Fluoropolymers Fluon® and Fluoroelastomers AFLAS®

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Advanced technological innovation, complex systems, and environmental protection - current industries today face many challenges, and the market always seeks faster solutions. Hints were found in advanced materials derived from the 9th element. Asahi Glass Co., Ltd (AGC) is a total solution supplier of fluorine chemistry, and supplies fluorine chemicals such as fluoropolymers, fluoroelastomers, fluorine solvents, and fluorine intermediates to various manufacturing industries. In particular, AGC’s fluoropolymer products are known for the name of Fluon® brand with a history of over 70 years, as well as AGC’s fluoroelastomer products are known for the name of AFLAS® brand.

Fluon® and AFLAS® have won the trust of many customers around the world. Fluon® and AFLAS® are high-performance materials with excellent properties including durability, chemical resistance, heat resistance, etc. AGC develops new applications and supports strongly the customers with fluorine solution.

Asahi Glass Co., Ltd.
AGC Chemicals Europe, Ltd
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Fluoropolymers/fluoroelastomers products derived from fluorine as an advanced element has surprisingly various possibilities. AGC has developed various useful properties of these including durability, processability, transparency, etc. These products are applied in many fields including automobiles, architecture, electronics, and super express railways, etc, as well as future industries including atomic energy and space industries. Fluoropolymers/fluoroelastomers products are strongly expected to be important materials supporting technological innovations in the future. AGC has a great variety of products including the most basic Fluon® PTFE with the highest performance, Fluon® ETFE with global No.1 supplying and great processability, and Fluon® PFA with excellent quality and purity, as well as AFLAS® with unique and high property. In addition, we can deliver solutions of many variations including grades and types with these line-up fitting on customers’ needs to each market.

Fluorine's variety of advantages are realized on many product lines:
ETFE is a copolymer comprised of tetrafluoroethylene (C₂F₄) and ethylene (C₂H₄), and is a thermoplastic fluoropolymer developed by AGC with excellent processability and mechanical properties. It can be molded by various methods including extrusion molding, injection molding, and powder coating, etc. Furthermore, ETFE has fluoropolymer characteristics such as chemical resistance and electrical properties. ETFE is easy to use, exhibits high performance, has versatility, and is used in various fields.

**Features:**

- **Processability:** Various molding/forming applications are available including extrusion molding, injection molding, and powder coating, etc. as well as conventional thermoplastics. This fluoropolymer can be molded into a film. Heat sealing, combination with rubber, and various secondary processing is available.
- **Heat Resistance:** It is usable within a wide temperature range from -200°C to +150°C, while maintaining stable mechanical and electrical properties. Continuous usage at +150°C is also possible.
- **Mechanical Property:** It has more mechanical strength than other fluoropolymers.
- **Chemical Resistance:** It has excellent resistance to almost all chemical agents and solvents.
- **Electrical Property:** It has excellent electric insulation property, and exhibits higher dielectric strength even in a thin film. It has a lower dielectric constant and dielectric loss tangent over a wide frequency range.
- **Flammability/Safety:** Nonflammable material conforming to UL standards 94V-0. Tasteless, odorless, and nonpoisonous. Recommended for the food industry. Moreover, Fluon® ETFE is US FDA compliance, and registered in the inventory of Food Contact Substances at #4681.
- **Weatherability:** Resistant to ultraviolet light, and durable to weather for a long period.
- **Surface Property:** It possesses lower frictionality, anti-stick, and excellent water and oil repellency.

**Applications:**

Various linings and coatings/electric wires coating/tubes and hoses/various injection-molded parts/films/etc.
Fluon® LM-ETFE exhibits higher performance and is easier to use than conventional ETFE. Although its melting point is 40 degrees lower than conventional ETFE, it has higher thermal stability. Because of this property, it is processable within a wide range of temperatures. In addition, its chemical resistance and mechanical property are as good as those of conventional ETFE. Further, it has some unique properties developed by AGC, such as excellent light transmittance, expanding possibilities of fluoropolymers.

**Features:**

- **Processability:** Melting point is as low as 225°C. It has lower viscosity up to 240°C, so processing is possible at temperatures 50°C lower than conventional ETFE. Usable within a wide temperature range from -200 to +180°C. Continuous usage at 180°C is also possible.
- **Heat Resistance:** Usable within a wide temperature range from -200 to +180°C. Continuous usage at 180°C is also possible.
- **Mechanical Property:** Softer than ETFE, and particularly superior in flex life.
- **Chemical Resistance:** It has excellent resistance to almost all chemical agents and solvents.
- **Electrical Property:** It has excellent electric insulation property and exhibits higher dielectric strength even as a thin film. It has lower dielectric constant and dielectric loss tangent over a wide frequency range.
- **Flammability/Safety:** Nonflammable material conforming to UL standards 94V-O. Tasteless, odorless, and nonpoisonous. Moreover, Fluon® LM-ETFE is US FDA compliance, and registered in the inventory of Food Contact Substances at #481.
- **Surface Property:** It possesses lower frictionality, anti-stick, and excellent water and oil repellency. It possesses higher surface smoothness, and reduces resistance of fluids.
- **Light Transmittance:** Higher transmittance is presented in a wide range covering from the visual region to the ultraviolet region than that of conventional ETFE.

**Applications:**

Various linings and coatings/electric wire coating/tubes and hoses/various injection-molded parts/ transparent films/etc.
This revolutionary thermoplastic fluoropolymer has an adhesive ability enabling melt-bonding to other materials such as nylon, while maintaining anti-stick property as an original feature of fluoropolymer. Multilayer molding with strong adhesion can be completed in a process without specific adhesives or surface treatments, thereby providing various advantages such as productivity advancement by simplified process, and cost reduction by thinning fluoropolymer layer. Furthermore, ultra high-speed production of high-quality tube products has been achieved by newly developed double-layer tubing system SUNBESTA®.

Features:
- **Adhesive:** Can be directly adhered to other materials such as nylon by coextrusion processing. Heat sealing is also available. Good adhesiveness is exhibited even when the molding temperature is raised to 350°C.
- **Processability:** Ultra high-speed processing is possible, when used in the SUNBESTA® double-layer tubing system. Further, this fluoropolymer can be molded into a single layer/laminated film. Heat sealing is also available. Injection molding, combination with elastomer, and secondary processing are available, too.
- **Chemical Resistance:** It has excellent resistance to almost all chemical agents and solvents.
- **Electrical Property:** It has excellent electric insulation property, and exhibits higher dielectric strength even as a thin film. It has lower dielectric constant and dielectric loss tangent over a wide frequency range.
- **Surface Property:** It possesses lower frictionality, anti-stick, and excellent water and oil repellence. It possesses higher surface smoothness, and reduces resistance of fluids.

Applications:
Fuel hoses/laminated films, tubes/various industrial tubes and hoses/packing materials/etc.

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**Fluon® LM-ETFE AH Series**

**Features:**
- Adhesive: Can be directly adhered to other materials such as nylon by coextrusion processing. Heat sealing is also available. Good adhesiveness is exhibited even when the molding temperature is raised to 350°C.
- Processability: Ultra high-speed processing is possible, when used in the SUNBESTA® double-layer tubing system. Further, this fluoropolymer can be molded into a single layer/laminated film. Heat sealing is also available. Injection molding, combination with elastomer, and secondary processing are available, too.
- Chemical Resistance: It has excellent resistance to almost all chemical agents and solvents.
- Electrical Property: It has excellent electric insulation property, and exhibits higher dielectric strength even as a thin film. It has lower dielectric constant and dielectric loss tangent over a wide frequency range.
- Surface Property: It possesses lower frictionality, anti-stick, and excellent water and oil repellence. It possesses higher surface smoothness, and reduces resistance of fluids.

**Applications:**
Fuel hoses/laminated films, tubes/various industrial tubes and hoses/packing materials/etc.
Fluon® ETFE FILM is high-performance film produced by AGC with its own ETFE resin. It has fluoropolymer’s characteristics such as excellent heat resistance, chemical resistance, anti-stick property, electrical properties, and long-term weatherability, and is used in various fields including electronics, aviation/space industries, solar cells, kitchen equipments, and wallpaper materials, as well as roofs and facade of architecture.

F-CLEAN®, produced by Asahi Glass Green-Tech Co., Ltd., is a high-performance fluoropolymer film with additional functions for greenhouse coverings. It features surface treatment techniques and UV transmission controlling techniques uniquely developed by AGC, in addition to excellent light transmittance and long-term weatherability.

Features:

- **Heat resistance:** Usable within a wide temperature range from -200°C to +150°C.
- **Chemical resistance:** It has excellent resistance to almost all chemical agents and solvents.
- **Weatherability:** It possesses excellent weatherability from ultraviolet to infrared range, and maintains mechanical characteristics of fluoropolymers even after long-term outdoor exposure. This is proven by the fact that the film deployed on a greenhouse in 1985 is still used without degradation. Further, after an accelerated light resistance test (by sunshine weathermeter) for 15,000 hours, no substantial degradation of these fluoropolymers was found. This test corresponds to actual exposure of 30 years or longer.
- **Light transmittance:** It possesses excellent light transmittance with a total luminous transmittance of 95%. This property is effectively exhibited when used as solar cell protecting film, greenhouse horticulture, and membrane structure material.
- **Anti-stick property:** It possesses high surface tension and excellent anti-stick property, anti-fouling property, and mold release property.
- **Electrical property:** It possesses excellent insulation property, achieves high dielectricity even as a thin coating, and exhibits low dielectric constant and dielectric loss tangent over a wide frequency range.

Applications:

- Mold-releasing films
- Solar cell-protecting film
- Greenhouse coverings
- Wallpaper surface material
- Protective film for noise insulation material
- Membrane structure material
This fluoropolymer is a copolymer of tetrafluoroethylene (C2F4) and perfluoro alkoxy ethylene. Its chemical resistance is the best of meltprocessable fluoropolymers. It also has superior heat resistance, flexibility, transparency, and surface property, and is capable of acting as a meltprocessable thermoplastic fluoropolymer for parts in complicated shapes. It also maintains a stable state over a wider range from extreme low to high temperatures.

Features:

- **Processability:** Melt processing is possible. A grade suitable for fine injection molding is also available.
- **Heat Resistance:** Usable within a wide temperature range from -180 to +260°C.
- **Chemical Resistance:** Inert to almost all chemical agents, and not corroded by solvents.
- **Flammability/Safety:** Nonflammable material conforming to UL standards 94V-O. Tasteless, odorless, and nonpoisonous.
- **Electrical Property:** Electrical insulating material exhibiting extremely low dielectric constant and dielectric loss tangent.
- **Mechanical Property:** It maintains mechanical strength over a wider temperature range from -200 to +260°C, and is usable in a stable state.
- **Surface Property:** It possesses low frictionality, anti-stick, and excellent water and oil repellence.
- **Weatherability:** No functional degradation or deterioration in direct sunlight, wind, rain or exhaust gas, usable outdoors over a long period.

Applications:

Electric wire coating/semiconductor-related wetting parts, pipes, joints, wafer carriers, rectangular vessels/electric and electronic parts/etc.
This is a tetrafluoroethylene resin (PTFE: polytetrafluoroethylene) with a history of over half a century since its industrialization. It is highly rated for many excellent properties, and is the most widely used fluoropolymer. New applications are continuously developed. Its durability against chemical agents significantly outperforms others.

Features:
- **Heat Resistance:** Usable over a wide temperature range from -180 to +260°C.
- **Chemical Resistance:** Inert to almost all chemical agents, and not corroded by solvents.
- **Flammability:** Nonflammable material conforming to UL standards 94V-O. Tasteless, odorless and nonpoisonous.
- **Electrical Property:** It has a low dielectric constant and a low dielectric loss tangent over a wide frequency range, and exhibits excellent electric insulation properties.
- **Friction property:** It exhibits minimum friction coefficient among solid materials.
- **Surface property:** It has excellent anti-stick and mold-releasing ability with any adhesive material, and it is easy to peel.
- **Weatherability:** No functional degradation or deterioration in direct sunlight, wind, rain or exhaust gases, and usable outdoors over a long period.

Applications:
- Sheets and rods/packings and gaskets/sealing tapes and filters/paste extrusion for tubes and electric wire coatings/coatings for glass fabrics and metals/binders/lubricating additives for resin and paint/etc.

Line-up:
- There is a line-up of various products for a wide array of operating conditions and applications.
  - Molding powder (general molding powder)/fine powder (paste extruding powder)/dispersion (aqueous suspension for impregnation processing and coating)/lubricant (additive for lubrication)/filled compound (FC: filler-containing powder)
LUMIFLON® was developed and commercialized in 1982 by AGC as the first solvent-soluble fluoropolymer for coatings that can be cured under room temperature conditions. During this 30 years period, fluoropolymer coatings based on LUMIFLON® have been produced by many coating manufactures worldwide. LUMIFLON® based coatings maintain excellent appearance (gloss, color) of buildings and other structures for over 20 years, and also protect steel and concrete from sunshine, wind and rain, and corrosion. Therefore, LUMIFLON® based coatings reduce the total maintenance cost such as repainting or cleaning. Recently Asahi Glass has developed environmentally friendly LUMIFLON® grades, such as emulsion and powder grades.

Features:
- Excellent weatherability: LUMIFLON® has good chemical stability as fluoropolymer and shows excellent weatherability compared to other traditional coatings.
- Soluble in Common Solvents: LUMIFLON® polymer can be dissolved in various organic solvents.
- Curable under room temperature: LUMIFLON® gives you a choice of curing conditions from ambient to high temperatures (5°C/41F to 230°C/446F).
- Superior appearance: LUMIFLON® is a transparent fluoropolymer, therefore both clear and enamel coatings are possible. LUMIFLON® also can attain gloss retention over 80%.

Applications:
- Exteriors of buildings: Concrete/metal/plastic
- Heavy-duty anticorrosion: Bridges/chemical plants/off shore structures
- Transportation equipment: Aircraft/automobiles/trains/ships

CYTOP has an amorphous (noncrystalline) structure that differs from conventional fluoropolymers completely. It has an extremely high transparency exemplified by the fact that the transmittance of an ultraviolet light, a visible light, and a near infrared light is more than 95%. And is soluble in specific fluorocarbon solvent, enabling a thin film coating in the submicron order. Moreover, this "innovative" material still has the same properties (chemical resistance, electric insulation, water and oil repellency, and electret property) as conventional fluoropolymers.

Features:
- High Transmittance: CYTOP is a transparent material that allows transmission of 95% or more of light ranging from ultraviolet light to infrared light.
- Low Refractive Index and Low Dispersibility: CYTOP has unique properties including low refractive index and low dispersibility at various wavelengths that are not found in other materials.
- Electric Insulation: It possesses properties equivalent to PTFE resin.
- Thin Film Formation: Chemical resistance property specific to fluoropolymers is retained, enabling coating at 0.1 μ level.
- Electret Property: CYTOP shows high surface charge density to achieve high-power vibration-driver micro generators.

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CYTOP (Amorphous fluoropolymer)

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LUMIFLON® (High-weatherability fluoropolymer for coatings)

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CYTOP (Amorphous fluoropolymer)

LUMIFLON® (High-weatherability fluoropolymer for coatings)
AFLAS® is a fluoroelastomer based on an alternating copolymer of tetrafluoroethylene (C₂F₄) and propylene (C₃H₆), the molecular structure of which is different from that of conventional fluoroelastomers. This structure gives excellent properties, such as heat resistance, chemical resistance, electrical insulation, solvent resistance and steam resistance. AFLAS® will meet the applications where higher reliability is required.

Features

<table>
<thead>
<tr>
<th>Acid and alkaline</th>
<th>AFLAS® shows high resistance to high-concentration acids and alkalines.</th>
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<tbody>
<tr>
<td>Heat resistance</td>
<td>AFLAS® offers excellent heat resistance with a continuous service temperature of 200°C and a maximum peak exposure temperature of 250°C.</td>
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<tr>
<td>Oil resistance</td>
<td>AFLAS® is resistant to lubricating oils and hydraulic oils at high temperatures, especially to high performance engine oils formulated with amino additives. AFLAS® will be hardly affected by different types of additives.</td>
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<tr>
<td>Steam resistance</td>
<td>AFLAS® will remain stable when used for a long time. Porosity and softening do not occur even at 200°C of steam (1.5 MPa).</td>
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<tr>
<td>Electrical properties</td>
<td>AFLAS® exhibits excellent electrical insulation (Volume resistivity &gt;10¹⁶ Ω·cm) which cannot be found in conventional fluoroelastomers.</td>
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<td>Solvent resistance</td>
<td>AFLAS® is stable up to 2000Kg of Gamma-ray irradiation.</td>
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<tr>
<td>Applications</td>
<td>AFLAS® exhibits high resistance to polar solvents such as alcohols, amines, etc.</td>
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Applications:
- Oil seals, O-rings, packing, and gaskets
- Heat resistant electrical cable
- Diaphragms/rods/drawers, hoses, and tube/coated fabrics and belts
- Fluoroplastics modifier/substitutes for fluoroplastics
### Chemicals and Immersion Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>PTFE</th>
<th>Silastic</th>
<th>TFE</th>
<th>Fluorocarbon</th>
<th>TFE-ETFE</th>
<th>PTFE-ETFE</th>
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<td>Sulfuric acid (35%)</td>
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<td>Nitric acid (68%)</td>
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<td>Hydrochloric acid (37%)</td>
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<td>Sodium hydroxide (50%)</td>
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○ Volume change 5%  
□ Volume change ~15%  
✓ Volume changes ~40%  
× Decomposed or dissolved

### AFLAS® Product Lineup

**AFLAS® 150 Series**
- Standard Grade: Excellent in chemical resistance and electric insulation properties. Suitable for compression molding and extrusion molding.

**AFLAS® 100 Series**
- High Strength Grade: High mechanical strength is given by the extremely high molecular weight. Molecular structure is the same as the AFLAS® 150 series.

**AFLAS® 200 Series**
- High-temperature properties and chemical resistance: Improved in the flexibility of the AFLAS®100/150 series at low temperatures. Excellent processability for the compression molding and injection molding.

**AFLAS® 300 Series**
- Surface improvement for extrusion: Improved curability and extrusion processability with its special termonomer. It also gives low die-swell, good dimensional stability of moulded parts and smooth surface finish.

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**AGC History of Development of Fluoropolymer Products**
- 1972: Fluon® ETFE fluoropolymer
- 1975: Fluon® ETFE fluoropolymer film
- 1980: AFLAS® Fluoroelastomer
- 1983: Fluon® PTFE fluoropolymer
- 1987: Fluon® PFA fluoropolymer
- 1990: CYTOP transparent fluoropolymer
- 1992: Fluon® LM-ETFE low melting-point fluoropolymer
- 1999: Fluon® Ultra Pure PFA ultra-purity fluoropolymer
- 2003: Fluon® LM-ETFE AH Series adhesive fluoropolymer

**Fluoropolymer as Environment-symbiotic Technology**
Nowadays, environmental protection is regarded as the highest priority theme in every industrial field. Fluoropolymers and fluoroelastomers have been applied to environmental friendly products and process techniques. The properties of Fluoropolymers and fluoroelastomers including weatherability, nonflammability and chemical resistance, gives longer life to various products and save resources and reduce industrial wastes. For example, Fluon® ETFE is used for fuel hose of automobile to reduce its fuel permeation, and F-CLEAN ® ETFE film is used as film for agricultural house because of its long life. AGC helps your continuous effort for environment protection, through our development, improvement, and enhanced applications of these products. Simultaneously AGC as a manufacturer of fluorine chemicals establishes recycling process technique and anti-pollution process technique in actual production sites to continuously effort to reduce the environmental load by the fluorine products themselves. AGC believes that the technology of fluoropolymer with advantageous possibilities contributes to solve environmental problems and plays an important role in realizing a safe and comfortably society of environment-symbiotic type.