High-Function Fluoroelastomer
As a leading manufacturer of various fluorochemical products, AGC keep asking ourselves this question: What could we do to contribute to creating a more fulfilling society and making people’s lives more comfortable while protecting the global environment? One of the answers that AGC has come up with is AFLAS®.

It is high-performance fluoroelastomer that is superior to conventional rubber products in terms of thermal resistance, chemical resistance, strength, etc. and is commonly used to make sealing, hose, and covering materials. Its wide-ranging applications include underground resource mining without environmental pollution, highly reliable production equipment and facilities, enhancement of the energy-saving performance of vehicles, enabling our track record to continuously increase. One’s choice to use AFLAS® signifies their prioritization of a sense of security, safety, and quality as well as being future-minded. With AFLAS®, more can be accomplished.
Fluoroelastomer is a general term that refers to any synthetic rubber that contains fluorine in its molecular structure. Compared to silicone and other synthetic rubber, it shows superior characteristics in terms of thermal resistance, chemical resistance, electric insulation, steam resistance, etc. and therefore has been used in a growing number of industries where the parts and products are subjected to harsh operating conditions.

FKM, FEPM, and FFKM* are common fluoroelastomers that have unique characteristics respectively. AGC’s AFLAS® includes especially high-functioning FEPMs and FFKMs in its product range.

FKM was the fluoroelastomer that was developed first, which offers a good balance between performance and cost. As for FFKM, it offers superb performance but is proportionately more costly, so it’s targeted for special applications.

Meanwhile, the AFLAS® FEPM product series, which AGC first introduced to the market in the 1970s, has been able to successfully expand the possibilities of what fluoroelastomers can do, with its cost competitiveness and excellent thermal resistance, chemical resistance, electric insulation, etc. that nearly match those of FFKM.

In 2017, AGC debuted the AFLAS® FFKM series that was created based on the technical know-how that AGC gained from FEPM, which allows AGC to meet the ever more advanced needs of various industries.

*AFLAS® is AGC’s collective brand of high-performance fluoroelastomer products FEPM and FFKM.

<table>
<thead>
<tr>
<th>Types of fluoroelastomer and the position of AFLAS®</th>
<th>AFLAS® FFKM</th>
<th>AFLAS® PM-1100</th>
<th>AFLAS® PM-3000</th>
<th>AFLAS® CP-4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFLAS® FEPM</td>
<td>AFLAS® 100</td>
<td>AFLAS® 150</td>
<td>AFLAS® 400</td>
<td>AFLAS® 600</td>
</tr>
<tr>
<td>FKM</td>
<td>Ternary</td>
<td>Binary</td>
<td></td>
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AFLAS® FEPM is a fluoroelastomer product series that is mainly composed of alternating copolymers of tetrafluoroethylene and propylene. The thermal and chemical stability of the polymers are achieved by the structure where almost all propylene units are positioned between the adjacent tetrafluoroethylene units on both sides. The product series has a track record of being successfully used in various fields for over 40 years, and also is known for its stable quality and reliability.

**Flame retardance:** It burns when put into a flame but stops burning when removed from the flame.

**Chemical resistance:** It hardly deteriorates when exposed to a high-temperature strong acid or base.

**Thermal resistance:** It has sufficient thermal resistance as long as the continuous-use temperature does not exceed 200˚C, and the short-time use temperature is kept between 230 and 250˚C.

**Low odor-adhesiveness:** With its very low odor-adhesiveness compared to other rubber materials, it is suitable for making gaskets and packing that will be used between piping parts at production lines, where any residual or adhesion of odor to products, etc. should be avoided.

**Oil resistance / amine resistance:** It exhibits excellent oil resistance to engine oil, gear oil, etc. that contain large amounts of amine additives.

**Durability / strength:** It is a material of high hardness and elongation that can be used under high-temperature and high-pressure conditions without issue. (Even if material has high-strength, it might crack in a high-pressure environment unless it has proper extendibility.)

**Electric insulation:** It has high electric insulation of $3 \times 10^{16} \text{ Ω cm}$ in terms of volume resistivity.

**Steam resistance:** It can withstand being exposed to 250˚C steam.

**Low-temperature property:** It has a low brittle temperature and has excellent overall strength when used in a low-temperature environment.

**FEPM SERIES**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Main applications</th>
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</tr>
</thead>
<tbody>
<tr>
<td>AFLAS® 100S/100H</td>
<td>Sealing material</td>
<td>Oil seal</td>
</tr>
<tr>
<td>AFLAS® 150E/150P</td>
<td>Reinforcement</td>
<td>Sealing material</td>
</tr>
<tr>
<td>AFLAS® 150CS/150C</td>
<td>Sealing material</td>
<td>Oil seal</td>
</tr>
<tr>
<td>AFLAS® 600X</td>
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**Characteristics of FEPM**

Fluoroelastomers with excellent thermal, oil, and chemical resistance that has a successful track record of use in various industries.
The frontier of resource development is now widening into the unknown realms of the deep sea, the high-temperature and high-pressure layers of earth, etc. With such trends emerging, the technical requirements of digging equipment, etc. are becoming increasingly demanding. For example, the tip of an oil-well drilling machine must be made of material that has high thermal and pressure resistance, as it is constantly exposed to hydrogen sulfide and other corrosive gas and steam that are emitted in the ground as well as to the drilling oil that is supplied from above ground. The AFLAS® FEPM series is capable of meeting all these stringent requirements and has been widely used to make sealing and protective covering materials. It makes a significant contribution to oilfield development around the world.

It ensures safety and protects the natural environment while functioning properly under the harshest conditions at production sites.

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Resource recovery

It ensures safety and protects the natural environment while functioning properly under the harshest conditions at production sites.
Examples of use of AFLAS® in automotive applications

It contributes to natural resource conservation and environmental protection by generating the potential of vehicles and heavy machinery.

Vehicles and heavy machinery today are quite safe and friendly to both the environment and humans alike. Although such high-level performance is a common requirement, it can only be achieved by meeting strict technical requirements, one by one. Engine lubricant and fuel products are intrinsic parts of this technological progress.

A wide variety of chemicals and additives are often incorporated to enhance product performance. However, they could also deteriorate or otherwise negatively affect the seals and hoses that are made of elastomers.

This sort of issue is however resolved in the case of the AFLAS® FEPM series, as it offers superior chemical resistance and increases the longevity of vehicles and heavy machinery, although it’s not necessarily evident upon the surface.

Cylinder-head gasket
As AFLAS® is resistant to both engine oil and coolant, it is suitable for gaskets that consist of metal and rubber (metal-rubber gaskets), such as... Recommended grades: AFLAS®150E, 400E

Oil cooler hose / turbocharger hose
Due to today’s stringent regulations on exhaust gas emissions, it has become necessary for diesel engines to return the fuel gas and oil mist that leak from the cylinder blocks back into the intake passage through the Oil cooler hose. AFLAS® is highly resistant to the various additives that are contained in the oil, which... Recommended grade: AFLAS®100S

Oil seal / pinion shaft seal
The seals that are used in engine oil, transmission oil, and brake fluid contain large amounts of various dispersions and antioxidants. AFLAS® is resistant to such agents and is suitable for high-moisture environments such as... Recommended grade: AFLAS®100S

*The illustration is a sample image.
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Transport machinery / heavy machinery

Vehicles and heavy machinery today are quite safe and friendly to both the environment and humans alike. Although such high-level performance is a common requirement, it can only be achieved by meeting strict technical requirements, one by one. Engine lubricant and fuel products are intrinsic parts of this technological progress.
Green vehicles (HVs, PHVs, EVs, etc.) and railroad vehicles are thought to be friendly to the global environment due to their low CO2 emissions. However, the electric wires and power cables that sustain their operation are used under more demanding conditions, partly due to those vehicles becoming lighter in weight.

The AFLAS® FEPM series offers high resistance to both external and internal heat along with flexibility that provides improved installation of wiring, in addition to superb electric insulation that is a mandatory feature of electric wire coating material. Its track record of use in various applications is ever-improving, ranging from vehicles and large machinery to home appliances.

It protects electric wires that are vital to the operation of various electric equipment, from large-scale facilities to home appliances.

<table>
<thead>
<tr>
<th>Electric insulation property</th>
<th>Dielectric breakdown voltage</th>
<th>Volume resistivity</th>
<th>Permittivity</th>
<th>Thermal resistance</th>
<th>Chemical resistance</th>
<th>Oil resistance</th>
<th>Flame retardance</th>
<th>Flexibility</th>
<th>Stress cracking resistance</th>
</tr>
</thead>
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Although fluoroplastics are excellent in electric insulation, they lack flexibility. As a result, they often lead to wiring routing issues. Meanwhile, AFLAS® offers flexibility; it has been used as thin wire material in a wide variety of applications, from automobiles to home electronics and gas appliances, etc. It is also used as thick wire material around blast furnaces, etc.

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<th>Power cable coverings</th>
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In order reduce the weight of an electric wire, the diameter of its electric conductor has to be reduced. However, if the electric conductors are made thinner, the amount of electrical resistance will increase, which in turn requires higher thermal resistance to cope with more internally generated heat. As AFLAS® is valued as insulating material that satisfies all these tough requirements, it has been used to make power cable coverings in bullet trains and electric cars.

Power cables are crucial for supplying power to batteries and motors in a reliable manner. In the latest models of EVs, HVs, and PHVs, lightness is a standard requirement for energy- and space-saving, in addition to dustproof and electric insulation. Given its high thermal resistance, superb electric insulation, and low-specific gravity, AFLAS® is an optimal material for making electric wire coverings for these applications.
As the AFLAS® FEPM series offers superb thermal resistance and durability among other excellent features, it has been used in an ever-increasing number of applications including various infrastructures, factories, etc. For example, due to its low odor-adsorption characteristics, it is used to make packings, and other similar components in food manufacturing. As it is also highly resistant to both chemicals and steam, its use has become widespread as sealing material that is incorporated into chemical plants, replacing FKM.

It has also been adopted in a growing number of fields where only highly reliable products are accepted, such as in space stations and satellites, because of its superb radiation and ozone resistance.

Its excellent characteristics are highly valued in various manufacturing operations and extreme environments.

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The data shown in the graph were measured after immersing the test objects in a commercially available 80˚C orange-flavored beverage (30% pure orange juice) for 24 hours and then washing them in running water for 30 minutes.

Odor adsorption is proven based on odor index equivalent value.
AFLAS® FFKM is a fully fluorinated rubber copolymer product series that is mainly composed of tetrafluoroethylene (CF₂) and perfluoroalkoxy ether (C₂F₃-ORf). It has characteristics that are superior to those of partially fluorinated fluoroelastomer (FKM/FEPM) in terms of thermal resistance, chemical resistance, solvent resistance, ozone resistance, etc., and can meet heavy-duty operating conditions such as high temperature and high pressure since being introduced to the market in 2017. It has been used in a wide variety of applications as high-performance sealing material.

Fluoroplastic that overcomes higher-temperature conditions and seeks new possibilities

**AFLAS® FFKM product range by their heat-resisting temperatures**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Thermal resistance</th>
</tr>
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<tbody>
<tr>
<td>CF-099</td>
<td>230°C</td>
</tr>
<tr>
<td>CF-097</td>
<td>250°C</td>
</tr>
<tr>
<td>CB-046</td>
<td>280°C</td>
</tr>
<tr>
<td>CB-099</td>
<td>300°C</td>
</tr>
</tbody>
</table>

**Characteristics of FFKM**

**Chemical resistance:** It has significantly high resistance to high-temperature and highly active acids, alkalis, hydrogen sulfide, etc.

**Thermal resistance:** It has sufficient thermal resistance as long as the continuous-use temperature is kept between 200 and 280°C, and the short-term use temperature is maintained between 280 and 300°C.

**Oil resistance / solvent resistance:** It has significantly high resistance to oil and solvents.

**Durability / strength:** It has a superb compression set and also an excellent mechanical strength of over 20 MPa.

**Ozone resistance:** Its physical properties do not change even after being exposed to 50 ppm ozone at 40°C for a month.
AGC’s AFLAS® manufacturing system ensures steady supply

Its plants in Japan utilize cutting-edge fluorochemical technology and deliver high-quality products.

With roughly 100 years of experience in chemical production and around 50 years of experience with fluorochemical products, AGC has been a leading developer and manufacturer of high-performance fluoroelastomers from an early stage, while leveraging its technical competency and delivering superb results. In 1975, AGC started marketing AFLAS® FEPM, catering to the wide-ranging needs of various industries. In 2017, AGC introduced AFLAS® FFKM to the market and has constantly been taking on different challenges to cultivate new possibilities for fluoroelastomers. It is also noteworthy that all products that belong to the AFLAS series are made in Japan. Being integrally produced at AGC’s dedicated plants in Japan under meticulous quality control, AFLAS products can be securely supplied to every corner of the world.
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2) Please refer to the SDS (Safety Data Sheet) for safety and details.

3) This product is not designed for use in the implantation of the human body or for medical applications that come in contact with body fluid or body tissues, AGC Inc. carries out no test as to the fitness of the product for any medical applications.

4) The contents are subject to change without prior notice.