



PALSUN[®]

Flat Solid Polycarbonate Sheet



PALSUN® Flat Solid Polycarbonate Sheet



Content

About Palram	2
PALSUN® - The Modern Transparent Steel	3
Main Benefits	3
PALSUN® Project Gallery	6
Colors	10
Standard Dimensions	11
PALSUN® Product Range	11
Flammability	15
Solar Transmission Properties	12
SolarSmart™ Technology - Efficient Daylighting	13
PALSUN® LB - Outdoor Light Box Applications	14
Protection from the Harmful Effects of UV Radiation	14
Thermal Characteristics	15
Weather Resistance	15
Mechanical Characteristics	16
Optical Characteristics	16
Physical Properties Table	17

About Palram

A Global Leader in Thermoplastic Sheets

Palram Industries Ltd. is a leading multinational manufacturer of thermoplastic sheets, mainly from polycarbonate, PVC and acrylic. The products are used in a wide variety of applications and projects around the world, including the following market sectors: building and construction, architectural projects, advertising and printing, agriculture, fabrication and DIY. Palram's global presence and advanced technological abilities allow us to provide our customers with competitive products, while maintaining a high level of service. Palram delivers excellence to a global marketplace, backed by professional support and service on both local and regional levels. Palram is proud of its unique corporate culture that makes us agile, creative and committed to all our customers.

Research & Development

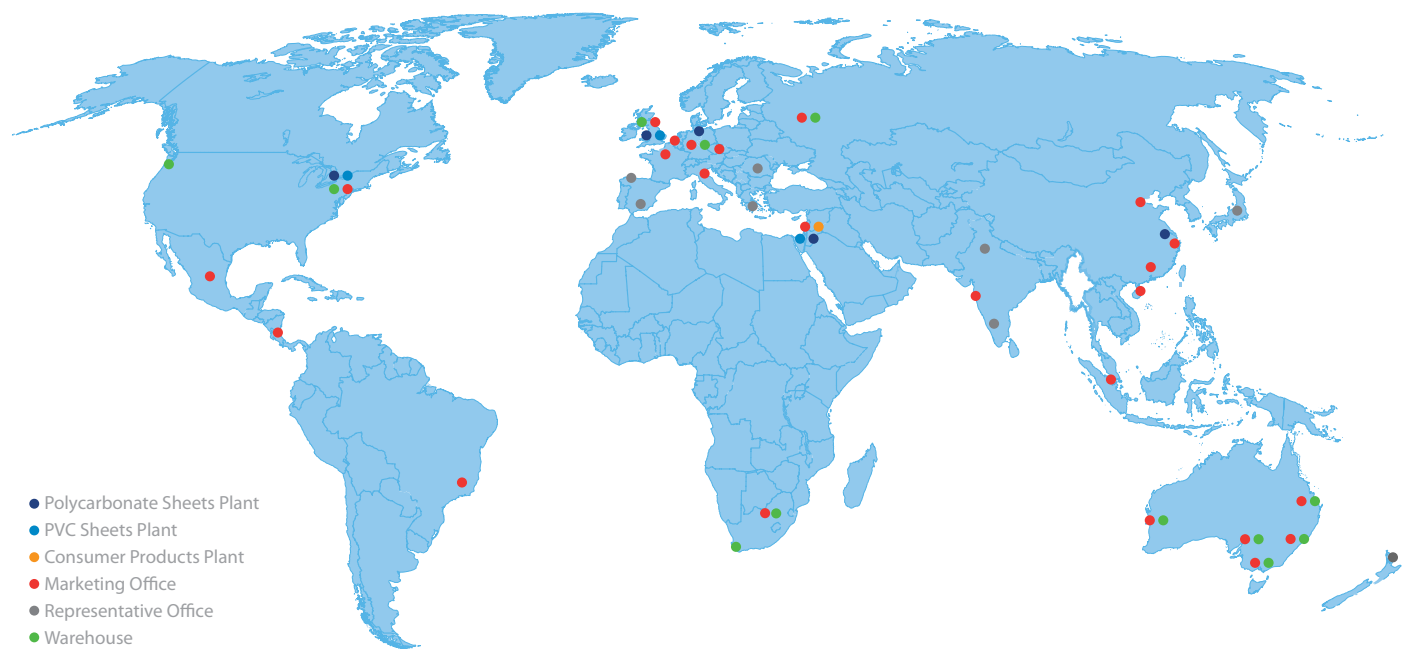
As part of the high quality sheet production tradition, Palram is constantly adapting new technologies to refine the existing manufacturing methods. The accumulated production knowledge and technology results in an ever growing product range, which allows specific matching of the most suitable product to be matched to each project.

Polycarbonate Corrugation Expertise

Palram pioneered the production of polycarbonate sheets in 1985 and has maintained its leadership through constant research and innovation. Our polycarbonate extrusion know-how allows us to stretch PALSUN offering beyond the standard specifications and offer unique product characteristics.

Global Presence

Palram operates production plants in Europe, the Americas and on the shores of the Mediterranean, allowing close logistic support and SUNTUF supply.



PALSUN® The Modern Transparent Steel

Introduction

PALSUN combines a unique variety of features, combining strength, transparency, low weight, flexibility, durability, thermal and fire resistance. This highly versatile sheet can be applied to virtually any roofing and glazing requirement of designers and architects. PALSUN can also be machined and formed into a wide variety of tough and durable fabrications.

Unique Characteristics

PALSUN is transparent as glass, 200 times stronger and less than half the weight. In addition to all of these features, PALSUN can be bent either hot or cold (within limitations). PALSUN's absolute resistance to breakage qualifies it as the best existing safety glazing material available, with impact resistance that is impervious to hammer blows, stones etc. PALSUN is ideal for use in areas exposed to vandalism and in cases of high impact.

Built-In Protection Against Harmful UV Radiation

Installation of PALSUN will protect the people, plants, furniture and other objects from exposure to harmful solar UV radiation. PALSUN is also offered with an integrated co-extruded UV protective layer on one or both sides, which dramatically improves its durability and compliance with outdoor applications.

Main Benefits

Lightweight

Less than half the weight of glass and aluminum.

Transparent

Available in clear with up to 90% light transmission (same as glass). Tinted, colored and embossed PALSUN is also available for a variety of light transmission, light diffusion and surface options.

Weather Resistant

PALSUN Sheets retain their characteristics for years under all conditions.

Thermal Insulation

PALSUN exhibits good thermal insulation, considerably better than glass and aluminum.

Resistance to Chemicals

PALSUN resists various chemicals and other substances. However, they should be prevented from coming in contact with certain materials, as specified by the manufacturer.

Easy to Mount

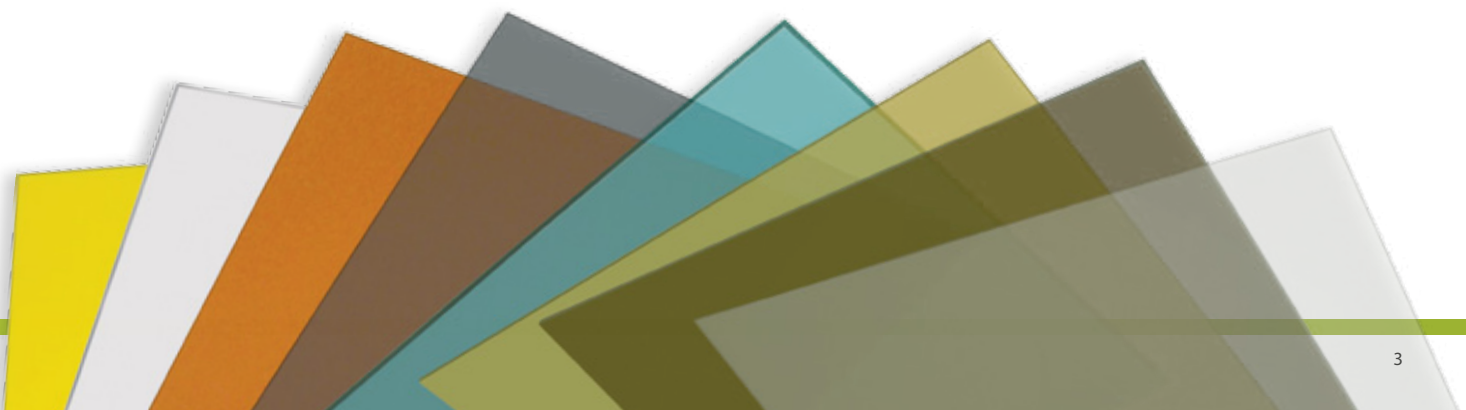
PALSUN Sheets are easy to work with and install.

Flexible, Formable, Machinable

PALSUN can be bent either hot or cold, can be thermoformed into an unlimited range of shapes, and can readily be machined and/or fabricated.

Easy to Clean

PALSUN can easily be cleaned with a 100% cotton cloth using generous amounts of mild detergent and water.



PALSUN® Project Gallery

Sport Venues

Project: Athens Olympic Stadium - Greece (24,000sqm) | Type: PALSUN® Solar Olympic 12mm



Project: Universiade Main Stadium - Shenzhen, China (45,000sqm) | Type: PALSUN® Smart Green 8,10,12mm

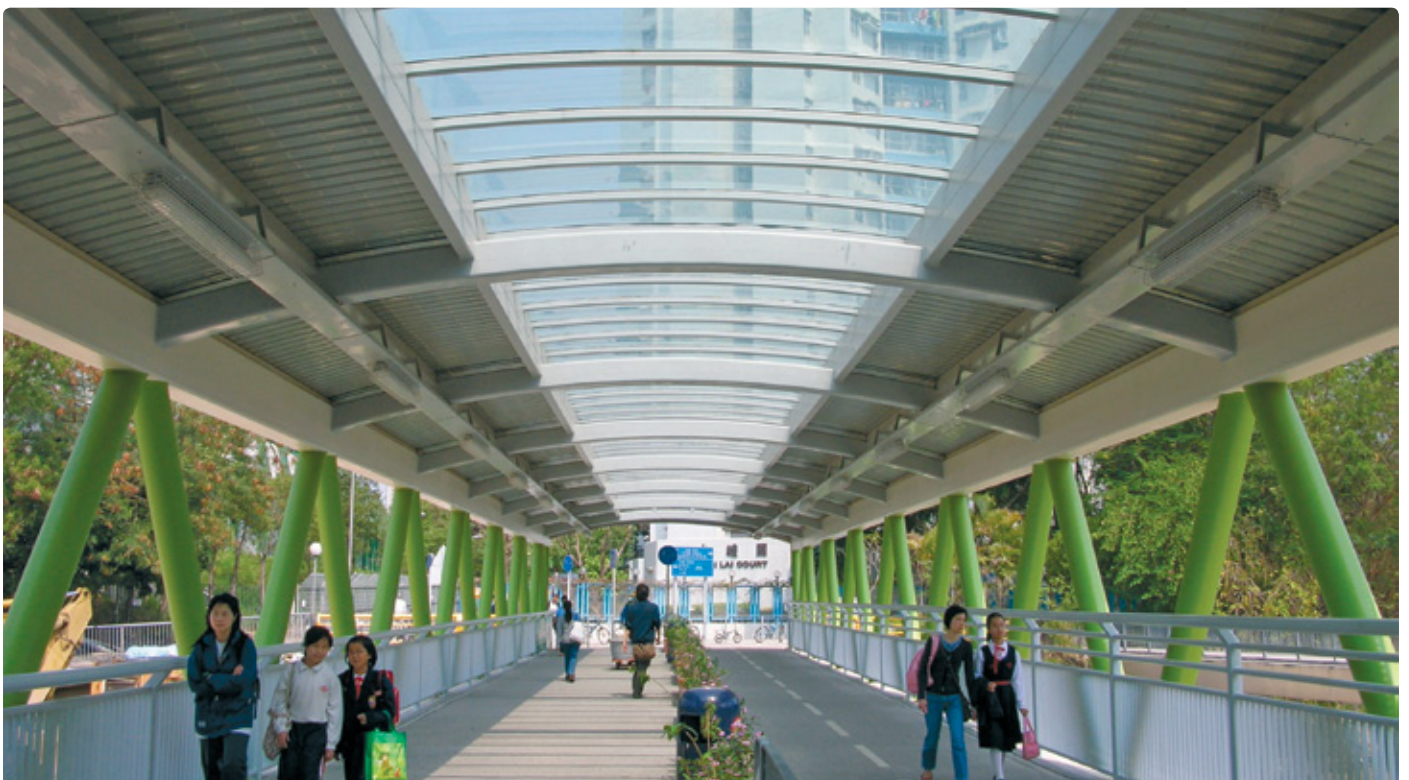


Roofs and Skylights

Qingdao Railway Station - China (55,000sqm) | Type: PALSUN® W. Diffuser 8mm



Project: Man Lai Court Bridge - Hong Kong, China | Type: PALSUN® Clear 8mm



Acoustic Barriers

Project: Zhanxi Soundproof Tunnel - Beijing, China (3,800sqm) | Type: PALSUN® Clear 10mm



Curtain Walls

Project: Haeco Hangar II - Hong Kong Airport, China | Type: PALSUN® Clear and White Opal 12.7mm



Project: Office Building - Barranquilla, Colombia | Type: PALSUN® Bluish Breeze 6mm



Safety & Fabrication

Project: Hangzhou Bay Bridge - China | Type: PALSUN® Clear 8mm



Project: Police Shields - Middle East | Type: PALSUN® Clear 6mm



Sign & Display

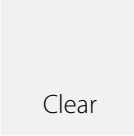

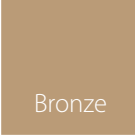





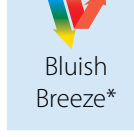



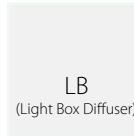



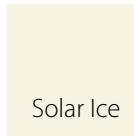
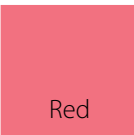


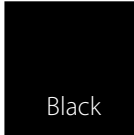


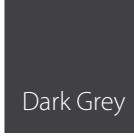
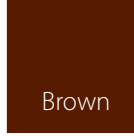
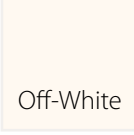
Project: Emirates Stadium - UK | Type: PALSUN® LB (Light box) 4mm



Project: Gas Station Light Boxes - Middle East | Type: PALSUN® White Diffuser 4mm



Colors

Group	Description	Colors
Clear	Transmits up to 90% natural daylight, resulting in high lighting within the structure.	 <p>Clear</p>
Transparent	Low haze colors offering high clarity. Breeze and Smart are SolarSmart™ colors with that reduce heat buildup while allowing a clear view through the sheet (see page 13 for more details on SolarSmart products).	 Solar Gray  Bronze  Blue  Green  Red  Smart Blue*  Smart Green*  Bluish Breeze*
Translucent	<p>White Opal: Transmits 11-50% visible light with high light dispersion, produces mild and even lighting within the structure.</p> <p>Diffuser: Transmits 50% visible light with high light dispersion, produces diffused and consistent lighting within the structure.</p> <p>LB (Light Box): Diffuser sheet for illuminated signs and display applications, offering 44-50% light transmission.</p>	 Yellow  White Opal  White Diffuser  LB (Light Box Diffuser)  Mint Green  Solar Control (Solar Metallic Grey)  Solar Olympic  Solar Ice  Red
Opaque*	Colors that transmit very little to no light.	 Dark Green  Red Brick  Black  Dark Blue  Cream Ral 9001  Light Grey Ral 7035  Dark Grey  Brown  Off-White

* Subject to minimum quantity. Custom colors and light transmissions are also available in this manner.

** Colors shown above are a reproduction of the actual color. Only actual sample chips can accurately represent the colors. Contact your Palram distributor to receive a sample color chip.

Standard Dimensions*

Thickness (mm)	Width x Length (mm)	Surface Finish				
		Smooth Both sides	Embossed Both sides	Matte One side	Hair Cell One side	Prismatic One side
1	1220 x 2440	✓		✓		
1.5	1250 x 2440	✓	✓	✓		
2		✓	✓	✓		
2.5 - 6	1220 x 2440	✓	✓	✓	✓	✓
8	1250 x 2440	✓	✓		✓	
9 - 12.7	2050 x 3050	✓			✓	
2 - 18	2450 x 3050	✓				

*Other dimensions and specifications are available upon request, subject to a minimum order.

PALSUN® Product Range

Product	Description
PALTUF™	General purpose flat solid polycarbonate sheet for interior use
PALSUN®	Flat solid polycarbonate sheet, UV protected on one side
PALSUN® UV2	UV protection on both sides
PALSUN® Embossed*	Embossed, prismatic or hair cell surface finishes
PALSUN® FR*	Fire retardant, better flammability ratings
PALSUN® Matte*	Matte finish on one side
PALSUN® LB*	Diffused sheet for light boxes and various illuminated signs and displays
PALSUN® Solar Control*	Efficient heat-blocking with metallic appearance
PALSUN® Breeze*	Advanced heat-blocking with high transparency
PALGARD™	Abrasion resistance on one or both sides

* Available with UV protection on one or both sides.

** Available with masking (PE film) on one or both sides.

Flammability

Product	Standard	Classification*
PALSUN®	EN13501	B, s1, d0
	BS 476/7	Class 1
	NSP 92501, 4	M2
	DIN 4102	B1
	UL Classified	V2 (File e221255)
	ASTM D-635	CC1
PALSUN® FR	UL 94	V0 (File e221255)

* Depends on thickness. For additional information please contact your Palram distributor.

Solar Transmission Properties

Various types of PALSUN can be used to help reduce energy costs throughout the year. Textured, tinted, opal, diffused, and new PALSUN SolarSmart™ sheets feature properties that affect energy efficiency beyond what is depicted on the next page. Each of these products transmit different amounts of direct light in varying levels of light diffusion, which may help to spread the light throughout the structure or enclosure. The sheets also vary in their selectivity index (SI) values, which determines how efficiently they keep heat out while letting more "cool-light" in (See next page for more information on SolarSmart™ products). PALSUN textured, diffused and opal sheets are also suitable for incorporation into light fixtures. They enable designers to deliver the exact quantity and quality of light desired.

Color*	% Light Transmission ASTM D-1003	%Haze ASTM D-1003	Solar Heat Gain (SHGC) ASTM E-424-71	Shading Coefficient ASTM E-424-71
Clear	90	<1	0.87	1.00
Bronze	20	<1	0.45	0.52
	35	<1	0.56	0.64
Solar Grey	50	<1	0.65	0.75
	20	<1	0.44	0.51
White Opal	35	<1	0.56	0.64
	50	<1	0.65	0.75
White Diffuser	28	100	0.32	0.37
White Ice	80	100	0.87	1.00
Solar Control	20	100	0.37	0.45
	20	67	0.33	0.36
	35	52	0.45	0.52
Solar Olympic	50	50	0.54	0.61
	20	35	0.41	0.47
	35	20	0.52	0.60
Smart Green	50	63	0.63	0.73
Smart Blue	70	42	0.58	0.67
Bluish Breeze	70	42	0.57	0.65
	70	42	0.55	0.63

*Values in the table above relate to 3mm Sheet. Further information on additional products is available upon request.

Terminology Used in the Table

Solar Radiation: The solar spectrum ranging from 300 nm to 2400 nm. Included are UV, visible and Near-IR radiation.

Visible Light Radiation: The portion of the light spectrum whose wavelength ranges from 400nm to 780nm.

% Light Transmission (ASTM D-1003): Percentage of incident visible light that passes through an object.

% Solar Heat Gain (SHGC): The percent of incident solar radiation transmitted by an object which includes the direct solar transmission plus the part of the solar absorption reradiated inward.

Shading Coefficient (ASTM E424-71): The ratio of the total solar radiation transmitted by a given material to that transmitted by normal glass, whose light transmission is 87%. It can be approximately calculated by:

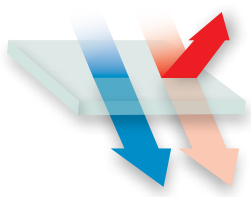
$$\%ST + (0.27 \times \%SA) = \%ST_t$$

$$SC = (1.15 \times ST_t)/100$$

SolarSmart™ Technology - Efficient Daylighting



Enjoy light
without heat.



Promoting Energetic Efficiency and Well Being

SolarSmart technology defies standard transmission of solar energy in transparent sheets and allows more versatile color and solar transmission specification per project. Unlike regular tints, SolarSmart sheets and panels admit more natural daylight while reflecting outwards Infrared radiation that creates heat. This characteristic breaks the traditional link between shading coefficient and light transmission, allowing a different perspective on the specification of natural light in architectural design.

SolarSmart tints allow better use of natural lighting without sacrificing the interiors. More natural light results in a healthier and more productive ambience. Energy saving is also promoted through reduction of both illumination and air conditioning requirements.



Color Specification

SolarSmart™ tints can be applied to any Palram transparent polycarbonate sheet or panel system, including PALSUN. The tints can be blended with any color to tailor the desired appearance and solar properties.

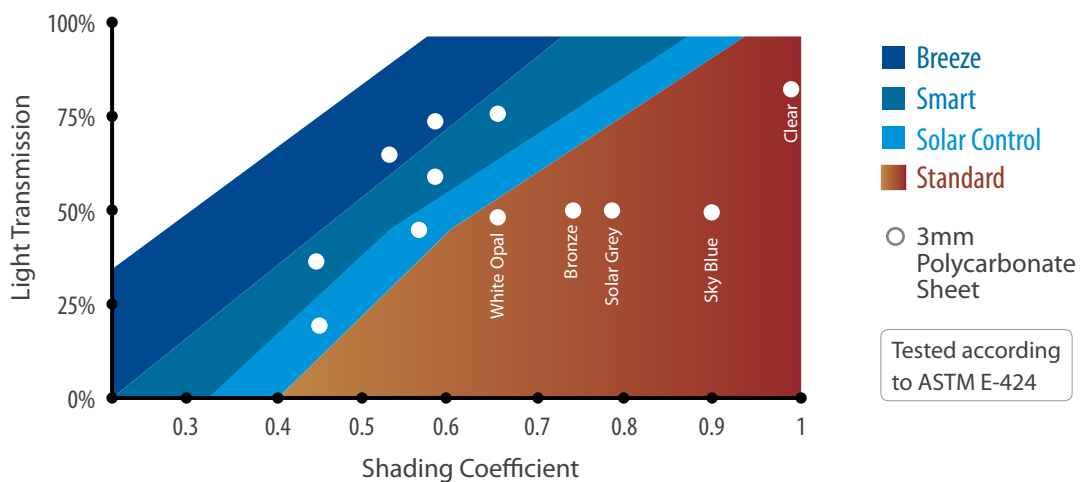


Technology Groups

The SolarSmart product range includes 3 technology groups, which have different characteristics and appearance. For more information please refer to the SolarSmart™ product brochure.

Efficiency Comparison

The graph below demonstrates the efficiency of SolarSmart products in comparison with clear and standard colored sheets. The graph shows how SolarSmart™ tints enable higher light transmission specification while maintaining or decreasing shading coefficient values.





PALSUN® LB

Diffuser Sheet for Outdoor light box applications

- High light transmission for a strong impact.
- Excellent diffusion - conceals light source.
- Enables smaller and more efficient light boxes.
- UV protected for extensive outdoor service.

Protection from the Harmful Effects of UV Radiation

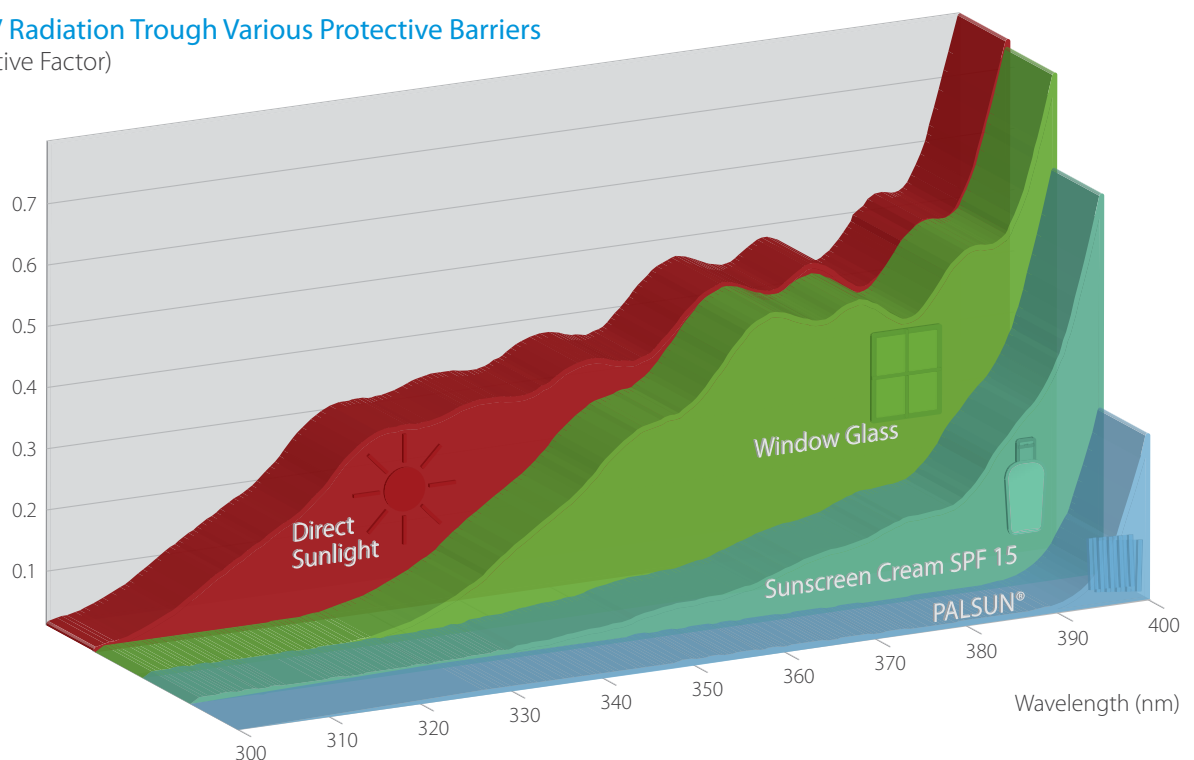
Exposure to Ultraviolet (UV) solar radiation is a well known and major health concern. In addition to skin cancer, premature aging has been associated with exposure to UV. PALSUN sheets completely block out UV radiation.

A comparison of the UV protection offered by PALSUN and that offered by sunscreen cream 15 is depicted in the graph below. Note that no barrier is as effective as PALSUN sheet. Activity under PALSUN will be more protected than that offered by proper application of sunscreen, though the latter is sufficient in almost all cases.

Irradiance of UV Radiation Trough Various Protective Barriers

(SPF = Sun Protective Factor)

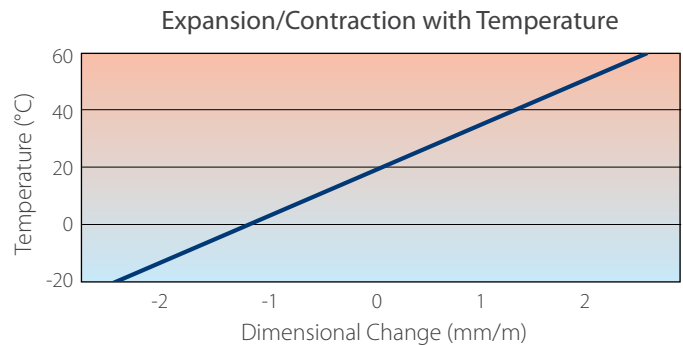
Irradiance
(W/m²/min)



Thermal Characteristics

Thermal Expansion

The thermal expansion of PALSUN sheets is higher than that of glass. This important factor must be taken into account when mounting the sheets. The graph on the right shows the degree of expansion/contraction as a function of temperature.



Service Temperature

The temperature range over which the characteristics of PALSUN are retained extends from -50°C to +120°C (-60°F to +250°F) for short periods and from -50°C to +100°C (-60°F to +210°F) for long periods. This range of temperatures make PALSUN sheets suitable for use in most climates.

Thermal Insulation

On very hot days, the surface temperature of the sheet might reach up to +50°C (+122°F). The U-value characterizes the degree of thermal transmittance offered by a given glazing material, so higher U-values are associated with materials that are poor insulators and result in a greater loss of heat. The following table compares the U-values of glass and PALSUN sheets of equivalent thicknesses. Thicker sheets of a given material will offer greater thermal insulation and be characterized by a lower U-value and reduced heat loss. For any given thickness, the U-value of PALSUN sheet is lower than that of glass. This means that heat loss from the building interior, as well as penetration of heat or cold into a building, will be less if it were glazed with PALSUN than for one glazed with glass. This can result in a significant reduction in energy costs both for heating in winter and air-conditioning during the summer. Note that use of Solar Control sheets will insulate just as well, but will also reduce air-conditioning costs because of Near Infra-Red reflection and reduced heat buildup.

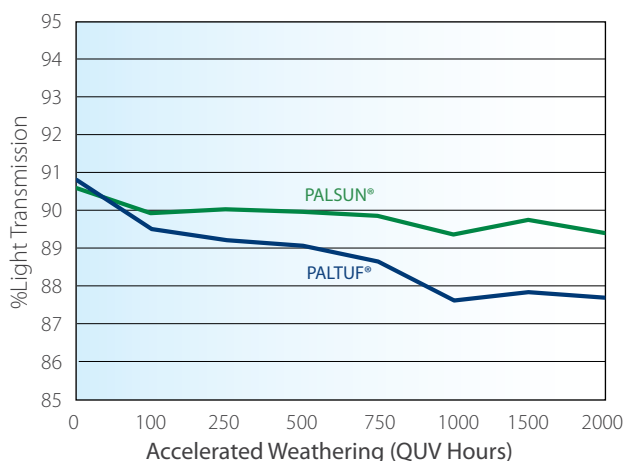
Thermal Insulation of PALSUN® vs. Glass

Thickness mm	Thickness in	PALSUN U-Value (W/m ² ·°K)	Glass U-Value (W/m ² ·°K)
3.0	(0.12)	5.47	5.81
5.0	(0.20)	5.19	5.72
6.0	(0.24)	5.07	5.68
8.0	(0.31)	4.48	5.60
10.0	(0.39)	4.63	5.52
12.0	(0.47)	4.43	5.45

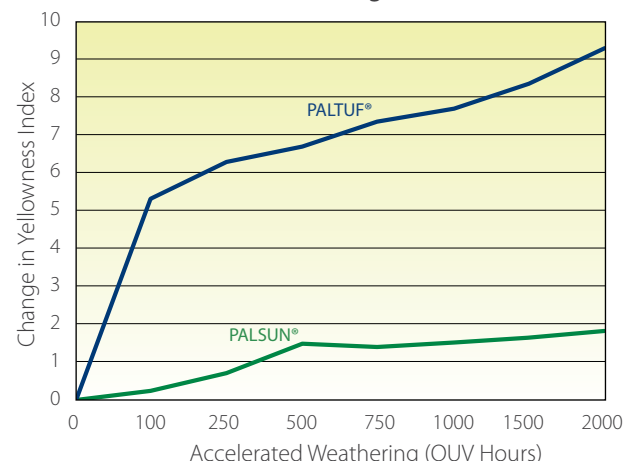
Weather Resistance

PALSUN is impervious to high temperature encountered in the environment and will effectively withstand the affects of solar UV radiation (PALTUF is a general purpose sheet without UV protection and only intended for indoor use). The changes in optical properties of a typical 3mm PALSUN and PALTUF sheets under accelerated weathering tests are presented in the graphs below. 100 hours of accelerated weathering in a QUV accelerated weathering machine are roughly equivalent to 1 year of actual outdoor exposure in warm climates. Please bear in mind that changes in optical properties of PALSUN, are hardly perceptible to the naked eye.

% Light Transmission Loss of 3mm Sheets



Yellowness Index Change in 3mm Sheets



Mechanical Characteristics

PALSUN maintain its mechanical properties over their entire performance temperature range. Guidelines for thickness as function of span and wind-load may be found in the appropriate tables on page 23.

Weight

The specific gravity of PALSUN sheets is 1.2, which is about half that of glass. The following table compares the weight of PALSUN sheets of various thicknesses, and glass.

Sheet Thickness		PALSUN® Weight		Glass Weight	
mm	in.	kg/m ²	lb/ft ²	kg/m ²	lb/ft ²
2	0.08	2.40	0.491	4.90	1.00
3	0.12	3.60	0.737	7.34	1.50
4	0.16	4.80	0.983	9.80	2.00
5	0.20	6.00	1.23	12.24	2.51
6	0.24	7.20	1.47	14.68	3.00
8	0.31	9.60	1.97	19.60	4.01
10	0.31	12.00	2.46	24.48	5.01

Acoustic Properties

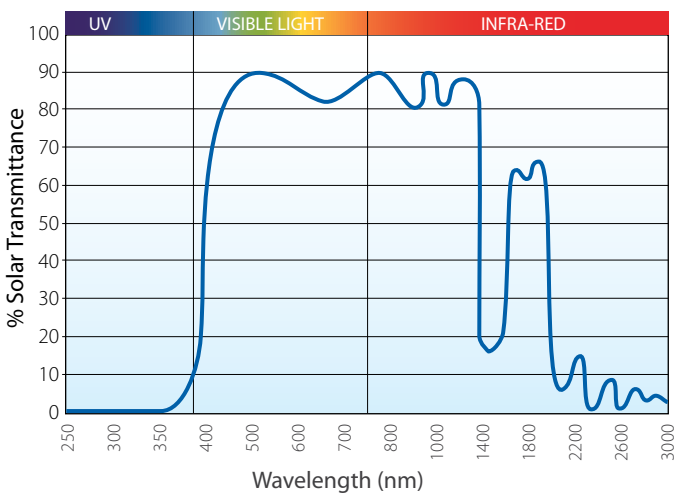
PALSUN sheets have excellent sound insulation properties as indicated in the table on the right. The ability to absorb sound waves, together with its impact resistance, has made PALSUN widely used for clear acoustic barriers.

Thickness		Acoustic Insulation
mm	(in.)	DIN 52210-75 RW (dB)
4	(0.16)	24
5	(0.20)	25
6	(0.24)	26
8	(0.31)	28
10	(0.39)	30
12	(0.47)	31

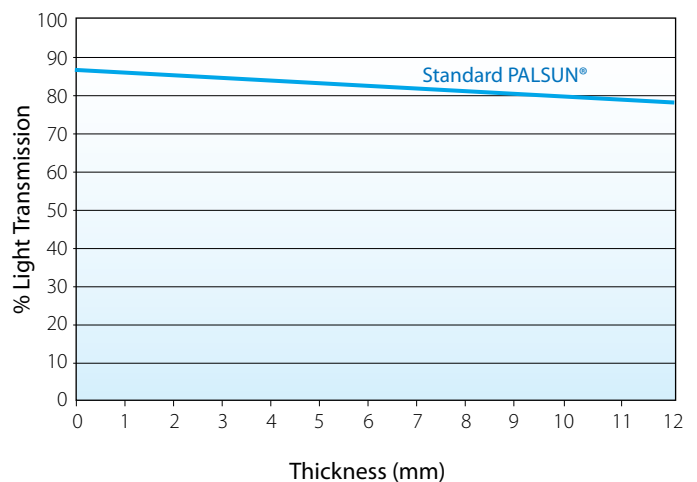
Optical Characteristics

All PALSUN products completely screen out potentially the harmful ultraviolet (UV) radiation (discussed in detail on page 19) and a significant amount of Near Infrared (NIR) radiation. Over the visible range, a typical 3mm (0.12in.) clear PALSUN transmits an average, 90% of incident light. The % light transmission of a typical 3mm (0.12in.) PALSUN clear sheet is presented in the left-hand graph below. In the visible range of the spectrum, clear PALSUN admits from 87% to 91% of the light, depending on the sheet thickness as shown in the upper left graph.

Solar Transmittance of Clear 3mm PALSUN®



Thickness vs. Light Transmission



Physical Properties

The following table displays physical properties of 3mm (0.12 inch) PALSUN sheets.

Property	Method**	Conditions (U.S. Customary)*	Units - SI (U.S. Customary)*	Value (U.S. Customary)*
Physical				
Density	D-792		g/cm ³ (lb/ft ³)	1.2 (75)
Water Absorption	D-570	24 hr. @ 23°C	%	0.15
Mechanical				
Tensile strength at yield	D-638	10 mm/min (0.4 in./min)	MPa (psi)	62.5 (9,100)
Tensile strength at break	D-638	10 mm/min (0.4 in./min)	MPa (psi)	65 (9,500)
Elongation at yield	D-638	10 mm/min (0.4 in./min)	%	6
Elongation at break	D-638	10 mm/min (0.4 in./min)	%	>80
Tensile Modulus of Elasticity	D-638	1 mm/min (0.4 in./min)	MPa (psi)	2,300 (290,000)
Flexural Modulus	D-790	1.3 mm/min (0.052 in./min)	MPa (psi)	2,350 (343,000)
Flexural Strength at Yield	D-790	1.3 mm/min (0.052 in./min)	MPa (psi)	93 (13,600)
Notched Impact Strength Izod	D-256	23°C (73°F)	J/m (ft-lbf/in.)	800 (15)
Notched Impact Strength Charpy	D-256	23°C (73°F)	J/m (ft-lbf/in.)	800 (15)
Impact Falling Weight	ISO-6603/1b		J (ft-lbf)	158 (117)
Rockwell Hardness	D-785		R scale / M scale	125 / 75
Thermal				
Long Term Service Temperature			°C (°F)	-50 to +100 (-175 to +212)
Short Term Service Temperature			°C (°F)	-50 to +120 (-175 to +250)
Heat Deflection Temperature	D-648	Load: 1.82 MPa (264 psi)	°C (°F)	135 (275)
Vicat Softening Temperature	D-1525	Load: 1 kg (2.2 lb)	°C (°F)	150 (300)
Coefficient of Linear Thermal Expansion	D-696		mm/m °C (Mil/in. °F)	0.065 (0.036)
Thermal Conductivity	C-177		W/m K (Btu-in/hr-ft ² -°F)	0.21 (1.46)
Specific Heat Capacity	C-351		kJ/kg-°K (Btu/lb-°F)	1.26 (0.31)
Optical				
Haze	D-1003	Clear Sheet	%	<0.5
Light Transmission	D-1003	Clear Sheet	%	89
Refractive Index	D-542	Clear Sheet		1.586
Yellowness Index	D-1925	Clear Sheet		<1
Electrical				
Dielectric Constant	D-150	50 Hz		3.0
	D-150	1 MHz		2.9
Dissipation Factor	D-150	1 KHz		0.001
	D-150	1 MHz		0.01
Dielectric Strength Short Time	D-149	500 V/s	kV/mm (V/mil)	>30 (>770)
Surface Resistivity	D-257	Keithley	Ohm	10 ¹⁶
Volume Resistance	D-257	Keithley	Ohm-cm	10 ¹⁷

* Conditions, units and values in U.S. Customary units are presented in the table within parentheses.

** ASTM except where noted otherwise.



Designing the future

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