Fluoropolymer Resins and Compounds Improve Performance in Critical Applications

by:
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Protecting and optimizing wires and cables by building on the high-performance characteristics of fluoropolymers, and adding fillers, pigments and other additives.

Fluoropolymer resins and compounds enhance the performance of wires and cables used in automotive, industrial, aerospace, transit and appliance applications. When compounded with fillers, pigments and other additives, wires and cables exhibit superior chemical, wear and creep resistance; toughness; lubricity; and thermal and electrical conductivity. **AGC** uses PVDF, ECTFE, ETFE, FEP, MFA, PFA and ECA resins to produce Fluon® melt processable compounds, which can be processed using extrusion, injection and compression molding techniques.

Melt processable compounds based on Fluon fluoropolymer resins are suited for challenging uses including wire insulation, cable sheathing, tubing and molded parts. This article discusses some recent advances.

ETFE with the Highest MFR and Temperature Rating Available

AGC recently introduced an ultra heat-resistant grade that maintains performance characteristics at temperatures up to 200°C without the need for cross-linking. Fluon ETFE C88AXMP-HT is ideal for industrial and automotive wire and cable insulation as well as under-floor heating cables because it provides improved crack and abrasion resistance and enhanced mechanical strength. This grade was designed to pass the strenuous German automotive *LV112 class F* stress-crack testing standards. It also meets automotive *FLUR* specifications and is available in a full range of color concentrates (see **Figure 1** and **Figure 2**).

PFAs with Less Shrink

AGC research has demonstrated that compounding with specialty fillers helps to control shrinkage in PFAs. The company customizes the sets of fillers and pigments selected according to the specific requirements of each cable construction. PFA jackets can be difficult to work with when adding connectors because the PFA tends to shrink, but the other layers of the construction do not. To limit shrinkage AGC adds specialty fibers to the compound to make the cable installation easier, more efficient and cost effective (see **Figure 3**).

Superior Glass-Reinforced Compounds

Reinforced compounds incorporate glass fillers for enhanced toughness, dimensional stability, abrasion resistance and tensile strength. However, it is tricky to compound fluoropolymers with glass because the glass does not disperse easily.

Also, glass characteristics vary widely. Glass can be chopped or milled, treated or untreated. Depending on the

	C-88AXM-HT ETFE	Standard ETFE
5% weight loss	395 °C	380 °C
10% weight loss	405 °C	390 °C
MIT (no. cycles)	26,500	16,400
Tensile Elongation (%)	550	496
Tensile Strength (Mpa)	52	52
Stress Crack T*	220 °C	185 °C

*MIL W 81822 Type A

Fig. 1 — Improved properties of Fluon C-88AXMP-HT versus standard ETFE.

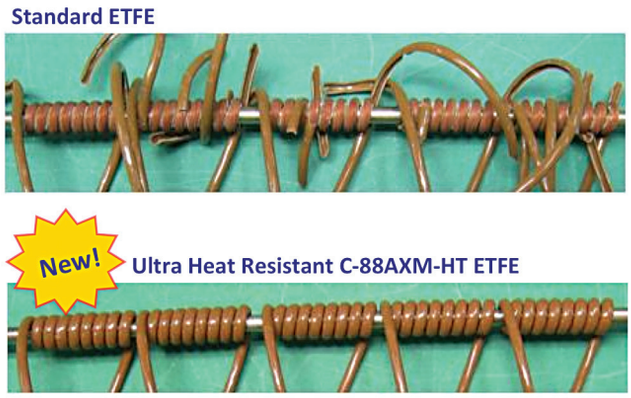

Fig. 2 — Stress crack improvement of Fluon C-88AXMP-HT versus standard ETFE pre-aged three hours at 225°C before coiling and six hours at 225°C after coiling.

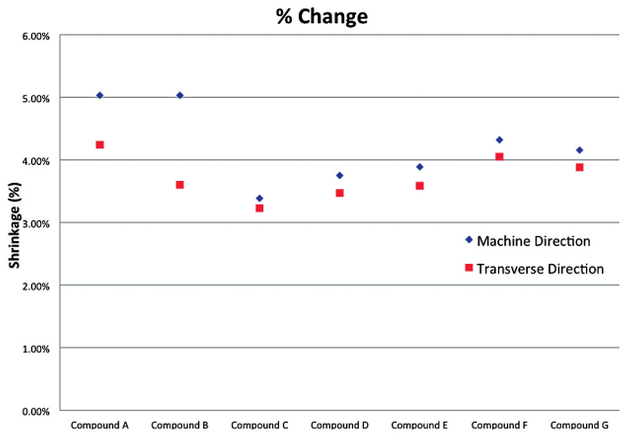

Fig. 3 — Percentage of shrinkage of various PFA compounds as measured by injection molded plaques.

glass and resin combination, the resulting compound could have improved temperature performance, higher flexural modulus, higher strength, different compressive properties, etc. Choosing the correct glass filler system depends on the application and desired results (see **Figure 4**).

Conductive & Anti-Static Compounds

Conductive and anti-static compounds are used to control heat and static electricity. Wire coated with a conductive fluoropolymer is used for freeze protection and process temperature control. Conductive fluoropolymers are also used for static dissipation in fuel lines and self-regulating/constant wattage heater cable. Customized compounds are available in a variety of conductivity levels depending on the application.

As an expert in conductive compounds, AGC understands the sensitivity of the carbon network to shear forces. Compounding a robust carbon network helps to better maintain properties after processing (see **Figure 5**).

Downhole Cable for Oil & Gas Recovery

Fluon ETFE compounds reinforced with proprietary fillers better protect cables used in extreme downhole conditions. These compounds contain conductive, strengthening and reinforcing fillers that help tolerate extreme temperatures, pressures, harsh chemicals and volatile weather conditions. Cable components made with fluoropolymer compounds can withstand depths of 25,000', 15,000 psi, resist abrasion and bending fatigue, have an ultra-smooth outer surface and endure torsion, tension and extreme temperature cycling.

Fiber reinforced compounds enable cables to perform better in continuous insertion/extraction operations. When Fluon ETFE is compounded with fillers that dissipate the electrical charges that accumulate within the cable construction during operation, spark outs and heat build-up are reduced, keeping the cable operable. Spooling and other motions of the cable can cause stress cracking and breakage. By using reinforced ETFE compounds for the inner and outer layers of the jacket, cables are more protected due to the inherent mechanical strength of the resin further enhanced by adding fibers. Cable manufacturing is also improved, because these compounds exhibit excellent adhesion and flow behavior. Fluon melt processable compounds can be applied efficiently in intricate cable constructions, especially when it is critical to minimize gas migration (see **Figure 6**).

Conclusion

Fluoropolymer resins and reinforced compounds are used to protect and optimize high-performance wire and cabling. These compounds build on the high-performance characteristics of fluoropolymers, adding fillers, pigments and other additives that enhance their performance and make them better suited for challenging wire and cable applications.

For more information about fluoropolymer resins and reinforced compounds for wire and cable applications from AGC FluoroCompounds Group, visit the website below, which details Fluon products, compounding capabilities, testing and customer support services. *www.fluorocompounds.com*

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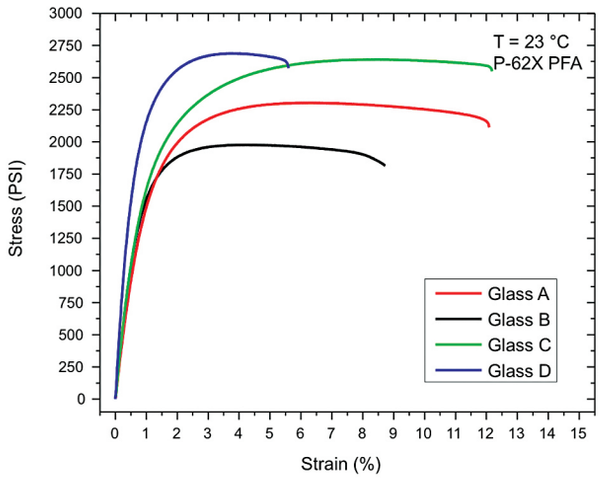

Fig. 4 — Stress strain curve for four types of glass compounded with PFA.

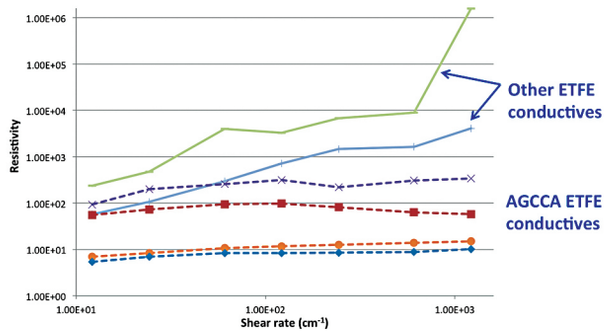

Fig. 5 — Resistance to shear process of AGC ETFE conductives vs. other ETFE conductives.

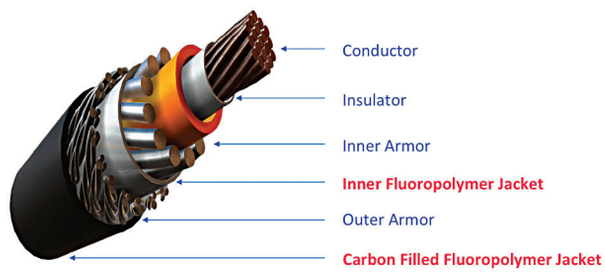

Fig. 6 — Fluoropolymers used in downhole oil and gas recovery cables.

Company Profile:

AGC Chemicals Americas Inc. *is a wholly owned subsidiary of* ***Asahi Glass Company Ltd.****, a US$13 billion multinational corporation and one of the world's largest manufacturers of glass, electronic displays and chemical products. The company was formed in 2004 through the merging of sister companies* ***Asahi Glass Fluoropolymers USA*** *and* ***AGA Chemicals****. Headquartered in Exton, PA, USA, AGC Chemicals Americas maintains manufacturing operations in nearby Thorndale, PA, USA, and warehouses located throughout North America.* ***www.agcchem.com***