Technical information

Cast Acrylic sheet (GP)

WARNING: This product can expose you to chemicals including Ethyl acrylate, CAS 140-88-5, which are known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov

Physical Properties

Cast acrylic sheet is made to exacting standards. It offers excellent optical characteristics, thickness tolerances, light stability, and low internal stress levels for consistent performance.

Typical cast sheet carries an exclusive 30-year limited warranty on light transmission, your assurance of a quality product.

Characteristics

Acrylic sheet is a lightweight, rigid thermoplastic material that has many times the breakage resistance of standard glass and is highly resistant to weather conditions. Cast acrylic sheet can be easily sawed, machined, thermoformed, and cemented and is ultraviolet light absorbing up to approximately 360 nanometers.

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

- Retail store displays
- Security glazing
- Industrial and residential glazing
- Luminaries
- Aquariums
- Decorative paneling
- Spectator shielding
- Skylights
- Signs

Availability

Cast acrylic sheet is available in clear, colors and a wide range of standard sizes and thicknesses from .118” (3mm) to 1.0” (24mm). Cast acrylic sheet is also available with a velvet frost surface on one or both sides. It is available in a plethora of colors with varying degrees of transmitted and reflected light. The velvet frost surface retains the same physical properties of standard cell cast acrylic.

Safety

Cast acrylic 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. Cast acrylic 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. Cast acrylic 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. Acrylic sheet has been widely accepted for use in skylights, school buildings, industrial plants, aircraft glazing and outdoor signs.

Dimensional Stability

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

Light Weight

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

Rigidity

Acrylic 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 acrylic cast sheet is formed into corrugated or domed shapes, rigidity is increased and deflection minimized.

Cold Flow

Large, flat acrylic 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 cast acrylic is 10,000 psi (69 M Pa) 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 M Pa). 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 cast acrylic will gradually lose tensile strength as the temperature approaches the maximum recommended for continuous service. Cast sheet, the maximum is 180°F (82°C).

Expansion and Contraction

Like most other plastics, cast acrylic 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.

Acrylic cast 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

Cast acrylic 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 cast acrylic 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

Colorless cast acrylic has a light transmittance of 92%. It is warranted not to lose more than 3% of its light-transmitting ability in a 30-year period.

Chemical Resistance

Cast acrylic 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

Acrylic 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 cast acrylic sheet to more than 70 chemicals, refer to the table on page 6.

Formability

Acrylic 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. Acrylic sheet will typically shrink 1.5% when heated without a frame. As the sheet cools, it will harden and retain the formed shape.

Because cast acrylic 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

Acrylic 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 ideal 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

Acrylic sheet can be cemented using common solvent or polymerizable cements, such as ACRIFIX®. 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. Cast acrylic 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® cell cast would be heated for 3 hours at 180°F (82°C) and slowly cooled for at least 2 hours.

Flammability

Cast acrylic is a combustible thermoplastic. Precautions should be taken to protect the material from flames and high heat sources. Acrylic 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 judgment 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.

Cast acrylic 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 acrylic sheet is:

1.3 B.T.U. / (hour) (sq. ft.) (°F /inch) or 0.19 W/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 acrylic sheet for single-glazed, vertical installations, based on the standard ASHRAE* summer and winter design conditions.

U-Factors—BTU/hour sq. ft. F° (w/m² x K)

ACRYLITE® Cell Cast 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.

Acrylic 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 RT-Factor is about 10% greater.

Thermal Shock and Stresses

Cast acrylic 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.

Chemical Resistance

The table on the next page gives an indication of the chemical resistance of clear acrylic sheet. The code used to describe chemical resistance is as follows:

R = Resistant

Cast acrylic sheet withstands this substance for long periods and at temperatures up to 120°F (49°C).

LR = Limited Resistance Fabrication

Cast acrylic 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 Application of Chemicals

Cast acrylic is not resistant to this substance. It is swelled, attacked, dissolved or damaged in some manner.

Chemical Resistance of Clear ACRYLITE®

Chemical	Code	Chemical	Code	Chemical	Code
Acetic-Acid (5%)	R	Ethyl Acetate	N	Mineral Oil	R
Acetic Acid (Glacial)	N	Ethyl Alcohol (30%)	LR	Naphtha (VM&P)	R
Acetone	N	Ethyl Alcohol (95%)	N	Nitric Acid (up to 20%)	R
Ammonium Chloride (Saturated)	R	Ethylene Dichloride	N	Nitric Acid (20%-70%)	LR
Ammonium Hydroxide (10%)	R	Ethylene Glycol	R	Nitric Acid (over 70%)	N
Ammonium Hydroxide (Conc.)	R	Formaldehyde	R	Oleic Acid	R
Aniline	N	Gasoline (Regular, Leaded)	LR	Olive Oil	R
Battery Acid	R	Glycerine	R	Phenols	N
Benzene	N	Heptane	R	Soap Solution (Ivory)	R
Butyl Acetate	N	Hexane (Commercial Grade)	R	Sodium Carbonate	R
Calcium Chloride (Sat.)	R	Hydrochloric Acid	R	Sodium Chloride	R
Calcium Hypochlorite	R	Hydrofluoric Acid (40%)	N	Sodium Hydroxide	R
Carbon Tetrachloride	N	Hydrogen Peroxide (up to 40%)	R	Sodium Hypochlorite	R
Chloroform	N	Hydrogen Peroxide (over 40%)	N	Sulfuric Acid (up to 30%)	R
Chromic Acid	LR	Isopropyl Alcohol (up to 50%)	LR	Sulfuric Acid (Conc.)	LR
Citric Acid (20%)	R	Kerosene	R	Toulene	N
Detergent Solution (Heavy Duty)	R	Lacquer Thinner	N	Trichloroethylene	N
Diesel Oil	R	Methyl Alcohol (up to 15%)	LR	Turpentine	LR
Dimethyl Formamide	N	Methyl Alcohol (100%)	N	Water (Distilled)	R
Dioctyl Phthalate	N	Methyl Ethyl Ketone (MEK)	N	Xylene	N
Ether	N	Methylene Chloride	N		

Plastic materials can be attacked by chemicals in several ways. The methods of fabrication and/or conditions of exposure of acrylic 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 by 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 contacts, rubbing wiping, spraying, etc.

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

Physical Properties of Acrylic

		ASTM Method	Typical Value (.236" Thickness)[b]
Property[a] Mechanical	Specific Gravity	D 792	1.19
	Tensile Strength Elongation, Rupture Modulus of Elasticity	D 638	10,000 psi (69 M Pa) 4.2% 400,000 psi (2800 M Pa)
	Flexural Strength (Rupture) Modulus of Elasticity	D 790	16,500 psi (114 M Pa) 475,000 psi (3300 M Pa)
	Compressive Strength (Yield) Modulus of Elasticity	D 695	18,000 psi (124 M Pa) 430,000 psi (2960 M Pa)
	Shear Strength	D 732	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	D 785	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 UV Transmission Haze	D 1003	92%, 0 at 320 nanometers, 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)	Ceno-Fitch	1.3 BTU/(Hr) (Sq. Ft.) (°F/in.) (0.19 w/m.K)
	Flammability (Burning Rate 3 mm 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/(lb.) (°F) (1470 J/Kg.k)
	Smoke Density Rating (3 mm thickness)	D 2843	11.4%
Electrical	Dielectric Strength Short Time (0.125"-thickness)	D 149	430 volts/mil (17 KV/mm)
	Dielectric Constant 60 Hertz 1,000 Hertz, 1,000,000 Hertz	D 150	3.5, 3.2, 2.7
	Dissipation Factor 60 Hertz 1,000 Hertz, 1,000,000 Hertz	D 150	0.06, 0.04, 0.02
	Volume Resistivity	D 257	1.6 x 10^{16} ohm-cm
	Surface Resistivity	D 257	1.9 X 10^{15} ohms
Water Absorption	24 hrs @ 73 F Weight Gain during Immersion Soulable Matter Lost Water Absorbed Dimensional Change during Immersion	D 570	0.2% 0.2% 0.0% 0.2% 0.2%
Long Term Water Absorption	Weight Gain during Immersion 7 Days 14 Days 21 Days 35 Days 48 Days	D 570	 .05% .06% .08% 1.0% 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.