Fluon+™ MPC
Melt Processable Compounds

Introduction to Fluon+™ Melt Processable Compounds

Superior Quality

When it comes to melt processable fluoropolymer compounds, no company has more experience, more varieties, or more technical expertise. More importantly, this expertise is available to customers at every step of the process. Fluon+™ Melt Processable Compounds (MPC) are based upon fluorinated copolymer resins: PFA, FEP, ETFE, PVDF and ECTFE.

AGC Chemicals Americas' (AGCCA) Melt Processable Compounds are used to enhance properties of and add functionality to a wide array of fluoropolymers. These products, ranging from pigmented to reinforced, exhibit properties that are critical in today's applications, combining inherent chemical resistance with enhanced properties made possible by compounding. The benefit of fluoropolymer compounds can be seen in such properties as toughness and lubriciousness. The table below summarizes common products. Additionally, unique products are developed continuously to address specific customer and application requirements.

Fluon+™ MPC Common Products

Resin	PFA	FEP	ETFE	PVDF	ECTFE
Color Concentrates	Standard	Standard	Standard	Standard	Standard
Foam Concentrates	Custom	Standard			
Cross-linkable			Standard		
Conductive & Anti-static	Standard	Custom	Standard	Custom	Custom
Flexible			Standard		
Reinforced	Standard	Custom	Standard	Custom	Custom
Adhesive	Custom		Standard		

Color Concentrates

Fluon+ MPC Color Concentrates are used in injection molded parts, tubes, colored wire insulation, or any products that require pigmentation. The AGCCA product line includes color concentrates based on FEP, ETFE, PFA, PVDF, and ECTFE melt processable fluorinated copolymers with a range of flow rates for various processing and application needs.

White, Orange, Blue, Green, Brown, Red, Black, Yellow, Violet, and Gray are the standard colors available; see individual data sheets for approximate RAL and CIELAB color values. Custom colors and color matching available upon request.

The color concentrates are supplied in cylindrical pellet form, approximately 0.080-inch long by 0.080-inch diameter (2.03 mm long by 2.03 mm diameter). The typical loading level for Fluon+ MPC Color Concentrates is 1-5%; the optimal level is based on the part thickness, conductor type, and desired opacity.

Foam Concentrates

Fluon+ MPC Foamed FEP products have a lower dielectric constant and a lower dissipation factor thus minimizing signal loss and enhancing high-speed data transmission of data cables. In addition, foamed products are lighter in weight compared to similar constructions using a solid wall and results in a reduction in FEP usage, which leads to a cost savings.

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FEP Foam Concentrates contain a well-dispersed nucleating agent that acts as a site for foaming during the gas injection extrusion process. Standard grades are available in both high and low viscosity resins, allowing for foamed cable production of everything from LAN to coaxial cable constructions.

These concentrates are added at approximately 8-10% to natural FEP for applications requiring void contents of up to 55%. Maximum void content is dependent upon foam extrusion system, tooling designs, and concentrate level. Thinner wall constructions or applications requiring lower void content may more typically use a letdown level of 1-3%.

Cross-linkable Compounds

Fluon+ MPC ETFE Cross-Linkable compounds contain a cross-linking agent, which is used to enhance the toughness of ETFE, commonly required in automotive or aerospace cables. Crosslinking ETFE increases its mechanical properties such as abrasion resistance, cut-through resistance, and tensile strength, especially at elevated temperatures (see Fig. 1).

These products are manufactured as "ready-to-use" and can be used in combination with Fluon+ MPC Color Concentrates for pigmented cables. Typical customization of cross-linkable product includes desired color, flexibility, melt flow rate of final compound, and amount of cross-linking needed for the application. The processed article can be cross-linked using electron-beam radiation or gamma radiation.

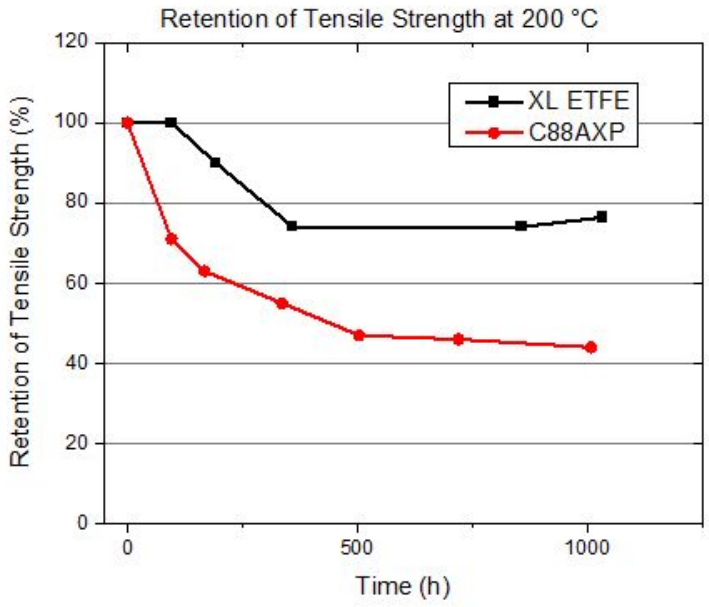

Figure 1. Differences in retention of tensile strength between crosslinked and un-crosslinked ETFE at 200 °C exposure.

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Conductive/Anti-Static Compounds

Conductive fluoropolymers are manufactured as ready-to-use products and used in self-regulating or constant wattage heater cables, static dissipative fuel lines, and other applications where conductivity or static dissipation is required. AGC offers standard conductive grades in ETFE and PFA.

Fluon+ MPC Conductive compounds can also be customized for unique application requirements. Customization of products includes melt flow rate and physical properties of final compound as well as conductivity needed for the application. Consistency and processability are the key factors in developing these compounds. In addition, Fluon+ Conductive compounds show stable conductivity over a range of shear rates.

The graph in Fig. 2 shows conductivity as a function of carbon content and ETFE base resin. Product conductivity performance can be tailored to the application and the customer's process.

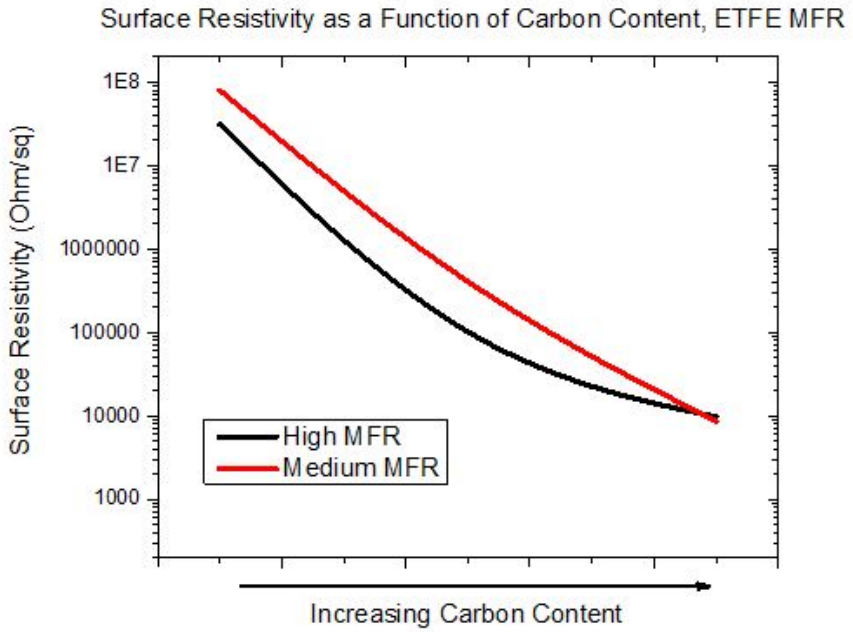

Figure 2. Compound conductivity as a function of carbon content and ETFE resin melt flow rate.

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Flexible AR Compounds

Fluon+ MPC Flexible AR grades are melt-processable compounds based on modified ethylene / tetrafluoroethylene (ETFE) copolymer and a fluoroelastomer. Fluon+ AR grades maintain many of the desirable properties of ETFE, but in a form that is much more flexible (see Fig. 3). These materials can be used in many applications including wire and cable (automotive, industrial, aerospace, transit, and appliance markets); films and sheets; tubing and pipe; and electronic components.

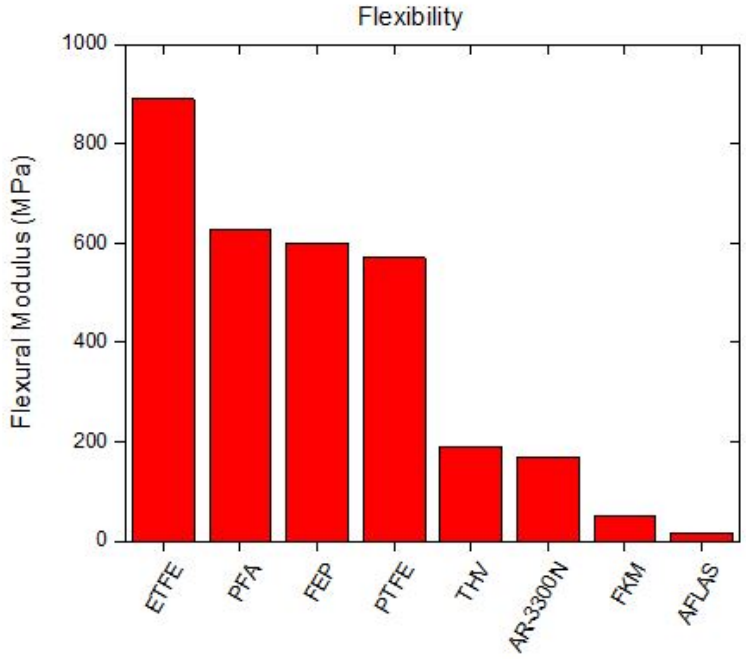

Figure 3. Flexibility as measured by Flexural Modulus of AR-3300N compared to various fluoropolymer materials.

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Heat Aging of Fluon+ Flexible AR Compounds

The heat resistance of Fluon+ Flexible AR grades can be improved by radiation curing. The product can be cross-linked without the presence of curing agents or co-agents. The recommended dosage is 1-10 Mrads of electron-beam or gamma-ray radiation. Fig. 4 shows the effect of crosslinking on AR-3300N and how the compound retains strength at elevated temperatures.

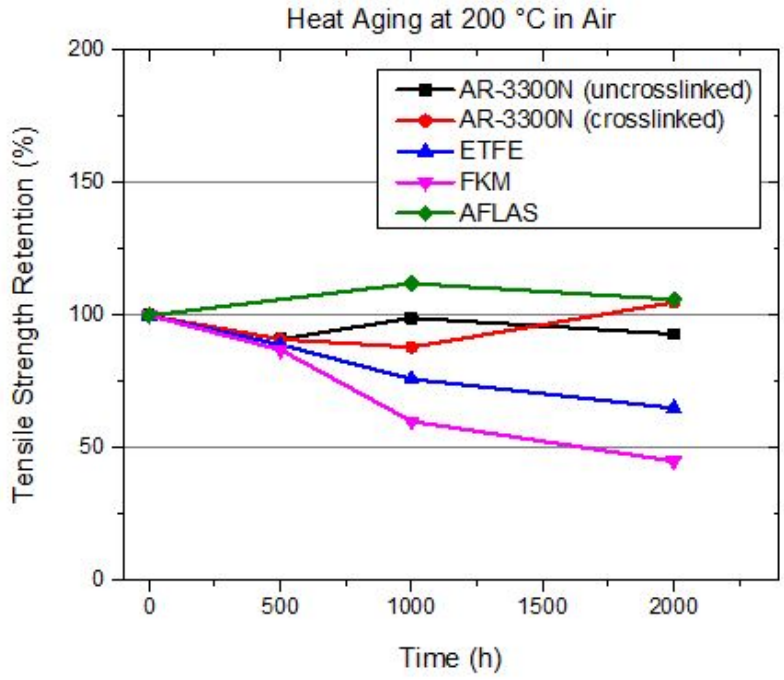

Figure 4. Tensile strength retention of AR-3300N (crosslinked and un-crosslinked) at 200 °C exposure.

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Reinforced Compounds

Fluon+ Reinforced Compounds incorporate glass, carbon, or mineral fillers for enhanced dimensional stability, abrasion resistance, or physical strength. These products can be used in demanding applications where the thermal and chemical resistance of a fluoropolymer is required with additional mechanical toughness provided by the addition of a fiber or other reinforcing filler.

Fig. 5 provides an example of how mechanical properties of ETFE are affected through the use of reinforcing glass fibers.

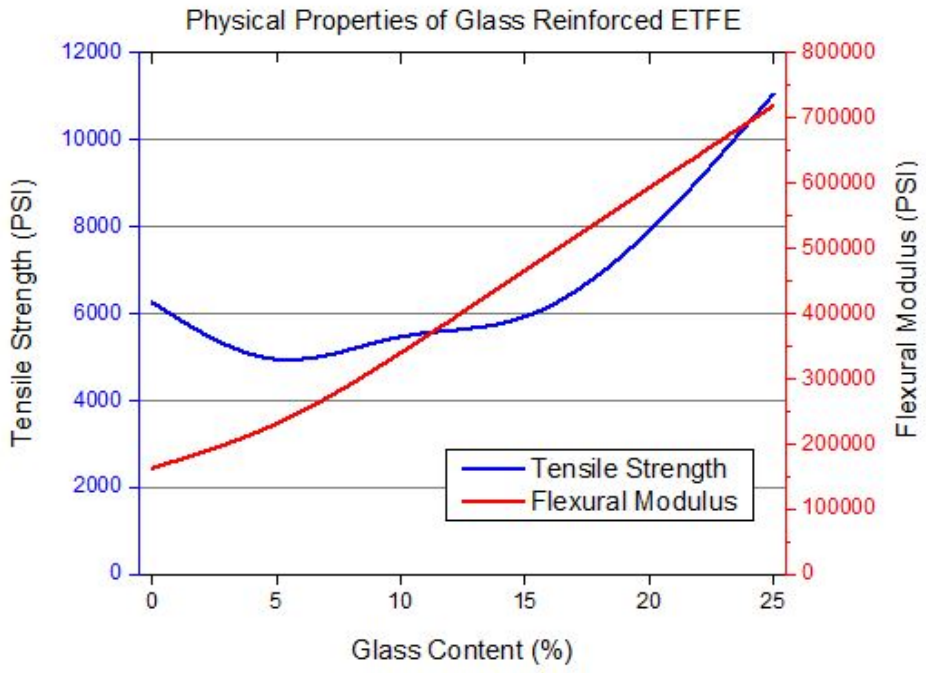

Figure 5. Changes in mechanical properties for ETFE-based, glass-reinforced compounds.

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Adhesive Compounds

Fluon+ Adhesive resins are based on either ETFE or PFA polymers. These materials are functionalized such that they can chemically adhere to non-similar materials. This adhesive functionality grants the user an amount of design flexibility that would not be possible with a typical fluoropolymer. It also reduces cost, weight, and processing time by eliminating the need for tie layers in multi-layer constructions.

Adhesive ETFE and Adhesive PFA each contain a unique functional component, which reacts with compatible groups to form a thermally stable chemical bond that maintains adhesion even in extended exposure to chemical environments (see Fig. 6). Adhesive ETFE is commonly used in automotive applications by co-extruding ETFE with a polyamide to produce a hose that cannot be delaminated even after thousands of hours of fluid exposure.

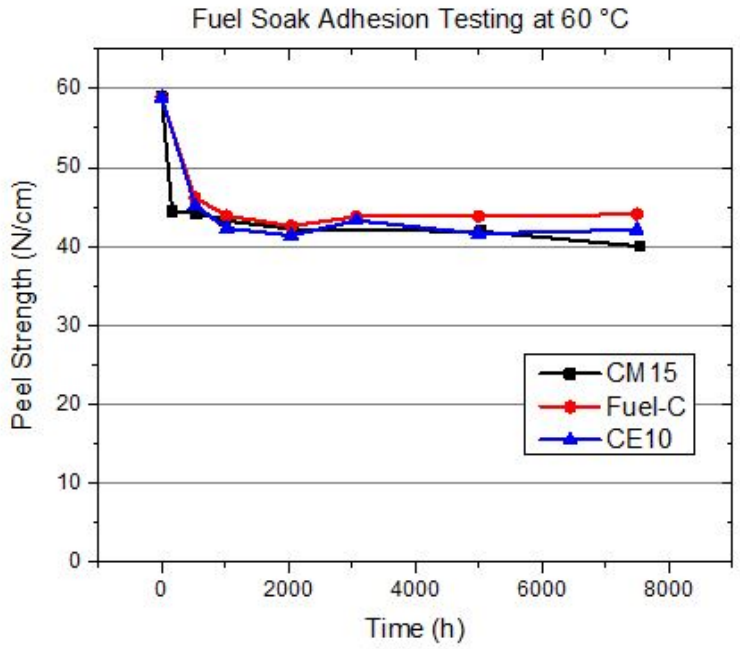

Figure 6. Adhesion strength between Adhesive ETFE and Polyamide in various fuels.

Custom Products

AGC is continuously developing new compounds to meet unique customer demands and evolving market requirements. Custom compounds may be developed by creating custom colors or by combining material technologies to create uniquely qualified compounds. For instance, the combination of adhesive ETFE with a carbon filler to create a compound that is both co-extrudable with another polymer as well as electrically conductive.

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Handling Precautions and Storage

Heating Fluon+ products in excess of 750 °F (399 °C) can produce toxic fumes. It is, therefore, necessary to provide local exhaust ventilation in areas where Fluon® products are exposed to high temperatures. Avoid breathing fumes or contaminating smoking tobacco with fumes, powder, or dust.

Thermal decomposition of this product will generate hydrogen fluoride, which is corrosive. Corrosion resistance materials are required for prolonged contact with molten resin.

All compounds and resins should be stored in their original containers. This will be either in re-sealable plastic pails, or in drums with the liner bags and chime rings securely re-fastened.

Products should be stored indoors at nominal conditions of 23 °C and 50% relative humidity. Refrigeration is not required.

Although fluoropolymers will not readily adsorb moisture when stored under appropriate conditions, other components of the compound may. Customers may wish to dry the material immediately prior to use, especially in the case of filled or conductive compounds. Your AGCCA representative can recommend appropriate drying conditions.

Hazardous Substances

This product does not contain lead, hexavalent chromium, or cadmium, and is used in applications where RoHS (Restrictions on the use of Certain Hazardous Substances) compliance is required.

Shelf Life Statement

All compounds and resins should be stored in their original containers. This will be either in re-sealable plastic pails, or in drums with the liner bags and chime rings securely re-fastened.

Products should be stored indoors at nominal conditions of 23^{o}C and 50% relative humidity. Refrigeration is not required.

Although fluoropolymers will not readily adsorb moisture when stored under appropriate conditions, other components of the compound may. Customers may wish to dry the material immediately prior to use, especially in the case of filled or conductive compounds. Your AGCCA representative can recommend appropriate drying conditions.

Cross-linkable compounds should be properly disposed of after two (2) years from the date of manufacture; this date is located on each material container. Other resins and compounds do not have a shelf life when stored under appropriate conditions.

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Safe Handling Information

A summary of the hazards, as defined by OSHA Hazard Communication Standard, 29 CFR 1910.1200 for this product are:

Physical hazards: None

Health hazards: None

FOR ADDITIONAL INFORMATION AND HANDLING INSTRUCTIONS READ AGC CHEMICALS AMERICAS, INC. MATERIAL SAFETY DATA SHEET.

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