Fluon+™

High Voltage Wire and Cable Solutions for Future Technology Needs

AGC

Your Dreams, Our Challenge

As energy demands and industry trends change, challenges in materials selection emerge. Opportunities for the introduction of novel transit solutions such as eVTOL, or drones, require newer technologies.

Cables need to be suited for handling high voltages and high temperatures, be of lightweight construction, and be highly flexible. With high voltages also comes the possibility of partial discharge, which can affect the reliability and lifetime of the cable. Beyond battery-powered transport, other characteristics such as mechanical toughness and chemical resistance provide advantages in applications such as subsea cables and in the broader energy sector.

Fluon+™ Adhesive

Fluon+™ adhesive grades are functionalised fluoropolymers that can bond chemically with a range of materials. This allows greater design flexibility to the user that would ordinarily not be possible with a typical fluoropolymer. They have been used largely in automotive fuel hoses.

Partial discharge can lead to complete breakdown of electrical insulation, and is often initiated by electrically charged gas within microscopic voids. These voids occur most frequently between the conductor and insulator. Incorporating a Fluon+™ adhesive product into the insulating layer can reduce the incidence of voids and hence partial discharge.

		Standard Fluon® ETFE		Fluon+™ ETFE			Fluon+™ PFA
Property	Unit	C-88AXP	LM-720AP	LH-8000	AH-2000	AH3000L-CH1	EA-2000
Melting Point	°C	260	225	180	240	236	298
MFR (297°C, 5kg)	g/10min	11	15	78	25	7	10 – 30*
Specific Gravity	-	1.73	1.78	1.75	1.78	1.77	2.14
Tensile Strength	MPa	48	43	44	49	29	40
Tensile Elongation	%	415	380	417	425	433	330
Flex Modulus	MPa	900	716	959	793	1221	580
Flex Life (MIT)	Cycles			1 x 10^5	1 x 10^5		1 x 10^5
Izod Impact (23°C)	J/m			No break	No break		No break

** MFR Fluon+™ EA-2000 measured to D3307 (372°C; 49N)*

	Peel Strength (N/m)				
Material	Copper foil (R = 1.2µm)	Copper foil (R = 0.4µm)	SUS	Aluminium	Polyimide film
Standard PFA	3	No adhesion	No adhesion	No adhesion	3
EA-2000	**15**	**> 10**	**> 10**	**> 10**	**> 10**

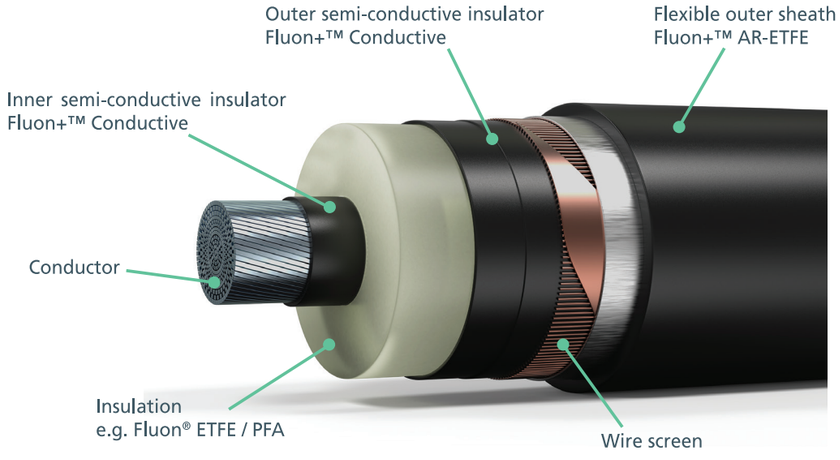


Illustration of where Fluon+™ and Fluon® products can be used within a high voltage cable

Fluon+™ Semi-conductive and Antistatic

Fluon+™ semi-conductive and antistatic grades combine the exceptional qualities of fluoropolymers with the functional capabilities of carbon black in applications where the modulation or dissipation of static electricity is required.

These compounds are manufactured as ready-to-use products, and are already well established in high voltage cable applications, where semi-conductive layers perform a critical role in ensuring a uniform electrical field. Fluon+™ semi-conductive and antistatic grades are available in PFA or ETFE variants.

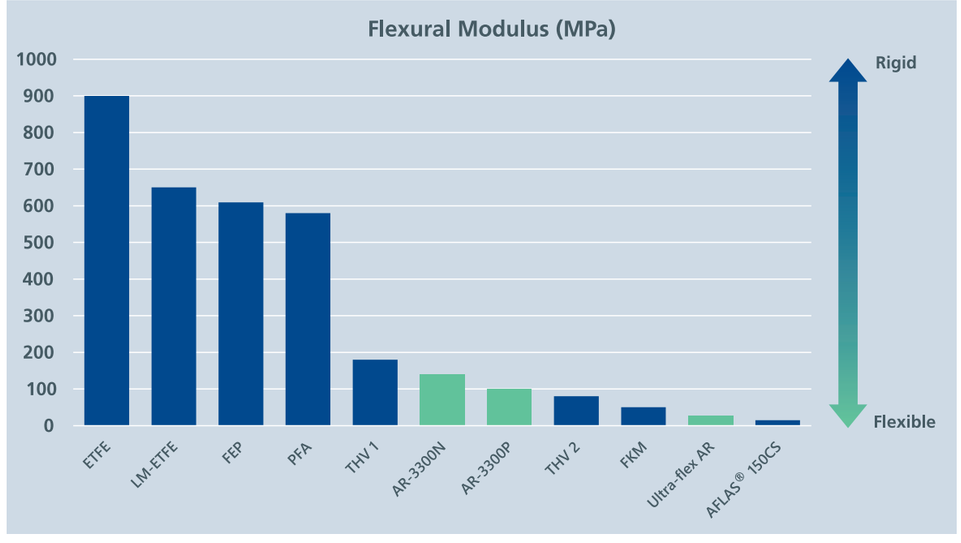
		Standard Fluon® ETFE		Fluon+™ ETFE		Fluon+™ PFA
Property	Unit	C-88AXP	LM-720AP	CB-8015X	AH-800C	CB-6093TD
Melting Point	°C	260	225	265	250	305
MFR (297°C, 5kg)	g/10min	11	15	1.7	5.7	11
Specific Gravity	-	1.73	1.78	1.77	1.75	2.1
Tensile Strength	MPa	48	43	40	39	25
Tensile Elongation	%	415	380	480	490	400
Surface Resistivity	Log Ω/☐	-	-	3	2.7	12

Fluon+™ High Performance Flexible Fluoropolymers

Fluon+™ AR-ETFE is a range of melt-processable compounds that provides the desirable properties of a fluoropolymer with greatly enhanced flexibility. Cables that require a thicker jacket construction, such as high voltage subsea cables, can be made much more flexible for ease of handling.

The Fluon+™ AR-ETFE grades are capable of continuous operation at 200°C, and their properties can be enhanced by radiation crosslinking. They can also be coloured for branding and identification by incorporating Fluon+™ Colour Concentrates.

		Standard Fluon® ETFE		Fluon+™ AR-ETFE				NEW
Property	Unit	C-88AXP	LM-720AP	AR-3300N	AR-3300P	AR-3300XL	AR-3300LH	Ultra-flex
Flex Modulus	**MPa**	**900**	**716**	**140**	**100**	**100**	**100**	**25**
Melting Point	°C	260	225	225	225	225	**190**	225
MFR (297°C, 5kg)	g/10min	11	15	9	8	9	9	3
Specific Gravity	-	1.73	1.78	1.62	1.64	1.63	1.63	1.5
Tensile Strength	MPa	48	43	11	11	10	10	2 – 5
Tensile Elongation	%	415	380	440	290	260	380	1000
Service Temp	°C	150	150	200	200	200	200	200
Flammability	UL94	V-0	V-0	V-2	**V-0**	V-2	V-2	TBD
MIL-W-22759 Crosslinking proof test	7 h @ 300°C	-	-	-	-	**Pass**	-	-



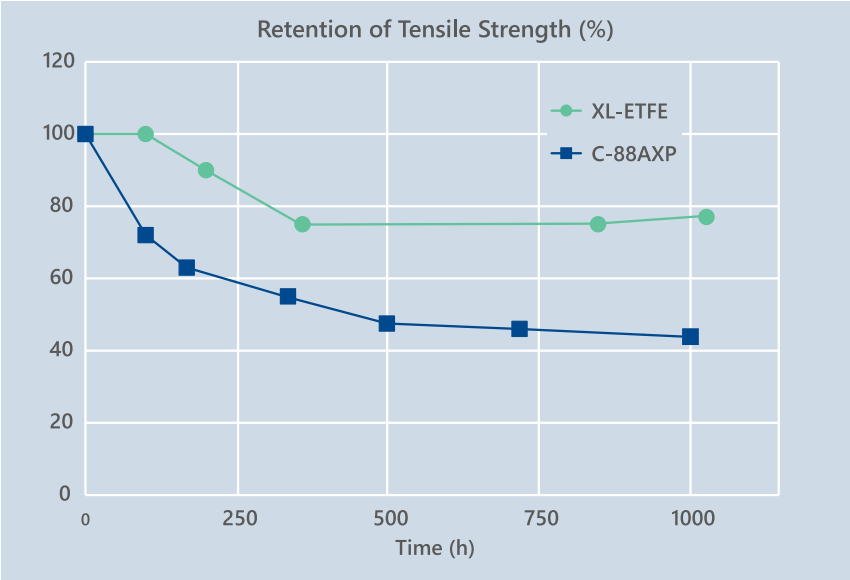
Fluon+™ AR-ETFE flexibility comparison with other common fluoropolymers and fluoroelastomers

Fluon+™ ETFE Cross linkable Compounds

Preloaded with a cross linking agent, these grades provide enhanced properties for more demanding applications, compared with standard ETFE:

- Abrasion resistance
- Cut-through resistance
- Tensile strength
- Thermal stability

Fluon+™ ETFE cross-linkable compounds can be processed by extrusion or compression moulding, with crosslinking by electron-beam or gamma irradiation.



Fluon+™ MPC Colour Concentrates

Fluon+™ Colour Concentrates is a range of colour masterbatches, specifically designed for compatibility with Fluon® and Fluon+™ fluoropolymer resins.

There is a trend in the automotive industry to make high voltage cables and harnesses within electric vehicles easily identifiable for safety reasons, and a vibrant orange is becoming the standard. AGC has introduced a new colour into its range, called '**Blaze Orange**', to meet the needs of the industry.

As with all Fluon+™ Colour Concentrates, Blaze Orange is resistant to prolonged exposure to high temperatures and will withstand attack by most chemicals.

Target Markets:

- EV cable insulation
- EV convoluted heat protection tubes
- Short-range aircraft (e.g. drone taxis) high voltage cables

AGC Chemicals Europe, Ltd.
Hillhouse International, Fleetwood Road North
Thornton-Cleveleys, FY5 4QD, UK
Tel: +44 (0) 1253 209560 • Email: fluonplus.info@agc.com • www.agcce.com

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