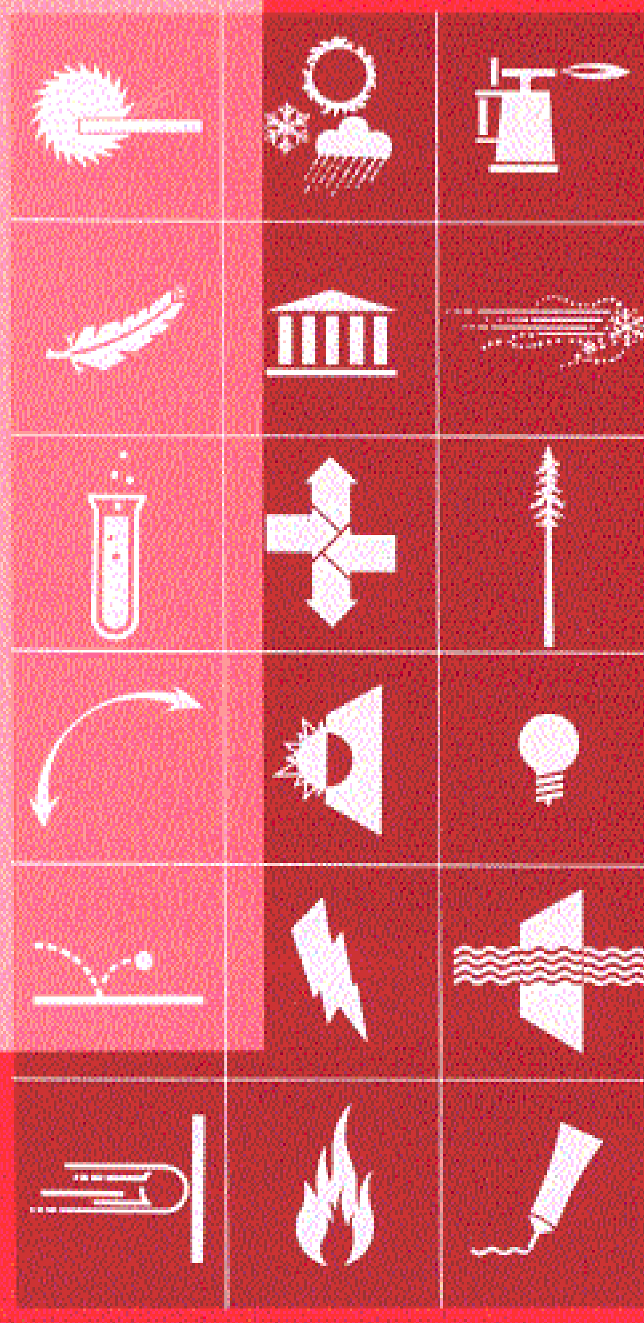
CYRO

Physical properties of Acrylite® GP

ACRYLIC SHEET



Physical Properties of Acrylite® GP ACRYLIC SHEET

Property(a)		ASTM Method	Typical Value (.236" Thickness)(b)
Mechanical	Specific Gravity	D 792	1.19
	Tensile Strength	D 638	10,000 psi (69 M Pa)
	Elongation, Rupture		4.2%
	Modulus of Elasticity		400,000 psi (2800 M Pa)
	Flexural Strength (Rupture)	D 790	16,500 psi (114 M Pa)
	Modulus of Elasticity		475,000 psi (3300 M Pa)
	Compressive Strength (Yield)	D 695	18,000 psi (124 M Pa)
	Modulus of Elasticity		430,000 psi (2960 M Pa)
	Shear Strength	D732	9,000 psi (62 M Pa)
	Impact Strength Izod Milled Notch	D 256	0.4 ft. lbs/in. of notch (21.6 J/m of notch)
	Rockwell Hardness	D785	M-94
	Barcol Hardness	D 2583	49
	Residual Shrinkage(c) (Internal Strain)	D 702	2%
Optical (Clear Material)	Refractive Index	D 542	1.49
	Light Transmission, Total	D 1003	92%
	UV Transmission		0 at 320 nanometers
	Haze		Less than 1%
Thermal	Forming Temperature	—	340-380°F (170-190°C)
	Deflection Temperature under load, 264 psi	D 648	210°F (99°C)
	Vicat Softening Point	D 1525	239°F (115°C)
	Maximum Recommended Continuous Service Temperature	—	180°F (d) (82°C)
	Coefficient of Linear Thermal Expansion	D 696	0.000040 in/in-°F (0.000072 m/m-°C)
	Coefficient of Thermal Conductivity (k-Factor)	Cenco-Fitch	1.3 BTU/(Hr) (Sq. Ft.) (°F/in.) (0.19 w/m·K)
	Flammability (Burning Rate 3mm thickness)	D 635	1.2 in/min. (30.5 mm/min.)
	Self-Ignition Temperature	D 1929	910°F(490°C)
	Specific Heat @ 77°F	—	0.35 BTU/(Ib.) (°F) (1470 J/Kg·k)
	Smoke Density Rating (3mm thickness)	D 2843	11.4%
Electrical	Dielectric Strength Short Time (0. 1 25"-thickness)	D 149	430 volts/mil (17 KV/mm)
	Dielectric Constant		
	60 Hertz	D 150	3.5
	1,000 Hertz		3.2
	1,000,000 Hertz		2.7
	Dissipation Factor		
	60 Hertz	D 150	0.06
	1,000 Hertz		0.04
	1,000,000 Hertz		0.02
	Volume Resistivity	D 257	1.6×10^{16} ohm-cm
	Surface Resistivity	D 257	1.9×10^{15} ohms
Water Absorption	24 hrs @ 73°F	D 570	0.2%
	Weight Gain during Immersion		0.2%
	Soluble Matter Lost		0.0%
	Water Absorbed		0.2%
	Dimensional Change during Immersion		0.2%
Long Term Water Absorption	Weight Gain during Immersion	D 570	
	7 days		0.5%
	14 days		0.6%
	21 days		0.8%
	35 days		1.0%
	48 days		1.1%
Odor		—	None
Taste		—	None

NOTES: (a) Typical values: should not be used for specification purposes.
(b) Values shown are for 6mm thickness unless noted otherwise. Some values will change with thickness.
(c) Difference in length and width, as measured at room temperature, before and after heating above 300°F.
(d) It is recommended that temperatures not exceed 180°F for continuous service, or 200°F for short, intermittent use.

Acrylite® GP
ACRYLIC SHEET

ACRYLITE® GP acrylic sheet is a cell-cast acrylic sheet made to exacting standards. It offers excellent optical characteristics, thickness tolerances, light stability, and low internal stress levels for consistent performance.

Colorless ACRYLITE GP 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.

In addition to colorless sheet, a wide range of transparent, translucent and opaque colors are also available.

Characteristics

ACRYLITE GP sheet is a lightweight, rigid thermoplastic material that has many times the breakage resistance of standard window pane glass. It is highly resistant to weather conditions. ACRYLITE GP sheet can be easily sawed, machined, thermoformed, and cemented. It is suitable for most commercial applications and is ultraviolet light absorbing up to approximately 360 nanometers.

For greater ultraviolet light transmission, ACRYLITE® OP-1 or ACRYLITE® OP-4 acrylic sheet may be used. For greater ultraviolet light absorption, ACRYLITE® OP-2 acrylic sheet filters out more of the UV radiation than regular ACRYLITE GP sheet grades.

For security applications, ACRYLITE GP 1.25” sheet may be used.

Because of its unique properties, ACRYLITE GP acrylic sheet is ideal for a wide range of applications, such as:

- Merchandising Displays
- Lighting Fixture Diffusers
- Decorative Paneling
- Security Glazing
- Aquariums
- Hockey Rinks
- Industrial and School Glazing
- Shower Enclosures
- Skylights
- Signs

Availability

ACRYLITE GP sheet is available in thicknesses from .060” to 2” (1.5 mm to 50 mm) and in more than 40 standard sizes from 36” x 48” to 72” x 120” (1.83 m x 3.05 m). Sheets can be furnished masked with paper or polyethylene film, or half-masked.

Colorless sheets and over 50 standard colors are available from distributors across the country. Custom colors can be made to order.

ACRYLITE GP sheet is also available with a non-glare, matte surface as ACRYLITE® GP P-95 and ACRYLITE® GP DP-9 acrylic sheet. Both retain the same physical properties of standard ACRYLITE GP sheet with the addition of the matte surface. ACRYLITE GP P-95 sheet offers a one-sided textured non-glare surface, while ACRYLITE GP DP-9 sheet offers the same surface on two sides.

Safety

ACRYLITE GP 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 GP sheet meets the requirements of ANSI Z 97.1 for use as a Safety Glazing material in Buildings (for thicknesses 0.080” [2.0 mm] to 0.500” [1 2.7mm]).

Weather Resistance

Acrylic offers better weather resistance than other types of transparent plastics. ACRYLITE GP sheet will withstand exposure to blazing sun, extreme cold, sudden temperature changes, salt water spray and other harsh conditions. It will not deteriorate after many years of service because of the inherent stability of acrylic. ACRYLITE GP sheet has been widely accepted for use in skylights, school buildings, industrial plants, aircraft glazing and outdoor signs.

Dimensional Stability

Although ACRYLITE GP sheet will expand and contract due to changes in temperature and humidity, it will not shrink with age. Some shrinkage occurs when ACRYLITE GP sheet is heated to forming temperature.

Light Weight

ACRYLITE GP sheet is less than half the weight of glass, and 43% the weight of aluminum. One square foot of 1/8” (3.0 mm) thick ACRYLITE GP sheet weighs less than 3/4 pound (1/3 kilogram).

Rigidity

ACRYLITE GP 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, a 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 the panel and the depth and width of the glazing channels are to be determined.

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

Cold Flow

Large, flat ACRYLITE GP sheet may deform due to continuous loads such as snow, or even from its own weight if not sufficiently supported. Increased rigidity obtained by forming will minimize cold flow.

Strength and Stresses

Although the tensile strength of ACRYLITE GP sheet is 10,000 psi (69 MPa) at room temperature (ASTM D638), stress crazing can be caused by continuous loads below this value. For most applications, continuously imposed design loads should not exceed 1,500 psi (10.4 MPa).

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 GP sheet-will gradually lose tensile strength as the temperature approaches the maximum recommended for continuous service. For ACRYLITE GP sheet, the maximum is 180°F (82°C).

Expansion and Contraction

Like most other plastics, ACRYLITE GP sheet will expand 3 times as much as metals, and 8 times as much as glass. The designer should be aware of this rather large coefficient of expansion. 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”. Glazing channels must be of sufficient depth to allow for expansion as well as for contraction.

ACRYLITE GP 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%, 0.4% and 0.2%, respectively.

Heat Resistance

ACRYLITE GP sheet can be used at temperatures from -40°F (-40°C) up to +200°F (93°C), depending on the application. It is recommended that temperatures not exceed 180°F for continuous service, or 200°F for short, intermittent use. Components made of ACRYLITE GP 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 GP 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-1 and ACRYLITE OP-4 sheet (ultraviolet transmitting) transmit more ultraviolet light in the range from 240 to 380 nanometers than regular ACRYLITE GP sheet grades. ACRYLITE OP-2 sheet (ultraviolet filtering) absorbs more radiation in the ultraviolet range below 400 nanometers than regular ACRYLITE GP sheet grades. It is used to protect art objects and documents from the damaging effects of ultraviolet light.

Solar Energy Control

Transparent colored ACRYLITE GP sheet can be used to reduce glare and solar energy transmittance. Sheets are available in a wide range of colors with light transmittance values from approximately 6% to 79%. This broad selection enables the designer to choose a color which provides adequate daylight while, at the same time, controls glare and solar heat buildup.

Translucent white and translucent colored ACRYLITE GP sheet diffuses light. Colorless, textured sheet also diffuses light to some extent.

Chemical Resistance

ACRYLITE GP 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

ACRYLITE GP 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 GP sheet to more than 70 chemicals, refer to the table on page 7.

Formability

ACRYLITE GP sheet will soften gradually as the temperature is increased above 210°F (99°C). At temperatures from 340°F to 380°F (171°C to 193°C), ‘it becomes soft and pliable and can be formed into almost any shape using inexpensive molds. The optimum forming temperature within this range depends on thickness and desired depth of draw. ACRYLITE GP sheet will typically shrink 1.5% when heated without a frame. As the sheet cools, it will harden and retain the formed shape.

Because ACRYLITE GP sheet is a thermoplastic material, heating a formed part to temperatures above 210°F (99°C) may cause it to revert to its original flat condition.

Cutting and Machining

ACRYLITE GP 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. Cooling of the cutting tool is recommended to keep the machined edge of the sheet as cool and stress free as possible. Heat buildup should be avoided because it could lead to stress crazing. Tool sharpness and “trueness” are also essential to prevent gumming, heat buildup and stresses in the part.

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 GP sheet can be cemented using common solvent cements or polymerizable cements. The most critical factor is the edge of the part to be cemented. The edge must have been properly machined so as 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

To eliminate stresses caused by machining and/or polishing, annealing is recommended. ACRYLITE GP 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 cool-down period is a minimum of 2 hours ending when sheet temperature falls below 140°F. For example, 1/8” (3 mm) ACRYLITE GP sheet would be heated for 3 hours at 180°F (82°C) and slowly cooled for at least 2 hours.

Flammability

ACRYLITE GP sheet is a combustible thermoplastic. Precautions should be taken to protect the material from flames and high heat sources. ACRYLITE GP 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 is from other combustible materials. We urge good judgement in the use of this versatile material and recommend that building codes be followed carefully to ensure it is used properly.

Other properties related to flammability:

- Burning rate is 1.2 inches per minute (for 3 mm thickness) according to ASTM D 635.
- Smoke density: Measured by ASTM D 2843 is 11.4%.
- Self-ignition temperature is 910°F (488°C) when measured in accordance with ASTM D 1929.

While these test data are based on small scale laboratory tests frequently referenced in various building codes, they do not duplicate actual fire conditions.

ACRYLITE GP sheet meets the requirements of the following building codes for use as a Light Transmitting Plastic:

- NES (See National Evaluation Services, Inc., Report # NER-582)
- ICBO (See ICBO Evaluation Services, Inc., Evaluation Report #3715-CC2 Classification)
- BOCA and SBCCI (Accept National Evaluation Services, Inc., Report # NER-582)

Thermal Conductivity

The thermal conductivity of a material-its ability to conduct heat-is called the 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 GP sheet is: $\frac{\text{1.3 B.T.U.}}{\text{(hour) (sq. ft.) (°F /inch)}}$ or $\frac{\text{0.19 W}}{\text{m.K}}$

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 between each of the 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 GP 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 GP Sheet Thickness		Summer Conditions	Winter Conditions
mm	inches		
3.0	.118	0.98 (5.56)	1.06 (6.02)
4.5	.177	0.94 (5.34)	1.02 (5.79)
6.0	.236	0.90 (5.11)	0.97 (5.51)
9.0	.354	0.83 (4.71)	0.89 (5.05)
31.5	1.25	0.56 (3.18)	0.58 (3.29)

*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 GP sheet is a better insulator than glass. Its U-Factor or heat transfer value 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 GP 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 GP sheet.

Electrical Properties

ACRYLITE GP sheet has many desirable electrical properties and continuous outdoor exposure has little effect on these properties. It is a good insulator with surface resistivity higher than that of most plastics.

Chemical Resistance of Acrylite® GP ACRYLIC SHEET

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

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

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

N= Not Resistant
ACRYLITE GP 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 GP 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, polishing, 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 therefore should be used only as a general guide and, in case of doubt, supplemented by tests made under actual working conditions.

Chemical	Code	Chemical	Code
Acetic-Acid (5%)	R	Hydrogen Peroxide (up to 40%)	R
Acetic Acid (Glacial)	N	Hydrogen Peroxide (over 40%)	N
Acetone	N	Isopropyl Alcohol (up to 50%)	LR
Ammonium Chloride (Saturated)	R	Kerosene	R
Ammonium Hydroxide (10%)	R	Lacquer Thinner	N
Ammonium Hydroxide (Conc.)	R	Methyl Alcohol (up to 15%)	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	Naphtha (VM&P)	R
Calcium Hypochlorite	R	Nitric Acid (up to 20%)	R
Carbon Tetrachloride	N	Nitric Acid (20%-70%)	LR
Chloroform	N	Nitric Acid (over 70%)	N
Chromic Acid	LR	Oleic Acid	R
Citric Acid (20%)	R	Olive Oil	R
Detergent Solution (Heavy Duty)	R	Phenols	N
Diesel Oil	R	Soap Solution (Ivory)	R
Dimethyl Formamide	N	Sodium Carbonate	R
Dioctyl Phthalate	N	Sodium Chloride	R
Ether	N	Sodium Hydroxide	R
Ethyl Acetate	N	Sodium Hypochlorite	R
Ethyl Alcohol (30%)	LR	Sulfuric Acid (up to 30%)	R
Ethyl Alcohol (95%)	N	Sulfuric Acid (Conc.)	LR
Ethylene Dichloride	N	Toluene	N
Ethylene Glycol	R	Trichloroethylene	N
Formaldehyde (40%)	R	Turpentine	LR
Gasoline (Regular, Leaded)	LR	Water (Distilled)	R
Glycerine	R	Xylene	N
Heptane	R		
Hexane (Commercial Grade)	R		
Hydrochloric Acid	R		
Hydrofluoric Acid (40%)	N		

Acrylite® GP
ACRYLIC SHEET

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