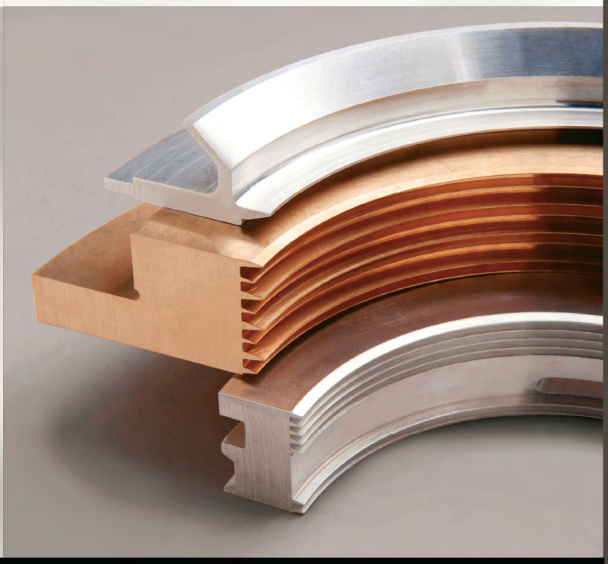
ROC CARBON COMPANY

60th Anniversary

Segmented Seal Rings

Bushings

Raw Materials



Labyrinth Seals

ISO 9001

ROC CARBON COMPANY

ROC Carbon Company manufactures a wide variety of seals, rings, bearings, and other high-precision wear parts for compressors, steam turbines, centrifugal pumps, and industrial fans and blowers. We supply parts to original equipment manufacturers, to repair shops, and to end users—petrochemical plants, refineries, power plants and the marine industry.

We manufacture parts from a wide range of high-performance materials including:

- Graphite
- Carbon/graphite of various grades, including metal-impregnated and resin-impregnated (page 8)
- PTFE materials, virgin or filled (page 10 and 11)
- PEEK materials, virgin or filled (page 10)
- Ryton
- Metals, both common and exotic (Inconel, Monel, titanium, etc.)
- Other plastics

Fast Turnaround

Since our beginning, ROC Carbon's success has been built on fast delivery of critical parts. ROC has a 98 percent on-time delivery record since 1990, including emergency shipments. We respond quickly without sacrificing competitive pricing or the highest level of quality, and we provide one-source accountability to our customers.

Engineering and Technical Services

Our engineering support group designs or modifies seals and other parts to meet individual requirements and provides field consultation, installation assistance, and follow-up to assure proper performance. Our recommended solutions are based on years of experience with virtually all makes and types of equipment.

Special Services

In addition to parts manufacturing, we offer the following stand-alone services:

- Contract machining and waterjet cutting (page 7)
- Mechanical seal repair
- Press-fit and shrink-fit (calculations & installation)
- Lapping

Raw Materials Inventory

We stock a range of raw materials for customers who wish to machine their own replacement parts. Our raw material inventory includes:

- Graphite: rectangular shapes (up to 12" x 24" x 39"), as well as cylindrical rod shapes from 0.25-in. to 24-in. diameter. Other sizes available on special request.
- Carbon/graphite (including resin-impregnated seal grades): cylindrical rods up to 14 in. OD (various inside diameters) in lengths up to 23 in. (not all outside diameters).
- PTFE: cylinders up to 20-in. diameter; plate up to 48 in. x 48 in. x 2 in. Larger sizes are available on request.
- PEEK: cylinders up to 20-in. diameter

Facilities

Our 30,000-sq ft manufacturing plant in west Houston accommodates both small-quantity, quick-turnaround orders and longer-lead-time, high-volume production runs. The success of ROC Carbon's Quality Program is reflected in our ISO 9001 certification since 1999.

OEM Replacement Parts

We manufacture replacement carbon/graphite, PTFE, and metal parts for the following rotating and reciprocating equipment:

Steam Turbines

Carling
Coppus
Dean Hill
Delaval
Elliott
General Electric
Murray
Terry
Westinghouse
Whiton
Worthington

Reciprocating Compressors

Gardner-Denver
Sullair
Westinghouse

Centrifugal & Axial Compressors

Allis-Chalmers
Atlas Copco
Carling
Carrier
Chicago Pneumatic
Clark (Dresser, Inc.)
Delaval
Elliott
Ingersoll-Rand
Joy
Siemens Company
Sulzer
Westinghouse
York

Rotary Steam Joints

Maier Gmbh
Johnson

ROC CARBON OFFERS

Short Lead Times with up to Same Day Deliveries

Reliable On-Time Delivery

Responsive Technical Consultation

24/7 Ordering and Sales Assistance

ROC CARBON COMPANY

SIXTY

YEAR ANNIVERSARY

This year ROC is celebrating 60 years of serving customers along the Gulf Coast and around the world. My grandfather, Morgan Ricks, started the company in 1956. He began in the garage of his home with a large inventory of carbon seals. Family members pitched in to take orders, manage inventory and package products for shipment. From the beginning, Morgan recognized that his customers needed a supplier for carbon products that could provide quality products, short lead times, and custom parts for rotating equipment.

Today at ROC, despite all the changes in the world over the past 60 years, we are still providing short lead times, quality products, and the responsiveness our customers have come to expect from us. While many of the products we provide have changed over the years, the core elements that ROC was founded upon remain the same.

We are blessed to be on this journey with you, our valued customers, and look forward to continuing to serve you for the next 60 years.

President, CEO

Our History

First founded in 1956 by Mr. Morgan Ricks, the company was shortly joined by Bob Owens to create the Ricks and Owens Company, which later became the ROC Carbon Company that we know today.

It's a well-known fact that a business will only be as good as those who are energizing and running it from the behind the scenes, and that's where Morgan Ricks gave strength and integrity to the ROC Carbon Company. Born a salesman, Ricks understood that relationships and contacts needed to play a part in a business.

It was this, alongside his creativity and perceptive ways, that led to him winning the "state championship" for selling a pictorial review door-to-door at the tender age of 7. He then went on to win several more state awards and travel trips, all the while building on his customer relationship and service skills through his job as a paperboy.

Over 16 years, he accumulated a wealth of experience in sales, and that's when he decided to start his own business. In 1956, Ricks set up a workshop in the garage of his own home, battling against the hard times to make his business succeed. In fact, one customer waited an entire year before ordering from him, just to make sure he stayed in business that long!
His main product at the time was turbine rings, and, as a family company, everyone became involved in the day-to-day running of it. Mrs. Ricks would be found answering the phone while daughter Pam would be typing and filing.

Utilizing customer surveys to find out what a customer's needs were, to reference spare parts and to maintain the availability of parts, the company was able to offer a successful service to their customers. An impressive feat, considering computer listings were unavailable at the time!

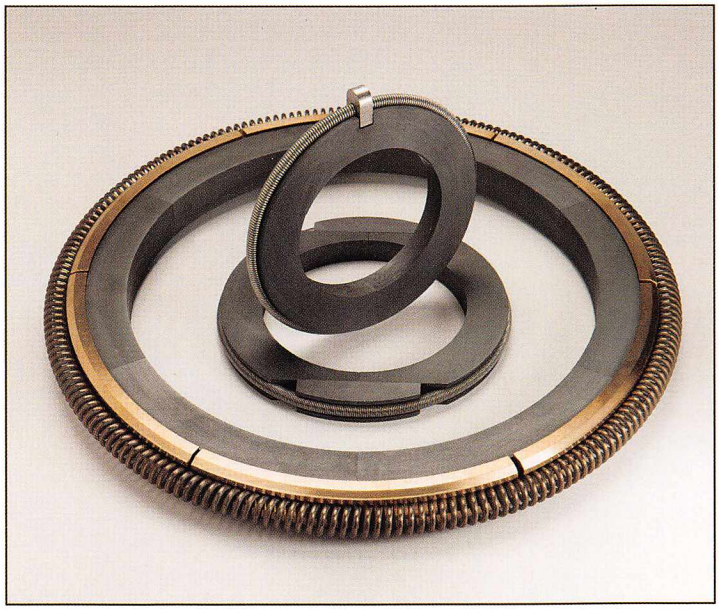
Before long, a 24/7 service was introduced and this is still available today for redesigning, engineering, troubleshooting, and producing customized parts.

ROC Carbon Company moved to their current facilities in 1969, extending their capacity to over 30,000 square feet. A large inventory of parts was produced in order to provide a fast delivery to the industry.

Today, the company remains dedicated to this philosophy of excellent service, constantly striving forward with their innovations and producing high-quality products that meet the exacting standards of their clients.

SEGMENTED SEAL RINGS

Graphite is an ideal material for steam turbine packing rings. Our rings feature precision manufacturing and special material grades for optimum sealing performance and long service life.



Materials

Graphite grades used are from our Group C graphite, Group B and Group A materials (see page 8). These grades have a fine-grain structure with excellent mechanical properties. Retaining (or "garter") springs are made from Inconel (for temperatures above 700° F) or stainless steel. Stops are made from cadmium-plated steel or bronze.

Precision Manufacturing

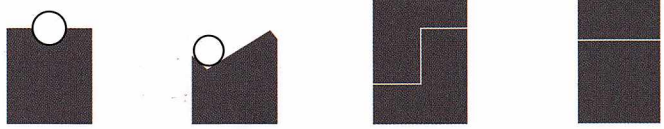
Sealing effectiveness of ROC Carbon turbine rings is achieved by a combination of careful design and painstaking craftsmanship in manufacturing. Shaft clearance calculations take into account the coefficient of thermal expansion of both the shaft material and the selected carbon/graphite grade as well as the exact operating temperature. Typical segment ends are either overlap or light-tight butt joints, and each joint is matched and marked. Ring faces are given a commercial lap finish.

Availability

Over the past 40 years, we have compiled a comprehensive database of 20,000 cross reference part numbers. If you can supply model number or OEM part number, we can quickly determine the correct ROC part number and respond with a quote or ship the part immediately if it is in stock.

Technical Services

ROC Carbon's engineering staff is available to help you evaluate seal problems and to recommend solutions involving seal geometry and material. For nonstandard parts on modified machines, we will recommend the proper turbine ring ID if you furnish steam conditions and shaft size.



Straight OD Profile | *Angle OD Profile* | *Lap Joint* | *Butt Joint*

For original equipment replacement parts, please furnish the OEM part number or the specifications of the machine. For custom-designed parts, we will furnish drawings. If you wish, we will design a seal for you.

MECHANICAL SEAL FACES

ROC Carbon manufactures carbon/graphite seal faces to OEM specifications, working from your drawings or samples and using the same high-quality materials and tolerances that original equipment manufacturers use. ROC is experienced in machining intricate details, such as flow channels and ports. Our lapping capabilities encompass both carbon and hard faces up to 17 inches in diameter and flatness as tight as 1 helium light band. We can insert the carbon seals in metal housings (machined by us or furnished by you) by heat shrink fitting or by using specialty adhesives.

ROC Carbon's engineering staff is available to help you evaluate seal problems and to recommend solutions involving seal geometry and material.

CARBON/GRAPHITE BUSHINGS AND BEARINGS

ROC Carbon self-lubricating bearings and bushings are available as standard replacement styles or custom-designed parts for specific operating problems. Parts range from simple sleeve bushings to complex styles incorporating notches, grooves or metal reinforcing sleeves.

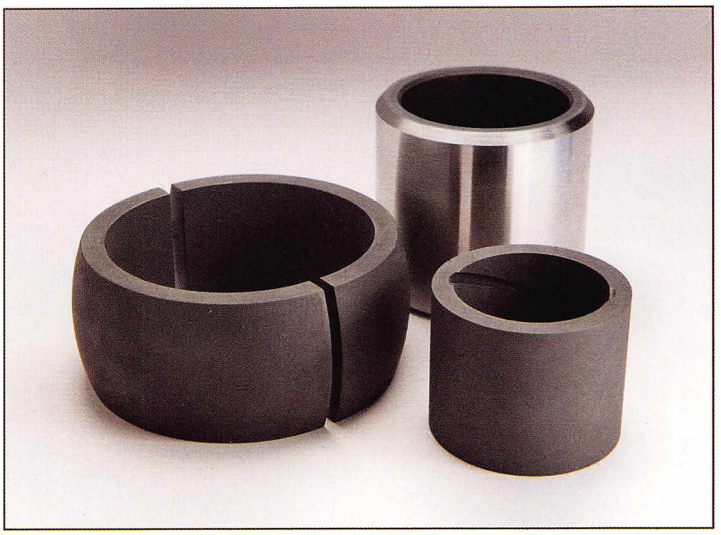
High-Performance Materials

Carbon/graphite grades selected should be compatible both with the fluids being handled and the operating parameters. The typical grades used are as follows:

- Material Group A is resin-impregnated for abrasive & food applications
- Material Group B with anti-oxidant impregnation is used for higher operating temperatures
- Both Material Group C and Material Group F are used in general-purpose applications
- Material Group E is metal-impregnated for improved heat dissipation, wear, and strength characteristics. Depending on the application, various types of metal-impregnation can be used.

Press Fitting and Shrink Fitting

For metal-reinforced styles, the method used to assemble the carbon into the metal housing depends on the carbon grade used, the metal selected, and the operating temperature. Press fitting is generally used for low-temperature applications, where relatively low interference is needed to keep the carbon



from rotating independently. Shrink fitting is used for high temperature applications requiring greater interference to prevent carbon rotation.

ROC Carbon's engineering staff can help you evaluate bearing and bushing problems and recommend solutions involving seal geometry and material. For nonstandard parts used for modified machines, we can recommend the proper bore sizes and materials for optimum performance.

METAL-BACKED SEAL RINGS

ROC Carbon Type MB carbon/graphite compressor seal rings are typically double-face seals that provide a critical seal to prevent fugitive emissions. The seals are installed over the shaft, sandwiched between the rotating seal ring and stationary sleeve. Carbon's hardness and graphite's lubricating properties combine to deliver long service. Type MB compressor seal rings have an outer metal ring to reinforce the carbon/graphite and preserve seal geometry at high speeds.

ROC metal-backed seals are available in both standard replacement styles and in custom configurations to solve specific operating problems.

Precision Manufacturing

Seal geometry is extremely important to service life. The two seal faces must be identical so that the seal rotates at one-half speed relative to the rotating seal ring, subjecting both seal faces to the same wear rate. If not identical, one seal face will wear excessively, shortening seal life. ROC seal surfaces are lapped and polished to within 1 helium light band (less than 12 millionths of an inch) for optimum sealing performance. Precise machining also produces perfectly round seals, preventing vibration that causes premature seal failure.

Shrink-Fitting and Stress Relieving

To prevent stress buildup that can shorten seal life, ROC Carbon follows a proprietary procedure that shrink-fits the metal ring over the carbon/graphite followed by full stress relieving.

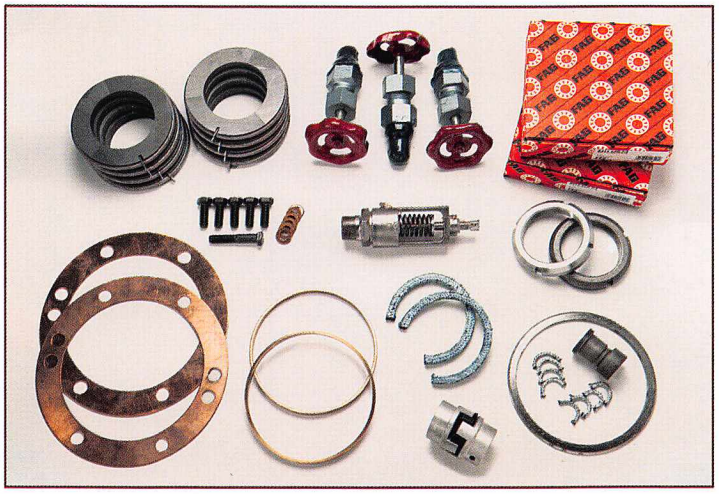
To further assure optimum geometry, larger ROC Carbon Type MB seal rings are shipped with a carbon/graphite plug that helps prevent seal damage during storage and handling. The plug is removed prior to seal installation.

Materials

Carbon/graphite grades are chosen to be compatible with the fluids being handled and with the mating seal surfaces. Typical carbon grades used are in our Materials Group A, with Shore Scleroscope hardnesses ranging from 77 to 95 (see page 8). For operating temperatures above 500° F, metal-impregnated carbon/graphite is used. The metal also has the appropriate corrosion resistance for the intended service.

REPAIR PARTS FOR TURBINE REBUILDS

In addition to steam turbine rings, ROC Carbon now offers other parts you need to rebuild popular turbine models: gaskets, seals, packing, valves, bearings, and more. You get the convenience of ordering from a single source and receiving a single invoice. Our goal is to provide parts for most of the popular turbines in service, so we are constantly adding to the selection.



Parts shown are for rebuilding a Coppus RLA-22 turbine.

LABYRINTH SEALS

ROC manufactures labyrinth seals up to 12 inches OD for all makes and models of turbines. Our CNC machining capabilites include the full range of tooth configurations: straight, stepped, angled, staggered, and more. We work from your drawings or samples. Custom sizes and fast delivery are our specialty.

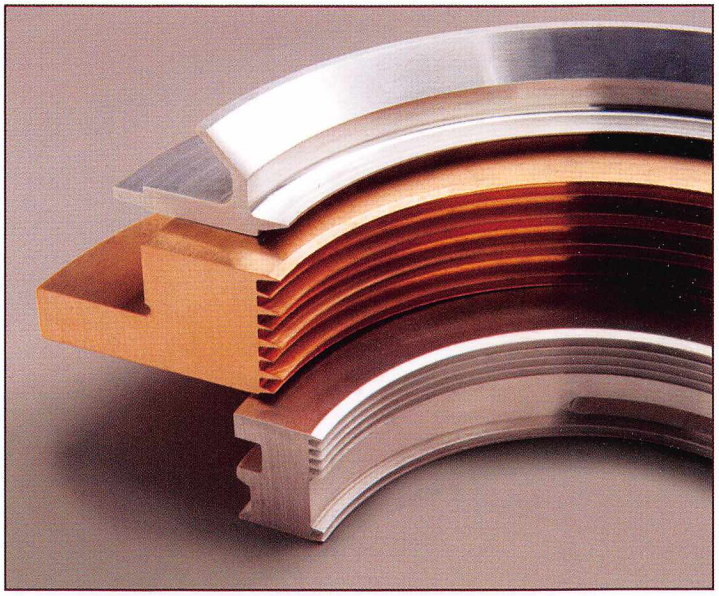
These seals (typically two-piece) are precision-machined at our Houston facility. To match virtually any application, we offer the following materials:

- bronze
- aluminum
- nickel-silver alloy

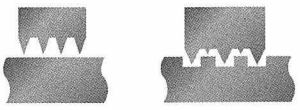
We can provide other materials on request.

The seals are machined with no gap at the split line and ID tolerance as tight as ± 0.001 in. for maximum sealing integrity.

Please contact us for more information on labyrinth seals.



Typical labyrinth seal cross-sections



AXIAL FLOW COMPRESSOR BUSHINGS

ROC Carbon can help you with your stator bushing repair jobs. We offer 2 types of services for these types of parts.

One option is to have us install new carbon bushings in to the original housings. We will remove the old, worn bushings, clean/sand blast the metal housings and install new bushings.

A second option is to have us supply complete new parts (metal housing with carbon bushings). We can reverse engineer the parts from a sample, or work directly from your drawing.

BRONZE BUSHINGS

ROC Carbon offers custom-machined bronze bushings and bearings for applications where alloys are more suitable than carbon-graphite for impact strength, resistance to corrosion, and durability against abrasives. Numerous bronze alloys are available. We machine bushings for pumps, sumps, veritcal turbines and other equipment. Our CNC manufacturing center can machine straight or spiral ID grooves, and we also offer two-piece bushings with milled split lines.

To get started, supply your drawing and specifications or send samples so that we can reverse engineer replacement parts.

WATERJET CUTTING SERVICE

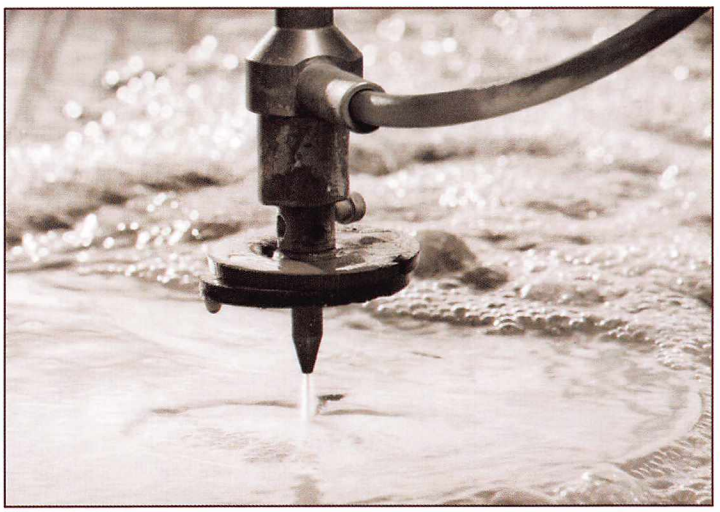
Waterjet cutting is a versatile, high-precision cold-cutting process that uses a high-velocity (Mach 2 to Mach 3) stream of water to efficiently cut a wide range of materials, producing parts in a wide range of sizes, down to tiny pieces.

The waterjet with entrained garnet sand cuts stone, concrete, glass and metals, including titanium, stainless steel, Inconel, and ceramics including alumina.

Waterjet cutting is ideal for short-run part production, just-in-time manufacturing, tooling, and prototype part development.

Advantages of Waterjet Cutting

- Materials can be conserved by nesting parts on the cutting layout
- Little material loss from cutting
- No heat-affected zones or mechanical stresses on cut objects
- Cuts extremely fine details
- Little or no burr
- Efficiently cuts extremely hard materials



One of ROC's waterjet cutting machines is an OMAX Model 5555, which has a 55 in. x 55 in. work envelope.

CARBON GRAPHITE GRADE SELECTION GUIDE

ROC Carbon carbon/graphite materials combine the superior strength, hardness, and wear resistance of carbon with the natural lubricity of graphite. These chemically bonded carbon materials are strong and thermally stable and are inert in most chemical and corrosive applications. When even higher mechanical properties or impervious materials are required, material performance properties can be enhanced by special impregnation with resins or metals. These impregnated carbon grades offer maximum resistance to corrosion, wear, and oxidation.

The grades presented in the guide are only a representative sampling of our many grades. Please call for information on other grades.

In general, ROC Carbon carbon/graphite seals and beaings are used where extreme operating temperatures and/or corrosive fluids would cause conventional lubricants to decompose, where lubricants would contaminate process fluids, and where equipment design make conventional lubricating systems too expensive to install and maintain. Other applications for which ROC Carbon supplies carbon/graphite materials include electrodes and brazing boats, jigs, and fixtures.

Using This Guide

1. Look up the chemical/environment for your application in Table 2 and determine the CR (Corrosion Resistance) Group.
2. Using Table 1, find the materials(s) that match the CR Group found in step 1.
3. Verify the operation temperature does not exceed temperature limit of the material. Remember to consider heat generation in the bearing or seal can cause higher temperatures in the materials.
4. Our Technical Support Group would be happy to assist you in:
   - ◊ material selection
   - ◊ bearing loads
   - ◊ press fits and recommended clearances

Table 1 - Physical Properties of Selected Grades

CR Group	Grade	Composition Code[1]	Apparent Density	Hardness	Flexural Strength		Compressive Strength		Modulus of Elasticity	Coefficient of Thermal Expansion	Temperature Limit			
											Oxidizing Atmosphere		Inert Atmosphere	
			(g/cc)	(Shore Scleroscope)	PSI	MPa	PSI	MPa	(10^6 PSI)	(x10^{-6} in/in/°F)	°F	°C	°F	°C
1	R-103	G	1.72	45	4,200	29	9,600	66	-	1.5	750	399	5,000	2,760
1	R-115	G	1.78	76	9,425	65	19,575	135	1.7	3.1	850	454	5,000	2,760
1	R-138	G	1.81	60	8,000	55	14,000	97	-	2.7	800	427	5,000	2,760
1	R-383	G	1.78	55	6,000	41	12,100	83	1.4	2.6	800	427	5,000	2,760
1	R-433	CG	1.72	72	8,400	58	24,000	166	1.5	2.2	650	343	1,800	982
2	R-122	CGI	1.82	84	9,300	64	30,000	207	3.3	2.9	500	260	500	260
2	R-143	CGI	1.86	90	11,000	76	32,000	221	-	2.8	500	260	500	260
2	R-208	CGI	1.80	101	10,150	70	31,900	220	3.7	2.7	400	204	400	204
2	R-211	CGI	1.87	87	11,300	78	35,500	245	3.2	3.1	480	249	480	249
2	R-307	CGI	1.85	85	10,000	69	25,000	172	2.3	2.6	500	260	500	260
4	R-422	GX	1.85	55	5,500	38	14,000	97	1.2	2.1	1,200	649	1,600	871
5	R-190	CG(Cu)	2.85	40	7,500	52	16,000	110	2.8	2.0	700	371	1,700	927
5	R-191	CG(NiCr)	2.40	55	7,500	52	23,000	159	2.8	1.4	700	371	1,700	927
5	R-203	CG(Sb)	2.20	120[2]	11,600	80	36,000	248	4.2	2.2	750	399	1,100	593
5	R-204	CG(B)	2.45	55	4,800	33	23,500	162	2.9	1.9	400	204	400	204
5	R-391	CG(Br)	2.55	55	8,500	59	25,000	172	3.1	2.1	700	371	1,700	927

B Babbit
Br Bronze
C Carbon
Cu Copper
G Graphite
I Impregnation

[1]Composition Codes

NiCr	Nickel chrome
X	Oxidation impregnation
Sb	Antimony

[2]HRB

Note: The physical properties of ROC Carbon grades may vary in relation to the molded part size and configuration; the above values are typical and should be considered only as a guide or reference.

Chemical Compatibility

The tables on this page present general grade recommendations for chemical service. However, a particular grade's resistance to chemical attack can vary substantially according to temperature, concentration, and exposure time. Please consult with ROC Carbon's applications engineering staff to determine the appropriate grade for your specific application.

Table 2 - Corrosion Resistance by Specific Chemical

✔ Compatible ○ Questionable ✘ Not Recommended

	CR Groups						CR Groups						CR Groups						CR Groups				
	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5
Abietic Acid	✔	✔	✔	○	✔	Carbolic Acid (Phenol)	✔	✔	✔	✘	✔	Hydrocyanic (Prussic) Acid	✔	✔	✔	✘	○	Potassium Alum	✔	✔	✔	✘	○
Acetaldehyde	✔	✔	✔	○	✔	Carbon Dioxide to 600° F	✔	✔	✔	✔	○	Hydrofluoric Acid to 48%	✔	✔	✔	✘	○	Potassium Bicarbonate	✔	✔	✔	✘	✔
Acetanilide	✔	✔	✔	✘	✔	Carbon Dioxide above 600° F	○	○	○	✔	○	Hydrogen	✔	✔	✔	✔	✔	Potassium Carbonate	✔	✔	✔	✘	✔
Acetic Acid to 350° F	✔	✔	✔	✘	○	Carbon Disulfide	✔	✔	✔	○	✔	Hydrogen Chloride	✔	✔	✔	○	✔	Potassium Chlorate	○	✔	✔	✘	○
Acetic Anhydride to 350° F	✔	✔	✔	✘	○	Carbon Monoxide	✔	✔	✔	✔	✔	Hydrogen Fluoride	✔	✔	✔	○	✔	Potassium Choride	✔	✔	✔	✘	✔
Acetone	✔	✔	✔	○	✔	Carbon Tetrachloride	✔	✔	✔	✔	✔	Hydrogen Sulfide	✔	✔	✔	○	✔	Potassium Cyanide	✔	✔	✔	✘	✘
Acetophenone	✔	✔	✔	○	✔	Castor Oil	✔	✔	✔	○	✔	Hydrogen Peroxide	○	○	✔	✘	○	Potassium Hydroxide to 350° F	✔	✔	✔	✘	○
Acetylene	✔	✔	✔	✔	✔	Caustic Soda	✔	✔	✔	✘	○	Hydroxylamine	✔	✔	✔	✘	✔	Potassium Nitrate to 300° F	✔	✔	✔	✘	✔
Acetylsalicylic Acid (Aspirin)	✔	✔	✔	○	✔	"Cellosolves"	✔	✔	✔	○	✔	Hypochlorous Acid	○	○	✔	○	✘	Potassium Permanganate to 300° F	✔	✔	✔	✘	○
Acrolein	✔	✔	✔	○	✔	Cellulose Acetate (rayon)	✔	✔	✔	○	✔	Isobutyl/Isopropyl Alcohols	✔	✔	✔	○	✔	Potassium Phosphate	✔	✔	✔	✘	✔
Acrylonitrile	✘	○	✔	✔	○	Chloracetic Acid	✔	✔	✔	○	✔	Isophthalic Acid	✔	✔	✔	✘	✔	Propane	✔	✔	✔	✔	✔
Adipic Acid	✔	✔	✔	○	✔	Chloral	✔	✔	✔	✔	✔	Kerosene	✔	✔	✔	✔	✔	Propionic Acid	✔	✔	✔	✘	○
Air to 600° F	✔	○	✔	✔	○	"Chlorethene"	✔	✔	✔	✔	✔	Lactic/Lauric Acids	✔	✔	✔	○	✔	Propylene	✔	✔	✔	✔	✔
Air above 600° F	○	✘	○	✔	✘	Chlorine	✔	✔	✔	○	✔	Lead (Molten)	✔	○	✔	○	✘	Pyridine	✔	✘	✔	✘	✔
Alkyl Aryl Sulfonate	✔	✔	✔	○	✔	Chlorobenzene	✔	✔	✔	✔	✔	Lithium Carbonate	✔	✔	✔	✘	✔	Pyroligneous Liquor	✔	✔	✔	✘	○
Allyl Chloride	✔	✔	✔	✘	✔	Chloroform	✔	✔	✔	✔	✔	Lithium Hydroxide	✔	✔	✔	✘	○	Sal Ammonia	✔	✔	✔	✘	○
Alum (ammonia)	✔	✔	✔	✘	✔	Chlorosulfonic Acid	✔	✔	✔	✘	✔	Lubricating Oil	✔	✔	✔	✔	✔	Sal Soda—Na2CO3 • 10 H20	✔	✔	✔	✘	✔
Alum (chrome)	✔	✔	✔	✘	✔	Chromic Acid to 300° F	○	○	✔	✘	✔	Lye	✔	✔	✔	✘	○	Salicylic Acid	✔	✔	✔	✘	✔
Alum (potash)	✔	✔	✔	✘	✔	Chromium Potassium Sulfate	✔	✔	✔	✘	✔	Magnesium (Molten)	✔	○	✔	✘	✘	Sea Water	✔	✔	✔	✘	✔
Aluminum (molten)	✔	○	✔	○	✘	Citric Acid (citrus juices)	✔	✔	✔	✘	✔	Magnesium Bisulfite	✔	✔	✔	✘	✔	Sewage	✔	✔	✔	✘	✔
Aluminum Chloride	✔	✔	✔	✘	○	Coal Tar	✔	✔	✔	✔	✔	Magnesium Sulfate	✔	✔	✔	✘	○	Silver	✔	○	✔	○	✘
Aluminum Sulfate	✔	✔	✔	✘	✔	Copper	✔	○	✔	○	✘	Maleic Acid	✔	✔	✔	✘	○	Soap and Soap Liquors	✔	✔	✔	✘	✔
Ammonia (wet) to 300° F	✔	✔	✔	✘	✔	Copper Sulfate	✔	✔	✔	✘	✔	Maleic Anhydride	✔	✔	✔	✘	○	Soda Ash	✔	✔	✔	✘	✘
Ammonia (anhydrous)	✔	✔	✔	✔	✔	Cottonseed Oil	✔	✔	✔	○	✔	Mercuric Chloride	✔	✔	✔	✘	✘	Sodium Salts-see Potassium Salts					
Ammonium Chloride	✔	✔	✔	✘	○	Creosote	✔	✔	✔	○	✔	Mercury	✔	✔	✔	✘	✘	Sodium Bisulfite	✔	✔	✔	✘	✔
Ammonium Hydroxide	✔	✔	✔	✘	✔	Cresols, Cresylic Acid	✔	✔	✔	○	✔	Methane	✔	✔	✔	✔	✔	Sodium Dichromate	✔	✔	✔	✘	✔
Ammonium Nitrate	✔	✔	✔	✘	✔	Crotonaldehyde	✔	✔	✔	○	✔	Methyl Alcohol (Methanol)	✔	✔	✔	○	✔	Sodium Hypochlorite	○	○	✔	✘	○
Ammonium Phosphate .	✔	✔	✔	✘	✔	Cumene	✔	✔	✔	✔	✔	Methyl Chloride	✔	✔	✔	✔	✔	Sodium Metaphosphate	✔	✔	✔	✘	✔
Amyl Acetate	✔	✔	✔	○	✔	Cupric Chloride	✔	✔	✔	✘	✔	Methylene Dichloride	✔	✔	✔	✔	✔	Sodium Nitrate (Nitrate Melt)	○	✘	○	○	○
Amyl Alcohol	✔	✔	✔	○	✔	Cuprous AmmoniumAcetate-Viscose	✔	✔	✔	✘	✔	Methyl Ethyl Ether	✔	✔	✔	○	✔	Sodium Perborate	○	✔	✔	✘	○
Amyl Amines	✔	✔	✔	✘	✔	Cyanic Acid	✔	✔	✔	○	○	Methyl Ethyl Ketone	✔	✔	✔	○	✔	Sodium Perchlorate	○	✔	✔	✘	○
Amyl Chloride	✔	✔	✔	✘	✔	Cyanide Plating Solutions	✔	✔	✔	✘	○	Methyl Isobutyl Ketone	✔	✔	✔	○	✔	Sodium Sulfate	✔	✔	✔	✘	○
Aniline	✔	✔	✔	✔	✔	Cyclohexane	✔	✔	✔	✔	✔	Methyl Salicylate	✔	✔	✔	○	✔	Sodium Sulfide	✔	✔	✔	✘	○
Anthracene	✔	✔	✔	✔	✔	Detergents	✔	✔	✔	✘	✔	Milk	✔	✔	✔	✘	✔	Sodium Tetraborate (Borax)	✔	✔	✔	✘	○
Antimony	✔	○	✔	○	✘	Dibutyl Phosphate	✔	✔	✔	○	✔	Mineral Oil	✔	✔	✔	✔	✔	Sodium Thiosulfate (Hypo)	✔	✔	✔	✘	✔
Argon	✔	✔	✔	✔	✔	Diethanol Amine	✔	✔	✔	✘	✔	Molasses	✔	✔	✔	✘	✔	Sorbitol	✔	✔	✔	○	✔
Arsenic (Molten)	✔	○	✔	○	✘	Diethyl Sulfate (Ethyl Sulfate)	✔	✔	✔	✘	✔	Monoethanol Amine	✔	✔	✔	✘	✔	Stannic Chloride	✔	✔	✔	✘	○
Asphalt	✔	✔	✔	✔	✔	Disodium Phosphate	✔	✔	✔	✘	✔	Muriatic Acid	✔	✔	✔	✘	○	Steam to 600° F	✔	✔	✔	○	○
Aromatic Fuels	✔	✔	✔	✔	✔	"Dowtherm"	✔	✔	✔	✘	✔	Naphtha	✔	✔	✔	✔	✔	Steam 600 to 1500° F	○	✘	○	✔	○
Babbitt Metal (molten)	✔	○	✔	○	✘	Epichlorohydrin	✔	✔	✔	✘	✔	Naphthalene	✔	✔	✔	✔	✔	Stearic Acid	✔	✔	✔	○	✔
Baking Soda	✔	✔	✔	✘	✔	Ethane	✔	✔	✔	✘	✔	Nickel Chloride	✔	✔	✔	✘	○	Styrene	✔	✔	✔	✔	✔
Barium Hydroxide	✔	✔	✔	✘	○	Ether (Ethyl Ether)	✔	✔	✔	○	✔	Nickel Sulfate	✔	✔	✔	✘	✔	Sugar	✔	✔	✔	✘	✔
Barium Sulfide	✔	✔	✔	✘	✔	Ethyl Acetate	✔	✔	✔	○	✔	Nitrating Acid to 75% total acid	○	○	✔	✘	○	Sulfate Liquors	✔	✔	✔	✘	✔
Battery Acid (90% H2S04)	✔	○	✔	✘	○	Ethyl Alcohol	✔	✔	✔	○	✔	Nitric Acid to 15%	✔	✔	✔	✘	○	Sulfite Liquors	✔	✔	✔	✘	✔
Beer	✔	✔	✔	✘	✔	Ethyl Benzene	✔	✔	✔	✔	✔	Nitric Acid 15 to 100%	✔	○	✔	✘	✘	Sulfur	✔	○	✔	○	○
Benzaldehyde	✔	✔	✔	○	✔	Ethyl Chloride and Dichloride	✔	✔	✔	✘	✔	Nitrobenzene	✔	✔	✔	✔	✔	Sulfur Dioxide to 500° F	✔	✔	✔	○	○
Benzene (benzol)	✔	✔	✔	✔	✔	Ethylene	✔	✔	✔	✔	✔	Nitrogen	✔	✔	✔	✔	✔	Sulfuric Acid to 77%, 300° F	✔	✔	✔	✘	✔
Benzene Sulfonic Acid	✔	✔	✔	○	✔	Ethylene Glycol	✔	✔	✔	○	✔	Nitrogen Tetroxide	○	✘	○	✔	✘	Sulfuric Acid 77-98% to 200° F	✔	○	✔	✘	○
Benzoic Acid	✔	✔	✔	○	✔	Ethylene Oxide	✔	✔	✔	○	✔	Nitro Paraffins	✔	✔	✔	✔	✔	Tar	✔	✔	✔	✔	✔
Beta-Naphthol	✔	✔	✔	○	✔	Fatty Acids	✔	✔	✔	○	○	Oleic Acid	✔	✔	✔	○	✔	Terephthalic Acid	✔	✔	✔	✘	✔
Bismuth (Molten)	✔	✔	✔	✘	✔	Ferric Chloride	✔	✔	✔	✘	○	Oleum (Fuming H2S04) to 100° F	○	○	✔	✘	○	Tetrachloroethylene	✔	✔	✔	✔	✔
Black Ash	✔	✔	✔	✘	✔	Ferric Sulfate	✔	✔	✔	✘	✔	Olive Oil	✔	✔	✔	○	✔	Tin	✔	○	✔	○	✘
Black Sulfate Liquor .	✔	✔	✔	✘	✔	Fluorine gas	○	○	○	✔	○	Ortho Phosphoric Acid to 400° F	✔	✔	✔	✘	○	Toluene	✔	✔	✔	✔	✔
Bleaching Powder	✔	○	✔	○	✘	Fluorosilicic Acid	✔	○	✔	✘	○	Oxalic Acid	✔	✔	✔	✘	○	Toluene Sulfonic Acid	✔	✔	✔	✘	○
Borax	✔	✔	✔	✘	✔	Formaldehyde	✔	✔	✔	○	✔	Oxygen to 500° F	✔	✔	✔	✔	✔	Toluic Acid	✔	✔	✔	✘	○
Boric Acid	✔	✔	✔	✘	✔	Formamide	✔	✔	✔	✘	✔	Oxygen above 500° F	○	○	○	✔	✘	Trichloroethylene	✔	✔	✔	✔	✔
Boron Trifluoride	✔	✔	✔	✘	✔	Formic Acid	✔	✔	✔	✘	○	Palmitic Acid	✔	✔	✔	○	✔	Triethanol Amine	✔	✔	✔	✘	✔
Brass (Molten)	✔	○	✔	○	✘	Freons	✔	✔	✔	✔	✔	Paraffin	✔	✔	✔	✔	✔	Trisodium Phosphate	✔	✔	✔	✘	✔
Bromine	✔	○	✔	○	○	Fruit juices	✔	✔	✔	✘	✔	Pentaerythritol	✔	✔	✔	○	✔	Turpentine	✔	✔	✔	✔	✔
Bronze (Molten)	✔	○	✔	○	✘	Fuel Oil	✔	✔	✔	✔	✔	Perchloric Acid to 72%, 200° F	○	○	✔	✘	✘	Urea	✔	✔	✔	✘	✔
Butadiene	✔	✔	✔	✔	✔	Furfural	✔	✔	✔	○	✔	Perchloroethylene	✔	✔	✔	✔	✔	Vegetable Oil	✔	✔	✔	○	✔
Butane	✔	✔	✔	✔	✔	Gallium	✔	○	✔	○	○	Petroleum	✔	✔	✔	✔	✔	Vinegar	✔	✔	✔	✘	○
Butter, Buttermilk	✔	✔	✔	○	✔	Gasoline	✔	✔	✔	✔	✔	Phenol	✔	○	✔	✘	✔	Vinyl Acetate	✔	✔	✔	○	✔
Butyl Acetate	✔	✔	✔	○	✔	Glutamic Acid	✔	✔	✔	○	✔	Phosphoric Acid to 400° F	✔	✔	✔	✘	○	Vinyl Chloride	✔	✔	✔	✔	✔
Butyl Alcohol	✔	✔	✔	○	✔	Glycerine	✔	✔	✔	○	✔	Phosphorus	✔	○	✔	○	○	Viscose	✔	✔	✔	✘	✔
Butyl Amines	✔	✔	✔	✘	✔	Gold (Molten)	✔	✔	✔	✘	✔	Phosphorus Oxychloride	✔	✔	✔	✘	○	Water to 300° F	✔	✔	✔	✘	✔
Butylene	✔	✔	✔	✔	✔	Green Sulfate Liquor	✔	✔	✔	✘	✔	Phosphorus Trichloride	✔	✔	✔	○	○	Water Glass (Na2SiO3)	✔	✔	✔	✘	✔
Cadmium (Molten)	✔	○	✔	○	✘	Helium	✔	✔	✔	✔	✔	Phthalic Acid/Anhydride	✔	✔	✔	✘	○	Wood Pulp	○	✔	✔	✘	✔
Calcium Bisulfite	✔	✔	✔	✘	✔	Hexane	✔	✔	✔	✔	✔	Picric Acid	✔	✔	✔	✘	✔	Xylene	✔	✔	✔	✔	✔
Calcium Chloride	✔	✔	✔	✘	✔	Hydrazine	✔	✔	✔	✘	✔	Polyethylene	✔	✔	✔	✔	✔	Zinc	✔	○	✔	○	○
Calcium Hydroxide	✔	✔	✔	✘	○	Hydrobromic Acid	✔	✔	✔	✘	○	Polystyrene	✔	✔	✔	✔	✔	Zinc Chloride	✔	✔	✔	✘	✔
Calcium Hypochlorite	○	○	✔	✘	✘	Hydrochloric (muriatic) Acid	✔	✔	✔	✘	○	Polyurethane	✔	✔	✔	✔	✔	Zinc Sulfate	✔	✔	✔	✘	✔

✔ Compatible ○ Questionable ✘ Not Recommended

PEEK (POLY ETHER ETHER KETONE)

ROC Carbon offers a portfolio of PEEK thermoplastic grades that provide good chemical resistance and excellent physical properties for applications including bearings, seals and other parts. Material grades are available as finished parts per your specifications or as raw material blanks for machining.

General Properties

- Good chemical resistance to alkalis, aromatic hydrocarbons, halogenated hydrocarbons, alcohols, greases, and oils
- Self-lubricating
- Thermal stability
- Contamination resistance
- Mechanical strength

Raw Material Availability

Cylinders up to 20 in. diameter

PEEK MATERIAL PROPERTIES

Grade	Composition	Density g/cc	Hardness (HRR)	Strength			Temperature Limit, °F	Coefficient of Friction**
				Tensile psi	Shear psi	Flexural psi		
R700	Virgin	1.32	126	14,500	7,700	24,700	500	0.34
R-710	15% PTFE filled	1.40	124*	11,000	N/A	19,000	500	0.11
R-720	15% glass filled	1.39	124	17,800	N/A	26,000	500	N/A
R-721	30% glass filled	1.49	124	24,500	14,000	33,500	500	N/A
R-730	30% carbon filled	1.40	124	32,700	14,000	51,000	500	0.28
R-740	30% glass filled/PTFE filled	1.44	124	19,000	N/A	30,450	500	0.11

Values shown are typical properties, not guaranteed minimum values.
*Estimated value (actual Shore 88) ** Friction coefficients are measured under specific test conditions; actual values will vary with different operating parameters.

ROCBON PTFE COMPOSITES

ROCBON high-performance, reinforced fluorocarbon composites are unique in the plastics family and possess exceptional properties:

- chemical resistance
- self-lubricating
- thermal stability
- moisture resorbent
- contamination resistance
- mechanical strength
- electrical insulation

Grades and Applications (see opposite page for physical properties)

1007	Virgin PTFE for packings, seals and bushings
1051	25% fiberglass-filled grade for common seals and bushings
1521	50% stainless steel-filled grade for bearings and valve seat applications where high load and corrosion are primary concerns.
1551	Ceramic-filled grade (25% mica) for applications where high wear resistance is required.
1621	35% carbon fiber-filled grade where high strength and high wear performance is sought; a high-performance composite grade.
1821	Moly/bronze-filled grade for bearing and seal applications where high load strength is needed. 55% bronze, 5% moly filled
1911 and 1921	Carbon/graphite-filled grades for bearings, piston rings, rider rings and various seals. An excellent combination that provides good service life. 1911 has 25% fill, 1921 has 35% fill.

Sizes

Solid cylinder: 1.5 in. to 6 in. diameter, 12 in. long
Tube: 1.5 in. to 15.875 in. diameter, 12 in. long

Larger sizes are available upon request

Raw Materials Technical Support

Technical support is available to help select the proper grade for the application, and engineering design service can be provided for the finished product. For fastest response, call our toll-free number.

ROCBON PTFE COMPOSITE PROPERTIES

Physical Property		ASTM Test Method	Units	1007 Virgin PTFE	1051 Glass	1521 Stainless Steel	1551 Ceramic	1621 Carbon Fiber	1821 Moly/Bronze	1911 Carbon/Graphite	1921 Carbon/Graphite
Specific gravity		D792	g/cc	2.17	2.24	3.78	2.20	2.10	3.90	2.11	2.10
Tensile strength @ break	(MD)	D638	psi	4,900	2,100	2,500	2,300	3,000	2,300	1,800	1,600
			MPa	*33.8*	*14.5*	*17.2*	*15.9*	*20.7*	*15.9*	*12.4*	*11.0*
	(CD)		psi	5,600	2,900	2,900	2,700	3,400	2,700	2,200	2,000
			MPa	*38.6*	*20.0*	*20.0*	*18.6*	*23.5*	*18.6*	*15.2*	*13.8*
Elongation @ break	(MD)	D638	%	340	250	65	65	60	90	60	50
	(CD)		%	390	270	70	70	60	98	65	55
Deformation under load	(MD)	D621	%	12.0	9.5	2.8	2.8	10.0	3.6	6.0	5.5
	(CD)		%	15.0	13.6	3.0	3.0	10.0	4.0	10.2	5.5
Flexural strength, 3% strain		D790	psi	1,500	1,950	3,500	3,200	2,400	3,300	2,350	2,400
			MPa	*10.3*	*13.5*	*24.1*	*22.0*	*16.6*	*22.8*	*16.2*	*16.6*
Flexural modulus		D790	psi	90,000	190,000	250,000	250,000	160,000	210,000	160,000	180,000
			MPa	*622*	*1,313*	*1,727*	*1,727*	*1,106*	*1,451*	*1,106*	*1,244*
Compressive strength, 5% strain		D695	psi	1,800	2,200	4,000	3,500	2,500	3,000	2,500	2,700
			MPa	*12.4*	*15.2*	*27.6*	*24.1*	*17.2*	*20.7*	*17.2*	*18.6*
Hardness, Durometer		--	Type D	54	62	70	70	68	70	64	66
Thermal expansion, $x10^{-5}$	(MD)	D696	in/in/°F	7.5	6.4	5.3	5.3	4.0	5.6	6.0	4.6
			mm/mm/°C	*13.5*	*11.5*	*9.5*	*9.5*	*7.2*	*10.1*	*10.8*	*8.3*
	(CD)			6.2	4.1	4.0	4.0	3.6	4.3	4.7	4.0
				11.2	*7.4*	*7.2*	*7.2*	*6.5*	*7.7*	*8.5*	*7.2*
Limiting PV @100 fpm, 72° F (22° C)		--	psi*fpm	10,500	10,500	20,000	18,000	20,000	12,500	20,000	20,000
			*MPa*mpm*	*22*	*22*	*42*	*38*	*42*	*26*	*42*	*42*
Wear factor (F) $x10^{-10}$		--	$\frac{in^3/min}{lb/ft/hr}$	6	6	2	2	6	5	6	10
			$\frac{cm^3/min}{kg/m/hr}$	*13.6*	*13.6*	*4.5*	*4.5*	*13.6*	*11.3*	*13.6*	*22.6*
Coefficient of friction	static	--		0.04	0.07	0.08	0.08	0.07	0.08	0.08	0.13
	dynamic			0.05	0.12	0.10	0.10	0.08	0.09	0.09	0.16

Notes

1. The physical properties of ROC CARBON grades may vary in relation to the molded part size, configuration and the application conditions. The above values are typical and should be considered only as a guide or reference.
2. Estimated wear rate (in/hr) = (application PV) * (wear factor)
3. MD = molded direction; CD = cross direction

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