

Halar



SOLVAY

asking more from chemistry®

Halar[®] ECTFE

Films for Photovoltaic Front-Sheets

**SPECIALTY
POLYMERS**

High-Performance Films for Photovoltaic Applications

Halar® ECTFE is a partially fluorinated polymer offering outstanding fire and chemical resistance combined with excellent barrier properties. These unique characteristics make it the material of choice in several highly demanding applications ranging from Aerospace to Semiconductors.

Halar® ECTFE exhibits extreme long-term stability when exposed to sunlight and atmospheric events. This, combined with very high transparency, makes it ideal for use in photovoltaic and architectural structures.

The information below provides an in-depth look at its excellent characteristics for use in front-sheet and back-sheet PV applications.

Designed for Optimal Weight Reduction and Flexibility

Heavy, breakable and rigid glass is being replaced more and more by films made of specialty polymers. These films offer the expected light transmission, weatherability, UV resistance, and mechanical performances of glass but add flexibility, weight reduction, and a number of outstanding features including chemical and fire resistance along with self-cleanability.

Additional attributes such as UV-blocking, moisture barrier and anti-reflectivity through texturing also can be provided due to film processing techniques or combining in layers with other materials.

Films made from Halar® ECTFE have the ability to adapt to all surfaces including curves and can increase building integration. Moreover, they are able to meet the demanding lightweight requirements for industrial roofs, boats, and sports and military portable modules.

Halar® ECTFE films: main features

- Strong, hard, tough and abrasion resistant
- High-performance water vapor barrier (wvtr up to 10^{-4} g/sqm/day/atmosphere)
- Broad service temperature range (from -80 up to +150 °C)
- Excellent outdoor stability (hydrolysis and UV aging)
- Outstanding fire resistance properties (LOI > 52 %)
- Highly transparent and smooth (over 91 %)
- Very good dielectric properties (2.5 at 23 °C, 1 kHz)
- Lightweight (0.084 kg/m² for a 50 μ film)

Improved Performance Over Other Fluorinated Films

Tests reveal that Halar® ECTFE films have similar light transmission, weatherability, and UV resistance than existing fluorinated films while offering improved fire resistance, smoother film surface and better adhesiveness on EVA.

Halar® ECTFE Adhesiveness on EVA

Lamination of surface treated Halar® ECTFE to EVA at 150 °C (peel strength): 31 N/cm, after damp heat (1,000 hrs, 85 °C, 85 % RH)

Lamination conditions: measured at 150 °C, 0mbar, 20 min cycle time

Peel strength: measured at 180 °C, ASTM D903

Fire Resistance

Test	Halar® ECTFE	ETFE
UL-94	V-0 on 180 micron thick specimens	V-0 on 1.6 mm thick specimens only
Limiting Oxygen Index (ASTM D 2863)	> 52 %	32 %
Auto-ignition temperature (ASTM D 1929)	655 °C	470–555 °C
FM 4910 (Factory mutual)	Compliant	Not compliant

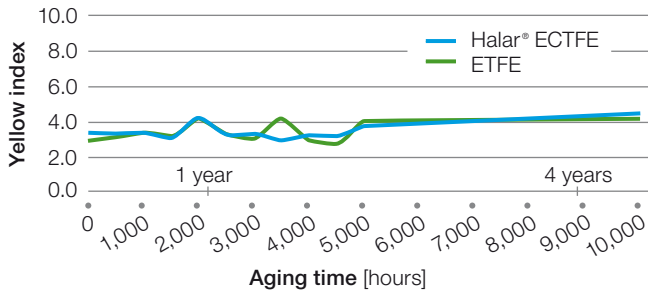
ECTFE vs. Glass

Halar® ECTFE film has a smoother surface and lower density and thickness compared to glass.

Property	Unit	Halar® ECTFE	Glass
Thickness	cm	0.005	0.3
Density	g/cm ³	1.68	2.5
Weight	kg/m ²	0.084	7.5

Aging Test

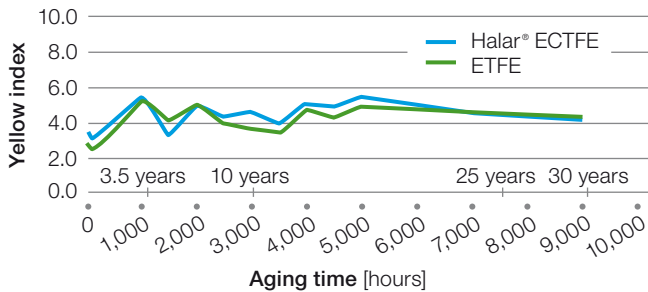
Weather-Ometer method



Atlas Ci35 Weather-Ometer

Black panel: 60 °C; Lamp: Xenon Arc I;
 filter inner and outer: Borosilicate; Irradiance: 0.35 W/m²;
 no dark cycle/no rain cycle
 1,000 hrs W-Om light = 164 days Florida outdoor exposure

Q-UV B method



Q-UV Panel

UV B 313 nm lamps; 8 h light at 70 °C;
 4 h condensation 50 °C
 100 hrs Q-UV light = 120 days Florida outdoor exposure

After 9 years of Florida outdoor weathering, real exposure testing confirms results of accelerated aging with very limited changes in the recorded properties.

Impact Resistance

Halar® ECTFE complies with:

- Hail test (IEC/EN 61215)
- Cut susceptibility test (IEC 61730)

Test conditions

Front-sheet:

- Halar® ECTFE: 0.05 & 0.02 mm

Encapsulant and PV cells:

- EVA 0.8 mm (0.48 mm/c-Si PV cells/0.48 mm)

Back-sheet (multilayer rigid):

- Epoxy-glass fiber (thickness: 0.5 mm)
- Aramid honeycomb – Cormaster C1_3.2_29 (thickness: 15 mm, density: 29 kg/m³)
- Epoxy-glass fiber (thickness: 0.3 mm)

Lamination conditions:

- 150 °C for 900 seconds

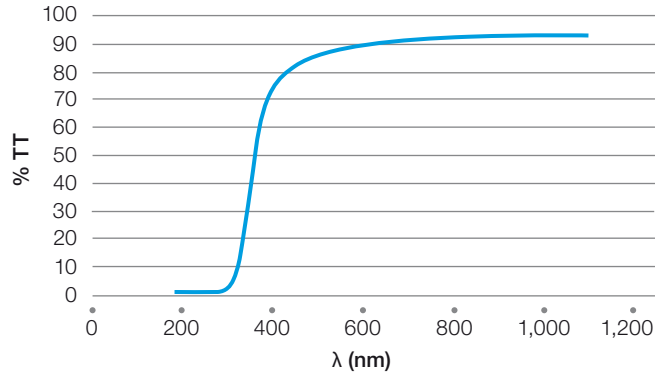


Halar® ECTFE UV-Blocking

While retaining all properties of ECTFE, this specific Halar® ECTFE film shows no change in UV blocking behavior over time.

(Patented WO 2012049193 & WO 2012049242)

Total transmission of Halar® ECTFE



17 μ Halar® ECTFE film protect the over 17,000 solar cells of the Solar Impulse 2.



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