F-CLEAN®

ETFE Foil for Greenhouse

AGC Green-Tech Co.Ltd.
Asahi Glass Company Profile

1. Founded  
   September 8, 1907  
   * The first sheet-glass producer in Japan

2. Sales  
   JPY 1,148 billion (Year 2010)  
   * World’s Largest Glass Company.

3. Employees  
   47,618
AGC Asahi Glass Co. Group –

Glass
- Flat Glass
  - Float Glass
  - Laminated Glass
  - Heat absorbing
  - Heat Reflecting
- Automotive Glass
  - Laminated
  - Tempered
- Others
  - Glass fibre

Electronics & Display
- Display
  - Flat panel display
  - Plasma screen
  - LCD screens
- Electronic Material
  - Display material
  - Semi conductor
  - process material

Chemicals
- Fluorochemicals
  - Fluoropolymers (PTFE, ETFE, etc.)
  - ETFE Film
  - Gas & solvents
  - Water & oil repellents
  - Ion exchange membranes
  - Pharmaceutical Intermediates
- Chloro, Alkali & Urethane
  - Caustic Soda
  - Potassium Carbonate
  - Sodium bicarbonate
  - HCl
  - Vinyl Chloride Products
  - Urethane

Others
What is ETFE FILM?

Fluon® ETFE FILM is high-performance film produced by AGC with its own [Fluon® ETFE] resin. Fluon® ETFE FILM shows the excellent features, and is used in various applications.

AGC’s advantage is to develop and produce both resin and film.

Ethylene-Tetrafluoroethylene copolymer
Weather Resistance

Chemical resistance

Heat resistance
-100 to 180c

Mechanical property

Non-flammability (UL 94 V-0)

Anti-stick property (Antifouling)

Anti-condensation can be added

Dielectric properties

Light transmittance

Light can be controlled by wave length range

Can be added
Various Applications of ETFE FILM

- **Structure**
  - Roof and façade
  - Greenhouse covering

- **Energy**
  - Solar-cell protection
  - Battery insulation

- **Electronics**
  - Release film for FPC
  - Release film for semiconductor

- **Others**
  - Protective film surfaces
  - Wallpaper surface
  - Thermo molded parts
Process of Fluon ETFE Film

Polymerization of Fluon ETFE

Extruding of Fluon ETFE film

Extruder

Fluon ETFE film
Fluon ETFE Product

Self-Cleaning
Long Life and Durability
Fire Safety
More Light Than Glass
Low Reflection and Refraction Rate
Improved Crop Quality
FILM Options

Clear – UV Open
Light Diffused
Anti-dripping
UV Block – UV Cut
Light Block – Soft Shine
Thickness Variations
Light transmission of F-CLEAN Clear (60micron) is 94%!!

*Light transmission is measured according to JIS standard.
Aging of Light transmittance

Transmittance (%)

Exposure Time (Year)

Long life PE (150 μm)

F-CLEAN® (60 μm)
Low reflection

Transmission of Solar radiation (%) vs. Incident angle

- Glass (4mm)
- F-CLEAN Clear (100 μm)
## High mechanical property

<table>
<thead>
<tr>
<th>Producer</th>
<th>AGC</th>
<th>AT Plastics</th>
<th>Ginegar</th>
<th>Hyplast</th>
<th>Plastika Kritis</th>
<th>Visqueen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Film name</strong></td>
<td>F-CLEAN</td>
<td>Dura 3</td>
<td>Sunsaver</td>
<td>HYTILUX</td>
<td>Sunmaster</td>
<td>Luminance</td>
</tr>
<tr>
<td><strong>Thickness(μm)</strong></td>
<td>100μm</td>
<td>150μm</td>
<td>200</td>
<td>200</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td><strong>Tensile strength at Break</strong></td>
<td>58MPa</td>
<td>25.6MPa</td>
<td>21.2MPa</td>
<td>23MPa</td>
<td>22MPa</td>
<td>–</td>
</tr>
<tr>
<td><strong>Elmendolf tear strength</strong></td>
<td>21N</td>
<td>7.5N</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Elongation at break</strong></td>
<td>400%</td>
<td>658%</td>
<td>–</td>
<td>550%</td>
<td>500%</td>
<td>–</td>
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</tbody>
</table>
Cut the film which is under the constant air-pressure.

It does not expand further.
Long Service Life: Greenhouse in Japan

Over 20 years

Greenhouse in Aichi
Installed in 1988
Photographed in 2009

Greenhouse in Kyushu
Installed in 1988
Photographed in 2008
F-CLEAN Diffuse

F-CLEAN Clear
Function

Clear type

Diffuse type

Shadow
F-CLEAN Diffuse

Light transmission

Wavelength (nm)

Light transmission (%)
Non-stick Properties

Poly

PVC

F-CLEAN
Easy or Self Cleaning Surface

Dust accumulation upon film

<table>
<thead>
<tr>
<th>Month</th>
<th>PE measured (1 m²)</th>
<th>F-Clean measured (1 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>0.4</td>
<td>0.05</td>
</tr>
<tr>
<td>June</td>
<td>0.1</td>
<td>0.05</td>
</tr>
<tr>
<td>August</td>
<td>0.3</td>
<td>0.05</td>
</tr>
<tr>
<td>October</td>
<td>0.5</td>
<td>0.05</td>
</tr>
<tr>
<td>November</td>
<td>0.2</td>
<td>0.05</td>
</tr>
<tr>
<td>December</td>
<td>0.1</td>
<td>0.05</td>
</tr>
<tr>
<td>January</td>
<td>0.1</td>
<td>0.05</td>
</tr>
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</table>
## Chemical Resistance

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Temp. (°C)</th>
<th>Days</th>
<th>Retention (%)</th>
<th>Elong.</th>
<th>Wt. Gain</th>
</tr>
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<tbody>
<tr>
<td>Conc. Hydrochloric acid</td>
<td>35%</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>0.0</td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>78%</td>
<td>121</td>
<td>100</td>
<td>100</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>98%</td>
<td>121</td>
<td>100</td>
<td>100</td>
<td>0.0</td>
</tr>
<tr>
<td>Nitric acid</td>
<td>25%</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>60%</td>
<td>120</td>
<td>10</td>
<td>100</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>70%</td>
<td>60</td>
<td>60</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>10%</td>
<td>120</td>
<td>10</td>
<td>97</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>120</td>
<td>10</td>
<td>100</td>
<td>-0.3</td>
</tr>
<tr>
<td>Ammonium Hydroxide</td>
<td>15%</td>
<td>66</td>
<td>7</td>
<td>98</td>
<td>0.1</td>
</tr>
<tr>
<td>Chlorine</td>
<td></td>
<td>90</td>
<td>10</td>
<td>94</td>
<td>-</td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td>100</td>
<td>7</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>
Installation type for ETFE FILM

1. Single Layer

2. Cushion Type (Multi Layer)

- Frame
- Fastener
- Film

Tension

Air Pressure
<Test conditions>
Period: 01/Jan/2008 to 31/Jan/2008
Set-point temperature in G/H: 10deg.C
Location: Kouchi, Japan
   (LAT. 33deg.C, Ave.winter temp.: 6deg.C)

<Result>
49% lower while the quality of crop is maintained
<Test conditions>
Period: 01/Nov/2006 to 28/Feb/2007
Set-point temperature in G/H: 18 deg.C
Location: Hokkaido, Japan
   (LAT. 42deg.C, Ave.winter temp.: -10deg.C)

<Result>
24.8% lower while the quality of crop is maintained
Crop Reactions
Young plant grown under F-CLEAN became more robust, more resistant to sudden climate change. As a result, time consuming work of getting the plants familiarized to Sun light has been omitted.

Location: Munich, Germany
Crop: Young plant of roman lettuce
Installed on: Feb. 2003
Photographed on: Sep. 2003
Evaluation of F-CLEAN Diffuse by Wageningen UR

<Period of evaluation>
Apr. 2006 to July 2006

<Crop>
Cucumber
Location: Vicinity of Frankfurt, Germany
Crop: Young plant of lettuce
Installed on: Apr. 2004
Photographed on: June 2005

Left: Under F-CLEAN
Right: Under Glass
F-CLEAN provides far better ultraviolet transmission than glass. That has prevented the abnormally elongated seedlings that result from insufficient light and from an unbalanced light spectrum. Our seedlings are compact and robust. They stand up to automated planting in the field. F-CLEAN has given us more-stable supply capacity, as well as lowering our operating costs.
Yield comparison (tomato)

Monitored by I.R.T.A.
(Agricultural institute in Spain)
Yield comparison (Pot plant)

Number of flower per plant (Pelargonium)

Monitored by CeRSAA (Agricultural institute in Italy)
Grown under F-CLEAN

Grown under Poly film
Greenhouse Applications
F-CLEAN
Roof bar distance is 2m

Glass
Roof bar distance is 1m
Upper layer: F-CLEAN Clear
Bottom layer: Glass
Upper layer: F-CLEAN Clear
Bottom layer: Glass