

# PALSUN<sup>®</sup>

Flat Solid Polycarbonate Sheet



## **PALSUN®** Flat Solid Polycarbonate Sheet



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# 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.

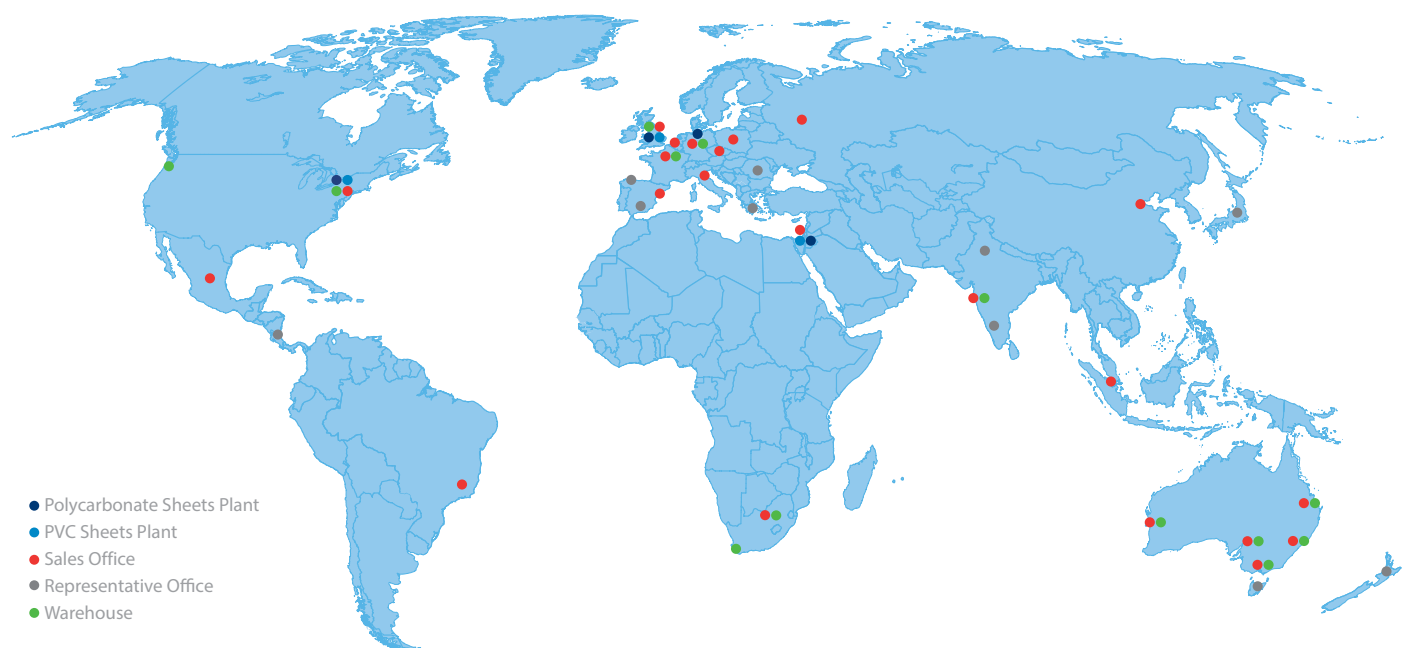
## Polycarbonate Corrugation Expertise

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.

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## 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

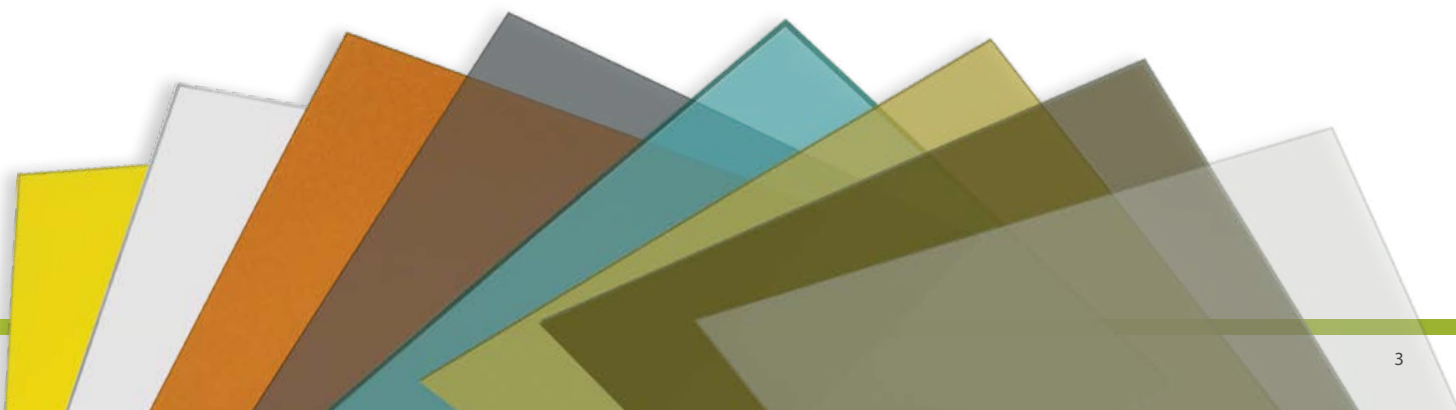
PALSUN Sheets are easy to work with and install.

### 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) | Application: Skylight/roof | Type: PALSUN® Solar Olympic 12mm



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



## Roofing & Skylights

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

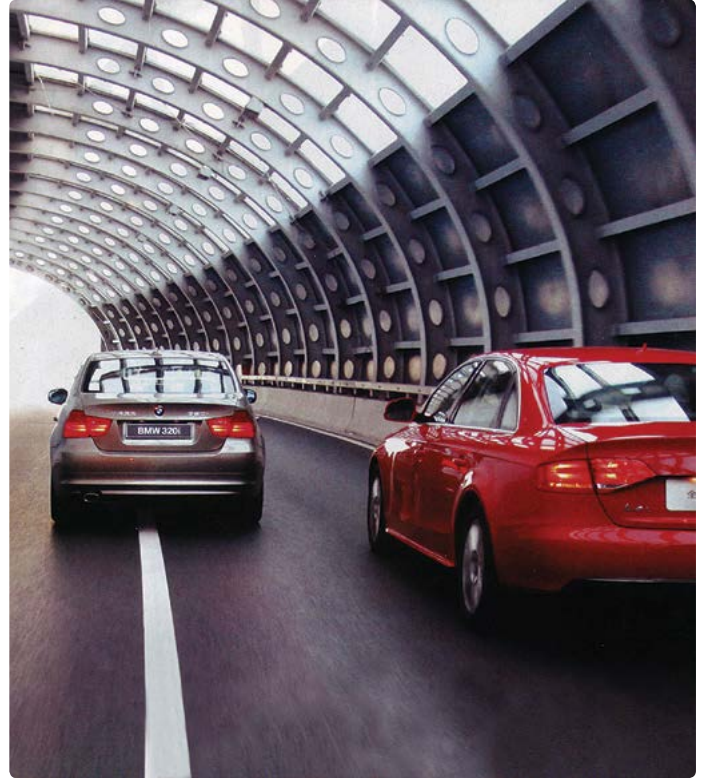


Project: Canopies at Beckett School - Nottingham, UK | **Application:** Skylight/roof | **Type:** PALSUN® Clear 8mm



## Acoustic Barriers

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



**Project:** Beijing Ring Road 6 - China (3,800sqm) | **Application:** Acoustic barrier | **Type:** PALSUN® Clear 6mm

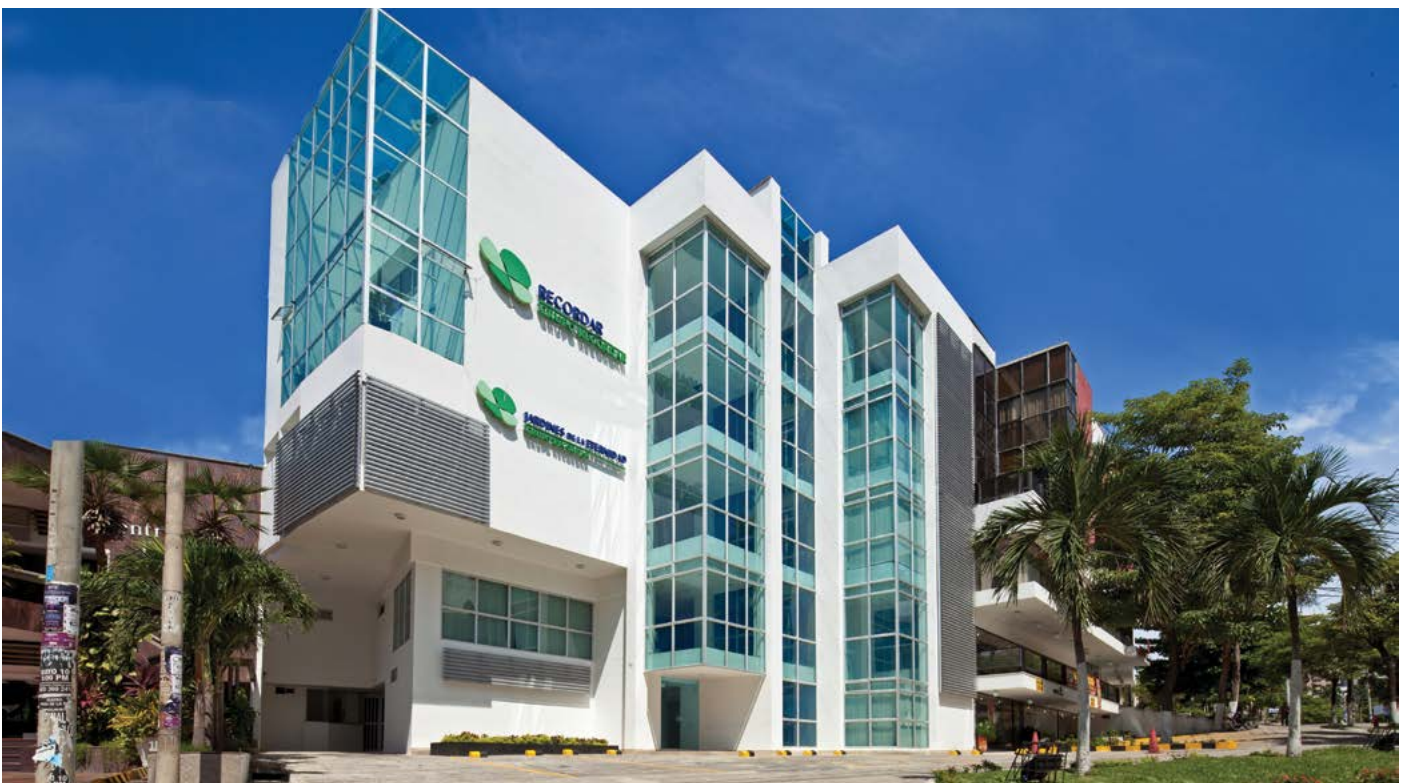


## Glazing & Curtain Walls

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

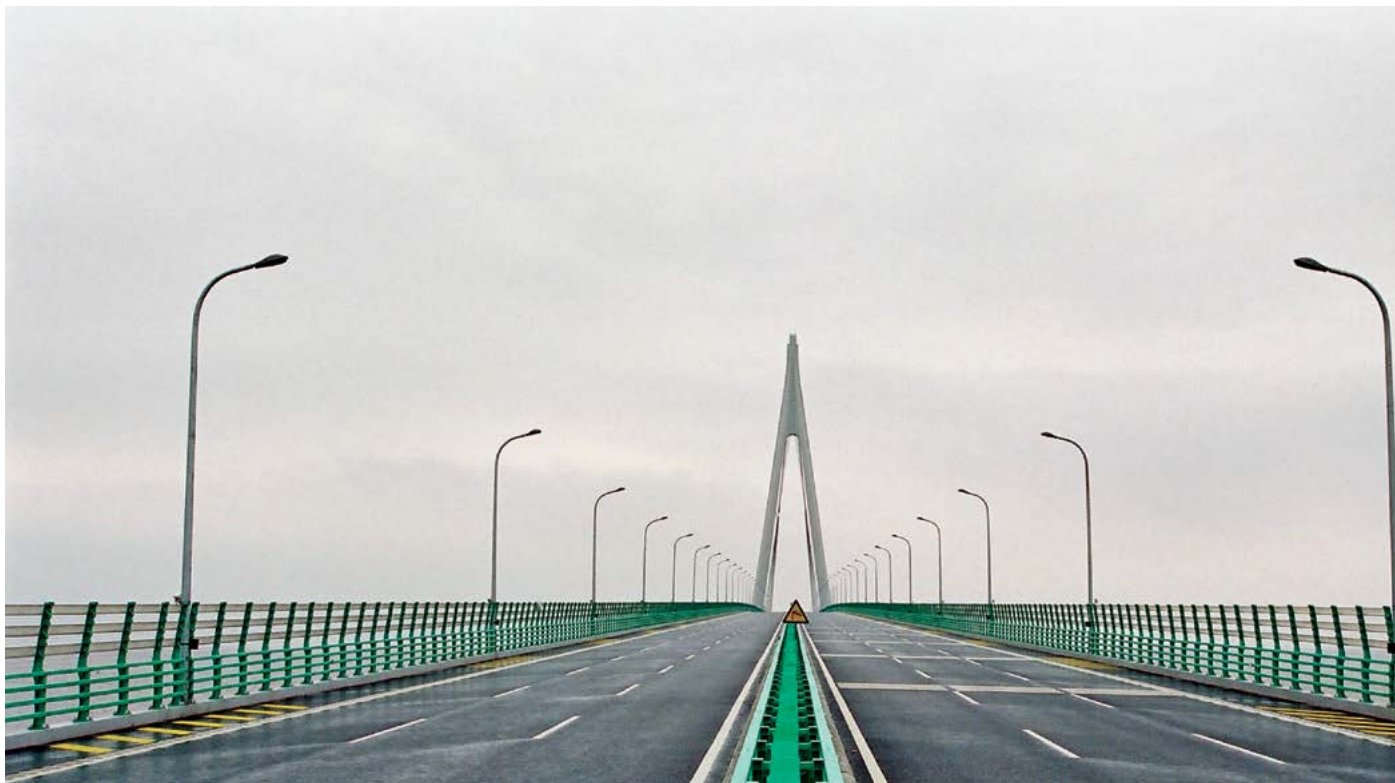


Project: Office Building - Barranquilla, Colombia | Application: Glazing and skylight | Type: PALSUN® Bluish Breeze 6mm



## Safety & Fabrication

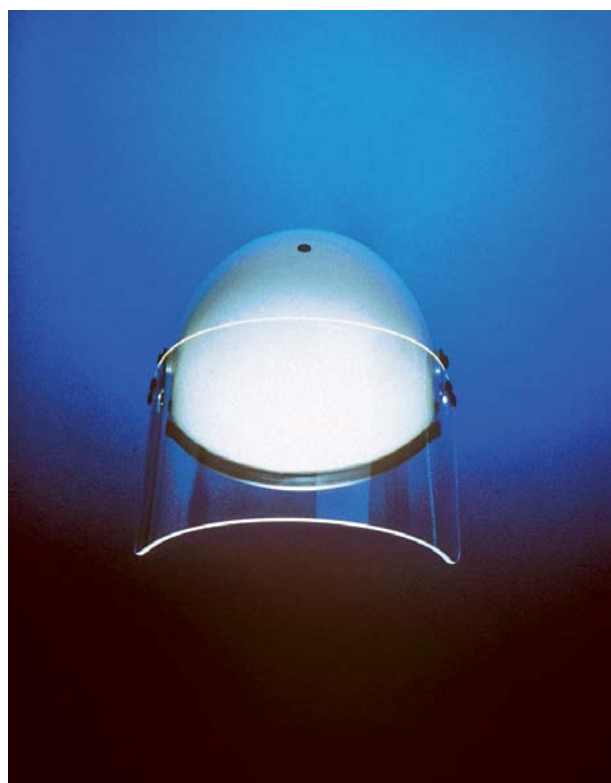
Project: Hangzhou Bay Bridge - China | Application: Wind shields | Type: PALSUN® Clear 8mm



Application: Thermoformed 3D sign | Type: PALSUN® Clear 4mm



Application: Curved helmet visor | Type: PALSUN® Clear 6mm



## Sign & Display

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



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



## Colors

Color Group	Description	Colors
Clear	Transmits up to 90% natural daylight, resulting in high lighting within the structure.	Clear
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).	<div> <div>Grey</div> <div>Bronze</div> <div>Blue</div> <div>Green</div> </div> <div> <div>Red</div> <div>Smart Blue*</div> <div>Smart Green*</div> <div>Bluish Breeze*</div> </div>
Translucent	<p><b>White Opal:</b> Transmits 11-50% visible light with high light dispersion, produces mild and even lighting within the structure.</p> <p><b>Diffuser:</b> Transmits 50% visible light with high light dispersion, produces diffused and consistent lighting within the structure.</p> <p><b>LB (Light Box):</b> Diffuser sheet for illuminated signs and display applications, offering 44-50% light transmission.</p>	<div> <div>Yellow</div> <div>White Opal</div> <div>White Diffuser</div> <div>LB (Light Box Diffuser)</div> </div> <div> <div>Mint Green</div> <div>Solar Control (Solar Metallic Grey)</div> <div>Solar Olympic</div> <div>Solar Ice</div> </div> <div> <div>Red</div> </div>
Opaque*	Colors that transmit very little to no light.	<div> <div>Dark Green</div> <div>Red Brick</div> <div>Black</div> <div>Dark Blue</div> </div> <div> <div>Cream Ral 9001</div> <div>Light Grey Ral 7035</div> <div>Dark Grey</div> <div>Brown</div> </div> <div> <div>Off-White</div> </div>

\* 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. To accurately represent the colors, contact your Palram distributor and request 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	✓	✓	✓	✓	✓
	1250 x 2440					
8	2050 x 3050	✓	✓		✓	
9 - 15		✓			✓	
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 film (PE) on one or both sides.

## Flammability

PALSUN complies with the most demanding international fire resistance standards in the field of plastics, as indicated in the detailed table herein. The classification is subject to product type, thickness and color.

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

\* For more detailed information please contact your Palram distributor.

## Solar Transmission Properties

Solar energy transmission is an extremely important consideration with transparent materials. Geographic location and typical thermal/optical properties of the specific glazing are the main factors influencing solar heat gain. Various types of PALSUN - textured, tinted, opal, diffused, and heat blocking SolarSmart™ sheets - can be used to deliver the exact quantity and quality of light desired. 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). Although colors and tints reduce the percentage of visible light transmitted through the sheets, but solar energy is still absorbed by the glazing itself, and in turn transferred by convection and far IR radiation from the heated glazing into the building. PALSUN sheets with embossed or matte surfaces, or diffuser colors, diminish glare and dazzle, preventing damage by direct irradiance. However solar energy is still transmitted through and increases the solar heat gain inside the structure.

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
	50	<1	0.65	0.75
Solar Grey	20	<1	0.44	0.51
	35	<1	0.56	0.64
	50	<1	0.65	0.75
White Opal	28	100	0.32	0.37
White Diffuser	80	100	0.87	1.00
Solar Ice	20	100	0.37	0.45
Solar Control	20	67	0.33	0.36
	35	52	0.45	0.52
	50	50	0.54	0.61
Solar Olympic	20	35	0.41	0.47
	35	20	0.52	0.60
	50	63	0.63	0.73
Smart Green	70	42	0.58	0.67
Smart Blue	70	42	0.57	0.65
Bluish Breeze	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

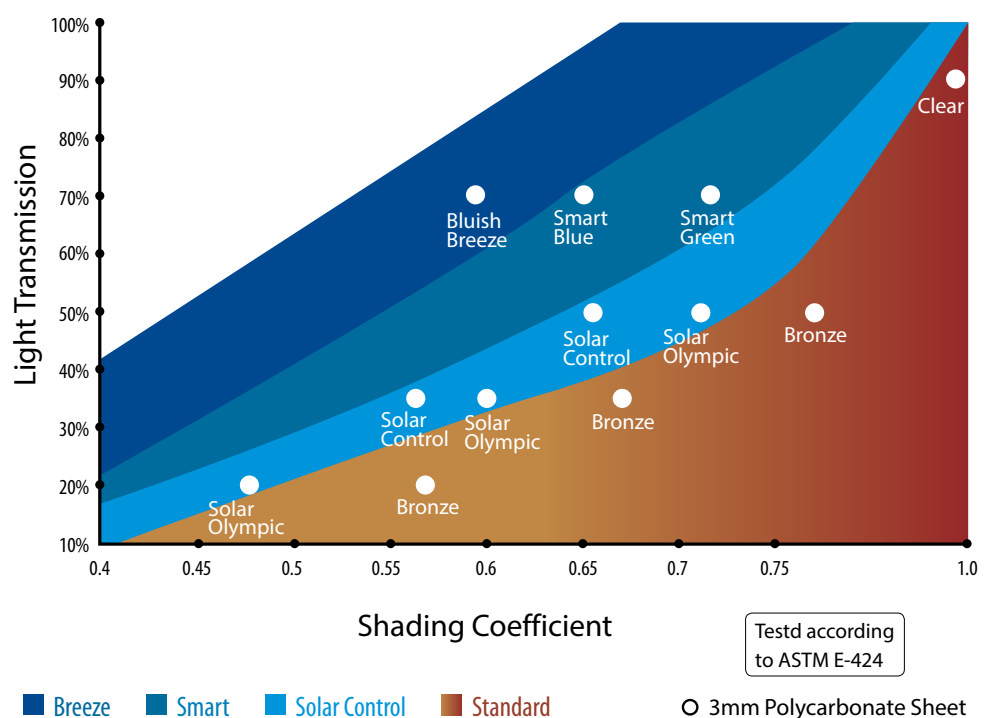
SolarSmart™ tints can be applied to any Palram transparent polycarbonate sheet or panel system, including PALSUN. The tints can be blended with any color to tailor the desired appearance and solar properties.

### 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.



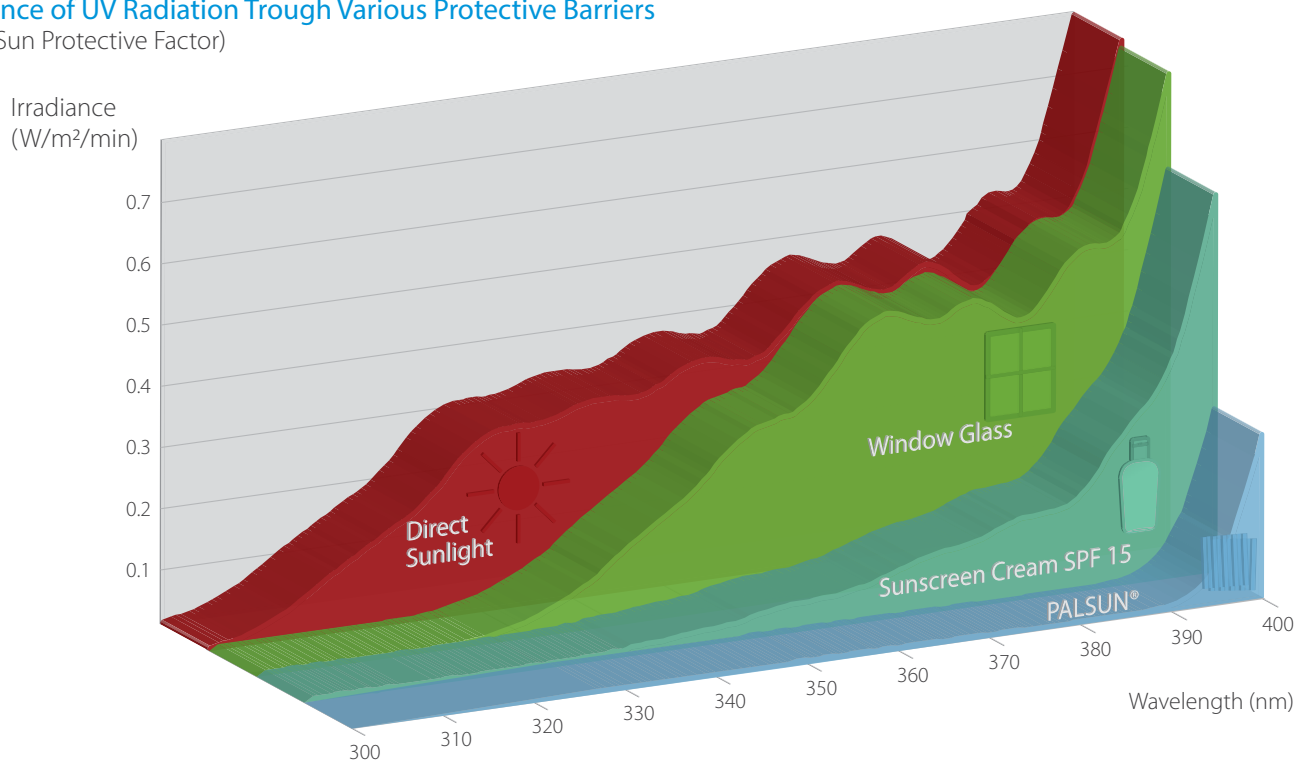
## Protection from the Harmful Effects of UV Radiation

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)



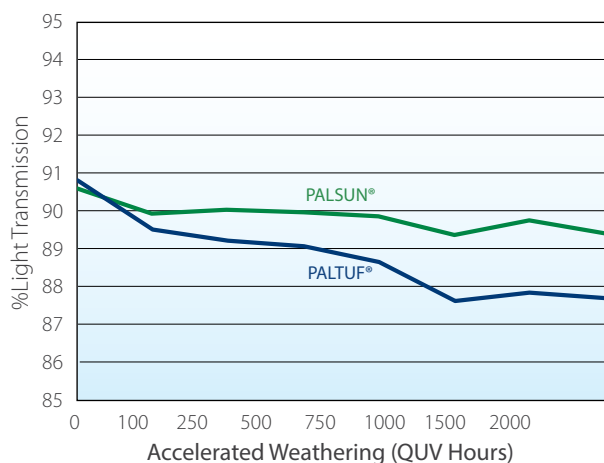
PALSUN® Solar Control glazing in bus station - Middle East



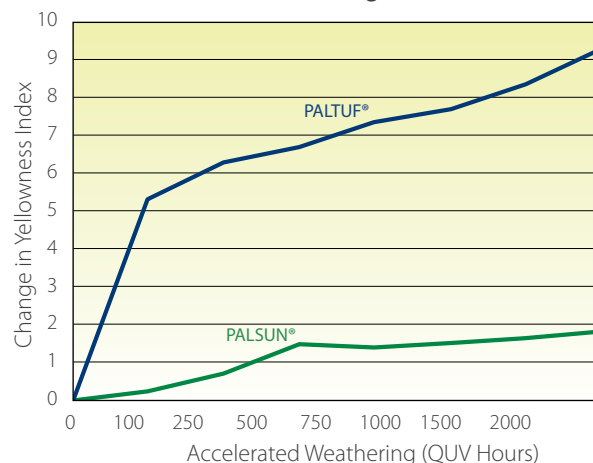
## Weather Resistance

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/m²	lb/ft²	kg/m²	lb/ft²
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	0.39	12.00	2.46	24.48	5.01

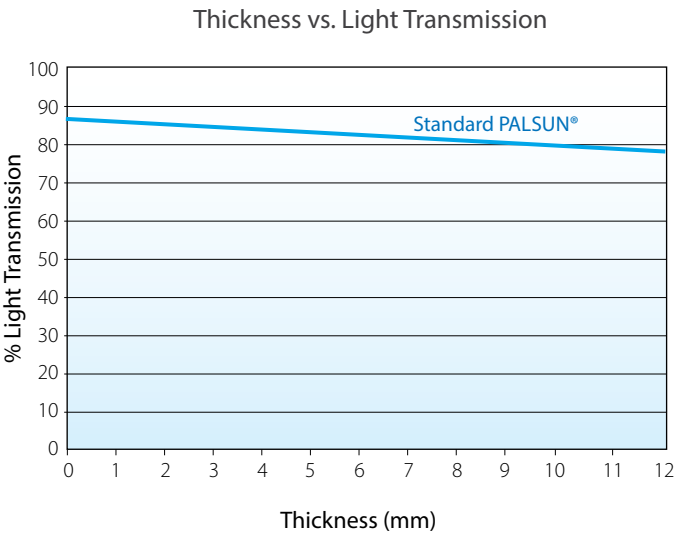
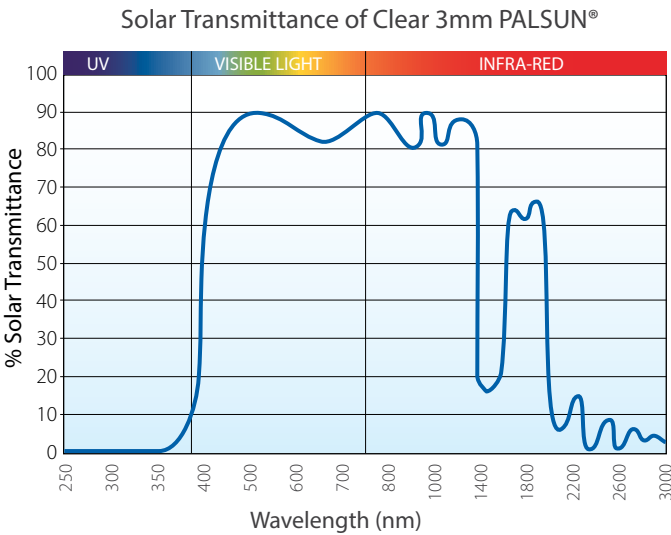
## Acoustic Properties

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.



## 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)*
<b>Physical</b>				
Density	D-792		g/cm <sup>3</sup> (lb/ft <sup>3</sup> )	1.2 (75)
Water Absorption	D-570	24 hr. @ 23°C	%	0.15
<b>Mechanical</b>				
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
<b>Thermal</b>				
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 <sup>2</sup> -°F)	0.21 (1.46)
Specific Heat Capacity	C-351		kJ/kg-°K (Btu/lb-°F)	1.26 (0.31)
<b>Optical</b>				
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
<b>Electrical</b>				
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 <sup>16</sup>
Volume Resistance	D-257	Keithley	Ohm-cm	10 <sup>17</sup>

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

\*\* ASTM except where noted otherwise.

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