

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 on copolymer resins: FEP, ETFE, PFA, MFA, PVDF and ECTFE.

AGC Chemicals Americas' Melt Processable Compounds are used to pigment and enhance properties in a wide range of fluoropolymers. These products exhibit properties very important in today's applications, excellent chemical resistance for instance, which can be coupled with properties only allowed by compounded additives. The benefit of fluoropolymer compounds can be seen in such properties as toughness and lubricity. The table below summarizes common products. Additional unique products are created constantly on a custom basis.

FLUON MPC COMMON PRODUCTS

Resin	FEP	ETFE	PFA	MFA	PVDF	ECTFE
Color Concentrates	Standard	Standard	Standard	Standard	Standard	Standard
Cross-linkable		Custom			Custom	
Foam Concentrate	Standard	Custom	Custom	Standard	Custom	Custom
Conductive	Custom	Custom	Custom	Custom	Custom	Custom
Reinforced	Custom	Custom	Custom	Custom		
Lubricated	Custom	Standard	Custom	Custom	Custom	Custom

HAZARDOUS SUBSTANCES

Fluon MPC compounds do not contain lead, hexavalent chromium or cadmium, and are used in applications where RoHS (Restriction of Hazardous Substances) compliance is required. In 1993, these hazardous ingredients were removed from our formulations to provide a safe working environment for our workers and our customers.

COLOR CONCENTRATES

Fluon color concentrates are used in injection molded parts, tubes and colored wire insulation. The AGC product line includes color concentrates based on FEP, ETFE, PFA, MFA, PVDF and ECTFE melt processable fluorinated copolymers with a range of flow rates for various processing and application needs.

Fluon® Melt Processable Compounds

Color Concentrate Base Resins: Our color concentrates are based on neat resin and pigment only. No other polymeric processing aids are added. To ensure the highest performing product, we have very tightly maintained raw material specifications that ensure the highest compatibility with your materials. In cases where unique materials are used, we can transfer any pigment system to match your specific needs.

Pigment Dispersion: AGC Chemicals color concentrates have excellent pigment uniformity and dispersion. This consistency provides the user with a more robust processing window even in the most demanding wire & cable applications such as plenum LAN cable production where line speeds can exceed 2000 feet per minute, and wall thickness can range from 5 to 7 mils.

Pellet Size: The color concentrates are supplied in cylindrical pellet form, approximately 0.125" long and 0.080" in diameter. In order to ensure consistent performance, every product we sell must meet uniform pellet size tolerances. The benefit of this to the customer is twofold. First, by ensuring tight pellet sizes, volumetric addition is much more consistent lot to lot. Secondly, consistent volume-to-surface area of each pellet results in consistent melt rate. This leads to improved product consistency and mixing with the base resin. Once your process is optimized, there is no need to adjust with each new lot.

Colors Available: White, Orange, Blue, Green, Brown, Red, Black, Yellow, Violet and Gray. See individual data sheets for approximate RAL color values. Custom colors are available upon request.

Typical Usage Levels: The table below summarizes the amount of color concentrate, by weight percent, to obtain 50% opacity on a 5 – 7 mil wall or part thickness. This information is meant to provide a starting point and may need adjustment depending upon wall thickness, conductor type and desired opacity.

Fluoropolymer	Recommended Loading Level
FEP	1.0 – 2.0%
ETFE	1.0 – 2.5%
PFA	5.0 – 6.0%
MFA	2.5 – 3.0%
PVDF	2.5 – 3.0%
ECTFE	2.0 – 2.5%

Determining the Right Usage Level for AGC Chemicals Americas Color Concentrates:

AGC recommends starting with the lowest recommended loading level and increasing the level in 0.25 to 0.50% increments until satisfactory results are achieved. By starting with the lowest concentration, it is easier to optimize the appropriate level. If too much color concentrate is added, it can be more difficult to disperse, and the effectiveness of the product is diminished. All color concentrates have been developed to work efficiently with today's volumetric addition systems and typical pigmentation needs for wire & cable, tubing and injection molding applications.

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Wire Extrusion Screen Packs: It is not necessary to use extremely fine screen packs to screen out agglomerates. Our compounding process ensures that pigments are uniformly dispersed and very finely divided. Using multiple very fine screen packs can create large amounts of dead space and areas for polymers to “hang up” and degrade over time. A summary of screen sizes is included below for your convenience when considering screen pack configuration.

Mesh per Inch (U.S. Standard)	Microns	Inches	Mils
50	300	0.0118	11.81
60	250	0.0098	9.84
70	212	0.0083	8.35
80	180	0.0071	7.09
100	150	0.0059	5.91
120	125	0.0049	4.92
140	106	0.0042	4.17
170	90	0.0035	3.54
200	75	0.0029	2.95
230	63	0.0025	2.48
270	53	0.0021	2.09
325	45	0.0018	1.77
400	38	0.0015	1.50
425	33	0.0013	1.30

COLOR COORDINATES

Three parameters describe where a particular color falls in the CIELAB color space:

L* describes the lightness of color. A value approaching 100 is considered very light, or white, whereas a L* of 0 is black.

a* describes the saturation of red and green. A positive value is red; a negative value is green.

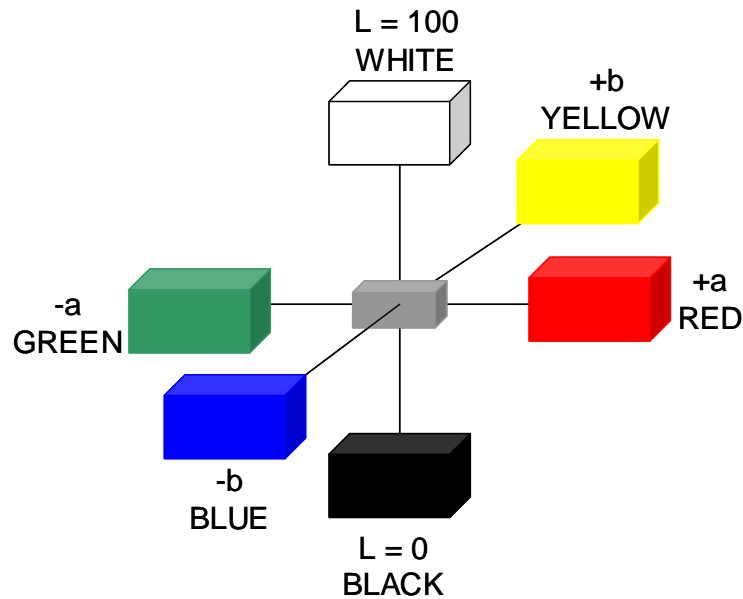
b* describes the saturation of yellow and blue. A positive value is yellow; a negative value is blue.

ΔE* (delta E*) describes the color difference between two samples. Color space is not uniform in all regions; however, a ΔE* equal to 1 in the red area may be less visible than the same ΔE* in the blue region.

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

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AGC Chemicals uses a 10° observer angle and a D65 illuminant when reporting CIELAB values. Specular reflectance has been excluded in order to discount any surface gloss effects.



CROSS-LINKABLE COMPOUNDS

Fluon cross-linkable compounds are typically used in automotive or aerospace applications using either ETFE or PVDF. Cross-linking fluoropolymers increase mechanical properties such as scrape abrasion, cut-through resistance and tensile strength, especially at elevated temperatures. Flammability of the cross-linked polymer is also improved.

These products are manufactured as ready to use and may be pigmented. Typical customization of products includes color, 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.

FOAM CONCENTRATES

Fluon FEP foam concentrates contain a well-dispersed nucleating agent that acts as a site for foaming during the gas injection extrusion process. In FEP, two standard grades are available. Higher flow FEP foam concentrates based on FEP TE9494, a 30-mfr product available from DuPont, can be used to manufacture thinner wall constructions such as LAN twisted-pair cables. Lower flow FEP foam concentrates based on FEP 100, a 6.5-mfr product available from DuPont, can be used to manufacture thicker wall constructions such as coaxial cable.

Product	Product Code	MFR (g/10 min)	Bulk Density (g/L)	L* Lightness	Dispersion Quality (microns)
FP-F-FMX1	420-516-110	6.7	1150	95.6	< 10
High Flow FXM1-9494	428-516-001	30	1180	94.1	< 10

Electrical Properties: 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 result in a reduction in FEP usage which leads to a cost savings.

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Usage Level: These concentrates are added (approximately 8-10%) to natural FEP. This letdown level is appropriate for typical high-void content applications. Maximum void content is dependent upon foam extrusion system, tooling designs and concentrate level.

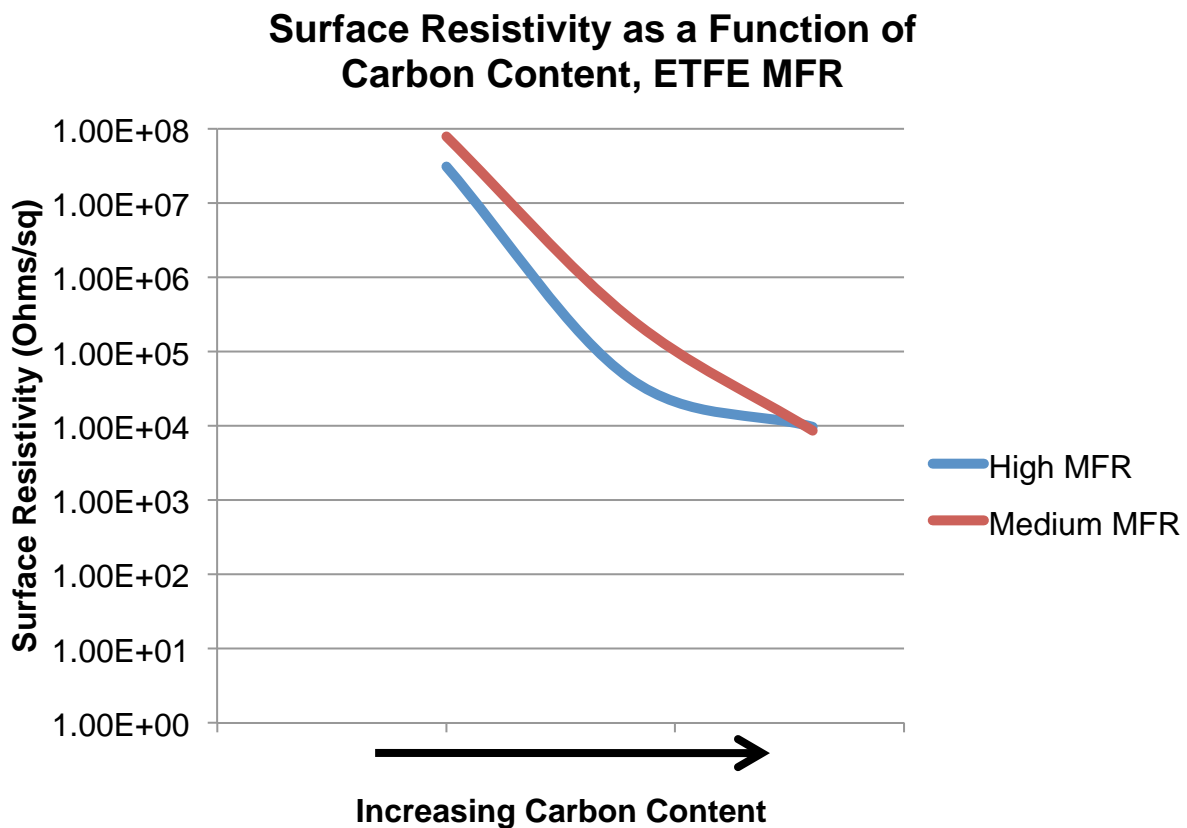
Custom Grades: Other foam grades are available as custom products and can be compounded to your specifications. In cases where concentrates are not acceptable, a ready-to-use compound can be developed.

CONDUCTIVE COMPOUNDS

Conductive fluoropolymers are used in self-regulating or constant-wattage heater cables, static dissipative fuel lines and other applications where conductivity or static dissipation is required.

Custom Grades: Conductive compounds are manufactured as ready-to-use products. Typical customization of products includes melt flow rate of final compound and conductivity needed for the application. Consistency and processability are the key factors in developing these compounds.

The graph below shows conductivity as a function of increasing carbon content for Fluon ETFE conductive compounds.



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FLEXIBLE AR COMPOUNDS

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

Property	Test Method	Units	AR-8018S
Melt Flow Rate	ASTM D-1238	g/10 min	3
Specific Gravity	ASTM D-792	--	1.67
Melting Point	--	°C	270
Tensile Strength	ASTM D-638	MPa	22
Tensile Strength (100 °C)	ASTM D-638	MPa	7
Tensile Strength (200 °C)	ASTM D-638	MPa	2
Tensile Elongation	ASTM D-638	%	360
Flexural Strength	ASTM D-790	MPa	11
Flexural Modulus	ASTM D-790	MPa	402
Hardness	JIS K 7215	Shore D	53
Volume Specific Resistance	ASTM D-257	Ω*cm	1 x 10 ¹⁶
Insulation Breakdown Voltage	ASTM D-149	kV / 0.1mm	7
Dielectric Constant (10 ⁶ Hz)	ASTM D-150	--	2.6
Dissipation Factor (10 ⁶ Hz)	ASTM D-150	--	0.005

Heat Resistance: The heat resistance of Fluon AR grades can be improved by radiation curing. The product can be cross-linked without the presence of curing agents or coagents. The recommended dosage is 1 – 10 mRads electron-beam or gamma-ray radiation.

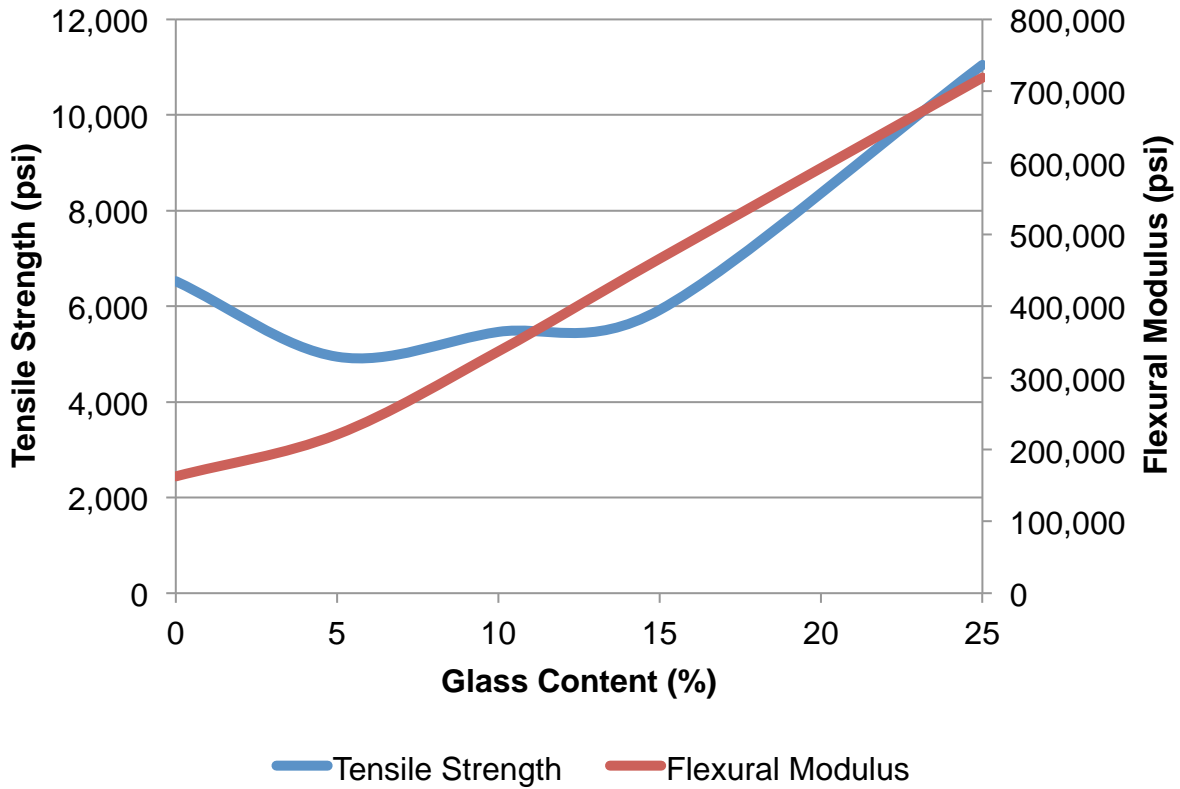
Property	Test Condition	Fluon AR-8018S			ETFE
		0	5	10	
Radiation (mRads)		0	5	10	Fluon C-88AX
Tensile Strength (psi) ASTM D-638	23 °C	3,000	4,200	4,600	6,700
	100 °C	1,000	1,400	1,600	4,500
	200 °C	270	310	410	850
Flexural Strength (psi) ASTM D-790	23 °C	1,600	2,000	1,900	2,800
Flexural Modulus (ksi) ASTM D-790	23 °C	59	75	73	140

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REINFORCED COMPOUNDS

Glass-filled compounds incorporate glass and mineral fillers for enhanced dimensional stability, abrasion resistance, shrinkage resistance and thermal conductivity. 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 addition of glass fiber.

Physical Properties of Glass-Reinforced ETFE



LUBRICATED COMPOUNDS

While fluoropolymers such as FEP offer a very smooth, lubricious surface, other fluoropolymers need to be modified to offer this benefit. Typical applications for such materials are push-pull cables or any application where reduction of the coefficient of friction is necessary.

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CUSTOM PRODUCTS

Every lot of material is subject to testing to ensure best quality and consistency from lot to lot. This information can be supplied with each shipment. Typical tests are listed below.

Test	Units	Method Used
Melt Flow Rate	g/10 min	ASTM D-2116
Bulk Density	g/L	ASTM D-1895
Filler Content	%	AGC Internal
L* (Lightness)	(CIELAB, 10° obs, D65)	AGC Internal
a* (Red-Green)	(CIELAB, 10° obs, D65)	AGC Internal
b* (Yellow-Blue)	(CIELAB, 10° obs, D65)	AGC Internal

HANDLING PRECAUTIONS

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-resistant materials are required for prolonged contact with molten resin.

SAFE HANDLING INFORMATION

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

Physical hazards: None

Health hazards: None

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

Fluon® Melt Processable Compounds

Meeting specifications and exceeding expectations along the way

There are seven different Fluon melt processable compound product types, all manufactured to precise specifications. Working with you to determine which product is exactly right for your application is our specialty.

Color Concentrates

Used for color-coded wire insulation, tubing and molded parts. Properties include superb surface finish, color consistency and dispersion – even at high-speed production runs of 1,500 to 2,500 feet per minute.

Foam Concentrates

Designed for gas injection foaming used for manufacture of LAN and coaxial cables, the properties of a foamed insulation help minimize signal loss, enhance high-speed data transmission and save weight and material.

Cross-linkable Compounds

For insulating air frame, industrial and shipboard wiring. Also for heat-shrinkable tubing in environments where high temperature, abrasion resistance or shrinkage are important considerations.

Conductive Compounds

For control of heat and static electricity. Wire coated with a conductive fluoropolymer may be used to wrap and thaw frozen pipes or to locate pipeline leaks by detecting thermal change.

Reinforced Compounds

Glass-filled compounds incorporate glass and mineral fillers for enhanced dimensional stability, abrasion resistance, shrinkage resistance and thermal conductivity characteristics.

Lubricated Compounds

These products contain lubricious fillers such as PTFE and FEP. For use in vehicle brake cables, for instance, or where a cable's liner needs to have a low-friction, abrasion-resistant surface, typically referred to as push-pull cable.

Compression & Rotomolding Powder Blends

Used in a variety of applications including tapes and molded parts.

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AGC Chemicals Americas, Inc.

AGC Chemicals Americas, Inc., is a wholly owned subsidiary of the Asahi Glass family, a \$13 billion multinational corporation and one of the world's largest manufacturers of glass, electronic displays and chemical products.

AGC Chemicals Americas manufactures, markets and sells high-quality fluoroproducts including Fluon[®] fluoropolymer resins and compounds and AsahiKlin fluorinated solvents. Our company also markets and sells LUMIFLON[®] fluoropolymer coatings, Asahi Guard E-SERIES[®] water and oil repellants, F-CLEAN[®] greenhouse films, fine silica additives, and various fluorointermediates.

Our company is headquartered in Exton, Pa., which is also the location of the Technical Center. The manufacturing plant is located in Thorndale, Pa. Field sales offices and warehouses are located throughout North America.



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