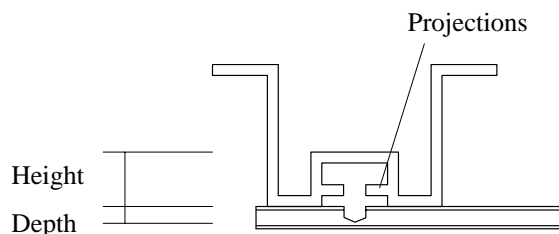


#### (2) Aluminum profile

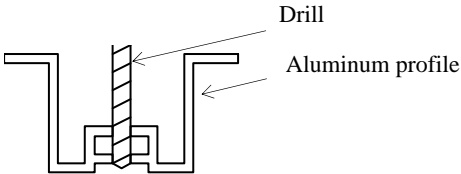
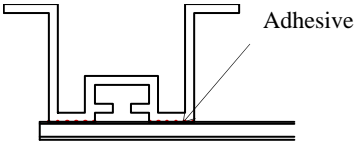
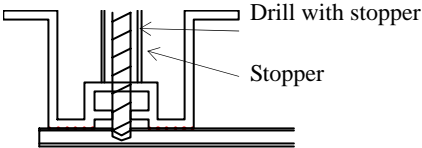
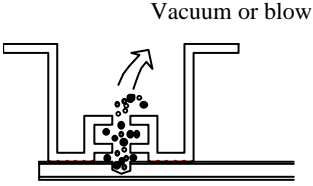
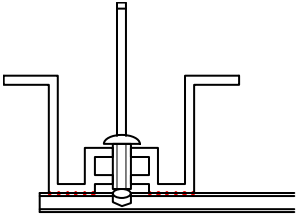
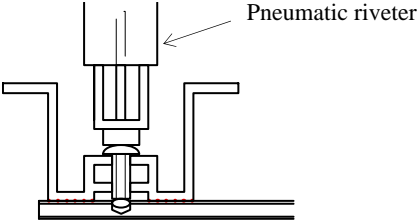
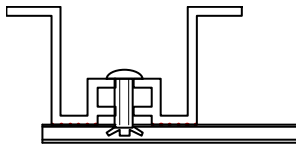
Any shapes of aluminum profiles are applicable, but the profile must allow the following fixing height, having projections to prevent lifting of aluminum skin.

#### (3) Fixing height and suitable depth

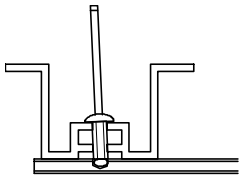
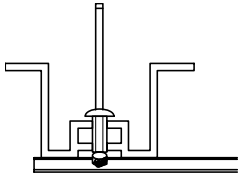
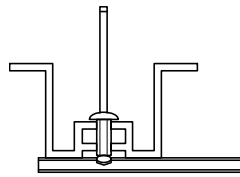
	Height, mm	Depth, mm
ALPOLIC/fr LT 3mm	7.5	2.5
ALPOLIC/fr 4mm	7.5	3.0
ALPOLIC/fr 6mm	6.0	3.5



#### (4) Procedures

<p>Step 1: Make 4.5mm hole in the aluminum profile.</p> 	<p>Step 2: Adhere the profile on ALPOLIC with adhesive. Use Cemedine Super X or equivalent.</p> 
<p>Step 3: Make 4.3mm hole in ALPOLIC. Use a drill with a stopper to give the specified depth.</p> 	<p>Step 4: Remove scraps and chips around the hole.</p> 
<p>Step 5-1: Set the rivet</p> 	<p>Step 5-2: Pull the mandrel to fasten.</p> 
<p>Step 5-3: Finish</p> 	

#### (4) Improper works

<p>Inclined setting</p> 	<p>Scraps remain.</p> 	<p>Hole is shallow.</p> 
---	---	---

### 3. Design strength

Use the following pulling strength for design as a net value. It includes a processing factor of 1.3, but it does not include a safety factor. Divide it by the safety factor, if necessary.

ALPOLIC type	Design strength/piece
ALPOLIC/fr LT 3mm	160 N
ALPOLIC/fr 4mm, 6mm	330 N

**Note:** Keep the distance from the rivet center to the edge at least 20mm to ensure the above strength.

## Panel Strength of ALPOLIC/fr LT

### 1. General calculation method

#### (1) Calculation of permanent deformation

In order to examine the possibility of permanent deformation, we calculate the maximum stress that may arise in aluminium skins of ALPOLIC/fr LT when a wind load works on it. We can use the following equation for this purpose:

$$\text{Stress} = B \cdot w \cdot b^2 / t^2$$

Where,      Stress:    in MPa or N/mm<sup>2</sup> (or psi)  
                  b:        Panel width or height, whichever the shorter side, in mm (or inch).  
                  B:        Coefficient dependent on a/b ratio (panel width/height) and supporting condition, as shown in Table 1.  
                  w:        Wind pressure in MPa or N/mm<sup>2</sup> (or psi)  
                  t<sup>2</sup>:        Square of apparent thickness of ALPOLIC/fr LT in mm<sup>2</sup> (or in<sup>2</sup>), given in the following table:

	t <sup>2</sup> (mm <sup>2</sup> )	t <sup>2</sup> (in <sup>2</sup> )
ALPOLIC/fr LT	4.39	0.68×10 <sup>-2</sup>

When the maximum stress calculated from the above equation is lower than 0.2% proof stress (117 MPa or N/mm<sup>2</sup> (or 170×10<sup>2</sup> psi)), aluminium skins are still within elastic range and permanent deformation will not occur. A suitable safety factor is herein taken into account.

#### (2) Maximum deflection

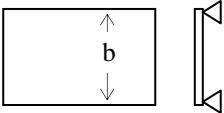
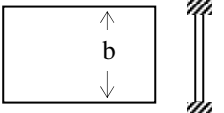
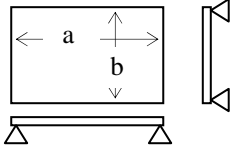
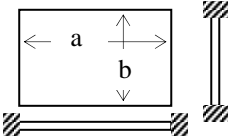
The maximum deflection of ALPOLIC/fr LT panel can be calculated with the following equation:

$$\text{Deflection} = A \cdot w \cdot b^4 / E_{AP} t_{AP}^3$$

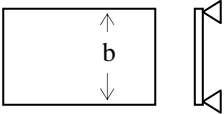
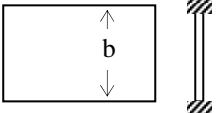
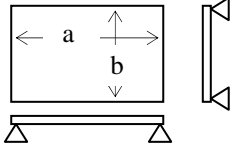
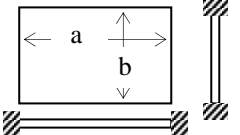
Where,      Deflection:    in mm (or inch)  
                  b:        Panel width or height, whichever shorter side  
                  A:        Coefficient dependent on a/b ratio (panel width/height) and supporting condition, as shown in Table 2.  
                  w:        Wind pressure in MPa or N/mm<sup>2</sup> (or psi)  
                  E<sub>AP</sub>:      Flexural elastic modulus of ALPOLIC/fr LT  
                  t<sub>AP</sub>:      Thickness of ALPOLIC/fr LT  
                  E<sub>AP</sub>t<sub>AP</sub><sup>3</sup> values are given as follows:

	E <sub>AP</sub> t <sub>AP</sub> <sup>3</sup> (N·mm)	E <sub>AP</sub> t <sub>AP</sub> <sup>3</sup> (lbs·inch)
ALPOLIC/fr LT	906×10 <sup>3</sup>	7.99×10 <sup>3</sup>

**Table 1 Coefficient B for calculation of stress**

Support condition		Equation and B value
2-side simply supported and 2-side free		$\text{Stress}_M = 0.75 \cdot w \cdot b^2 / t^2$
2-side fixed and 2-side free		$\text{Stress}_M = 0.5 \cdot w \cdot b^2 / t^2$
4-side simply supported		$\text{Stress}_M = B \cdot w \cdot b^2 / t^2$
		a/b    1    1.2    1.4    1.6    1.8    2.0    3.0
		B    0.2874   0.3762   0.4530   0.5172   0.5688   0.6102   0.7134
4-side fixed		$\text{Stress}_M = B \cdot w \cdot b^2 / t^2$
		a/b    1    1.2    1.4    1.6    1.8    2.0    >2.0
		B    0.3078   0.3834   0.4356   0.4680   0.4872   0.4974   0.5000

**Table 2 Coefficient A for calculation of deflection**

Support condition		Equation and A value
2-side simply supported and 2-side free		$\text{Deflection} = 0.156 \cdot w \cdot b^4 / (E_{AP} \cdot t_{AP}^3)$
2-side fixed and 2-side free		$\text{Deflection} = 0.0313 \cdot w \cdot b^4 / (E_{AP} \cdot t_{AP}^3)$
4-side simply supported		$\text{Deflection} = A \cdot w \cdot b^4 / (E_{AP} \cdot t_{AP}^3)$
		a/b    1    1.2    1.4    1.6    1.8    2.0    3.0    >3.0
		A    0.044   0.062   0.077   0.0906   0.1017   0.1110   0.1335   0.1422
4-side fixed		$\text{Deflection} = A \cdot w \cdot b^4 / (E_{AP} \cdot t_{AP}^3)$
		a/b    1    1.2    1.4    1.6    1.8    2.0    >2.0
		A    0.0138   0.0188   0.0226   0.0251   0.0267   0.0277   0.0284

## 2. Calculation results of typical cases

The following tables are calculation results of typical cases with the above calculation equation.

**Table 3 Maximum Stress, 4-Side Simply Supported**

Material: ALPOLIC/fr LT 3mm (Stress: N/mm<sup>2</sup>)

w, kPa (kg/m <sup>2</sup> )	b, Panel width (mm)	a, Panel length (mm)								
		900	1200	1500	1800	2100	2400	2700	3000	>3000
0.5 (51)	600	19	25	27	29	31	31	31	31	31
	900	27	39	49	57	59	63	66	69	69
	1200	39	47	65	75	91	100	104	109	109
	1500	49	65	74	96	116	133 *	146 *	156 *	156 *
1.0 (102)	600	38	50	54	59	62	62	62	62	62
	900	53	79	99	114	119 *	125 *	132 *	138 *	138 *
	1200	79	94	130 *	150 *	182 *	200 *	209 *	217 *	217 *
	1500	99	130 *	147 *	193 *	232 *	265 *	292 *	313 *	313 *
1.5 (153)	600	56	75	81	88	92	92	92	92	92
	900	80	118 *	148 *	171 *	178 *	188 *	197 *	208 *	208 *
	1200	118 *	141 *	195 *	225 *	274 *	300 *	313 *	326 *	326 *
	1500	148 *	195 *	221 *	289 *	348 *	398 *	437 *	469 *	469 *

**Table 4 Maximum Stress, 4-Side Fixed**

Material: ALPOLIC/fr LT 3mm (Stress: N/mm<sup>2</sup>)

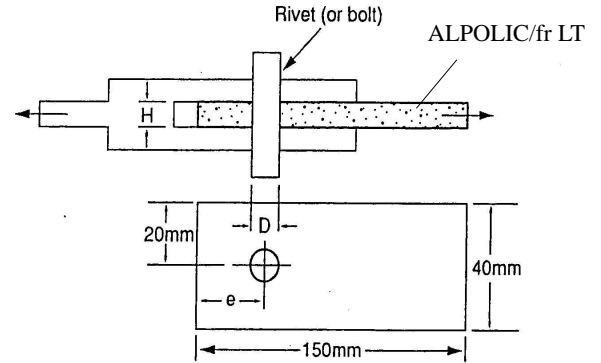
w, kPa (kg/m <sup>2</sup> )	b, Panel width (mm)	a, Panel length (mm)								
		900	1200	1500	1800	2100	2400	2700	3000	>3000
0.5 (51)	600	19	20	21	21	21	21	21	21	21
	900	28	38	44	46	46	46	46	46	46
	1200	38	50	65	74	79	82	82	82	82
	1500	44	65	79	98	112	120 *	125 *	127 *	128 *
1.0 (102)	600	37	41	41	41	41	41	41	41	41
	900	57	77	88	92	92	92	92	92	92
	1200	77	101	130 *	148 *	158 *	163 *	164 *	164 *	164 *
	1500	88	130 *	158 *	197 *	223 *	240 *	250 *	255 *	256 *
1.5 (153)	600	56	61	62	62	62	62	62	62	62
	900	85	115	131 *	138 *	138 *	138 *	138 *	138 *	138 *
	1200	115	151 *	195 *	222 *	237 *	245 *	246 *	246 *	246 *
	1500	131 *	195 *	237 *	295 *	335 *	360 *	375 *	382 *	384 *

**How to read the table:** \* indicates that the maximum stress becomes larger than 0.2% proof stress (yield stress) of aluminum skin 1100 H-14 (117 N/mm<sup>2</sup>). Stiffener will be required in this range. In other range where the calculated stress is lower than 117 N/mm<sup>2</sup>, the panel will withstand without stiffener.



## Strength of Junction Holes

Rivet, bolt/nut and tapping screw are quite often used for junction between ALPOLIC/fr LT panels and aluminum profiles. When tensile force loads on the junction point, stress will arise in the junction hole of ALPOLIC/fr LT panel. In order to evaluate the maximum elastic limit of junction hole, we held the following tensile test.



### 1. Test method:

Do tensile tests with 5mm holes (D) that locates different distance from edge (e). Determine the maximum elastic limits by means of stress-strain curve.

### 2. Test result:

Hole diameter, D, mm (in)	From hole center to edge, e, mm (in)	e/D	Max. elastic stress, S, in MPa (psi)	Max. tensile force, F, in N (lbs)
5 (.197")	5 (.197")	1	17 (3000)	320 (72)
	10 (.394")	2	29 (7000)	720 (162)
	15 (.591")	3	33 (8000)	820 (184)

### 3. How to use the above data:

To utilize the above data, we convert the stress to tensile force with the following equation:

$$F = S \times t \times D$$

Where, S: Maximum elastic stress in Mpa (psi)  
 F: Maximum tensile force in N (lbs)  
 t: Thickness of ALPOLIC® in mm (in)  
 D: Diameter of hole in mm (in)

Calculation example:

Premise: ALPOLIC®/fr 3mm (.118"), D = 3mm (.118"), e = 6mm (.236"),

Result:  $F = S \times t \times D = 29 \times 3 \times 3 = 261$  N per junction point

According to the above table, we can also understand that we cannot expect a sufficient hole-strength, if the position is quite near the edge. In order to ensure a reasonable strength of junction hole, the distance from the center of hole to the edge (e) should be larger than double of hole-diameter (D). Namely, we should keep  $e > 2 \times D$ .

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