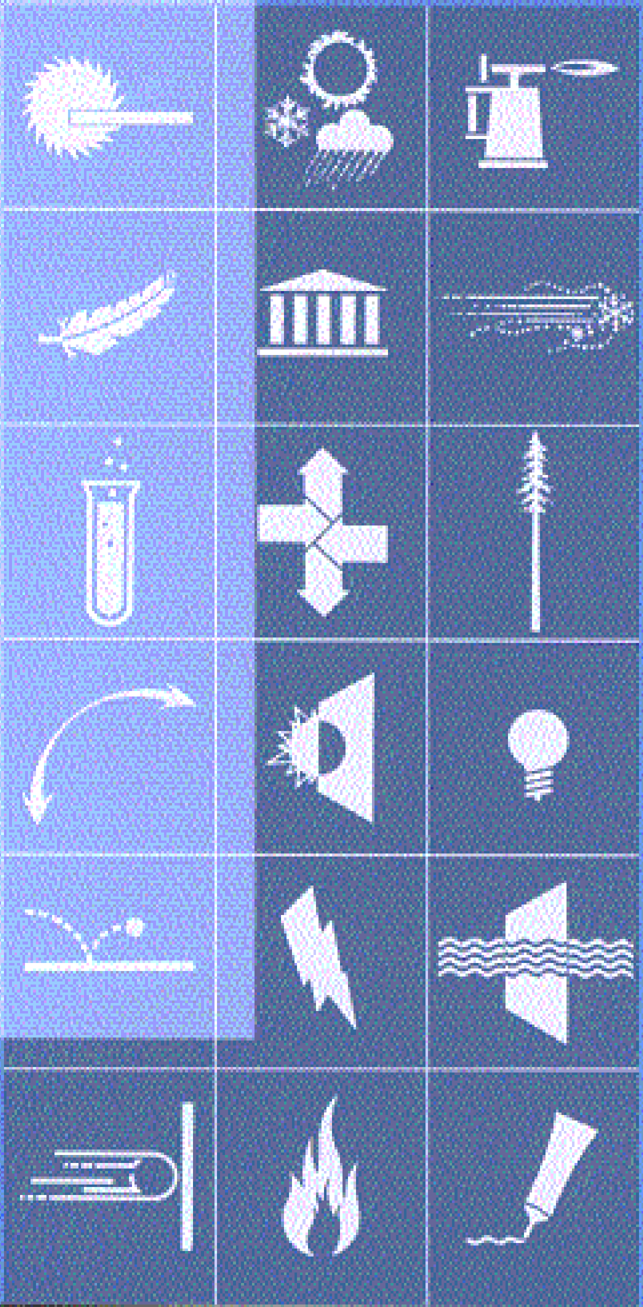
CYRO

Physical properties of Acrylite® FF

ACRYLIC SHEET



ACRYLITE® FF ACRYLIC SHEET

ACRYLITE® FF acrylic sheet is a continuously manufactured acrylic sheet. It is produced by an innovative process, resulting in a sheet offering the easy handling and processing of extruded sheet, along with the high optical characteristics and low stress levels expected of cast products. Colorless ACRYLITE FF sheet carries an exclusive 10-year limited warranty on light transmission – your assurance of a quality product. A printed copy of the warranty is available from CYRO Industries or wherever ACRYLITE® acrylic sheet is sold.

The clarity and light stability of acrylic resin make it possible to manufacture crystal clear ACRYLITE FF sheet.

Characteristics

ACRYLITE FF sheet is a lightweight, rigid and weather-resistant thermoplastic. ACRYLITE FF sheet is dimensionally stable and resistant to breakage, and can be easily sawed, machined, heat-formed and cemented.

Because of its virtually distortion-free clarity, it is well suited for use in a variety of applications.

- Skylights
- Signs
- Window Glazing
- Window Frames
- Picture Framing
- Store or P-O-P Displays
- Optical Displays

Availability

ACRYLITE FF sheet is available in thicknesses from 0.060" (1.5 mm) to 0.944" (24 mm) and actual sheet sizes from 48" x 96" (1.22 m x 2.44 m) to 100" x 150" (2.54 m x 3.81 m). Custom sizes are also available. All sheets are protected with polyethylene film or paper masking.

Safety

ACRYLITE FF sheet is more impact resistant than glass. If subjected to impact beyond the limit of its resistance, it does not shatter into small slivers, but breaks into comparatively large pieces. ACRYLITE FF sheet meets the requirements of ANSI Z97.1 for use as a Safety Glazing Material in Buildings (for thicknesses 0.080" to 0.500" [2.0 mm - 12.0 mm]).

Weather Resistance

ACRYLITE FF sheet will withstand exposure to blazing sun, extreme cold, sudden temperature changes, salt water spray, etc. It will not deteriorate after many years of service because of the inherent stability of acrylic resins. ACRYLITE FF sheet has been widely accepted for use in school buildings, industrial plants and outdoor signs.

Dimensional Stability

Although ACRYLITE FF sheet will expand and contract due to changes in temperature and humidity, it will not shrink with age. Some shrinkage occurs when ACRYLITE FF sheet is heated to forming temperature, but post-forming stability is excellent.

Light Weight

ACRYLITE FF sheet is only half the weight of glass and 43% the weight of aluminum.

Rigidity

ACRYLITE FF sheet is not as rigid as glass or metals. However, it is more rigid than many other plastics such as acetates, polycarbonates or vinyls. Under wind load an acrylic sheet will bow and foreshorten as a result of deflection.

For glazing installations the maximum wind load and the size of the window must be considered when the thickness of a panel is to be determined.

If ACRYLITE FF sheet is formed into corrugated or domed shapes, rigidity will be increased and deflection minimized.

Cold Flow

Large, flat ACRYLITE FF sheet, if insufficiently supported, may deform permanently due to continuous loads such as snow, or even their own weight. Increased rigidity obtained by forming will minimize cold flow.

Strength and Stresses

Although the tensile strength of ACRYLITE FF sheet is 10,000 psi (69 Mpa) at room temperature (ASTM D 638), stress crazing can be caused by continuous loads below this value. For glazing applications, continuously imposed design loads should not exceed 750 psi (5.2 Mpa) at 73°F (23°C). Temporary loads of up to 1,500 psi (10.4 Mpa) may be imposed for short durations of time at 73°F (23°C).

Localized, concentrated stresses must be avoided. For this reason, and because of thermal expansion and contraction, large sheets should never be fastened with bolts, but should always be installed in frames.

All thermoplastic materials, including ACRYLITE FF sheet, will gradually lose tensile strength as the temperature approaches the maximum recommended for continuous service–160°F (71°C).

Expansion and Contraction

Like most other plastics, ACRYLITE FF sheet will expand and contract from 3 to 8 times as much as glass or metals. The designer should be aware of its coefficient of expansion and make appropriate provisions. A 48" panel will expand and contract approximately .002" for each degree fahrenheit change in temperature. In outdoor use, where summer and winter temperatures differ as much as 100°F, a 48" sheet will expand and contract approximately 3/16". Sash rabbets must be of sufficient depth to allow for expansion as well as for contraction.

ACRYLITE FF sheet also absorbs water when exposed to high relative humidities, resulting in expansion of the sheet. At relative humidities of 100%, 80%, and 60%, the dimensional changes are 0.6%, 0.3% and 0.2%, respectively.

Heat Resistance

ACRYLITE FF sheet can be used at temperatures from -30°F (-34°C) up to +190°F (+88°C), depending on the application. It is recommended that temperatures not exceed 160°F (71°C) for continuous service, or 190°F (88°C) for short, intermittent use. Components made of ACRYLITE FF sheet should not be exposed to high heat sources such as high wattage incandescent lamps, unless the finished product is ventilated to permit the dissipation of heat.

Light Transmission

Clear, colorless ACRYLITE FF sheet has a light transmittance of 92%. It is warranted not to lose more than 3% of its light-transmitting ability in a 10-year period. Contact CYRO Industries for the complete warranty.

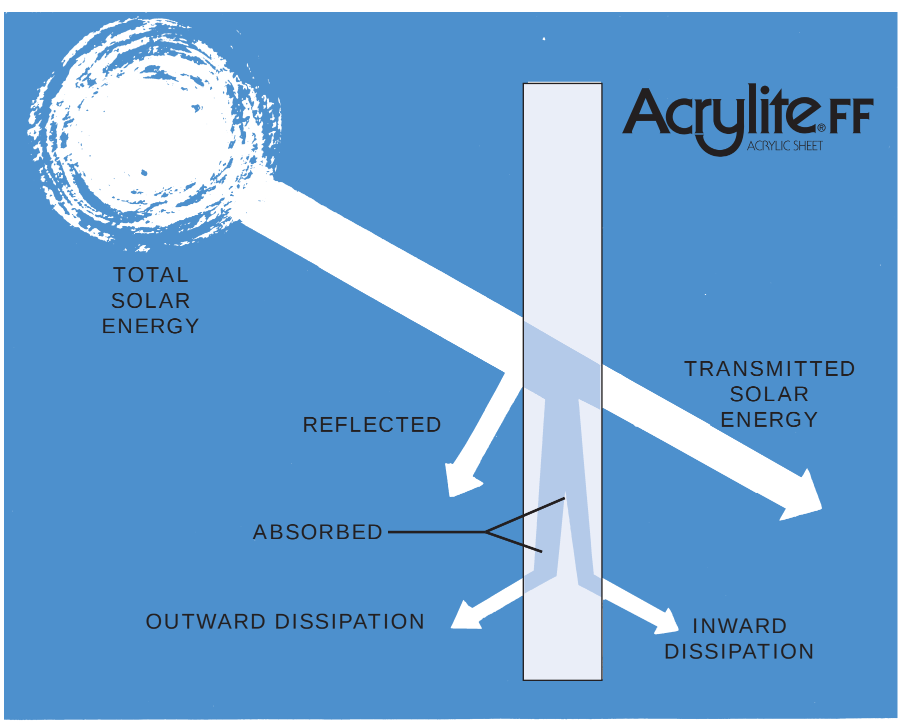
ACRYLITE® OP-3 acrylic sheet is formulated with ultraviolet absorbers designed to help protect pictures, photographs and posters from the damaging effects of ultraviolet light. ACRYLITE OP-3 sheet absorbs more than 98% of the radiation in the ultraviolet range below 400 nanometers.

Solar Energy Control

Transparent colored ACRYLITE FF sheet can be used to reduce glare and solar energy transmittance. Transparent colored sheets are available in a range of color densities.

This wide range of transmittance values enables the architect to select a density which will provide adequate daylight and at the same time will control glare and solar heat build-up.

Distribution of Solar Energy



Chemical Resistance

ACRYLITE FF sheet has excellent resistance to many chemicals including:
- solutions of inorganic alkalies such as ammonia
- dilute acids such as sulfuric acid up to a concentration of 30%
- aliphatic hydrocarbons such as hexane and VM&P naphtha

ACRYLITE FF sheet is not attacked by most foods, and foods are not affected by it.

It is attacked, in varying degrees, by:
- aromatic solvents such as benzene and toluene
- chlorinated hydrocarbons such as methylene chloride and carbon tetrachloride
- ethyl and methyl alcohols
- some organic acids such as acetic acid
- lacquer thinners, esters, ketones and ethers

For a listing of the resistance of ACRYLITE FF sheet to more than 60 chemicals, refer to the table on page 7.

Formability

ACRYLITE FF sheet will soften as the temperature is increased above 195°F (91°C). As the temperature is increased the sheet passes through the thermoelastic state to the thermoplastic state. The change is gradual rather than sharply defined. The forming temperature range is between 290°F and 320°F (143°C and 160°C). Because the sheet gradually becomes thermoplastic, certain procedures should be considered during thermoforming. If the sheet is to be hung in an oven it is necessary to use a continuous clamp rather than several individual clamps. This will prevent the sheet from permanently deforming between clamps. If the sheet is to be heated by infrared heaters while clamped in a horizontal frame, it may be necessary to control the heaters above the center of the sheet. This will prevent the center from becoming too hot and sagging under its own weight.

The sheet will exhibit very little “memory” after forming and probably will not return to its original flat condition if reheated.

ACRYLITE FF sheet will shrink in the machine direction when heated without a frame. Sheet thicknesses of .118” (3.0 mm) and greater will shrink no more than 3%. Thinner thicknesses could shrink more.

Cutting and Machining

ACRYLITE FF sheet can be sawed with circular saws or band saws. It can be drilled, routed, filed and machined much like wood or brass with a slight modification of tools. Because the sheet softens quickly, it is necessary to keep the cutting tool and machined edge of the sheet as cool as possible. Cooling of the cutting tool is recommended. Tool sharpness and “trueness” are essential to prevent gumming, heat buildup and stresses in the part. Heat buildup at the machined edge could lead to subsequent stress crazing and therefore must be avoided.

Laser Cutting

Laser technology is rapidly being accepted by the industry for quick and accurate cutting, welding, drilling, scribing and engraving of plastics.

CO_2 lasers focus a large amount of light energy on a very small area which is extremely effective for cutting complex shapes in acrylic sheet. The laser beam produces a narrow kerf in the plastic allowing for close nesting of parts and minimal waste. CO_2 lasers vaporize the acrylic as they advance resulting in a clean polished edge but with high stress levels; annealing acrylic sheet after laser cutting is recommended to minimize the chance of crazing during the service life of the part.

Cementing

ACRYLITE FF sheet can be cemented using common solvent cements or polymerizable cements. The most critical factor is good edge preparation of the part to be cemented. The edge of the sheet must be properly machined in order to have a square flat surface and no stresses. Annealing of the part prior to cementing is recommended. Cement and cement fumes should not contact formed or polished surfaces.

Annealing

ACRYLITE FF sheet may be annealed at 180°F (82°C) with the heating and cooling times determined by the sheet thickness. An approximate guideline is annealing time in hours equals the sheet thickness in millimeters and the cooldown period is a minimum of 2 hours ending when sheet temperature falls below 140°F. For example, 1/8” (3 mm) ACRYLITE FF sheet would be heated for 3 hours at 180°F (82°C) and slowly cooled for 3 hours.

Flammability

ACRYLITE FF sheet is a combustible thermoplastic. Precautions should be taken to protect this material from flames and high heat sources. ACRYLITE FF sheet usually burns rapidly to completion if not extinguished. The products of combustion, if sufficient air is present, are carbon dioxide and water. However, in many fires sufficient air will not be available and toxic carbon monoxide will be formed, as it will when other common combustible materials are burned. We urge good judgement in the use of this versatile material and recommend that building codes be followed carefully to assure it is used properly.

The combustibility test data for ACRYLITE FF sheet is: self-ignition temperature (ASTM D-1929) is 850°F (455°C), smoke density as measured by ASTM D-2843 is 6.4%, and the rate of burning as measured by ASTM D-635 is 1.0 in/min (25mm/min) for 1/8" (3mm) thick sheet. While these data are based on small scale laboratory tests frequently referenced in various building codes, these tests do not duplicate actual fire conditions.

Thermal Conductivity

The thermal conductivity of a material–its ability to conduct heat–is called k-Factor. The k-Factor is an inherent property of the material, and is independent of its thickness and of the surroundings to which it is exposed.

The k-Factor of ACRYLITE FF sheet is: $\frac{1.3 \text{ B.T.U.}}{\text{(hour) (sq. ft.) (°F/inch)}}$ or $\frac{0.19 \text{ W}}{\text{m. K}}$

Whereas the k-Factor is a physical property of the material, the U-Factor—or overall coefficient of heat transfer—is the value used to calculate the total heat loss or gain through a window.

The U-Factor is the amount of heat per unit time and area which will pass through a specific thickness and configuration of material per degree of temperature difference on each of its two sides.

This value takes into account the thickness of the sheet, whether the sheet is in a horizontal or vertical position, as well as the wind velocity.

U-Factors are based on specific conditions (e.g., single-glazed or double-glazed installations) and are different for summer and winter.

Listed below are U-Factors for several thicknesses of ACRYLITE FF sheet for single-glazed, vertical installations, based on the standard ASHRAE* summer and winter design conditions.

U-Factors–BTU/hour sq. ft. °F (w/m^2 • K)

ACRYLITE FF Sheet Thickness	Summer Conditions	Winter Conditions
.118 (3.0 mm)	0.98 (5.56)	1.06 (6.02)
.177 (4.5 mm)	0.94 (5.34)	1.02 (5.79)
.236 (6.0 mm)	0.90 (5.11)	0.97 (5.51)
.375 (9.5 mm)	0.83 (4.71)	0.89 (5.05)

*American Society of Heating, Refrigerating and Air-Conditioning Engineers

The total heat loss or gain through a window (due to temperature difference only) can be calculated by multiplying the area of the window, times the difference between indoor and outdoor temperatures, times the appropriate U-Factor (from Table above). Heat intake through solar radiation must be added to arrive at the total heat gain.

ACRYLITE FF sheet is a better insulator than glass. Its U-Factor or overall coefficient of heat transfer is approximately 10% lower than that of glass of the same thickness. Conversely, its R_T-Factor is about 10% greater.

Thermal Shock and Stresses

ACRYLITE FF sheet is more resistant than glass to thermal shock and to stresses caused by substantial temperature differences between a sunlit and a shaded area of a window or by temperature differences between opposite surfaces of a window.

Surface Hardness

The surface of plastic is not as hard as that of glass. Therefore, reasonable care should be exercised in handling and cleaning ACRYLITE FF sheet.

Electrical Properties

ACRYLITE FF sheet has many desirable electrical properties. It is a good insulator. Its surface resistivity is higher than that of most plastics. Continuous outdoor exposure has little effect on its electrical properties.

Physical Properties of Acrylite® FF Acrylic Sheet

Property[a]		ASTM Method	Typical Value (0.250" Thickness)[b]
Mechanical	Specific Gravity	D 792	1.19
	Tensile Strength Elongation, Rupture Modulus of Elasticity	D 638	10,000 psi (69 M Pa) 4.5% 400,000 psi (2800 M Pa)
	Flexural Strength Modulus of Elasticity	D 790	17,000 psi (117 M Pa) 480,000 psi (3300 M Pa)
	Compressive Strength (Yield)	D 695	17,000 psi (117 M Pa)
	Impact Strength Izod Milled Notch	D 256	0.4 ft. lbs/in. of notch (21.6 J/m of notch)
	Rockwell Hardness	D 785	M-93
	Barcol Hardness	D 2583	48
Optical	Refractive Index	D 542	1.49
	Light Transmission, Total	D 1003	92%
Thermal	Forming Temperature	—	Approx. 300°F (149°C)
	Deflection Temperature under load, 264 psi	D 648	195°F (91°C)
	Vicat Softening Point	D 1525	220°F (105°C)
	Maximum Recommended Continuous Service Temperature	—	160°F(c) (71°C)
	Coefficient of Linear Thermal Expansion	D 696	0.000040 in/in - °F (0.000072 m/m - °C)
	Coefficient of Thermal Conductivity	Cenco-Fitch	1.3 BTU/(Hr) (Sq. Ft.) (°F / in.) (0.19 w/m•K)
	Flammability, Burning Rate (0.125" thickness)	D 635	1.0 in/min. (25 mm/min.)
	Self Ignition Temperature	D 1929	850°F(455°C)
	Specific Heat @ 77°F		0.35 BTU/(lb.) (°F) (1470J/Kg•K)
	Smoke Density Rating	D 2843	4.8%
Electrical	Dielectric Strength Short Time (0.125")	D 149	430 volts/mil (17 KV/mm)
	Dielectric Constant 60 Hertz 1000 Hertz 1000000 Hertz	D 150	 3.6 3.3 2.8
	Dissipation Factor 60 Hertz 1000 Hertz 1000000 Hertz	D 150	 0.06 0.04 0.02
	Volume Resistivity	D 257	10^{16}ohm-cm
	Surface Resistivity	D 257	10^{15}ohms
Water Absorption 24 hrs @ 73°F		D 570	0.2%
Odor		—	None
Taste		—	None

NOTES: (a) Typical values; should not be used for specification purposes.
(b) Values shown are for 0.250" thickness. Some values will change with thickness or pigmentation.
(c) It is recommended that temperatures not exceed 160°F for continuous service, or 190°F for short intermittent use.

Chemical Resistance of ACRYLITE® FF ACRYLIC SHEET

The table below gives an indication of the chemical resistance of ACRYLITE FF sheet. The code used to describe chemical resistance is as follows:

R = Resistant
ACRYLITE FF sheet withstands this substance for long periods and at temperatures up to 120°F (49°C).

LR = Limited Resistance
ACRYLITE FF sheet only resists the action of this substances for short periods at room temperatures. The resistance for a particular application must be determined.

N = Not Resistant
ACRYLITE FF sheet is not resistant to this substance. It is either swelled, attacked, dissolved or damaged in some manner.

Plastic materials can be attacked by chemicals in several ways. The methods of fabrication and/or conditions of exposure of ACRYLITE FF sheet, as well as the manner in which the chemicals are applied, can influence the final results even for "R" coded chemicals. Some of these factors are listed below.

Fabrication — Stress generated while sawing, sanding, machining, drilling, and/or forming.

Exposure — Length of exposure, stresses induced during the life of the product due to various loads, changes in temperatures, etc.

Application of Chemicals — by contact, rubbing, wiping, spraying, etc.

The table should therefore be used as only a general guide and, in case of doubt, it should be supplemented by tests made under actual working conditions.

Chemical	Code	Chemical	Code
Acetic Acid (5%)	LR	Hydrogen Peroxide (<40%)	R
Acetic Acid (Glacial)	N	Hydrogen Peroxide (>40%)	LR
Acetone	N	Isopropyl Alcohol	LR
Ammonium Chloride	R	Kerosene	R
Ammonium Hydroxide (10%)	R	Lacquer Thinner	N
Ammonium Hydroxide (Conc.)	R	Methyl Alcohol (30%)	LR
Aniline	N	Methyl Alcohol (100%)	N
Battery Acid	R	Methyl Ethyl Ketone (MEK)	N
Benzene	N	Methylene Chloride	N
Butyl Acetate	N	Mineral Oil	R
Calcium Chloride (Sat.)	R	Nitric Acid (10%)	R
Calcium Hypochlorite	R	Nitric Acid (40%)	LR
Carbon Tetrachloride	N	Nitric Acid (Conc.)	N
Chloroform	N	Oleic Acid	R
Chromic Acid	LR	Olive Oil	R
Citric Acid (20%)	R	Phenol Solution (5%)	N
Cottonseed Oil (Edible)	R	Soap Solution (Mild dish soap)	R
Detergent Solution (Heavy Duty)	R	Sodium Carbonate (2%)	R
Diesel Oil	R	Sodium Carbonate (20%)	R
Diethyl Ether	N	Sodium Chloride (10%)	R
Dimethyl Formamide	N	Sodium Hydroxide (1 %)	R
Dioctyl Phthalate	N	Sodium Hydroxide (10%)	R
Ethyl Acetate	N	Sodium Hydroxide (60%)	R
Ethyl Alcohol (30%)	LR	Sodium Hypochlorite (5%)	R
Ethyl Alcohol (95%)	N	Sulfuric Acid (3%)	R
Ethylene Dichloride	N	Sulfuric Acid (30%)	R
Ethylene Glycol	R	Sulfuric Acid (Conc.)	N
Gasoline	LR	Toluene	N
Glycerine	R	Transformer Oil	R
Heptane	R	Trichloroethylene	N
Hexane	R	Turpentine	R
Hydrochloric Acid	R	Water	R
Hydrofluoric Acid (25%)	N	Xylene	N

Acrylite® FF
ACRYLIC SHEET

For the name of a local Authorized Distributor visit www.cyro.com, call 800-631-5384 in the U.S. or 800-268-4743 in Canada, or contact the nearest CYRO sales office:

Sales Offices:

Eastern Region
Rockaway, NJ 07866
100 Enterprise Drive
PO Box 5055
973-442-6130

South Central Region
Plano, TX 75074
101 East Park Blvd.
Suite 1039
972-424-6830

Western Region
San Ramon, CA 94583
3180 Crow Canyon Place
Suite 240
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