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Edge-Lit and Back-Lit LED Lighting with Acrylic

Edge Lighting

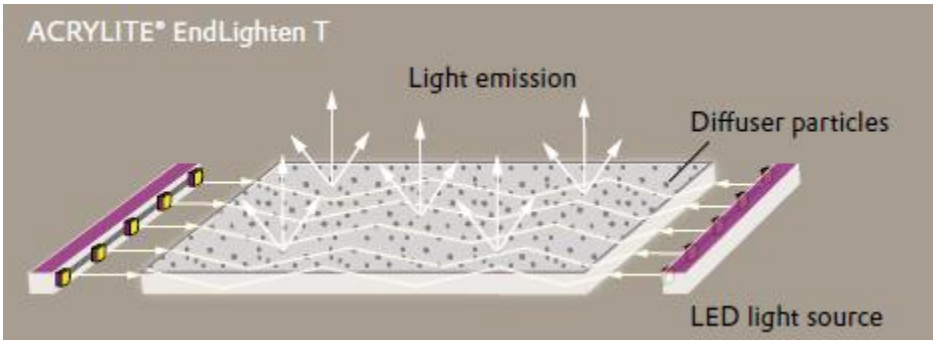
If you want general uniform illumination of a pane through edge lighting, use EndLighten. It is a clear, colorless, milky acrylic that is embedded with colorless light diffusing particles (sometimes referred to as "pixie dust") in the acrylic, which causes light to diffuse forward. The sheet accepts light through its edge and redirects it to the surface for bright, uniform illumination. When the light from the LED strip shines through the acrylic from the edge it hits the pixie dust dispersed throughout the acrylic, and shines out evenly from the pane, as shown below:

EndLighten is available in 3 grades: L, XL, and XXL. L has the highest concentration of diffusive material, and therefore is best for smaller brighter panes. XXL has the lowest concentration and is best for large panes, because it will help keep the center from being dark. XL is in the middle. The chart below can be used to determine which grade and size sheet is optimal for your project. **Application widths assume illumination on both sides.** The distance should be halved in the case of illumination from one side only.

EndLighten Sheet - Standard Product Offering

Grade	Sizes
Grade L: For application widths up to 24" available in .157" (4 mm) .236" (6 mm) .315" (8 mm)	49" x 97" (1245 x 2464 mm)
Grade XL: For application widths up to 51" available in .157" (4 mm) .236" (6 mm) .315" (8 mm) .394" (10 mm)	80" x 120" (2050 x 3050 mm)
Grade XXL: For application widths up to 78" available in .315" (8 mm) .394" (10 mm)	

EndLighten T is specially formulated and engineered for LED edge-lit applications, shows no clouding, and reduces total light reflection. In comparison to EndLighten, EndLighten T is less cloudy and projects light perpendicular to the surface at a higher intensity, as illustrated below. Optimized for vertical viewing, the apparent brightness of the surface is 250% brighter when viewed from the front. The surface shines with the color of the LED light.



EndLighten T is available in 4 grades: SM, L, XL, and XXL. SM has the highest concentration of diffusive material, and therefore is best for smaller brighter panes. XXL has the lowest concentration of diffusive material and is optimized to for maximum lighting range. Each grade has a different lighting range, based on the amount of diffusive material in the sheet.

Refer to the chart below as a guideline for which grade to choose, depending on your panel size and desired range for lighting. The lighting range is the distance from the LED to the furthest extremity.

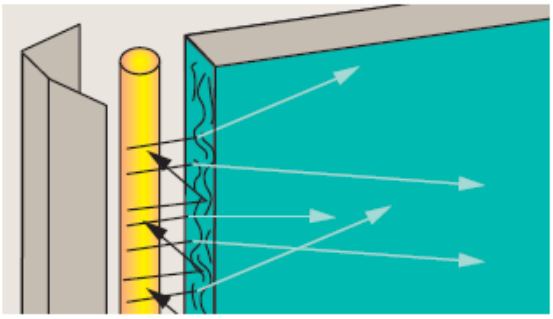
EndLighten T Sheet - Standard Product Offering

Lighting range with lighting both	Lighting range with lighting on one side	Sheet Size	Thickness	Recommended Grade
up to 12"	up to 6"	80" x 120" (2050 x 3050 mm)	.157" (4 mm)	OF10 SM
12" - 24"	6" - 12"	80" x 120" (2050 x 3050 mm)	.157" (4 mm) .236" (6 mm) .315" (8 mm) .394" (10 mm)	OF11 L
24" - 48"	12" - 24"	80" x 120" (2050 x 3050 mm)	.157" (4 mm) .236" (6 mm) .315" (8 mm) .394" (10 mm)	OF12 XL
48" - 78"	24" - 40"	80" x 120" (2050 x 3050 mm)	.315" (8 mm) .394" (10 mm)	OF13 XXL

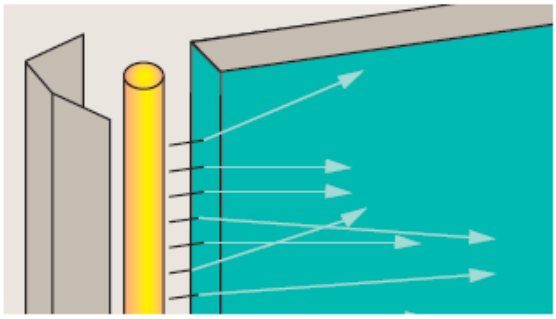
Example: If you want to light a 4’ x 8’ panel, it is best to light the long 8’ sides so you only have to make the lights reach in 2’ from each side to the center. If you light the 2 short sides, the light must travel 4’. If you only light on 4’ side, the light must travel 8’.

XXL can penetrate approximately 40” (1000 mm) from each side, which allows one to light a 78” pane, if you put lights on opposing edges. Below are some important pointers for optimizing your LED lighting of EndLighten and Endlighten T:

- The LEDs should be flush with the edge to ensure that light is correctly fed in, maximizing light input.
- All edges should be polished to reduce diffusion losses.

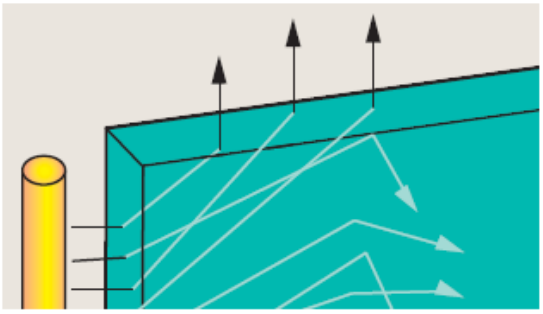


Rough edge: Some scattering on the sheet edge

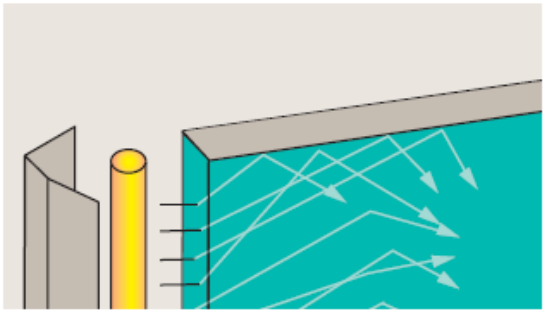


Smooth Edge: Very little scattering on the sheet edge

- To prevent light loss via the unlit edges, they should be reflective. This can be achieved for example by applying a white coating to the inside of the profiles that enclose the sheet edges or by using reflective adhesive tape, as illustrated below.



No reflective coating: Light leaves the sheet unused



With reflective coating: Light is reflected back into the sheet

Patterned or etched surface lighting

If you want to engrave a pattern or words into your acrylic, you will probably want to use a clear panel with no diffusive material such as Acrylite GP or FF. The engraved pattern and any exposed edges will be highlighted, as demonstrated below with Acrylite FF in the sign below:

Acrylite GP is a cell-cast product with superior optics, better toughness, but lower thickness tolerance, so it is not as good for thermoforming. Some shrinkage will occur when heated to forming temperature. The optimal temperature range for thermoforming is from 340°F to 380°F. The GP sheet is available in a selected range of colors. Standard thickness for GP ranges from 0.118'' to 1.00''. The product is available in the following sizes:

- 48''x 96''
- 72''x 120''
- 80''x 120''

Acrylite FF is an extruded product, which make it easier to fabricate at lower temperatures than cast sheets, making it ideal for thermoforming with low shrinkage. The FF sheet provides tight thickness tolerance, high optical characteristics, and low stress levels, and is available in a variety of thicknesses in colorless as well as in colors. The optimal temperature range for thermoforming is from 290°F to 320°F. Sheet sizes range from 48''x 96'' to 75''x 100''. Available thicknesses range from .060'' to .944'' in clear, and .060'' to .236'' in color.

GP and FF sheet differ because they are produced in different ways. The applications for which they are intended are also partly different, but their properties are nevertheless similar. Below is a breakdown of the differences and similarities between GP and FF:

ACRYLITE® GP (cast)

- Absolutely clear
- Custom colors made-to-order
- Break-resistant
- Resistant to weathering and aging

- High quality surface; high-gloss, textured (contemporary structures) or matte (GP P-95 for one sided or DP-9 for two sides)
- Very easy to work, similar to hardwood
- Easy to thermoform over a wide range of conditions
- Easily and firmly bonded, e. g. with reactions adhesives
- Burns more or less like hardwood; very little smoke generation; combustion gases are Non-toxic and non-corrosive
- Max. service temperature approx. 176 °F

ACRYLITE® FF (extruded)

- Economical
- Break-resistant
- Resistant to weathering and aging
- Very good surface; high-gloss, textured or satin
- Easier to fabricate at lower temperatures than cast sheet product
- Easy to work; similar to hardwood
- Very easy to thermoform under optimal, constant conditions
- Very easily bonded, also with solvent adhesives
- Burns more or less like hardwood; very little smoke generation; combustion gases are non-toxic and non-corrosive
- Max. service temperature approx. 158 °F

Physical Properties of ACRYLITE Acrylic Sheet

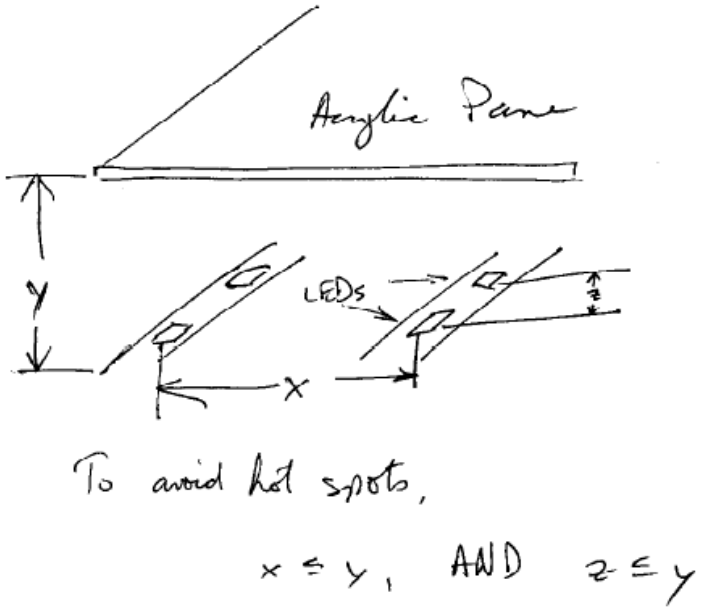
PROPERTY[a]		ASTM METHOD	TYPICAL VALUE[b]	
			FF	GP
Mechanical	Sheet Thickness Tested	—	0.250"	0.236"
	Specific Gravity	D 792	1.19	1.19
	Tensile Strength Elongation, Rupture Modulus of Elasticity	D 638	10,000 psi (69 MPa) 4.5% 400,000 psi (2800 MPa)	10,000 psi (69 MPa) 4.2% 400,000 psi (2800 MPa)
	Flexural Strength Modulus of Elasticity	D 790	17,000 psi (117 MPa) 480,000 psi (3300 MPa)	16,500 psi (114 MPa) 475,000 psi (3300 MPa)
	Impact Strength Izod Milled Notch	D 256	0.4 ft-lbs/in of notch (21.6 J/m of notch)	0.4 ft-lbs/in of notch (21.6 J/m of notch)
	Rockwell Hardness	D 785	M-93	M-94
Optical	Refractive Index	D 542	1.49	1.49
	Light Transmission, Total	D 1003	92%	92% (clear material)
Thermal	Forming Temperature	—	Approx. 300°F (149°C)	340-380°F (170-190°C)
	Deflection Temperature under load, 264 psi	D 648	195°F (91°C)	210°F (99°C)
	Vicat Softening Point	D 1525	220°F (105°C)	239°F (115°C)
	Maximum Recommended Continuous Service Temperature	—	160°F[c] (71°C)	180°F[d] (82°C)
	Coefficient of Linear Thermal Expansion	D 696	0.000040 in/in-°F (0.000072 m/m-°C)	0.000040 in/in-°F (0.000072 m/m-°C)
	Flammability, Burning Rate (0.125" thickness)	D 635	1.0 in/min. (25 mm/min.)	1.2 in/min. (30.5 mm/min.)
	Self Ignition Temperature	D 1929	850°F (455°C)	910°F (490°C)
	Smoke Density Rating	D 2843	4.80%	11.40%
Water Absorption	24 hrs @ 73°F	D 570	0.2%	0.2%

Back Lighting

If you want to make a light box, distribute the LED strips behind a diffusive acrylic. The hard part is make the "hot spots" (bright spots) of LEDs not appear. There are several things you can do to avoid bright spots:

1. Put your LEDs close together. This increases cost, power consumption and brightness.
2. Keep the plane of your LEDs as far away from the acrylic pane as you can. Limitations:
    a. If your LEDs are too far away, the box will not be very bright;
    b. If your LEDs far from the pane, your box will be thicker.

    The trade-off between 1 and 2 above is typically that your LEDs should not be further from each other than they are from the acrylic pane:



3. Use Acrylite TruLED, which is specially formulated to reduce the hot spots. This special product will allow you to remove the hot spots if the constraints of the above diagram are not met. This means you can make your light box thinner, with LEDs that are not as evenly spaced, and still avoid hot spots. The standard thickness for TruLED is .118'' and is available in two shades of white in 80''x 120''.

Satin Ice (P-95/DP-9)

An additional option for backlighting projects is Satin ice. Satin ice has a frosted surface throughout the entire sheet and performs well with LED lights, helping to eliminate hot spots. Product specifications for size and thickness are as follows:

- Standard sizes: 49″ x 97″ and 73″ x 97″
- Thicknesses: .060″ to .472″
- Colors: frosted, white, light blue, medium blue, dark blue, light grey, light green & black
- Light transmission: up to 89%

As the thickness of the product increases, light transmission value will decrease. Light transmission value percentages are listed by color below, for your convenience:

Light Transmission Values (%)

Thicknesses	.060"	.080"	.098"	.118"	.177"	.236"	.354"	.472"
Frosted 0D010 DF	89	88	87	86	82	78	68	65
White WD008 DF	59	58	56	54	47	42	38	33
Light Blue 5D004 DF	*	*	*	85	83	80	70	66
Medium Blue 5D005 DF	*	*	*	51	52	51	49	*
Dark Blue 5D006 DF	*	*	*	8	8	7	6	*
Light Green 6D001 DF	*	*	*	87	84	81	73	*
Light Grey 7D008 DF	*	*	*	70	70	69	67	*
Black 9D001 DF	OPAQUE	OPAQUE	OPAQUE	OPAQUE	OPAQUE	OPAQUE	OPAQUE	OPAQUE

There are 2 versions of Satin Ice: DP-9 and P-95. DP-9 has a matte two sided finish, which produces a finished look from any viewing angle. The nature of the matte surface also hides fingerprints, smudges, and scratches. If your project only requires a single sided matte surface, P-95 can be used. P-95 is the same premium-grade cell case sheet with the matte finish on one side, so if you are building an enclosed light box then P-95 would be ideal.