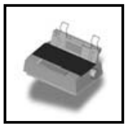
VESPEL® CR LINE

TYPICAL PROPERTIES OF VESPEL® PARTS & SHAPES







VESPEL® – THE ADVANTAGE OF DUPONT FORWARD ENGINEERING

DuPont aims to extend the life and efficiency of chemical and thermal processes by increasing their ability to withstand severe operating environments. That's why we're committed to a systems approach in advanced composite technology.

Vespel® CR parts are used in a wide range of chemical processing, fluid power engineering and thermal management equipment applications. They are ideally suited for valve seats and seals, bearings and gaskets, plus pump and compressor components. Plus, CR parts offer longer part life, reduced operating costs and increased reliability.

WHAT IS VESPEL® CR?

Chemical- and creep-resistant parts, created through DuPont composites technology. Vespel® CR parts are based on a high-performance Teflon® matrix, reinforced with high-aspect-ratio (length/diameter) fibers. Even under adverse conditions, these parts provide outstanding compressive creep resistance, high toughness, dimensional stability at high temperatures and pressures, and excellent chemical resistance. Vespel® CR can improve the performance of your designs, with properties like excellent chemical resistance, virtually no compressive creep, dimensional stability across a wide temperature range, a high degree of toughness, and superior wear characteristics.

VESPEL® CR'S BEST FEATURE – CHEMICAL RESISTANCE

When parts are made from Vespel® CR, good chemical resistance is one of their best performance properties. It's fairly typical of high-performance fluorinated polymers. But end-use behavior in specific conditions must also be taken into consideration. Variables like temperature, aeration, flow velocity, exposure duration, fluid stability and degree of contact help to determine a part's suitability in a particular situation.

In the Use Performance chart (upper right), results are listed for DuPont tests done in various chemicals and under various conditions.

Our Chemical Resistance chart (lower right) demonstrates CR's dimensional stability and strength in a separate set of tests performed using a wider range of compounds and different conditions.

Component tests are ongoing, both for additional environments and end-use conditions, so look for updates periodically.

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CHEMICAL- AND CREEP-RESISTANT PARTS FOR IMPROVED PERFORMANCE IN SEVERE ENVIRONMENTS

Valve Components: Valve seats and packing backup made from Vespel® CR benefit from extra creep resistance and low frictional characteristics, especially at elevated temperatures.

Compressor Parts: Piston and rider rings benefit from the excellent wear and thermal properties of Vespel® CR's composite structure.

Pump Components: Pump bearings, bushings and transmission components take advantage of the material's dimensional stability, high PV rating and exceptional mechanical properties.

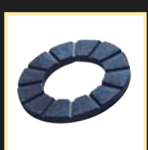
Compressor Parts: Valve plates made from Vespel® CR will benefit from the material's impact resistance and toughness.

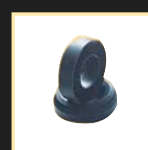
USE PERFORMANCE

CHEMICAL EXPOSURE	TEMPERATURE (°C)	TEMPERATURE (°F)	PRESSURE	TEST PERIOD (MONTHS)
FREON® Fluorocarbon Products	180	356	325	24
Hydrogen Fluoride (HF)	160	320	320	16
Hydrogen Chloride (HC)	185	365	300	12
Liquid Bromine	25	77	200	3

CHEMICAL RESISTANCE
(APPLIES TO CR-6100)

CHEMICALS	IMMERSION CONDITIONS: TEMPERATURE (°C)	TIME (DAYS)	SWELLING (PERCENT WEIGHT GAIN)	COMPRESSIVE STRENGTH LOSS (%)
ACIDS				
Sulfuric Acid, 96%	100	30	0.3	6
	200	7	3.9	36
Phosphoric Acid, 85%	100	30	<0.1	0
Acetic Acid, Glacial	106	30	0.6	0
SOLVENTS				
Xylene	140	30	0.9	3
Mineral Oil	100	30	<0.1	0
Aniline	100	30	0.1	0
Tetrahydrofuran	65	30	0.8	0
Methyl Ethyl Ketone	79	30	0.6	7
Methylene Chloride	40	30	0.9	3
Dimethyl Sulfoxide	100	30	<0.1	0
OTHERS				
Aqueous Ferric Chloride, 25%	100	30	<0.1	0
Aqueous Zinc Chloride, 25%	100	30	<0.1	1
Steam	260	7	0.4	–
Iodine	150	35	–	0





For more information about DuPont™ Vespel®:

UNITED STATES
DuPont Engineering Polymers
Pencader Site
Newark, DE 19714-6100
Tel: 800-222-VESP
Fax: (302) 733-8137

EUROPE
DuPont de Nemours
(Belgium) BVBA-SPRL
Engineered Parts Center
A. Spinoystraat 6
B-2800 Mechelen
Belgium
Tel: ++32 15 441527
Fax: ++32 15 441408

ASIA-PACIFIC
Japan
DuPont K.K.
Arco Tower
8-1, Shimomeguro 1-chome
Meguro-ku, Tokyo 153-0064
Tel: 03-5434-6989
Fax: 03-5434-6982

Korea
DuPont Korea Limited
4/5 Floor, Asia Tower, #726
Yeoksam-dong, Kangnam-ku
Seoul 135-082
Tel: 02-222-5200
Fax: 02-222-5470

Taiwan/China
DuPont Taiwan Limited
13th Floor, Hung Kuo Building
167, Tun Hwa North Road
Taipei, Taiwan 105
Tel: 02-719-1999
Fax: 02-712-0460

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VCR-053003

VESPEL®

CR

LINE

STANDS UP TO YOUR TOUGHEST ACID TEST.

NOT TO MENTION BASES, SOLVENTS AND OTHER CHEMICALS.

CR-6100 A Teflon® PFA body, reinforced with high-tensile-strength carbon fiber — CR-6100 offers excellent chemical resistance while exhibiting superior resistance to creep — even up to 550°F! It also provides excellent wear resistance and easy machinability for tight-tolerance applications. Add in a CTE lower than steel in the x-y plane (due to planar carbon-fiber reinforcement), and you have an ideal material for a variety of applications.

CR-6200 Has the same resistance to creep and chemicals as CR-6100, but with a more random orientation of its fiber. Consequently, CR-6200 doesn't exhibit the degree of x-y property orientation provided by CR-6100, but offers a balance of properties in the z and x-y directions instead.

CR-6300 & CR-6500 In some situations, the electrical conductivity of carbon fiber is a downright nuisance. That's why the forward-thinking engineers at DuPont are developing CR-6300 and CR-6500 — the glass- and quartz-fiber-reinforced versions of CR-6100. Coming soon.

Be prepared for the worst. We're talking about some of the harshest chemicals in the industry today. Luckily, being prepared simply means thinking Vespel® CR when you're designing for a tough chemical environment. Plus, CR can provide ultra-high purity for semiconductor applications, high-creep resistance for seals, even easy machinability for tight-tolerance parts like ball-valve seats. And of course, aside from chemical resistance, CR falls in line with the other Vespel® parts and shapes families — with its high resistance to convention-al wear and corrosion. So, what could CR do for your design process?

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TYPICAL PROPERTIES

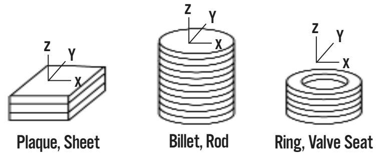
VESPEL® CR-6100

CHEMICALLY RESISTANT SHAPES FOR HOSTILE ENVIRONMENTS

Vespel® CR-6100 is a carbon fiber-filled thermoplastic fluoropolymer designed for use in hostile chemical environments. Due to its low creep and high thermal resistance, Vespel® CR-6100 often excels where other chemically resistant plastics fail. This makes Vespel® CR-6100 particularly well suited for seals, wear rings and other components used in a variety of devices and operating conditions.

Like most of the grades within the Vespel® parts and shapes product line, Vespel® CR-6100 is available in a wide variety of tube, rod, plaque and sheet sizes to satisfy your immediate needs. CR-6100 is also available as machined parts for more long-term usage.

NOMENCLATURE



Note: All fiber reinforcement is randomly oriented in the X-Y plane.

MECHANICAL	TEST METHOD	SI UNITS	ENGLISH UNITS
ULTIMATE TENSILE STRENGTH (x-y plane)	ASTM D-3039	221 MPa	32 ksi
TENSILE MODULUS (x-y plane)	ASTM D-3039	18,000 MPa	2,600 ksi
ULTIMATE FLEXURAL STRENGTH (x-y plane)	ASTM D-790	152 MPa	22 ksi
FLEXURAL MODULUS (x-y plane)	ASTM D-790	10,800 MPa	1,600 ksi
ULTIMATE COMPRESSIVE STRENGTH (x-y plane)	ASTM D-695	80 MPa	11.7 ksi
COMPRESSIVE MODULUS (x-y plane)	ASTM D-695	2,600 MPa	383 ksi
ULTIMATE COMPRESSIVE STRENGTH (z-direction)	ASTM D-695	302 MPa	43.8 ksi
COMPRESSIVE MODULUS (z-direction)	ASTM D-695	2,200 MPa	318 ksi

THERMAL	TEST METHOD	SI UNITS	ENGLISH UNITS
SOFTENING POINT	Thermal Mechanical Analysis	287°C	550°F
THERMAL EXPANSION COEFFICIENT (x-y plane) (RT – 500°F / RT – 260°C)	ASTM D-696	3.3x10^{-6} m/m/°C	1.8x10^{-6} in./in./°F
THERMAL EXPANSION COEFFICIENT (z-direction) (RT – 300°F / RT – 149°C)	ASTM D-696	326x10^{-6} m/m/°C	180x10^{-6} in./in./°F
THERMAL EXPANSION COEFFICIENT (z-direction) (300 – 400°F / 149 – 204°C)	ASTM D-696	453x10^{-6} m/m/°C	250x10^{-6} in./in./°F
THERMAL EXPANSION COEFFICIENT (z-direction) (400 – 500°F / 204 – 260°C)	ASTM D-696	923x10^{-6} m/m/°C	510x10^{-6} in./in./°F

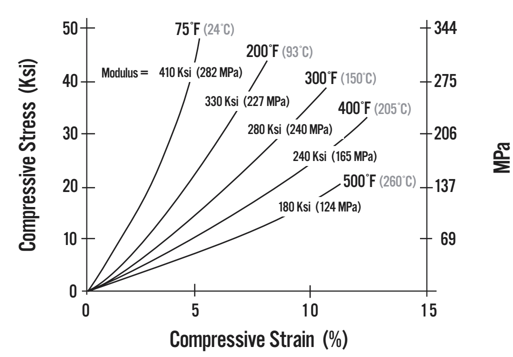
OTHER PROPERTIES	TEST METHOD	SI UNITS	ENGLISH UNITS
SPECIFIC GRAVITY	ASTM D-792	2.05 gr/cm^3	0.074 lbs./cu. in.
HARDNESS	ASTM D-2240	75-80 Shore D	75-80 Shore D
WATER ABSORPTION (24 hrs. at 23°C)	ASTM D-5229	<1%	<1%

COMPARATIVE WEAR DATA

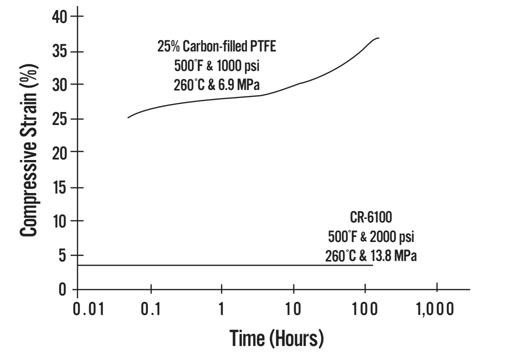
MATERIAL	WEAR RATE (E-6)				DYNAMIC COEFFICIENT OF FRICTION "fd"		LIMITING PV	
	25 ft./min.		50 ft./min.		25 ft./min. (0.13 m/sec.)	50 ft./min. (0.25 m/sec.)	ENGLISH (ft./min.-psi)	SI UNITS (MPa-m/sec.)
	in./hr.	cm/hr.	in./hr.	cm/hr.				
VESPEL® CR-6100	27.1	68.8	74.4	189.0	0.20	0.29	>155,000	>5.4
CARBON FIBER/PFA	47.1	119.6	102.8	261.1	0.18	0.24	>92,000	>3.2
PEEK-LUBRICATED	70.7	179.6	149.2*	379.0	0.52	0.18	40,000	1.4
PAI-LUBRICATED, WEAR-RESISTANT	37.3	94.7	1,435.2*	3,645.4	0.33	0.21	64,000	2.2
CARBON FIBER/PEEK	85.2	216.4	–	–	0.29	–	–	–
GLASS FIBER/PEEK	93.2	236.7	–	–	0.26	–	–	–
PEEK (UNFILLED)	699.0	1,775.5	–	–	0.42	–	–	–

*Stick-slip, vibration.
Unlubricated tri-pin-on AISI carbon steel disc finished to 16 microinches (0.4 micrometers) (AA): 400 psi (8.9 MPa)

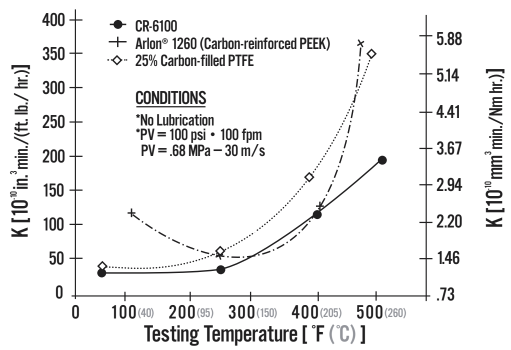
COMPRESSIVE STRESS-STRAIN BEHAVIOR OF CR-6100



COMPRESSIVE CREEP PROPERTIES

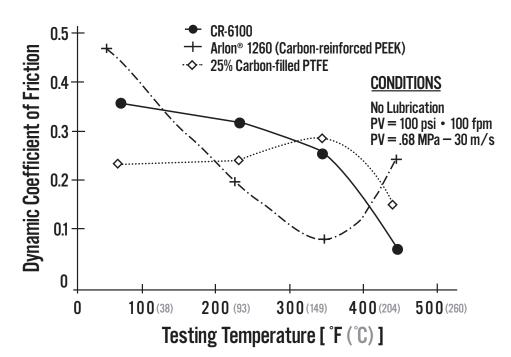


*WEAR FACTOR COMPARISON



*WEAR FACTOR x PV (psi-ft./min.) / (Pa-m/sec.) = Wear Rate

COEFFICIENT OF FRICTION COMPARISON



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TYPICAL PROPERTIES

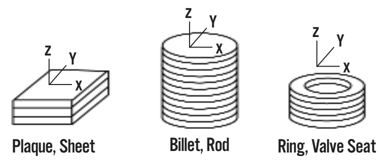
VESPEL® CR-6200

RANDOMLY ORIENTED FIBERS FOR CHEMICALLY RESISTANT SHAPES

Vespel® CR-6200 is a carbon fiber-filled thermoplastic fluoropolymer designed for use in hostile chemical environments. Due to its low creep and high thermal resistance, Vespel® CR-6200 often excels where other chemically resistant plastics fail. This makes Vespel® CR-6200 particularly well suited for seals, wear rings and other components used in a variety of devices and operating conditions.

The fiber reinforcement contained in CR-6200 has less x-y plane orientation than the fibers of CR-6100. Consequently, CR-6200 mechanical strengths are generally lower than x-y strengths of CR-6100, and the CR-6200 x-y and z-direction strengths are more comparable to each other and are superior to the z-direction properties of CR-6100.

NOMENCLATURE



MECHANICAL	TEST METHOD	SI UNITS	ENGLISH UNITS
ULTIMATE TENSILE STRENGTH (x-y plane)	ASTM D-3039	110 MPa	16 ksi
TENSILE MODULUS (x-y plane)	ASTM D-3039	10,000 MPa	1,500 ksi
ULTIMATE FLEXURAL STRENGTH (x-y plane)	ASTM D-790	121 MPa	17.5 ksi
FLEXURAL MODULUS (x-y plane)	ASTM D-790	9,000 MPa	1,300 ksi
ULTIMATE COMPRESSIVE STRENGTH (x-y plane)	ASTM D-695	81 MPa	11.8 ksi
COMPRESSIVE MODULUS (x-y plane)	ASTM D-695	3,700 MPa	536 ksi
ULTIMATE COMPRESSIVE STRENGTH (z-direction)	ASTM D-695	119 MPa	17.3 ksi
COMPRESSIVE MODULUS (z-direction)	ASTM D-695	1,700 MPa	244 ksi

THERMAL	TEST METHOD	SI UNITS	ENGLISH UNITS
SOFTENING POINT	Thermal Mechanical Analysis	287°C	550°F
THERMAL EXPANSION COEFFICIENT (x-y plane) (RT–500°F/RT–260°C)	ASTM D-696	80×10^{-6} m/m/°C	44×10^{-6} in./in./°F
THERMAL EXPANSION COEFFICIENT (z-direction) (RT–300°F/RT–149°C)	ASTM D-696	112×10^{-6} m/m/°C	62×10^{-6} in./in./°F
THERMAL EXPANSION COEFFICIENT (z-direction) (300–400°F/149–204°C)	ASTM D-696	194×10^{-6} m/m/°C	108×10^{-6} in./in./°F
THERMAL EXPANSION COEFFICIENT (z-direction) (400–500°F/204–260°C)	ASTM D-696	437×10^{-6} m/m/°C	243×10^{-6} in./in./°F

OTHER PROPERTIES	TEST METHOD	SI UNITS	ENGLISH UNITS
SPECIFIC GRAVITY	ASTM D-792	2.05 gr/cm^3	0.074 lbs./cu. in.
HARDNESS	ASTM D-2240	–	–
WATER ABSORPTION (24 hrs. at 23°C)	ASTM D-5229	–	–

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For more information about DuPont™ Vespel®:

UNITED STATES
DuPont Engineering Polymers
Pencader Site
Newark, DE 19714-6100
Tel: 800-222-VESP
Fax: (302) 733-8137

EUROPE
DuPont de Nemours
(Belgium) BVBA-SPRL
Engineered Parts Center
A. Spinoystraat 6
B-2800 Mechelen
Belgium
Tel: ++32 15 441527
Fax: ++32 15 441408

ASIA-PACIFIC

Japan
DuPont K.K.
Arco Tower
8-1, Shimomeguro 1-chome
Meguro-ku, Tokyo 153-0064
Tel: 03-5434-6989
Fax: 03-5434-6982

Korea
DuPont Korea Limited
4/5 Floor, Asia Tower, #726
Yeoksam-dong, Kangnam-ku
Seoul 135-082
Tel: 02-222-5200
Fax: 02-222-5470

Taiwan/China
DuPont Taiwan Limited
13th Floor, Hung Kuo Building
167, Tun Hwa North Road
Taipei, Taiwan 105
Tel: 02-719-1999
Fax: 02-712-0460

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