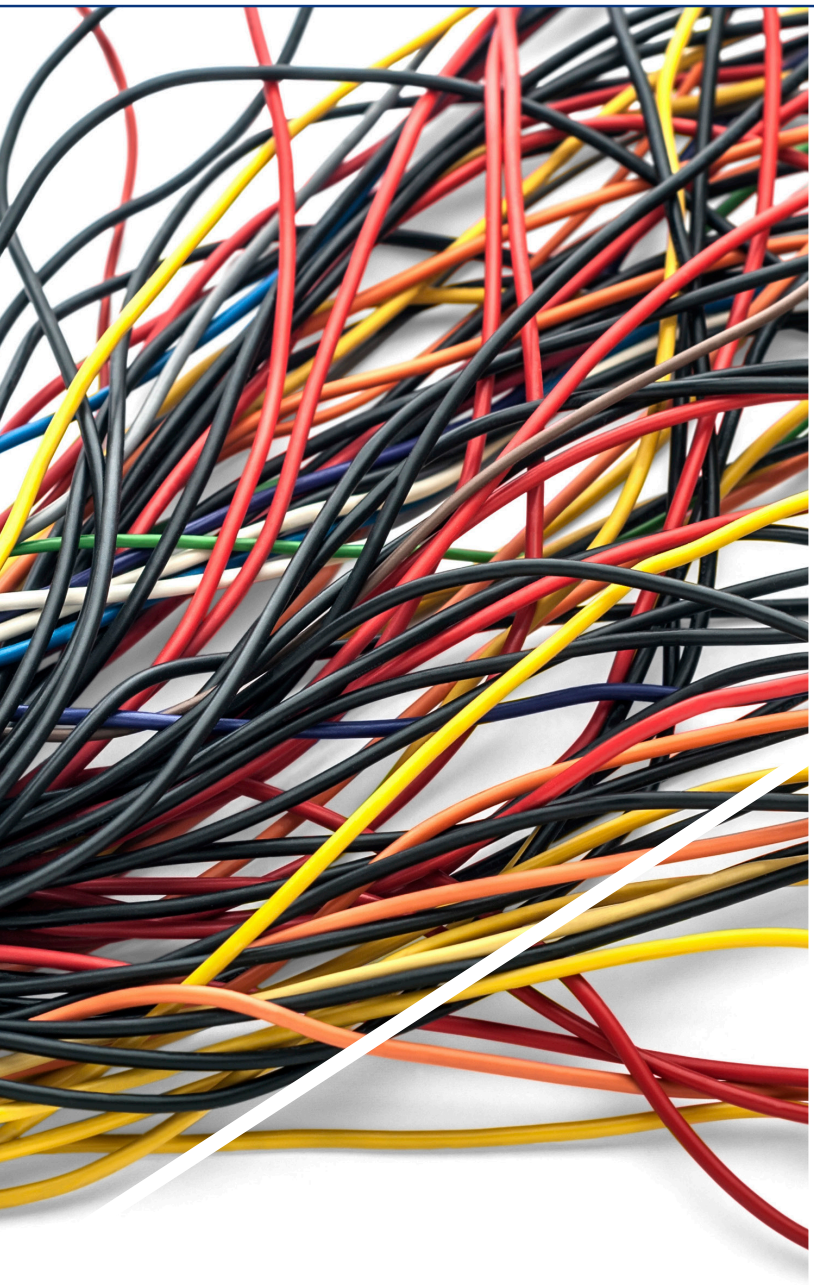
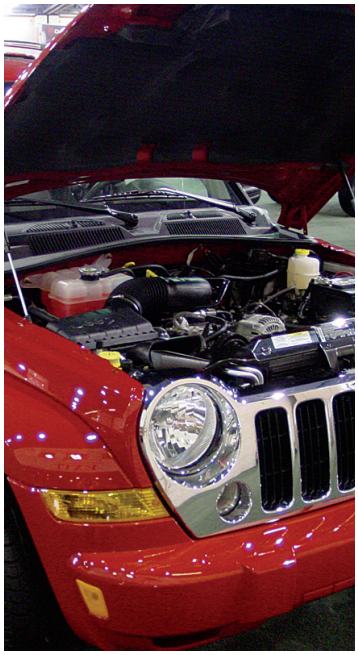
KYNAR® / KYNAR FLEX®

HIGH PERFORMANCE PVDF SOLUTIONS

Wire & Cable





Kynar Flex® resins retain excellent physical properties in adverse chemical and thermal environments allowing them to be used when more flexibility and toughness are required. Kynar® PVDF resin can be used as a support layer or protective exterior jacketing. The chemical resistance of Kynar® resin and Kynar Flex® resin make them well-suited for use in corrosive chemical, acid and extreme temperature environments. Kynar Flex® resin also provides exceptional abrasion resistance, excellent UV resistance, inherent flame resistance, and low smoke generation. New Kynar® 2620 FC foaming technology allows for a light weight flame resistant jacket on cables. A number of special Kynar® resin grades are available with enhanced flame and smoke characteristics, making them well-suited for plenum cable applications.

CHARACTERISTICS	MARKETS	APPLICATIONS
+ Produces very little smoke and self extinguishing when exposed to fire conditions + Lower fuel load than many other wire and cable polymers + Excellent resistance to most chemicals + Radiation cross-linkable + Resistance to sunlight + Resistance to electrical arc tracking + Excellent cut through resistance + Low cold flow and high abrasion resistance + Low coefficient of static and dynamic friction + Higher melting point than many other polymers used in wire and cable + Foamable for better strippability, lighter weight and greater flexibility + 150°C RTI rating + Can be run on standard polymer equipment + Continuous use temperature down to -40°C	+ Data communication copper and fiber optic + Telephone + Power limited cables + Fire alarm + Transit + Military/Defense + NYC Local Law 5 Compliant Cables (150°C rated) + High temperature automotive and aerospace + Fiber optics + Ship board + Automotive + Recreational boats + Mining cables + Plenum areas in buildings	+ Plenum cables + Plastic optical fibers + Heat shrinkable tubing + Jacket insulation for fiber optic cables + Jacket insulation for shielded constructions: coaxial cables, shielded twisted pair cables + Insulations for power limited and fire alarm cables + Military specification, cross-linkable Mil-Spec 81044 wire + Fiber optic raceways + Foamed jacket insulations + Cathodic protection cables + Insulated down well cables + Connectors

CUSTOMIZED PERFORMANCE

A wide range of Kynar® PVDF resin grades exist for various applications. Kynar® resins come in pellets or powder for ease of compounding depending on your equipment.

GRADE	COMMENTS
Kynar® 450 **Kynar® 460**	Easiest processing material for extrusion crosslinking. 150°C rating. Kynar® 460 can be used as an additive to Kynar Flex® 3120 to aid processing. Kynar® 450 is high molecular weight.
Kynar® 710 **Kynar® 720**	Stiff resin for thin wall extrusion. 150°C rated. High melt flow rate suitable for high flow injection molding
Kynar® Ex-Ad 3000	Extrusion aid, works great for wire and cable extrusion.
Kynar Flex® 2750 - 01	Very flexible, high molecular weight for crosslinking applications. 125°C rated.
Kynar Flex® 2850 - 00 **Kynar Flex® 2850 - 02** **Kynar Flex® 2850 - 07**	Mildly stiff with 150°C rating. - 00 is high molecular weight. – 02 is medium molecular weight for thinner wall processing with smoke suppressant. - 07 is medium molecular weight natural material suitable for extrusion or injection molding.
Kynar Flex® 2950 - 05	Very flexible and easy to process on wire & cable. Very flame and smoke resistant. Low shinkage over fiber optic cable. 125°C rated.
Kynar Flex® 2800 - 00	125°C rated. High molecular weight for crosslinking.
Kynar Flex® 2800 - 20	Higher melt flow rate for increased production rate and smoothness vs. Kynar Flex® 2800 - 00. Suitable for injection molding.
Kynar Flex® 2900 - 04	Good flame and smoke properties. Used mostly for plenum conduits (raceway) to protect fiber optics. 125°C rated.
Kynar Flex® 3030 - 10 **Kynar Flex® 3030 - 15**	Very flexible 150°C rated material with very good low temperature impact performance. Low shrinkage over fiber optic cable. Both versions are low viscosity and the «-15» version has smoke suppressant.
Kynar Flex® 3050 - 52	Flexible, 150°C rated material with best in class low temperature impact performance. Produces a nice, clear jacket. Tested to -60°C.
Kynar Flex® 3120 - 50 **Kynar Flex® 3120 - 10** **Kynar Flex® 3120 - 15**	150°C rated with the same flexibility as Kynar Flex® 2800/2900 with additional benefit of low temperature impact resistance. -10 is low viscosity and -15 is smoke suppressed. Good for crosslinking. For injection molding recommend Kynar Flex® 3120 -10.
Kynar SuperFlex® 2500 - 20 **Kynar SuperFlex® 2500 - 25**	Lower melt point and very flexible. - 20 clear. - 25 designed for plenum cable use and is opaque off-white.
Kynar® 340 **Kynar® 3312C**	Conductive grade using carbon additives (black). Stiff. Conductive grade using carbon Additives (black). Somewhat flexible and high melt flow rate.
Kynar Ultraflex B®	Most flexible. Kink resistant. Lower melting point and blendable with other resins.
Kynar® 2620 FC	Foaming concentrate used for all grades to lower weight, lower cost, increase flexibility, and improve strippability. Can generally be used without equipment modification.

GENERAL PROPERTIES OF KYNAR® & KYNAR FLEX® FLUOROPOLYMERS*

PHYSICAL PROPERTIES	TEST METHOD	UNITS	KYNAR® VF_2 HOMOPOLYMERS		KYNAR FLEX® VF_2 / HFP COPOLYMERS			
			710	460	2500	2750 - 01	2800	2850 - 00
Melt Flow Rate	ASTM D1238	g/10min, 230°C	15.0 - 35.0	6.0 - 14.0	—	4.0 - 14.0	3.0 - 8.0	3.0 - 8.0
Melt Flow Rate Load		lb (Kg)	8.36 (3.8)	47.5 (21.6)	—	27.5 (12.5)	27.5 (12.5)	27.5 (12.5)
Melt Viscosity	ASTM D3835	Kpoise, 232°C, 100s-1	4.0 - 8.0	23.5 - 29.5	6.0 - 15.0	20.0 - 25.0	22.0 - 27.0	23.0 - 27.0
Refractive Index	ASTM D542	—	1.42	1.42	1.40	1.41	1.41	1.42
Specific Gravity	ASTM D792	—	1.77 - 1.79	1.75 - 1.77	1.80 - 1.82	1.78 - 1.80	1.76 - 1.79	1.77 - 1.80
Water Absorption	ASTM D570	%	< 0.04	< 0.04	< 0.07	< 0.06	< 0.05	< 0.05

THERMAL PROPERTIES	TEST METHOD	UNITS	710	460	2500	2750-01	2800-00	2850-00
Melting Point	ASTM 3418	°F	329 - 342	311 - 320	242 - 257	266 - 280	284 - 293	311 - 320
		°C	165 - 172	155 - 160	117 - 125	130 - 138	140 - 145	155 - 160
Coef. of Thermal Expansion	ASTM D696	10E-5/°F	6.6 - 8.0	5.0 - 7.0	8.5 - 10.8	9.0 - 12.0	7.0 - 10.3	7.0 - 10.3
Glass Transition Temperature	ASTM D3418	°F	(-41) - (-37)	(-41) - (-37)	(-51) - (-46)	(-44) - (-40)	(-42) - (-39)	(-41) - (-37)
		°C	(-40) - (-38)	(-40) - (-38)	(-46) - (-43)	(-42) - (-40)	(-41) - (-39)	(-40) - (-38)

MECHANICAL PROPERTIES	TEST METHOD	UNITS	710	460	2500	2750-01	2800-00	2850-00
Tensile Strength at Yield	ASTM D638	psi	6,500 - 8,000	5,000 - 7,500	1,700 - 2,800	2,000 - 3,100	2,900 - 5,000	4,500 - 6,000
Tensile Strength at Break	ASTM D638	psi	5,000 - 8,000	4,500 - 7,000	2,000 - 4,500	2,900 - 4,000	2,500 - 5,000	4,000 - 7,000
Elongation at Yield	ASTM D638	%	5 - 10	10 - 15	12 - 25	15 - 25	10 - 20	5 - 15
Elongation at Break	ASTM D638	%	> 30	> 50	> 500	> 200	> 150	> 50
Tensile Modulus	ASTM D638	Kpsi	200 - 335	150 - 200	35 - 55	40 - 65	80 - 130	150 - 220
Flexural Modulus	ASTM D638	Kpsi	240 - 335	200 - 260	28 - 40	45 - 75	90 - 120	150 - 180
Notched Impact Strength	ASTM D256	ft-lbf/in	2 - 4	2 - 4	Non Break	Non Break	10 - 20	2 - 8
Hardness	ASTM D2240	Shore D	76 - 80	75 - 80	55 - 60	57 - 62	65 - 70	70 - 75
Tabor Abrasion	ASTM-G195-13A, CS 17 1000g:pad	mg/1000 cycles	5 - 9	7 - 9	28 - 33	21 - 25	16 - 19	6 - 9

ELECTRICAL PROPERTIES	TEST METHOD	UNITS	710	460	2500	2750-01	2800-00	2850-00
Dielectric Strength 73°F	ASTM D149	KV/mil	1.7	1.6	0.8 - 1.1	1.1 - 1.3	1.3 - 1.5	1.3 - 1.6
Volume Resistivity	ASTM D257	ohm-cm	—	2.7 - 2.9 x 10E 13	1.1 - 4.4 x 10E 13	6.4 - 6.6 x 10E 13	9.4 - 9.6 x 10E 13	2.9 - 3.2 x 10E 14
Dielectric Constant 73°F	ASTM D150	100Hz	8.0 - 9.5	8.0 - 9.5	10.9 - 13.5	10.5 - 12.1	9.4 - 10.6	9.0 - 10.2
		100MHz	4.5 - 5.5	4.5 - 5.5	4.5 - 5.8	3.8 - 4.5	3.5 - 4.3	3.5 - 4.0
Dissipation Factor 73°F	ASTM D150	1Hz	0.10 - 0.16	0.10 - 0.16	0.06 - 0.10	0.05 - 0.09	0.09 - 0.14	0.10 - 0.22
		100Hz	0.15 - 0.21	0.15 - 0.21	0.25 - 0.29	0.21 - 0.24	0.19 - 0.21	0.16 - 0.18

FIRE RESISTANCE	TEST METHOD	UNITS	710	460	2500	2750-01	2800-00	2850-00
Vertical Burn	UL 94	Class	V-0	V-0	V-0	V-0	V-0	V-0
Limiting Oxygen Index	ASTM D2863	% O_2	44	43	42	43	42	43

** General properties, not to be construed as specifications*

GENERAL PROPERTIES OF KYNAR® & KYNAR FLEX® FLUOROPOLYMERS*

PHYSICAL PROPERTIES	KYNAR FLEX® VF_2/HFP COPOLYMERS				FLAME RETARDANT KYNAR FLEX® VF_2/ HFP COPOLYMERS			
	3030-10	3050-52	3120-10	3120-50	3030-15	2900-04	2950-05	3120-15
Melt Flow Rate	8.0 - 25.0	2.5 - 7.5	13.0 - 50.0	2.5 - 7.5	8.0 - 25.0	3.0 - 17.0	3.0 - 17.0	3.0 - 17.0
Melt Flow Rate Load	8.36 (3.8)	27.5 (12.5)	8.36 (3.8)	27.5 (12.5)	8.36 (3.8)	8.36 (3.8)	8.36 (3.8)	8.36 (3.8)
Melt Viscosity	7.0 - 13.0	21 - 26	4.0 - 10.0	20.0 - 26.0	7.0 - 13.0	5.0 - 13.0	5.0 - 13.0	5.0 - 13.0
Refractive Index	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
Specific Gravity	1.78 - 1.82	1.61 - 1.67	1.77 - 1.79	1.75 - 1.77	1.78 - 1.82	1.78 - 1.80	1.76 - 1.79	1.77 - 1.80
Water Absorption	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.06	< 0.05

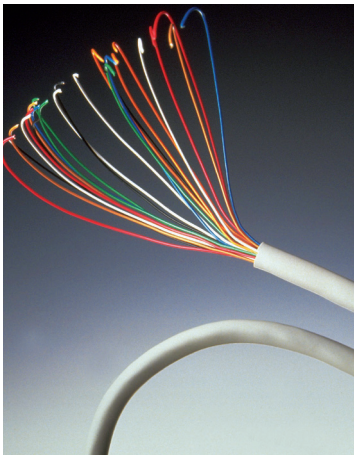
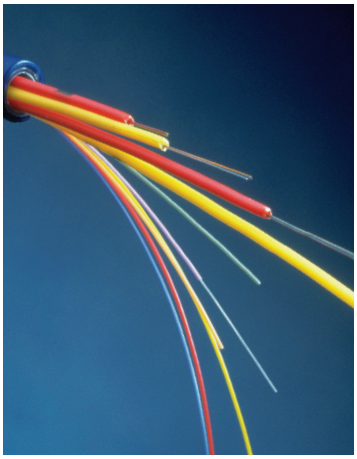
THERMAL PROPERTIES	3030-10	3050-52	3120-10	3120-50	3030-15	2900-04	2950-05	3120-15
Melting Point	320 - 334	320 - 334	322 - 334	322 - 334	320 - 334	284 - 293	266 - 280	322 - 334
	160 - 168	160 - 168	161 - 168	161 - 168	160 - 168	140 - 145	130 - 138	161 - 168
Coef. of Thermal Expansion	8.5 - 10.8	N/A	7.0 - 10.3	7.0 - 10.3	8.5 - 10.8	7.0 - 10.3	9.0 - 12	7.0 - 10.3
Glass Transition Temperature	(-43,6)	(-42) - (-39)	(-42) - (-39)	(-42) - (-39)	(-40)	(-44) - (-38)	(-47) - (-40)	(-42) - (-39)
	(-42)	(-41) - (-39)	(-41) - (-39)	(-41) - (-39)	(-40)	(-42) - (-39)	(-44) - (-40)	(-41) - (-39)

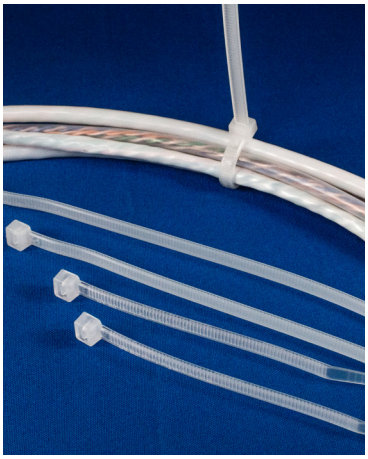
MECHANICAL PROPERTIES	3030-10	3050-52	3120-10	3120-50	3030-15	2900-04	2950-05	3120-15
Tensile Strength at Yield	1,800 - 2,400	2,500 -3,000	3,500 - 5,000	3,500 - 5,000	1,700 - 2,300	2,900 - 5,000	2,000 - 3,100	3,500 - 5,000
Tensile Strength at Break	2,800 - 3,600	3,400 - 4,000	5,000 - 7,000	5,000 - 7,000	2,700 - 3,500	2,900 - 4,000	2,900 - 4,000	5,000 - 7,000
Elongation at Yield	25 - 40	10 - 20	10 - 20	10 - 20	25 - 40	15 - 25	15 - 25	10 - 20
Elongation at Break	> 500	250 - 350	> 100	> 100	> 500	> 150	> 200	> 100
Tensile Modulus	30 - 50	80 - 140	100 - 170	100 - 170	30 - 50	40 - 65	40 - 65	100 - 170
Flexural Modulus	36 - 45	70 - 90	90 - 120	90 - 120	36 - 46	90 - 120	45 - 75	90 - 120
Notched Impact Strength	Non Break	Non Break	Non Break	Non Break	Non Break	Non Break	Non Break	Non Break
Hardness	45 - 55	65 - 70	65 - 70	65 - 70	53 - 60	60 - 68	55 - 62	65 - 70
Tabor Abrasion	28 - 33	N/A	16 - 19	16 - 19	28 - 33	16 - 19	21 - 25	16 - 19

ELECTRICAL PROPERTIES	3030-10	3050-52	3120-10	3120-50	3030-15	2900-04	2950-05	3120-15
Dielectric Strength 73°F	1.0 - 1.2	1.3 - 1.5	1.3 - 1.5	1.3 - 1.5	1.0 - 1.2	1.3 - 1.5	1.1 - 1.3	1.3 - 1.5
Volume Resistivity	7.6 - 7.8 x 10E 13	—	0.9 - 1.1 x 10E 14	3.6 - 3.8 x 10E 14	7.8 - 8.0 x 10E 13	1.1 - 1.3 x 10E 14	7.6 - 7.9 x 10E 13	1.9 - 2.1 x 10E 14
Dielectric Constant 73°F	10.9 - 13.5	8.7 - 10.2	8.7 - 10.2	8.7 - 10.2	10.9 - 13.5	9.4 - 10.6	10.5 - 12.1	8.7 - 10.2
	4.5 - 5.8	3.2 - 3.9	3.2 - 3.9	3.2 - 3.9	4.5 - 5.8	3.5 - 4.3	3.8 - 4.5	3.2 - 3.9
Dissipation Factor 73°F	0.06 - 0.10	0.8 - 0.14	0.8 - 0.14	0.8 - 0.14	0.06 - 0.10	0.09 - 0.14	0.05 - 0.09	0.08 - 0.14
	0.25 - 0.29	0.18 - 0.19	0.18 - 0.19	0.18 - 0.19	0.25 - 0.29	0.19 - 0.21	0.21 - 0.24	0.18 - 0.19

FIRE RESISTANCE	3030-10	3050-52	3120-10	3120-50	3030-15	2900-04	2950-05	3120-15
Vertical Burn	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0
Limiting Oxygen Index	> 45	42	42	42	> 90	75	95	95

** General properties, not to be construed as specifications*



PROCESSING INFORMATION

EQUIPMENT

Kynar® and Kynar Flex® resins are readily extruded using standard melt processing equipment with few modifications. Most Kynar® resins are processed using single screw extruders with an L/D ratio of 24/1 or higher. The extruder is most commonly outfitted with a general purpose, chrome plated 4140 stainless steel metering screw with a 3 to 1 compression ratio. Output fluctuations issues can be improved tremendously through the use of a barrier screw.

TOOLING

Kynar® and Kynar Flex® resins can typically be processed on standard wire and cable crossheads used for PVC and other materials considered moderately heat-sensitive. It is recommended that the tool design be free flowing and have limited flow restrictions. Kynar® PVDF is sensitive to burning and, if allowed to collect around undercuts or dead spots in the system, it will produce charred specks in the final extruded product. Kynar® resin is most often processed using tube-on tooling with an area draw down ratio between 7 to 1 and 10 to 1. It is very important to have the draw balance between 0.98 and 1.02 to reduce post-application shrinkback. Lower draw down ratios and higher process temperatures can also be used to reduce jacket shrinkback. Higher draw down ratios have been used for softer Kynar® resin grades that exhibit better melt stability under extensional deformation. Land lengths of approximately 0.250 inches are recommended, but lower land lengths can be used to reduce melt fracture. Double-angle dies with zero land length and a 15° taper, as well as higher die temperatures, can also be used.

PROCESS

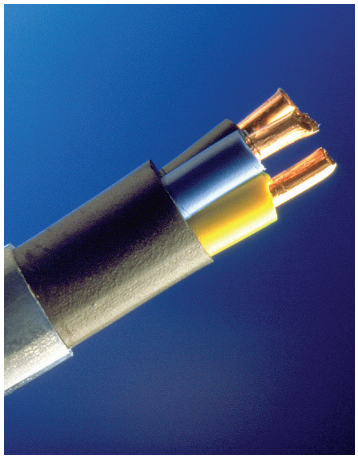
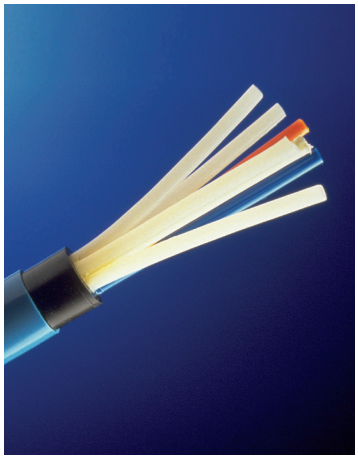
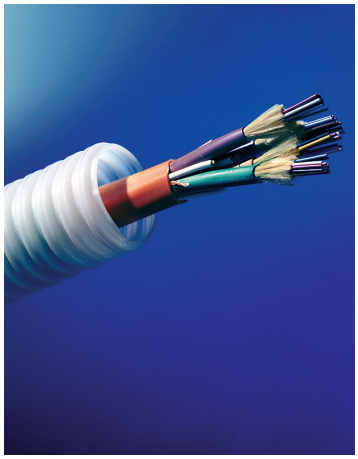
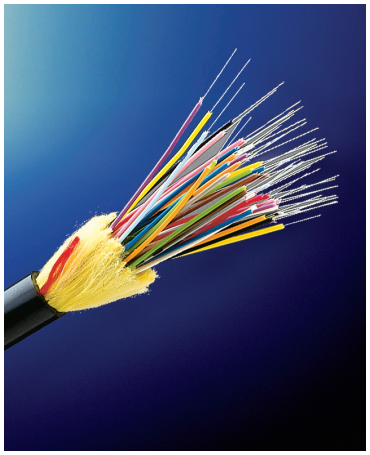
All Kynar® and Kynar Flex® resin grades are processed between 220°C and 255°C (428°F - 491°F). An ascending melt temperature profile is typically used, with the metering section of the screw set at the desired melt temperature and the feed section set at 220°C (430°F). The transition section can be set at an intermediate temperature between the feed and melt temperature. The clamp, adapter and extrusion head are typically set at the desired melt temperature. If there is a particular issue with burning, then lower temperatures in these areas are required. To smooth out the surface of the extrudate, higher die temperatures are sometimes used, with 260°C (500°F) being typical. This approach can only be used if the residence time of the material in the die is relatively short. Warm to hot water can be used in the cooling trough, as hotter water tends to reduce extrudate shrinkback. Typical cooling water temperatures range from 32°C to 43°C (90°F -110°F).

SPECIAL CONSIDERATIONS

Flame retardant Kynar® grades can burn in a system not optimized for Kynar® PVDF processing. Issues with undercuts and tooling dead spots must be resolved before running flame retardant grades. It is imperative to clean the screw, barrel and tooling completely before running Kynar® resin. Unclean extruder barrels and tooling typically result in poor product quality due to contamination. When a production run using a flame retardant Kynar® grade is complete, the flame retardant Kynar® resin must be removed before shutting down the system. If the process is to start up with a Kynar® grade in the future, then it is recommended that the extruder and tooling are purged using a non-flame retardant grade. If a different material is to be subsequently used, then a purge material such as HDPE or acrylic can be considered.

FOAMING

Kynar® 2620 FC foam concentrate is designed specifically for use in Kynar® PVDF resins for continuous extrusion applications. This technology is not limited to wire and cable. Foamed products using this technology show preferred properties such as flexibility, strippability, thermal insulation, reduced shrinkback, compressibility, and weight reduction. Targeted markets for wire and cable are low cost and flexible plenum cables, lighter wires for the transportation industry, and protective corrosion resistant cables at a reduced cost than is typically associated with fluoropolymer jackets.

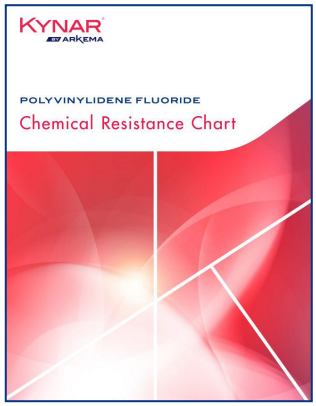
FIRE PERFORMANCE

The excellent flame and smoke properties of Kynar® PVDF are naturally achieved through its chemical structure. Thus, additives are not always necessary to achieve low smoke and low flame spread. Highly filled, non-fluoropolymers used as jacketing compounds provide very poor mechanical strength and little or no abrasion or cut-through resistance. These properties are especially important to maintain the integrity of the cable insulation and to withstand the abuses during the installation of plenum cable.

Virgin Kynar® resin does not easily burn and will self-extinguish when the flame source is removed. Fluoropolymers as a class have passed many flame and smoke tests designed to allow the use of polymers in building plenum applications.

The inherent fire performance of Kynar® PVDF can be further improved by modifying the polymer. These constructions generate almost no smoke and no flame spread when tested to UL 910/ NFPA 262, UL 2024 and NFPA 255 methods.

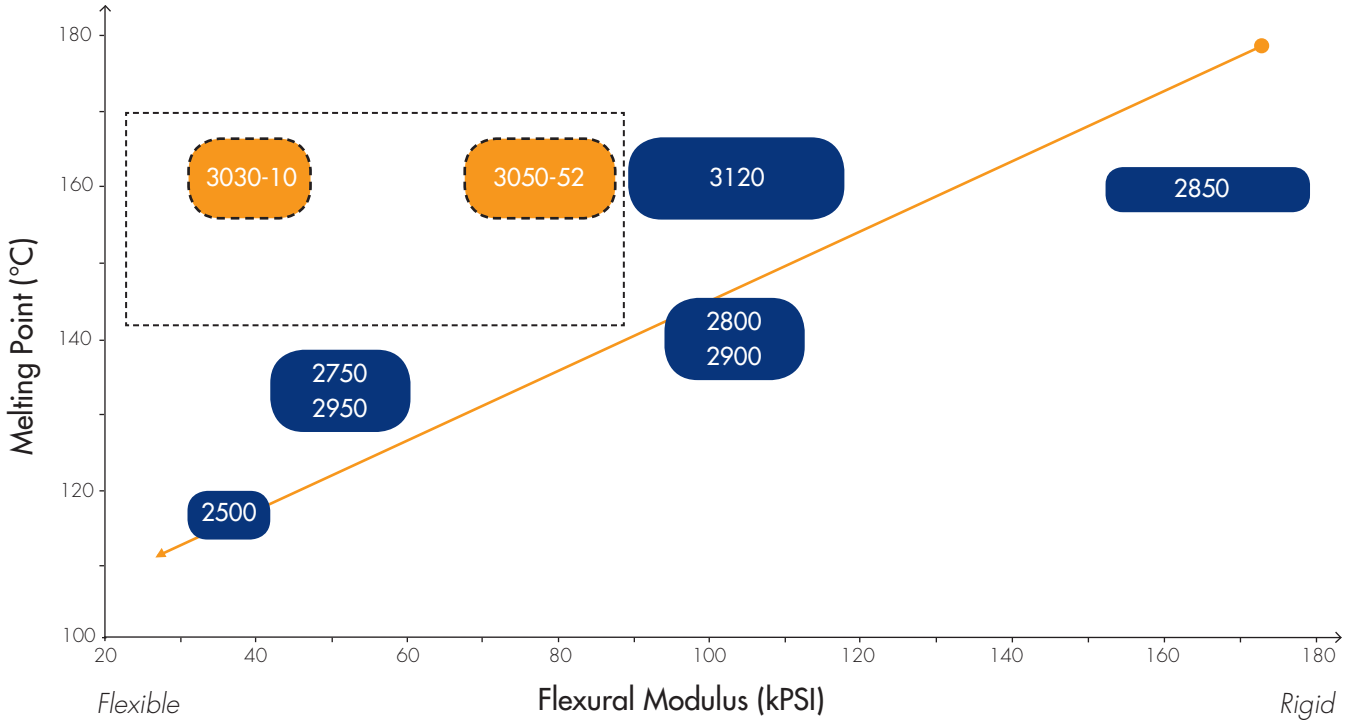
Chemical Resistance

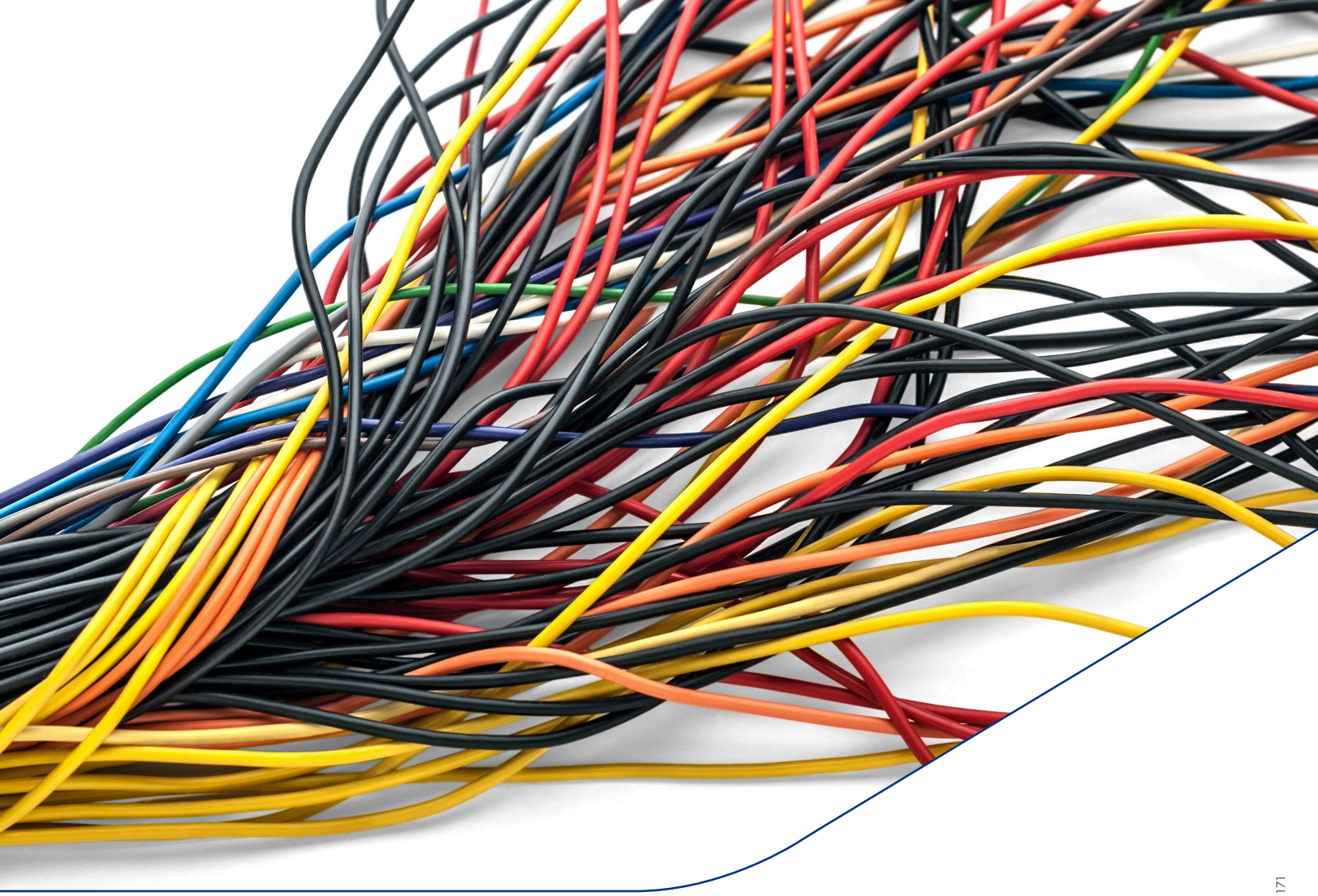


Kynar® PVDF has excellent overall chemical resistance compared to PVC, nylons, PET and polyolefins. Typical chemicals handled by Kynar® PVDF include strong acids, chlorides, bromides, hydrocarbons, weak to moderate bases, water, sweet and sour crude as well as waste mixtures.

Chemical Resistance Chart available from Arkema Inc.

KYNAR FLEX® - IMPROVING FLEXIBILITY AND HEAT RESISTANCE





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See SDS for Health & Safety Considerations.

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