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Alternatives to tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride (THV) for wire and cable applications

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Cable jackets form the outermost layer of a wire or cable, acting as a critical line of defense against physical and environmental damage. These jackets shield the inner conductors and insulation from mechanical wear, chemical attack, moisture, UV exposure, weathering and high heat. Protective sheaths are essential for ensuring safety, durability, electrical performance and regulatory compliance.

The choice of jacketing material depends on cost, operating environment, flexibility, chemical and flame resistance, and applicable regulatory standards. Fluorinated polymers are especially valued for wire and cable jacketing because they combine exceptional chemical inertness, wide temperature tolerance, excellent electrical properties and strong mechanical performance.

One such material, tetrafluoroethylene-hexafluoropropylene-vinylidene fluoride (THV), has been widely used in jacketing for its combination of flexibility, processability and chemical resistance. However, with the sole global producer of THV phasing out production and planning a complete shutdown by the end of 2025, wire and cable manufacturers must evaluate alternative materials that can deliver equivalent or superior performance.

Alternatives to THV

AGC Chemicals Americas offers two readily available high performance materials: Fluon+ flexible ETFE compounds and Fluon low-melting (LM) ETFE resins. These materials offer the same chemical resistance and enhanced mechanical and electrical properties as THV, so they can be used in many of the same applications as THV. They can even surpass THV in terms of durability, lower melting points and reduced flexural modulus.

Because of their unique formulations, Fluon+ flexible ETFE and Fluon LM ETFE have different properties, and each presents specific benefits for wire and cable applications.

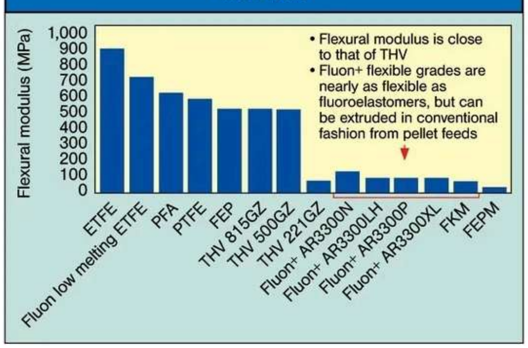
Maximum flexibility: Fluon+ flexible ETFE compounds

Modification of ETFE with a proprietary fluoroelastomer combines the many desirable properties of ETFE (tensile strength, chemical resistance, heat stability) in a more flexible form that can still be processed on extrusion equipment. This flexibility allows for production of thin-wall claddings or ribbon cables with much greater flexibility than is typically possible for ETFE.

As with ETFE, heat stability and physical properties of Fluon+ flexible ETFE can be further enhanced by radiation (electron beam) treatment after extrusion. Often, the resultant extrusions can be crosslinked without the presence of curing agents or co-agents as part of the formula.

The flexural modulus of Fluon+ flexible ETFE compounds is lower than that of standard ETFE, and close to that of THV, as shown in figure 1.

Figure 1 - flexural modulus of various fluorinated materials



Fluon+ flexible ETFE

Because they are compounded materials, Fluon+ flexible ETFE grades can be tailored to specific applications in wire and cable.

Custom compounding offers the ability to adjust performance by varying the modifier level, which directly affects tensile strength, elongation and flexural modulus (figure 2). When the compound is formulated with high temperature ETFE, it demonstrates that a higher modifier level results in greater flexibility.

Benefits to custom compounding

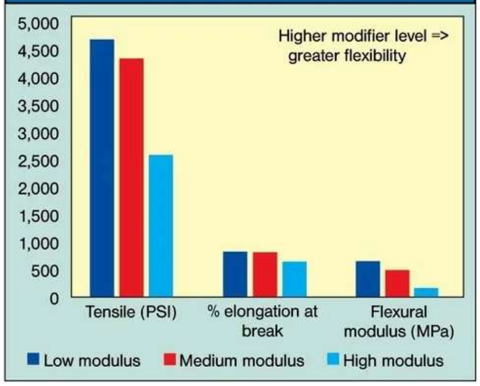
Fluon+ flexible ETFE compounds are available with curing agents to facilitate electron beam crosslinking. This process allows for use of lower radiation dosages than would typically be required, allowing for energy savings and reduced degradation of the cladding. Table 1 compares physical properties of Fluon+ AR-3300N before and after electron beam irradiation.

Fluon LM ETFE resins

Fluon LM ETFE resins are designed to be processed at temperatures 50°C below those required for standard ETFE.

Fluon LM ETFE resins have slightly more flexibility (lower flexural modulus) than conventional ETFE grades, so they are a better match for high stiffness THV than conventional ETFE. Additionally, because they are low melting point materials, Fluon LM ETFE grades can be extruded at lower processing temperatures than conventional ETFE grades. This allows for lower energy consumption during production campaigns. Figure 3 shows how Fluon LM ETFE resins compare to standard ETFE. Table 2 shows how Fluon+ flexible ETFE/fluoroelastomer compounds and Fluon LM ETFE

Figure 2 - modifier level versus tensile, elongation and flexural modulus Fluon+ flexible ETFE series; high temperature ETFE



resins surpass ETFE, while serving as viable replacements for THV.

Which is best for wire and cable applications?

Although both Fluon+ flexible ETFE compounds and Fluon LM ETFE resins can replace THV in wire and cable jacketing, they address different performance priorities. Both deliver improved flexibility compared to standard ETFE; are available in custom colors; and can be engineered to meet unique mechanical, thermal and processing requirements. Selection ultimately depends on the specific balance of flexibility, chemical resistance, thermal performance and processing characteristics needed. Table 3 outlines the attributes that can aid in selection.

Industry specific use cases

Both flexible ETFE blends and low melting ETFE resins address the unique performance demands of various industry sectors. Both of these ETFE based THV alternatives directly address the most common cable jacketing challenges:

- Tight bend radii: Achieved through low flexural modulus, preventing stress fractures in confined routing
- Continuous movement: Enhanced flex life for millions of cycles in dynamic applications
- Harsh chemical washdowns: Resistance to oils, solvents, acids and fuels
- Temperature extremes: Reliable performance from subzero cold to elevated continuous service temperatures

Aerospace

In the aerospace industry, wiring must be lightweight, flame-retardant and highly flexible to accommodate tight installation spaces in aircraft interiors.

- Flexible ETFE compounds deliver THV-like flexibility, allowing tight bend radii without compromising mechanical strength, making them ideal for routing cables through narrow bulkheads and behind panels.
- LM ETFE resins provide excellent dielectric properties, chemical resistance to hydraulic fluids and lubricants, and temperature stability up to 180°C, ensuring long service life in both cabin and wing environments.

Industrial automation

Automation environments often subject cables to continuous motion, bending and twisting inside cable carriers or robotic arms. They also face oils, coolants and abrasive wear.

- Flexible ETFE compounds offer superior flex life compared to standard ETFE, resisting cracking and maintaining integrity under millions of flex cycles. Their chemical resistance protects conductors from cutting fluids and cleaning agents used in manufacturing.
- LM ETFE resins can be extruded at lower temperatures, reducing processing stress on conductors, and they maintain high abrasion resistance to prevent wear in dynamic cable assemblies.

Telecommunications

Telecommunications cables, including fiber optic lines, require low signal loss, long outdoor service life and UV/weather resistance. Jackets must also resist deformation and maintain flexibility in cold temperatures.

- Flexible ETFE compounds can provide the added flexibility needed for drop cables in tight installations or where cables must be coiled and uncoiled repeatedly without damage.
- LM ETFE resins excel here, offering transparency for fiber identification, low dielectric constant for minimal signal attenuation and resistance to moisture ingress.

Table 1 - Fluon+ AR-3300N typical properties

Property	*Test method*	*Units*	*Fluon+ AR-3300N*	*With EB irradiation 120 kGy*
Melt flow rate (MFR)	ASTM D-2116	g/10 minutes	8.7	NA
Melting point	AGC internal	°C	225	NA
Tensile strength	ASTM D638	MPa	10.4	29.3
Tensile elongation	ASTM D638	%	441	366
Flexural modulus	ASTM D790	MPa	141	148
Durometer hardness	ASTM D1706	Durometer D	42	44
Flammability	UL 94		V-2	V-2

- Elongation decreases a small amount
- Tensile strength increases significantly

Oil and gas

The oil and gas sector requires cable jackets that offer exceptional chemical resistance and high abrasion durability. These jackets must also perform reliably in extreme temperatures and withstand harsh mechanical conditions, like those found in subsea environments.

Table 2 - Fluon+ flexible ETFE/fluoroelastomer compounds and Fluon LM ETFE resins surpass ETFE, while serving as viable replacements for THV

Material	*THV*	*ETFE*	*Fluon LM ETFE*	*Fluon+ flexible ETFE*
Specific gravity	1.93-2.06	1.73	1.78	1.62-1.64
Tensile strength	Moderate to high	Very high	High	Moderate to high
Elongation	High	Low to moderate	Moderate	High
Flexibility	Moderate to high	Low	Moderate	High
Flammability UL94	V-0	V-0	V-0	V-2 to V-0
Appearance	Transparent	Transparent	Transparent	Opaque

Table 3 - attributes that can aid in selection of Fluon+ flexible ETFE compounds and Fluon LM ETFE resins

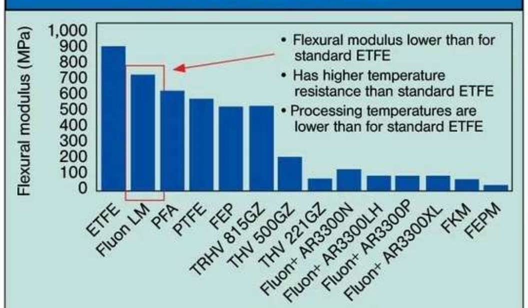
Fluon+ flexible ETFE compounds	*Fluon low melting LM ETFE resins*
Ultra-flexible wire and cable or tubing	Flexible wire and cable or tubing
Applications requiring opacity	Applications requiring good transparency
Custom tailored solutions to enhance physical properties, service temperatures, etc.	Applications that require good abrasion resistance and toughness
Chemical resistance	Fuel and chemical resistance
Heat resistance can be enhanced by radiation curing	Excellent electrical and insulation properties in a wide range of temperatures

- Flexible ETFE compounds withstand exposure to drilling muds, hydrocarbons and high pressure washdowns, while remaining pliable for routing through confined spaces.
- LM ETFE resins maintain toughness and insulation integrity in both arctic cold and desert heat, making them suitable for control cables, sensor lines and offshore umbilical systems.

Important steps for a smooth THV to ETFE transition

Switching from THV to alternative fluoropolymers such as Fluon+ Flexible ETFE compounds or Fluon LM ETFE resins is more than a simple material substitution. It is a full system change that affects processing, product design, performance validation and customer acceptance. To ensure a smooth transition without compromising cable quality, manufacturers must evaluate the entire production ecosystem, from extrusion parameters and tooling to compliance documentation and field performance.

Figure 3 - Fluon LM ETFE



Audit the processing setup

Confirm extrusion lines, tooling and temperature profiles can handle ETFE blends or low-melting ETFE without major retooling; and adjust melt temperatures, line speeds and cooling parameters for optimal surface quality and geometry control.

Revalidate cable design

Recalculate bend radius, verify flexural life and test adhesion in coextrusion or shielded constructions; and confirm jacket removability and termination performance with existing connectors and hardware.

Benchmark electrical and environmental performance

Test dielectric strength, signal loss, chemical resistance and flame performance against current THV baselines; and include UV/weathering, abrasion and fuel/oil resistance in qualification plans.

Update compliance and documentation

Refresh all relevant third-party certification and standards documentation, including testing files, drawings and materials lists; confirm compliance with applicable hazardous substance and chemical use regulations; and issue product change notifications to customers with comparative performance data and test results.

Secure supply and build stock resilience

Qualify at least two suppliers for each material; and set safety stock levels and evaluate total life cycle costs, factoring in throughput and scrap rates. A successful transition from THV to ETFE based alternatives requires a holistic approach that accounts for manufacturing readiness, design impacts, regulatory compliance and customer needs. By addressing each of these considerations early, manufacturers can enhance cable performance and increase production efficiency.

Conclusion

The impending discontinuation of THV presents both a challenge and an opportunity for wire and cable manufacturers. Delaying action risks production disruptions, increased costs and compliance issues. By turning to commercially available advanced fluoropolymer alternatives such as Fluon+ flexible ETFE compounds and Fluon LM ETFE resins, manufacturers can maintain, and in some cases enhance, performance in demanding environments. These materials not only meet the rigorous requirements of modern cable jacketing, but also offer the adaptability to evolve with changing industry standards, regulatory pressures and application needs.