DuPont™ Teflon® Films

FOR PHOTOVOLTAIC MODULES

Lightweight, Long Lasting, Flexible Films Offer Greater Power Output

Why Teflon® Fluoropolymer Films?

DuPont™ Teflon® fluoropolymer films are ideal as protective front sheets for solar modules because they have a unique balance of properties. They are smooth, flexible, lightweight, and long lasting, with superior power output. Teflon® films also have proven performance in both solar thermal and photovoltaic (PV) applications, offering a preferred, technologically advanced alternative to traditional glass.

Increased Power

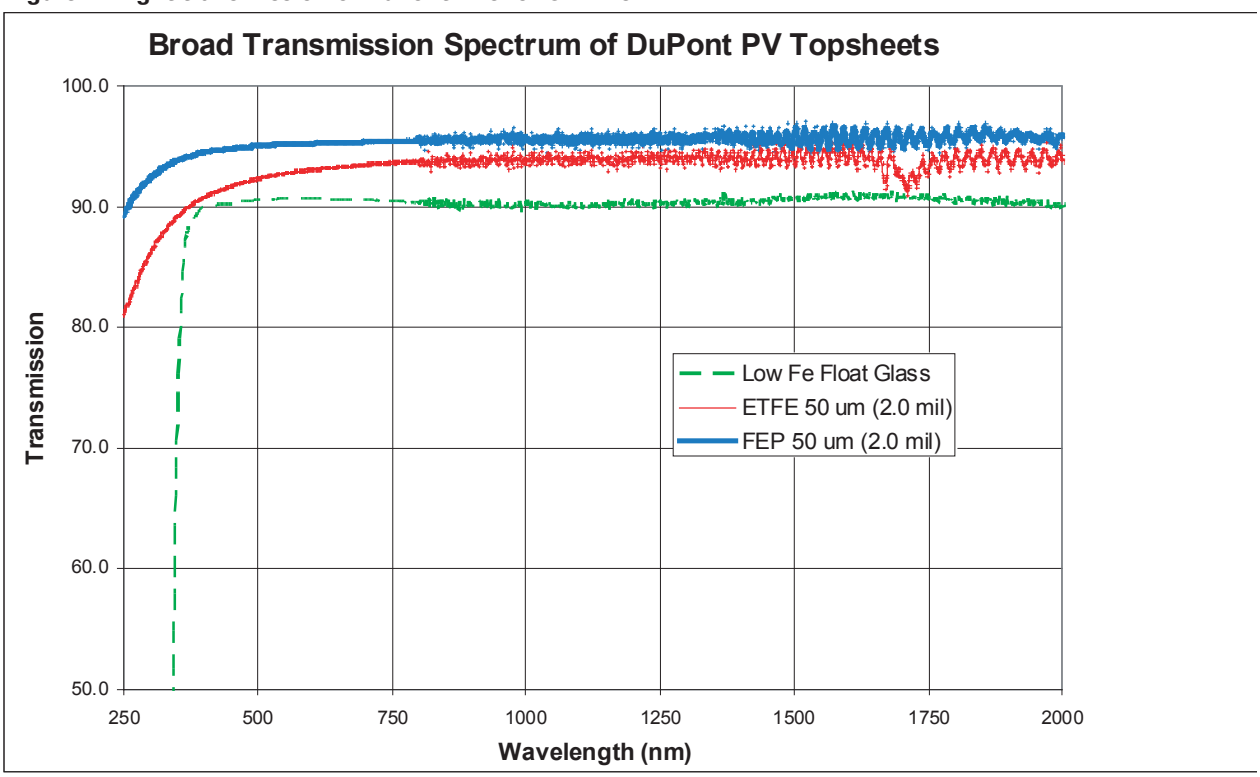
Due to their lower refractive indices, Teflon® films transmit light better than glass used in PV modules. Higher light transmittance means more photons are absorbed by the solar cells, and more power is produced.

In **Figure 1**, comparison data is shown on the light transmission of glass versus two different types of DuPont™ Teflon® fluoropolymer films, Teflon® ETFE and Teflon® FEP. Teflon® FEP film shows 2% more light transmittance than Teflon® ETFE, and both films show a significantly greater transmittance than low Fe float glass, which is commonly used in solar modules.

Long Lasting

Teflon® fluoropolymer films will last for years without degradation. In **Figure 2**, a study by the Institut für Solartechnik SPF shows the solar transmission of DuPont™ Teflon® FEP compared with low Fe float glass over 20 years of outdoor exposure. Not only does the DuPont film perform better with a higher transmittance, it performs better over an extended period of time to deliver increased power output vs. glass, hence improving long term cost efficiency.

Figure 1. Light transmission of DuPont™ Teflon® Films



Lightweight, Safer and Easy to Handle

A Teflon® film frontsheet on a typical 1600 mm x 800 mm module weighs less than 150 grams. The same glass frontsheet would weigh more than 10 kg. Not only is it lightweight, it is also flexible and unbreakable. As a result, corners will not chip, making it easier to install, and it is safer to handle than glass, with no sharp edges.

In addition, Teflon® fluoropolymer resins are recognized by Underwriters Laboratories for meeting rigorous V-0 flammability classification safety standards and will help prevent flame propagation in the event of a fire. Teflon® FEP has a higher limiting oxygen index that gives it slightly better flammability characteristics than Teflon® ETFE.

Available Sizes

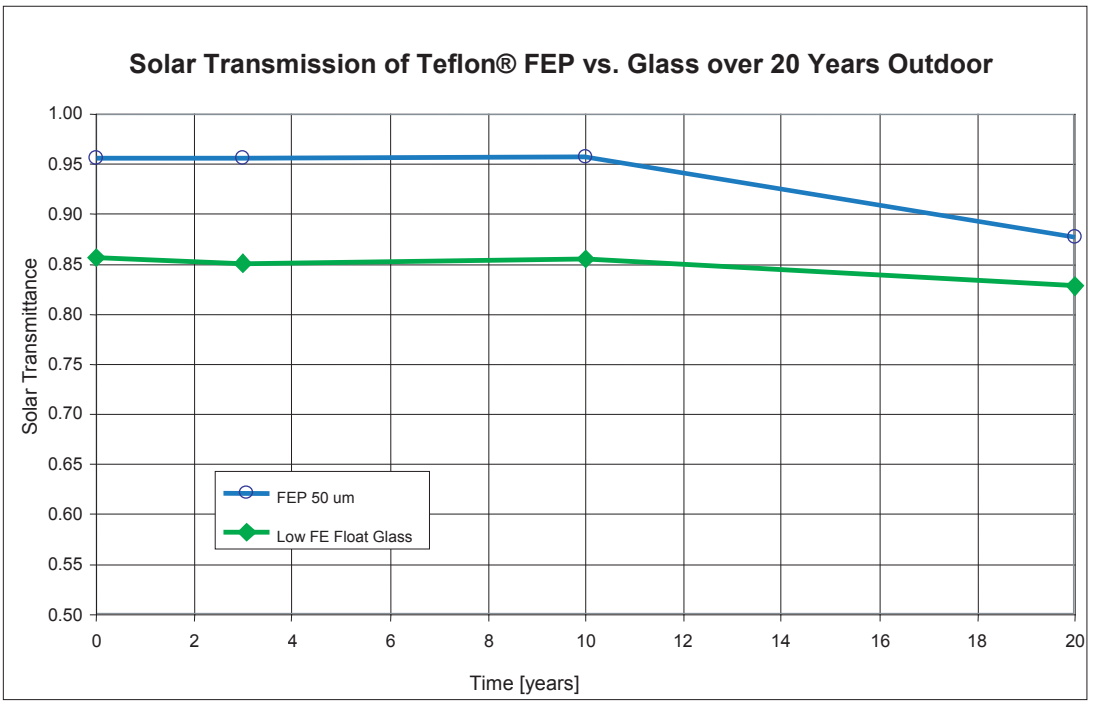
Films are supplied in roll form, as continuous lengths allow for easy roll to roll processing. Widths are available up to 1524 mm (60 inches) to fit any module size, and thicknesses are available from 13µ to 127µ (0.5 to 5.0 mils).

Other Key Properties

- **Adhesion to EVA Encapsulants:** Teflon® fluoropolymer films are surface treated using a proprietary treatment process, leading to superior adhesion to EVA.
- **Dielectric Properties:** excellent dielectric strength helps make these films effective insulators.
- **Mechanical Properties:** good mechanical strength and dimensional stability have proven to last even after 15 years of Florida exposure.
- **Moisture Permeability:** both Teflon® ETFE and FEP provide effective protection against moisture. For exceptional moisture barrier properties, Teflon® FEP is the recommended choice.

See **Table 1** for a comparison of these and other important physical properties of DuPont™ Teflon® FEP and ETFE fluoropolymer films.

Figure 2. Solar transmission of DuPont™ Teflon® FEP vs float glass over 20 year outdoor exposure



data courtesy of the Institut für Solartechnik SPF, Rapperswil, Switzerland

Table 1
Product Attributes of Teflon® ETFE and FEP Film

Product Attribute	Test Method	Test Item	ETFE	FEP
Refractive Index			1.3-1.5	1.3-1.5
Breakdown Voltage	ASTM D-149 kV	Film thickness 50 micron (2 mil)	 7	 7
Moisture Permeability	ASTM F372 at 100°F 90% RH in g/m²/day	50 micron (2 mil)	7.8	1.5
Flammability	 ASTM D-2863 ASTM D-635 ASTM D-2015	UL 94 (resin) LOI Horizontal rate of burning Heat of combustion Btu/lb K cal/kg	V-0 30% 10 mm; >5 sec 6200 3441	V-0 95% 5 mm; >5 sec 2200 1221
Strength and Dimensional Stability Initial % Retention after 15 yrs. Florida exposure	 % mPa % %	 Elongation Tensile Strength Elongation Tensile Strength	 300 41.4 85% 93%	 300 17.3 93% 100%
Adhesion to EVA	Instron	Mode of failure	No EVA adhesion failure; film breaks	No EVA adhesion failure; film breaks
Continuous Operating Temperature	°C	Resin	150 °C	204 °C

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