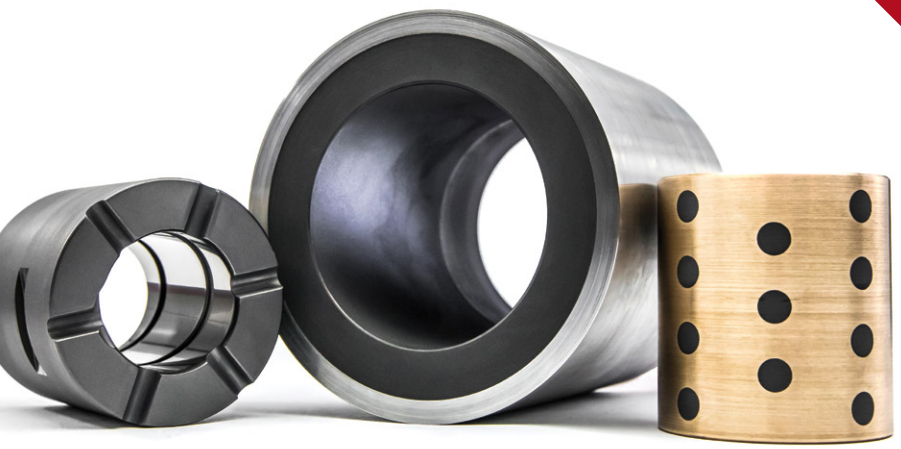
ROC CARBON COMPANY



Customer Driven, Service Focused, Purpose Led.

INTRODUCTION

FOR OVER 65 YEARS,

ROC Carbon has provided high quality products and responsive service to help meet our customer's needs.

Recently, we have initiated a program that expands our long history of offering urgent next day delivery of custom parts, to all orders. This initiative required many changes in all departments as well as a new, live order tracking system.

As our industry changes, ROC is working toward leveraging web based tools to better serve our customers. We redesigned our website, added web blogs, and a new chat service to make communication with prospects and customers more flexible and engaging. I encourage you to experience these new services. Also, with artificial intelligence gaining momentum, ROC is beginning to study how this tool can be used to serve customers faster and provide better solutions.

These changes are allowing ROC to improve upon the core elements that we have always provided: responsive service, custom parts, and technical assistance.

PRESIDENT, CEO

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, repair shops, end users, petrochemical plants, refineries, power plants and many other industries.

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

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

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.

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

ENGINEERING & 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)*
- Press-fit and shrink-fit *(calculations & installation)*
- Lapping

FACILITIES

Our 30,000-sq ft manufacturing plant in west Houston accommodates both small-quantity, quick-turnaround orders and longer-lead-time, medium-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

- Coppus
- Dean Hill
- Delaval
- Elliott
- General Electric
- Murray
- Skinner
- Terry
- Westinghouse
- Worthington

RECIPROCATING COMPRESSORS

- Gardner-Denver
- Sullair
- Westinghouse

ROTARY STEAM JOINTS

- Maier Gmbh
- Johnson

CENTRIFUGAL & AXIAL COMPRESSORS

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

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'S PRODUCT OFFERINGS

PREMIER PRODUCT MANUFACTURING & CRAFTSMANSHIP

SEGMENTED SEAL RINGS

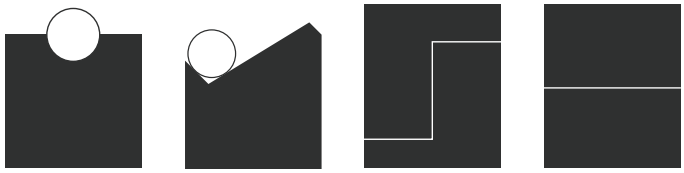
Graphite is an ideal material for steam turbine packing rings, secondary containment seals, and blower rings. Our rings feature precision manufacturing and special material grades for optimum sealing performance and long service life.

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 stainless steel, 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.



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

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 provide a quote or ship the part immediately if stock is available.

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.

FOR ORIGINAL EQUIPMENT REPLACEMENT PARTS, PLEASE FURNISH.

The OEM part number or the specifications of the machine.

For custom-designed parts, furnished engineered. Drawings can be made available

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 2 helium light bands. 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.

PISTON RINGS

Piston rings are used in reciprocating compressors, control valves, poppet valves, and other similar applications. The primary sealing surface is the contact between the OD of the seal and the cylinder wall. For some designs, a separate spring expander is required on the ID of ring to energize (push) the segments to the cylinder wall. The secondary sealing surface is the contact of the face of the ring and the face of the piston ring groove. Multiple rings are usually needed to seal the high pressure in the cylinder.

CARBON/GRAPHITE BUSHINGS & 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 & 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.

Cold Press fitting is generally used for low-temperature applications, where relatively low interference is needed to keep the carbon from rotating independently. Heat shrink fits are 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 face and stationary face. 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, while maintaining a constant gap between the shaft and the ID of the seal.

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 re-stabilizing the seal before final machining. 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.

BRONZE BUSHINGS WITH GRAPHITE PLUGS

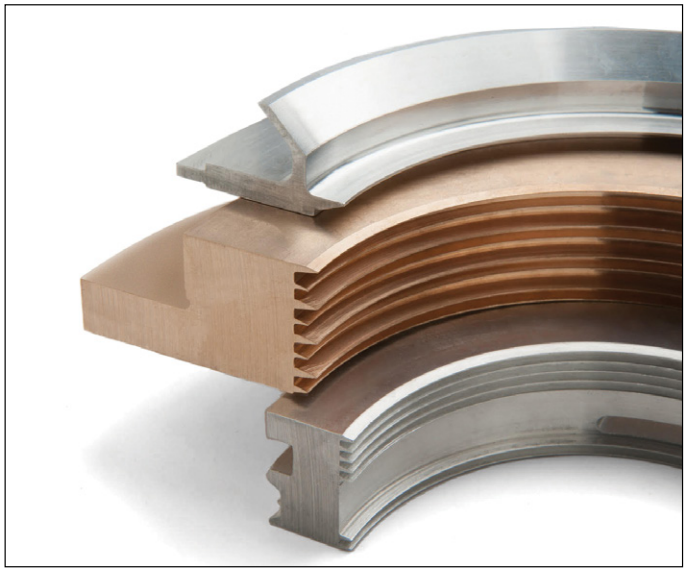
ROC Carbon offers bronze bushings with graphite plugs, ideal for applications requiring self-lubrication and wear resistance. The bronze provides strength, and embedded graphite acts as a solid lubricant. These bushings excel in high-load, low-speed scenarios where traditional lubrication methods are impractical. They demand minimal maintenance, offer some corrosion resistance, and function in wet and dry conditions and across a broad temperature range.

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



Typical labryinth 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, inspect for damage, and then 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 bronze 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, 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 abrasive 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.

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

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

BALL VALVE SEATS

Ball valve seats are the primary seal in a ball valve. Typically the seats are made from PTFE for lower temperatures, carbon for higher temperatures, and metal for the highest temperatures.The valve seats support the ball during the open/partially open position. When the valve is closed, fluid pressure in the pipe pushes the ball toward one of the seats. This action creates a seal since the seat has been lapped to the ball during the manufacturing process.

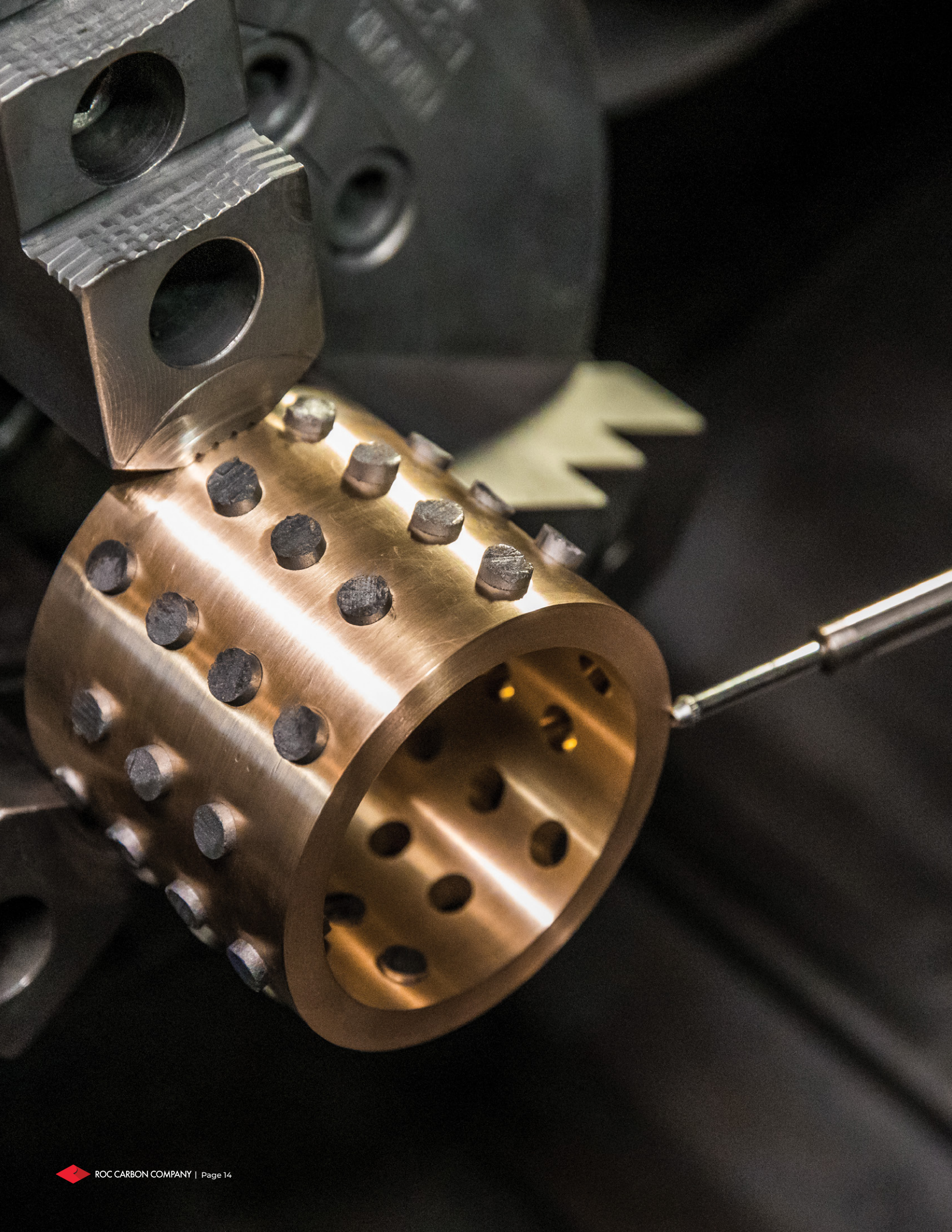
MANUFACTURING

With PTFE, the seat is machined as a single component. Because PTFE conforms to the ball surface, lapping the seat and ball is not necessary.

BLOWER SEALS

Blower systems typically employ various types of seals to ensure effective operation. These include labyrinth seals, which use intricate channels to obstruct the passage of air or gases. Segmented carbon seals utilize segments of carbon material to create a tight barrier. Mechanical face seals rely on two precisely engineered faces to prevent the escape of fluids or gases. Each type serves a specific purpose in maintaining the integrity and efficiency of blower systems.

Segmented blower seal



REPRESENTATIVE SAMPLING

CARBON GRAPHITE GRADE SELECTION GUIDE

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	1.80	60	7,850	54	14,800	102	1.5	2.7	800	427	5,000	2,760
1	R-383	G	1.78	55	6,000	41	12,100	83	1.2	2.6	800	427	5,000	2,760
1	R-433	CG	1.72	72	8,400	58	24,000	165	1.5	3.2	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	3.2	2.8	500	260	500	260
2	R-208	CGI	1.82	101	11,000	76	29,000	200	3.4	2.2	390	199	390	199
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-116	CG(SB)	2.30	88	13,050	90	43,500	300	3.9	2.8	752	400	932	500
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)	2.30	120 (2)	12,500	86	37,500	259	4.4	2.2	660	349	1,000	538
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

[1]COMPOSITION CODES

B - Babbitt

BR - Bronze

C - Carbon

CU - Copper

G - Graphite

I - Impregnation

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	1	2	3	4	5	CR GROUPS	1	2	3	4	5
Abietic Acid	✓	✓	✓	○	✓	Baking Soda	✓	✓	✓	×	✓
Acetaldehyde	✓	✓	✓	○	✓	Barium Hydroxide	✓	✓	✓	×	○
Acetanilide	✓	✓	✓	×	✓	Barium Sulfide	✓	✓	✓	×	✓
Acetic Acid to 350° F	✓	✓	✓	×	○	Battery Acid (90% H2S04)	✓	○	✓	×	○
Acetic Anhydride to 350° F	✓	✓	✓	×	○	Beer	✓	✓	✓	×	✓
Acetone	✓	✓	✓	○	✓	Benzaldehyde	✓	✓	✓	○	✓
Acetophenone	✓	✓	✓	○	✓	Benzene (benzol)	✓	✓	✓	✓	✓
Acetylene	✓	✓	✓	✓	✓	Benzene Sulfonic Acid	✓	✓	✓	○	✓
Acetylsalicylic Acid (Aspirin)	✓	✓	✓	○	✓	Benzoic Acid	✓	✓	✓	○	✓
Acrolein	✓	✓	✓	○	✓	Beta-Naphthol	✓	✓	✓	○	✓
Acrylonitrile	×	○	✓	✓	○	Bismuth (Molten)	✓	✓	✓	×	✓
Adipic Acid	✓	✓	✓	○	✓	Black Ash	✓	✓	✓	×	✓
Air to 600° F	✓	○	✓	✓	○	Black Sulfate Liquor	✓	✓	✓	×	✓
Air above 600° F	○	×	○	✓	×	Bleaching Powder	✓	○	✓	○	×
Alkyl Aryl Sulfonate	✓	✓	✓	○	✓	Borax	✓	✓	✓	×	✓
Allyl Chloride	✓	✓	✓	×	✓	Boric Acid	✓	✓	✓	×	✓
Alum (ammonia)	✓	✓	✓	×	✓	Boron Triflouride	✓	✓	✓	×	✓
Alum (chrome)	✓	✓	✓	×	✓	Brass (Molten)	✓	○	✓	○	×
Alum (potash)	✓	✓	✓	×	✓	Bromine	✓	○	✓	○	○
Aluminum (molten)	✓	○	✓	○	×	Bronze (Molten)	✓	○	✓	○	×
Aluminum Chloride	✓	✓	✓	×	○	Butadiene	✓	✓	✓	✓	✓
Aluminum Sulfate	✓	✓	✓	×	✓	Butane	✓	✓	✓	✓	✓
Ammonia (wet) to 300° F	✓	✓	✓	×	✓	Butter, Buttermilk	✓	✓	✓	○	✓
Ammonia (anhydrous)	✓	✓	✓	✓	✓	Butyl Acetate	✓	✓	✓	○	✓
Ammonium Chloride	✓	✓	✓	×	○	Butyl Alcohol	✓	✓	✓	○	✓
Ammonium Hydroxide	✓	✓	✓	×	✓	Butyl Amines	✓	✓	✓	×	✓
Ammonium Nitrate	✓	✓	✓	×	✓	Butylene	✓	✓	✓	✓	✓
Ammonium Phosphate	✓	✓	✓	×	✓	Cadmium (Molten)	✓	○	✓	○	×
Amyl Acetate	✓	✓	✓	○	✓	Calcium Bisulfite	✓	✓	✓	×	✓
Amyl Alcohol	✓	✓	✓	○	✓	Calcium Chloride	✓	✓	✓	×	✓
Amyl Amines	✓	✓	✓	×	✓	Calcium Hydroxide	✓	✓	✓	×	○
Amyl Chloride	✓	✓	✓	×	✓	Calcium Hypochlorite	○	○	✓	×	×
Aniline	✓	✓	✓	✓	✓	Carbolic Acid (Phenol)	✓	✓	✓	×	✓
Anthracene	✓	✓	✓	✓	✓	Carbon Dioxide to 600° F	✓	✓	✓	✓	○
Antimony	✓	○	✓	○	×	Carbon Dioxide aboce 600° F	○	○	○	✓	○
Argon	✓	✓	✓	✓	✓	Carbon Disfulfide	✓	✓	✓	○	✓
Arsenic (Molten)	✓	○	✓	○	×	Carbon Monoxide	✓	✓	✓	✓	✓
Asphalt	✓	✓	✓	✓	✓	Carbon Tetrachloride	✓	✓	✓	✓	✓
Aromatic Fuels	✓	✓	✓	✓	✓	Castor Oil	✓	✓	✓	○	✓
Babbitt Metal (molten)	✓	○	✓	○	×	Caustic Soda	✓	✓	✓	×	○

CR GROUPS	1	2	3	4	5
"Cellosolves"	✓	✓	✓	○	✓
Cellulose Acetate (rayon)	✓	✓	✓	○	✓
Chloracetic Acid	✓	✓	✓	○	✓
Chloral	✓	✓	✓	✓	✓
"Chlorethene"	✓	✓	✓	✓	✓
Chlorine	✓	✓	✓	○	✓
Chlorobenzene	✓	✓	✓	✓	✓
Chloroform	✓	✓	✓	✓	✓
Chlorosulfonic Acid	✓	✓	✓	×	✓
Chromic Acid to 300° F	○	○	✓	×	✓
Chromium Potassium Sulfate	✓	✓	✓	×	✓
Citric Acid (citrus juices)	✓	✓	✓	×	✓
Coal Tar	✓	✓	✓	✓	✓
Copper	✓	○	✓	○	×
Copper Sulfate	✓	✓	✓	×	✓
Cottonseed Oil	✓	✓	✓	○	✓
Creosote	✓	✓	✓	○	✓
Cresols, Cresylic Acid	✓	✓	✓	○	✓
Crotonaldehyde	✓	✓	✓	○	✓
Cumene	✓	✓	✓	✓	✓
Cupric Chloride	✓	✓	✓	×	✓
Cuprous Ammonium Acetate-Viscose	✓	✓	✓	×	✓
Cyanic Acid	✓	✓	✓	○	○
Cyanide Plating Solutions	✓	✓	✓	×	○
Cyclohexane	✓	✓	✓	✓	✓
Detergents	✓	✓	✓	×	✓
Dibutyl Phosphate	✓	✓	✓	○	✓
Diethanol Amine	✓	✓	✓	×	✓
Diethyl Sulfate (Ethyl Sulfate)	✓	✓	✓	×	✓
Disodium Phosphate	✓	✓	✓	×	✓
"Dowtherm"	✓	✓	✓	×	✓
Epichlorohydrin	✓	✓	✓	×	✓
Ethane	✓	✓	✓	×	✓
Ether (Ethyl Ether)	✓	✓	✓	○	✓
Ethyl Acetate	✓	✓	✓	○	✓
Ethyl Alcohol	✓	✓	✓	○	✓
Ethyl Benzene	✓	✓	✓	✓	✓
Ethyl Chloride and Dichloride	✓	✓	✓	×	✓
Ethylene	✓	✓	✓	✓	✓
Ethylene Glycol	✓	✓	✓	○	✓
Ethylene Oxide	✓	✓	✓	○	✓
Fatty Acids	✓	✓	✓	○	○
Ferric Chloride	✓	✓	✓	×	○
Ferric Sulfate	✓	✓	✓	×	✓
Fluorine gas	○	○	○	✓	○
Flourosilicic Acid	✓	○	✓	×	○
Formaldehyde	✓	✓	✓	○	✓
Formamide	✓	✓	✓	×	✓
Formic Acid	✓	✓	✓	×	○
Freons	✓	✓	✓	✓	✓
Fruit juices	✓	✓	✓	×	✓

CR GROUPS	1	2	3	4	5
Fuel Oil	✓	✓	✓	✓	✓
Furfural	✓	✓	✓	○	✓
Gallium	✓	○	✓	○	○
Gasoline	✓	✓	✓	✓	✓
Glutamic Acid	✓	✓	✓	○	✓
Glycerine	✓	✓	✓	○	✓
Gold (Molten)	✓	✓	✓	×	✓
Green Sulfate Liquor	✓	✓	✓	×	✓
Helium	✓	✓	✓	✓	✓
Hexane	✓	✓	✓	✓	✓
Hydrazine	✓	✓	✓	×	✓
Hydrobromic Acid	✓	✓	✓	×	○
Hydrochloric (muriatic) Acid	✓	✓	✓	×	○
Hyrdocyanic (Prussic) Acid	✓	✓	✓	×	○
Hydroflouric Acid to 48%	✓	✓	✓	×	○
Hydrogen	✓	✓	✓	✓	✓
Hydrogen Chloride	✓	✓	✓	○	✓
Hydrogen Flouride	✓	✓	✓	○	✓
Hydrogen Sulfide	✓	✓	✓	○	✓
Hydrogen Peroxide	○	○	✓	×	○
Hydroxlamine	✓	✓	✓	×	✓
Hypochlorous Acid	○	○	✓	○	×
Isobutyl/Isopropyl Alcohols	✓	✓	✓	○	✓
Isophthalic Acid	✓	✓	✓	×	✓
Kerosene	✓	✓	✓	✓	✓
Lactic/Lauric Acids	✓	✓	✓	○	✓
Lead (Molten)	✓	○	✓	○	×
Lithium Carbonate	✓	✓	✓	×	✓
Lithium Hydroxide	✓	✓	✓	×	○
Lubricating Oil	✓	✓	✓	✓	✓
Lye	✓	✓	✓	×	○
Magnesium (Molten)	✓	○	✓	×	×
Magnesium Bisulfite	✓	✓	✓	×	○
Magnesium Sulfate	✓	✓	✓	×	○
Maleic Aid	✓	✓	✓	×	○
Maleic Anhydride	✓	✓	✓	×	○
Mercuric Chloride	✓	✓	✓	×	×
Mercury	✓	✓	✓	×	×
Methane	✓	✓	✓	✓	✓
Methyl Alcohol (Methanol)	✓	✓	✓	○	✓
Methyl Chloride	✓	✓	✓	✓	✓
Methylene Dichloride	✓	✓	✓	✓	✓
Methyl Ethyl Ether	✓	✓	✓	○	✓
Methyl Ethyl Ketone	✓	✓	✓	○	✓
Methyl Isobutyl Ketone	✓	✓	✓	○	✓
Methyl Salicylate	✓	✓	✓	○	✓
Milk	✓	✓	✓	×	✓
Mineral Oil	✓	✓	✓	✓	✓
Molasses	✓	✓	✓	×	✓
Monoethanol Amine	✓	✓	✓	×	✓
Muriatic Acid	✓	✓	✓	×	○

CR GROUPS	1	2	3	4	5
Naphtha	✓	✓	✓	✓	✓
Naphthalene	✓	✓	✓	✓	✓
Nickel Chloride	✓	✓	✓	×	○
Nickel Sulfate	✓	✓	✓	×	✓
Nitrating Acid to 75% total acid	○	○	✓	×	○
Nitric Acid to 15%	✓	✓	✓	×	○
Nitric Acid 15 to 100%	✓	○	✓	×	×
Nitrobenzene	✓	✓	✓	✓	✓
Nitrogen	✓	✓	✓	✓	✓
Nitrogen Tetroxide	○	×	○	✓	×
Nitro Paraffins	✓	✓	✓	✓	✓
Oleic Acid	✓	✓	✓	○	✓
Oleum (Fuming H2S04) to 100° F	○	○	✓	×	○
Olive Oil	✓	✓	✓	○	✓
Ortho Phosphoric Acid to 400° F	✓	✓	✓	×	○
Oxalic Acid	✓	✓	✓	×	○
Oxygen to 500° F	✓	✓	✓	✓	✓
Oxygen above 500° F	○	○	○	✓	×
Palmitic Acid	✓	✓	✓	○	✓
Paraffin	✓	✓	✓	✓	✓
Pentaerythritol	✓	✓	✓	○	✓
Perchloric Acid to 72%, 200° F	○	○	✓	×	×
Perchloroethylene	✓	✓	✓	✓	✓
Petroleum	✓	✓	✓	✓	✓
Phenol	✓	○	✓	×	✓
Phosphoric Acid to 400° F	✓	✓	✓	×	○
Phosphorus	✓	○	✓	○	○
Phosphorus Oxychloride	✓	✓	✓	×	○
Phosphorus Trichloride	✓	✓	✓	○	○
Phthalic Acid/Anhydride	✓	✓	✓	×	○
Picric Acid	✓	✓	✓	×	✓
Polyethylene	✓	✓	✓	✓	✓
Polystyrene	✓	✓	✓	✓	✓
Polyurethane	✓	✓	✓	✓	✓
Potassium Alum	✓	✓	✓	×	○
Potassium Bicarbonate	✓	✓	✓	×	✓
Potassium Carbonate	✓	✓	✓	×	✓
Potassium Chlorate	○	✓	✓	×	○
Potassium Choride	✓	✓	✓	×	✓
Potassium Cyanide	✓	✓	✓	×	×
Potassium Hydroxide to 350° F	✓	✓	✓	×	○
Potassium Nitrate to 300° F	✓	✓	✓	×	✓
Potassium Permanganate to 300° F	✓	✓	✓	×	○
Potassium Phosphate	✓	✓	✓	×	✓
Propane	✓	✓	✓	✓	✓
Propionic Acid	✓	✓	✓	×	○
Propylene	✓	✓	✓	✓	✓
Pyridine	✓	×	✓	×	✓
Pyroligneous Liquor	✓	✓	✓	×	○
Sal Ammonia	✓	✓	✓	×	○
Sal Soa - Na2C03 . 10 H20	✓	✓	✓	×	✓

CR GROUPS	1	2	3	4	5
Salicylic Acid	✓	✓	✓	×	✓
Sea Water	✓	✓	✓	×	✓
Sewage	✓	✓	✓	×	✓
Silver	✓	○	✓	○	×
Soap and Soap Liquors	✓	✓	✓	×	✓
Soda Ash	✓	✓	✓	×	×
Sodium Salts-see Potassium Salts					
Sodium Bisulfite	✓	✓	✓	×	✓
Sodium Dichromate	✓	✓	✓	×	✓
Sodium Hypochlorite	○	○	✓	×	○
Sodium Metaphosphate	✓	✓	✓	×	✓
Sodium Nitrate (Nitrate Melt)	○	×	○	○	○
Sodium Perborate	○	✓	✓	×	○
Sodium Perchlorate	○	✓	✓	×	○
Sodium Sulfate	✓	✓	✓	×	○
Sodium Sulfide	✓	✓	✓	×	○
Sodium Tetraborate (Borax)	✓	✓	✓	×	○
Sodium Thiosulfate (Hypo)	✓	✓	✓	×	✓
Sorbitol	✓	✓	✓	○	✓
Stannic Chloride	✓	✓	✓	×	○
Steam to 600° F	✓	✓	✓	○	○
Steam 600 to 1500° F	○	×	○	✓	○
Stearic Acid	✓	✓	✓	○	✓
Styrene	✓	✓	✓	✓	✓
Sugar	✓	✓	✓	×	✓
Sulfate Liquors	✓	✓	✓	×	✓
Sulfite Liquors	✓	✓	✓	×	✓
Sulfur	✓	○	✓	○	○
Sulfur Dioxide to 500° F	✓	✓	✓	○	○
Sulfuric Acid to 77%, 300° F	✓	✓	✓	×	○
Sulfuric Acid 77-98% to 200° F	✓	○	✓	×	○
Tar	✓	✓	✓	✓	✓
Terephthalic Acid	✓	✓	✓	×	✓
Tetrachloroethylene	✓	✓	✓	✓	✓
Tin	✓	○	✓	○	×
Toluene	✓	✓	✓	✓	✓
Toluene Sulfonic Acid	✓	✓	✓	×	○
Toluic Acid	✓	✓	✓	×	○
Trichloroethylene	✓	✓	✓	✓	✓
Triethanol Amine	✓	✓	✓	×	✓
Trisodium Phosphate	✓	✓	✓	×	✓
Turpentine	✓	✓	✓	✓	✓
Urea	✓	✓	✓	×	✓
Vegetable Oil	✓	✓	✓	○	✓
Vinegar	✓	✓	✓	×	○
Vinyl Acetate	✓	✓	✓	○	✓
Vinyl Chloride	✓	✓	✓	✓	✓
Viscose	✓	✓	✓	×	✓
Water to 300° F	✓	✓	✓	×	✓
Water Glass (Na2Si03)	✓	✓	✓	×	✓
Wood Pulp	○	✓	✓	×	✓

CR GROUPS	1	2	3	4	5	CR GROUPS	1	2	3	4	5
Xylene	✓	✓	✓	✓	✓	Zinc Chloride	✓	✓	✓	×	✓
Zinc	✓	○	✓	○	○	Zinc Sulfate	✓	✓	✓	×	✓

PEEK (POLY ETHER ETHER KETONE) MATERIALS

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.

RAW MATERIAL AVAILABILITY

Solid cylinders up to 20-inch diameter

GENERAL PROPERTIES

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

PEEK MATERIAL PROPERTIES

GRADE Filler	R-700 None	R-710 15% PTFE	R-720 15% glass	R-721 30% glass	R-730 30% carbon	R-740 30% carbon/PTFE
Density, g/cc	1.32	1.40	1.39	1.49	1.40	1.44
Hardness, HRR	126	124*	124	124	124	124
Tensile strength, psi	14,500	11,000	17,800	24,500	32,700	19,000
Shear strength, psi	7,700	N/A	N/A	14,000	14,000	N/A
Flexural strength, psi	24,700	19,000	26,000	33,500	51,000	30,450
Temperature limit, °F	500	500	500	500	500	500
Coefficient of friction**	0.34	0.11	N/A	N/A	0.28	0.11

Values given 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 1000 series is a selection of high-performance, reinforced fluorocarbon resin composites that are unique in the plastic family and that possess exceptional properties:

- Chemical resistance
- Self-lubricating
- Thermal stability
- Moisture resorbant
- Contamination resistance
- Mechanical strength
- Electrical insulation

GRADES AND APPLICATIONS

1007	Virgin PTFE for packings, seals and bushings
1051	25% fiberglass-filled grade for common seals and bushings
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
1521	50% stainless steel-filled grade for bearings and valve seat applications where high load and corrosion are primary concerns.
1821	Moly/bronze-filled grade for bearing and seal applications where high load strength is needed. 55% bronze, 5% moly filled
1551	Ceramic-filled grade for applications where high wear resistance is required. (25% mica)
1621	35% carbon fiber-filled grade where high strength and high wear performance is sought; a high-performance composite grade.

SIZES

SOLID CYLINDER	TUBE	LARGER SIZES
1.5 in. to 6 in. diameter 12 in. long	1.5 in. to 15.875 in. diameter 12 in. long	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)	D638	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)	D621	%	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
				3.4	*2.3*	*2.2*	*2.2*	*2.0*	*2.4*	*2.6*	*2.2*
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

Note: 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.

MD = Molded direction; CD = Cross direction

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