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
- 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, 0 mbar, 20 min cycle time

Peel strength: measured at 180°C, ASTM D903

Fire Resistance

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

ECTFE vs. Glass

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

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Halar® ECTFE</th>
<th>Glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>cm</td>
<td>0.005</td>
<td>0.3</td>
</tr>
<tr>
<td>Density</td>
<td>g/cm³</td>
<td>1.68</td>
<td>2.5</td>
</tr>
<tr>
<td>Weight</td>
<td>kg/m²</td>
<td>0.084</td>
<td>7.5</td>
</tr>
</tbody>
</table>
Aging Test
Weather-Ometer method

![Graph showing aging test results for Halar® ECTFE](image)

**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**

![Graph showing Q-UV B method results for Halar® ECTFE](image)

**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**

![Graph showing transmission of Halar® ECTFE](image)

17 µ Halar® ECTFE film protect the over 17,000 solar cells of the Solar Impulse 2.
Safety Data Sheets (SDS) are available by emailing us or contacting your sales representative. Always consult the appropriate SDS before using any of our products.

Neither Solvay Specialty Polymers nor any of its affiliates makes any warranty, express or implied, including merchantability or fitness for use, or accepts any liability in connection with this product, related information or its use. Some applications of which Solvay’s products may be proposed to be used are regulated or restricted by applicable laws and regulations or by national or international standards and in some cases by Solvay’s recommendation, including applications of food/feed, water treatment, medical, pharmaceuticals, and personal care. Only products designated as part of the Solviva® family of biomaterials may be considered as candidates for use in implantable medical devices. The user alone must finally determine suitability of any information or products for any contemplated use in compliance with applicable law, the manner of use and whether any patents are infringed. The information and the products are for use by technically skilled persons at their own discretion and risk and does not relate to the use of this product in combination with any other substance or any other process. This is not a license under any patent or other proprietary right.

All trademarks and registered trademarks are property of the companies that comprise the Solvay Group or their respective owners.

© 2016, Solvay Specialty Polymers. All rights reserved. R 07/2016 | Version 1.1 | Brochure design by ahlersheinel.com