Greenhouse Film

Bringing the Sunshine Inside
Introduction to F-CLEAN™

F-CLEAN™ is a fluoropolymer (ETFE) film which improves the growth efficiency of fruits, vegetables and plants inside greenhouses. This film has a higher transmission rate of light and UV than glass, polyethylene or polycarbonate, allowing the full spectrum of solar light to pass through into the growing area. This results in more production, earlier blooms and more colourful petals, as well as sweeter fruit and better quality vegetables.

F-CLEAN™ is treated with an anti-drip coating, preventing water drops from forming and potential drip damage to the crop. Due to the low surface energy of the fluoropolymer film, dirt gets washed away easily by rain and snow, so excellent light conditions can be expected year-round.

- Remains naturally clean for years due to its low surface energy properties
- Excellent UV light transmission (up to 90%) – also available in a ‘UV Cut’ version
- Excellent durability due to minimal effects of ageing on tensile strength – over 30 years’ service life
- Lightweight but strong, requiring minimal structural support
- Self-extinguishing – tested to fire safety standard DIN 4102, Class B-1

F-CLEAN™ Product Range

<table>
<thead>
<tr>
<th>F-CLEAN™</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Clear (UV Open)</td>
<td>Uses the full spectrum of solar light and provides the same light conditions as outside.</td>
</tr>
<tr>
<td>Diffused</td>
<td>Diffuses light evenly, whilst maintaining high light transmission.</td>
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<tr>
<td>GR Series (UV Cut)</td>
<td>Available in 3 grades with different rates of UV Cut.</td>
</tr>
<tr>
<td>Grey</td>
<td>Cuts solar light up to 99%.</td>
</tr>
<tr>
<td>Soft Shine</td>
<td>Blocks heat energy from sunlight transmitting 14% light.</td>
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</tbody>
</table>

![F-CLEAN™ product range images]
F-CLEAN™ Clear (UV Open)

- Enables extremely high light transmission
- Highest UV transmission of all greenhouse covering materials
- Allows the full spectrum of solar light, resulting in healthy crops and vivid colours
- Excellent light transmission at all angles of incidence

**Performance**

![Graph: Light Transmission by Grade](image)

- **Light Transmission (%)**
  - F-CLEAN™ Clear (UV Open)
  - F-CLEAN™ GB (UV Cut)
  - F-CLEAN™ GBx (UV Cut)
  - Float Glass

![Graph: Angle of Incidence and Solar Light Transmission](image)

- 100% solar light transmission
- Reflective & refractive rate is low enough to fit in very low break of incident light as the angle of incidence increases
- F-CLEAN™ Clear (100µm)
- Float glass 3mm

**Applications**

- Crops requiring anthocyanin such as aubergines and strawberries
- Greenhouses growing high quality and/or high added value crops
- Compost houses (animal manure and food leftovers)
- Drying houses (e.g., salt, fish and plums)
- Improved honeybee pollination

**Double Layer Projects**

- Provides very high thermal insulation and light transmission.
- Energy saving of more than 30%
- 100% → 94% → 88%

**Coefficient of heat transmission:**

- 6.8 W/m²K (single layer 100µm); 3.8 W/m²K (double layer 100µm + 60µm)
  *Measurements based on AEC's test method

**Performance**

- Improved colours
- Prevention of internode elongation
- Excellent durability – life span over 30 years
- Installing a double layer provides increased thermal insulation, reducing heating costs

**Non-Agricultural Applications**

- Fermentation facilities for composting
- Greenhouses for drying fruit

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**Images:**

- Seedlings
- Aubergines
- Strawberries

**Composting fermentation facility**

**Hothouse for drying plums**
**F-CLEAN™ Diffused**

- Diffuses light evenly, eliminating shadows
- Extremely high haze level of 60 – 70%
- Condensation does not negatively affect the light transmitting. If condensation forms on the film's matte surface, the surface changes to clear.
- Enhancement of overall photosynthetic capacity
- Available in two grades: Clear and GR (mild UV cut)

**Performance**

![Graph showing optical properties of F-CLEAN™ Diffused and Clear](image)

**Comparison of F-CLEAN™ Clear and Diffused**

- F-CLEAN™ Clear
- F-CLEAN™ Diffused
- Eliminates shade

Tests done by the Dutch Agricultural Research Institute Wageningen University

- Greenhouse with diffused film recorded a 4.3% increase in yield and a 7.8% increase in numbers compared to greenhouses with clear film.

**Photometer Data**

Location of measurement: Kochi, Nankoku-shi, Japan

![Graph showing photon flux density in greenhouses](image)

The photometer results show no difference in photon levels of clear film and diffused film whether the weather is sunny or cloudy.

Note: Photometer Equipment which measures light transmission of photons with an angle of incidence of 23°

**Customer Satisfaction Survey**

Would you choose F-CLEAN™ Diffused again?

- Yes: 87%
- Undecided: 13%

**Case Studies**

- Grade: 60µm Diffused
  - Crop: Strawberries
  - Location: Tochigi

- Grade: 80µm GR Diffused
  - Crop: Chrysanthemums
  - Location: Ibaraki

- Grade: 80µm GR Diffused
  - Crop: Tomatoes
  - Location: Aichi

Note: The full benefits of F-CLEAN™ Diffused may not be realised with certain conditions or crops.
F-CLEAN™ GR Series (UV Cut)

- Three grades of UV cut film are available to suit the needs of different plants
- Protection of materials and tools from UV damage
- UV cut function does not deteriorate over time

F-CLEAN™ GR Product Range

- F-CLEAN™ GR provides low UV cut (clear/diffused)
- F-CLEAN™ GR80 provides UV cut properties similar to glass (clear)
- F-CLEAN™ GRUV provides the highest UV cut in the F-CLEAN™ series (clear)

**Performance**

**Light Transmission by Grade**

![Light Transmission Graph](image)

**Usage Trends of the GR Series**

![Usage Trends Table](image)

**Crop Examples**

- Cyclamen
- GR
- Melons
- Tomatoes
- GR80
- Spray Chrysanthemums
- Roses
- GRUV
- Roses

**Note:**

- Honeydew may behave differently under UV cut conditions; professional advice should be sought.
- Care should be taken when using F-CLEAN™ GR grades if the crop colour relies on anthocyanin.
F-CLEAN™ Grey

- Cuts over 99% of visible light, providing a cool environment even in hot weather
- Blocks heat energy from solar light, which prevents the internal temperature from rising
- The solar heat gain coefficient is 24%, equivalent to that of F-CLEAN™ Soft Shine
- Excellent weatherability and chemical resistance
- High absorption of infrared light which helps snow slide off the roof
- Standard dimensions: 100µm x 1300mm x 50m with anti-dripping treatment
- The film can be welded if wider dimensions are required
- Special repair tape is available for F-CLEAN™ Grey

**Performance**

![Graph showing properties by wavelength (light transmission)](image)

**Applications**

- Factories with artificial light only
- Mushroom cultivation
- Animal housing
- Warehousing
- Sports facilities
- Sewage disposal facilities

**Animal housing**

*Covered with alternating F-CLEAN™ Clear & F-CLEAN™ Grey

**Fish farm facility**

**Mushroom cultivation**

**Irrigation room**

**Machinery warehouse**

**Sewage disposal facility**
F-CLEAN™ Soft Shine

- Enables light transmission of about 14%, whilst blocking heat energy from solar light to prevent temperature build-up
- The solar heat gain coefficient is 24%, equivalent to that of F-CLEAN™ Grey
- Excellent weatherability and chemical resistance
- Cuts UV completely as well as infrared rays
- Standard dimensions: 100μm x 1300mm x 50m with anti-dripping treatment
- The film can be welded if wider dimensions are required

**Performance**

![Graph showing properties by wavelength (light transmission)](image)

**Applications**

- Mushroom cultivation
- Animal housing
- Sheds/Warehousing
- Sports facilities
EMEA Regional Projects

F-CLEAN™ greenhouse film can be used at extreme temperatures ranging from -100°C to 150°C. This makes it suitable for use in all types of climate, from the long, cold winters in Russia to the dry and dusty heat of Egypt. F-CLEAN™ has been used successfully for years in both these locations, as well as in many others, including Austria, Belgium, France, Germany, Italy, Jordan, Netherlands, Qatar, Switzerland and the UK.

Location: Switzerland*  
Area: 10,000m² + warehouse  
Type: Venlo 9.6m  
Crop: Young plants, vegetables & lettuce  
Covering: Single layer F-CLEAN™

Location: Austria*  
Area: 15,000m² + warehouse  
Type: Venlo 9.6m  
Crop: Herbs  
Covering: Single layer F-CLEAN™

Location: France  
Area: 11,232m²  
Type: PV greenhouse  
Crop: Strawberry  
Covering: Single layer F-CLEAN™

Location: Egypt*  
Area: 10,000m²  
Type: Wide Span 9.6m  
Crop: Sweet pepper & tomatoes  
Covering: Single layer F-CLEAN™

*Images courtesy of IBH Sustainable Greenhouse Solutions

Image courtesy of DING IT
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