Zircar

Advanced Fibrous Ceramics

ZYFB-3, ZYFB-6 & FBD

High Temperature Yttria Stabilized Zirconia Insulation

Porous and Machinable

Our Lowest K
Fibrous Ceramic Insulation

Three Types

- **ZYFB-3** (Good) - Lowest K
- **ZYFB-6** (Better) - Load Bearing
- **FBD** (Best) - Highest Temperature Rating

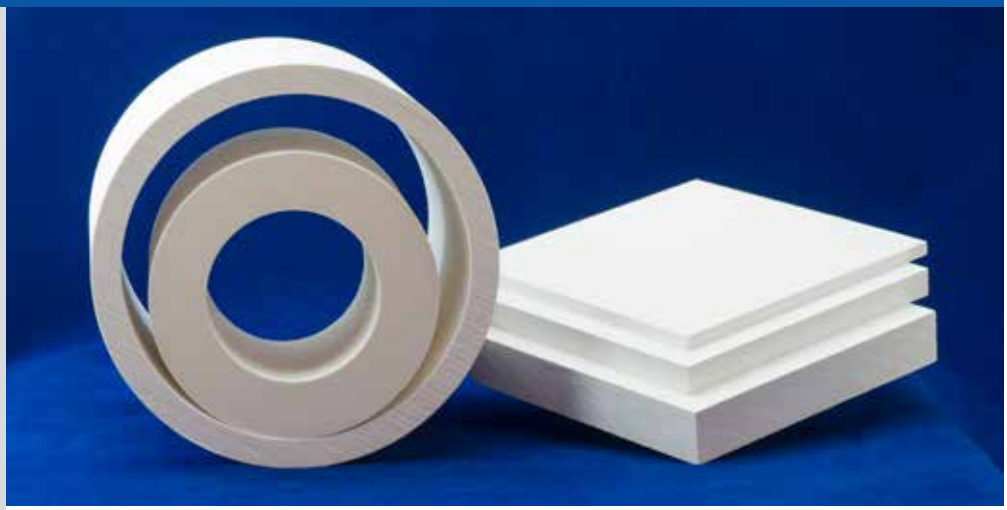
Numerous Sizes

- Boards to 12"x12" and 9"x18"
- Cylinders to 10" OD
- Custom Parts Machined to Your Specifications

Features

- Manufactured Using Our Own Unique Zircar ZYBF Bulk Fibers
- Temperature Rating to as high as 2000 °C(1)
- Phase stabilized with 10 wt% Yttria
- High Purity
- Zirconia Bonded
- 100% Inorganic, No Off-Gassing or Odors
- Extremely Low Silica Content
- Non-RCF, Asbestos Free
- Excellent in Corrosive, Oxidizing & Reducing Atmospheres

The Zircar Fibrous Ceramics Advantage
Low Mass,
Low Heat Storage &
Low Thermoconductivity
means
High Thermal Shock Resistance,
High Insulation Performance,
Higher System Efficiency &
Lower Energy Costs



High Temperature ..... Low Thermal Conductivity .... Zirconia Bonded

Rigid ZrO_2 advanced ceramic insulation for continuous applications to 2000 °C.

Product Information

Zircar Zirconium Oxide Fibrous Ceramic Insulation Types ZYFB-3, ZYFB-6 & FBD are rigid refractory structures composed of our own unique Zircar ZYBF Bulk Fibers which are openly porous, made using the original ZIRCAR Process at our plant in Florida, NY, USA. These materials are nearly 100% zirconia phase stabilized with yttria. They have extremely low thermal conductivity and are rated for use to as high as 2000 °C and can be exposed to significantly higher temperatures, up to 2200 °C, depending on the application.

ZYFB-3, ZYFB-6 & FBD are manufactured using a proprietary vacuum forming technique which includes pre-treatment of the Zircar ZYBF fiber prior to establishment of the zirconia bond. The formed product is further processed in a controlled environment then finished with slow cycle, high temperature heat soaks. The results are a ceramic with insulating properties that excel at extremely high temperatures and in severe environments such as corrosive, oxidizing and reducing atmospheres.

We use the highest purity materials in our products. The products contain only minimal trace oxides and no organics that off-gas when heated. Because Zircar zirconia fibers are yttria stabilized, they do not undergo the disruptive phase transitions of pure zirconia.

ZYFB-3 is our lowest density product at 30 lb/ft^3*
ZYFB-6 is medium density product at 60 lb/ft^3*
FBD is our strongest, highest density, premium product at 90 lb/ft^3*

* nominal

For more information,
phone: (845) 651-3040
email: sales@zircarzirconia.com
website: www.zircarzirconia.com

Product Type ZYFB-3 — 30 lb/ft³ — Up to 1800 °C

ZYFB-3 is our lowest density Zircar Zirconium Oxide Fibrous Ceramic Insulation product at 30 lb/ft³. It is rated for up to 1800 °C use in unloaded applications and can intermittently withstand higher temperatures for short periods without compromising its stability. ZYFB-3 is exceptional because it has the lowest thermoconductivity (k) at extreme temperatures of any fibrous ceramic insulation on the market today.

ZYFB-3 is manufactured using our Zircar ZYBF Bulk Fiber. Physically, it is a soft material that has the fragility of a lightweight, porous, powdery, chalk. When handled, finger impressions can be made in the material with slight pressure and fiber sloughing is obvious. ZYFB-3 is easily machineable but is not recommended for parts that require tight tolerances. ZYFB-3 is superior as a backup insulation, supported setter, fixture or shield.

ZYFB-3 is excellent for applications where the lowest heat flow is critical and physical strength or load bearing capability is not a requirement of the application.

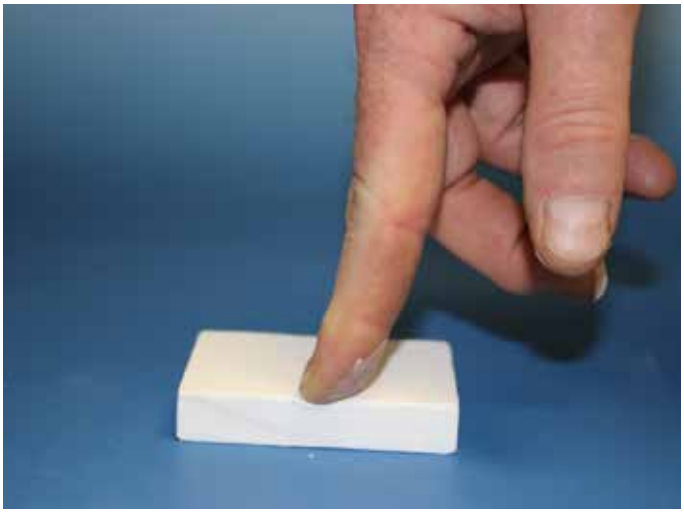
Product Type ZYFB-6 — 60 lb/ft³ — Up to 1800 °C

ZYFB-6 is the medium density product in our ZrO_2 line at 60 lb/ft³. It is rated at 1800 °C and can also remain stable to temperatures up to 2200 °C for short periods of time. ZYFB-6 has extremely low heat flow at high temperatures, has good hot strength up to 1400 °C, and is able to support loads up to twice its weight at temperature.

ZYFB-6 is formed with fibers pre-treated to be shorter than our regular Zircar ZYBF bulk fiber. Vacuum forming the shorter fiber results in a heavier product that is >5x stronger in compressive strength and >3x stronger in flexural strength than ZYFB-3.

ZYFB-6 is also physically like a soft chalk but it is denser, harder and less porous than ZYFB-3. Although fiber sloughing is still evident in ZYFB-6, it is much less friable than ZYFB-3 and takes more effort to make a finger impression in this product. ZYFB-6 is easily machinable and can maintain tight tolerances.

ZYFB-6 is an excellent selection when a light weight, medium density, machinable, high temperature insulation with extremely low thermoconductivity is required.



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Product Type FBD | 90 lb/ft³ | Up to 2000 °C

FBD is our premium Zirconium Oxide Fibrous Ceramic and is the best selling material in our rigid insulation product line. Zircar FBD is known worldwide as the fibrous ZrO_2 insulation of choice.

FBD has a nominal density of 90 lb/ft³ and our highest continuous use temperature rating up to 2000 °C, depending on the application. The material has very little shrinkage and has good hot strength enabling it to be useful in applications which may require a self supporting material. FBD remains dimensionally stable to 2000 °C and can be pushed to even higher temperatures if your application can tolerate sintering.

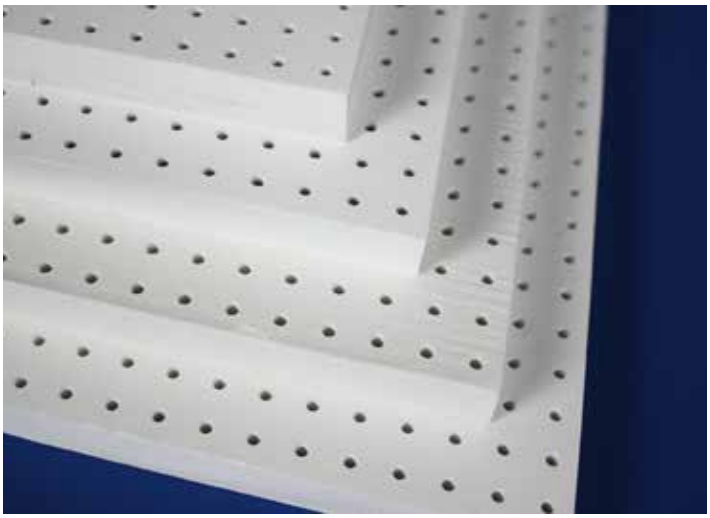
The Zircar fiber used to manufacture FBD undergoes multiple processing and heat treatments. It is composed of highly sintered fiber with the shortest fiber length contained in any of our rigid ZrO_2 products. The finished FBD product is a tightly bonded, nearly dust free, hard, strong fibrous ceramic.

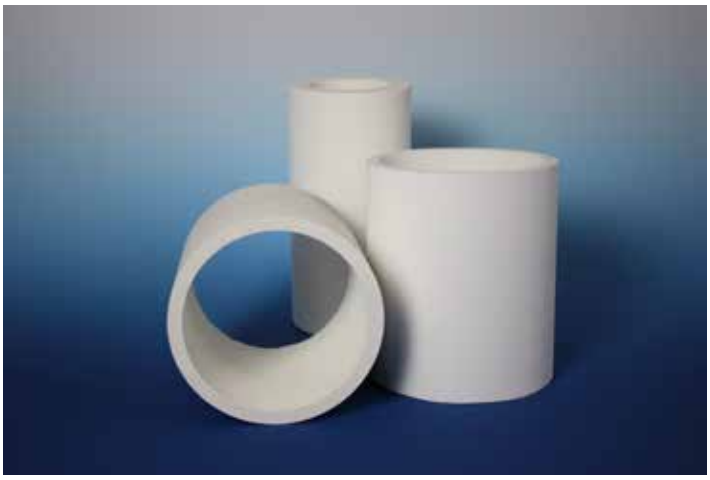
Physically FBD is like a dense, hard chalk and has very little of the fiber sloughing usually associated with fibrous ceramics. If the "finger test" were applied to FBD you should expect to break your digit before making an indent in this material. FBD is strong, it has 35x the compressive strength and 14x the flexural strength of our lower density ZYFB-3 material.

FBD is the least porous, least dusty, most tightly bonded, most stable, most sintered, and strongest Zircar zirconium oxide fibrous ceramic product manufactured. The tight bonding enables us to machine FBD to very tight tolerances. Solid carbide, carbide tipped, or diamond tipped tooling is recommended to cut through the material. FBD is the only material in our rigid ZrO_2 product line that we do not consider to be inherently fragile.

FBD has exceptional resistance to oxidizing and reducing atmospheres at high temperatures and to most corrosive environments. It holds up to molten alkali metal chlorides and carbonates at temperatures as high as 700 °C and can withstand aqueous solutions of alkali metal hydroxides at temperatures as high as 230 °C. FBD will tolerate exposure to inorganic acids at their boiling point for short lengths of time.

Zircar FBD contains no organic binders, produces no smoke or odor, and undergoes no physically disruptive phase transitions when heated. FBD is engineered to go to the limit and is the ultimate in Zirconium Oxide Fibrous Ceramics.





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Properties & Characteristics

Properties (Nominal)	ZYFB-3	ZYFB-6	FBD
Color	White		
Bulk Density, lb/ft^3 (g/cm^3)	30 (0.48)	60 (0.96)	90 (1.4)
Porosity, %	92	84	76
Rated Continuous Use Temperature, °C (°F)	1800 (3272)	1800 (3272)	2000 (3632)
Maximum Use Temperature, °C (°F) [1]	2200 (3992)		
Melting Point, °C (°F)	2590 (4694)		
Flexural Strength, MPa (psi) Normal to Fiber Plane	0.60 (85)	2.10 (300)	8.27 (1200)
Compressive Strength, MPa (psi) @ 10% Compression Normal to Fiber Plane	0.29 (42)	1.59 (230)	5.52 (800)
Outgassing in Vacuum	Nil		
Thermal Expansion Coefficient RT- 1425 °C (2600 °F)	10.7x10^{-6} /°C (6x10^{-6}/ °F)		
Dilatometric Softening Temperature at 10 psi °C (°F)	1180 (2156)	1240 (2264)	1400 (2552)
Linear Shrinkage, % (Perpendicular to Thickness)			
1 hour at 1650 °C (3002 °F)	1.2	1.0	0.0
24 hours at 1650 °C (3002 °F)	2.8	1.7	0.9
Thermal Conductivity, k (Parallel to Thickness)			
W/mk (BTU/hr ft^2 °F/inch) at 400 °C (752 °F)	0.08 (0.6)	0.12 (1.6)	0.24 (1.7)
W/mk (BTU/hr ft^2 °F/inch) at 800 °C (1472 °F)	0.11 (0.8)	0.19 (1.3)	0.26 (1.9)
W/mk (BTU/hr ft^2 °F/inch) at 1100 °C (2012 °F)	0.14(1.0)	0.22 (1.5)	0.31 (2.1)
W/mk (BTU/hr ft^2 °F/inch) at 1400 °C (2552 °F)	0.19 (1.3)	0.25 (1.7)	0.33 (2.3)
W/mk (BTU/hr ft^2 °F/inch) at 1650 °C (3002 °F)	0.24 (1.7)	0.27 (1.9)	0.35 (2.5)
Specific Heat (BTU/lb °F)	0.18		
Chemical Composition (Nominal)			
Oxide	**Wt%**		
ZrO_2 [2]	90		
Y_2O_3	10		
Typical Impurities			
HfO_2	1 to 2		
SiO_2	0.12		
TiO_2	0.14		
CaO	0.09		
MgO	0.03		
Fe_2O_3	0.04		
Al_2O_3	0.01		
Na_2O	0.01		

[1] Maximum use temperature is dependent on variables such as the chemical environment and stresses; both thermal and mechanical.
[2] 1-2% weight hafnia (HfO_2) occurs naturally with zirconia (ZrO_2) and does not affect performance.

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What Makes Our Zirconia Unique?

The products we manfacture at Zircar Zirconia, Inc. are unique due to the open and closed porosity of our zirconium oxide fibers. This is a one-of-a-kind porosity and is exclusive to Zircar. Our products are the best performing ZrO_2 fibrous ceramics in the industry, outperforming all others when challenged with extreme temperatures and severe environments. The micrographs below illustrate the uniqueness to our materials.

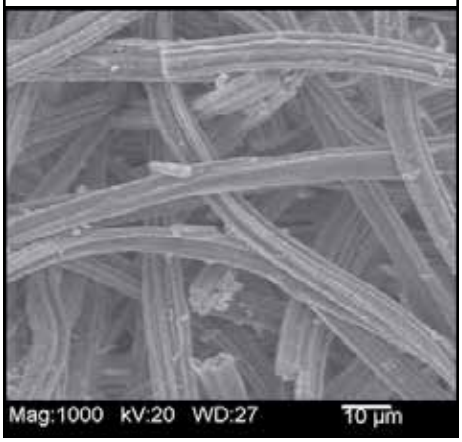
The micrographs in the top row show the very porous nature and lengths of the individual fiber used in our different product types. ZYFB-3 is manufactured using a relatively long fiber, ZYFB-6 with a shorter fiber, and FBD with the shortest. FBD is the highest density, lowest porosity, highest strength material of the three products.

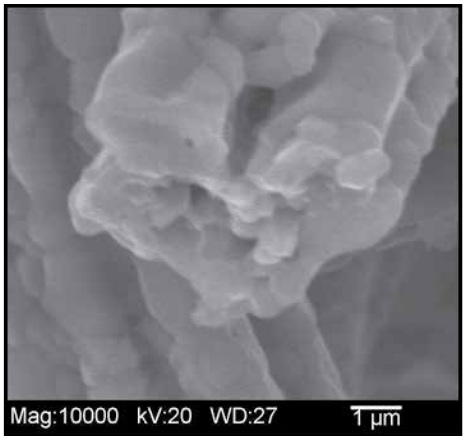
The top row micrographs also illustrate the serrated structure which is characteristic of all of our Zircar zirconia fibers. The fibers are preferentially arranged parallel to the vacuum formed board face creating anisotropic behavior. Vacuum formed ceramic fiber boards exhibit lower compressive strength and thermal conductivity perpendicular to the fiber plane while shrinkage is greater. Boards have the fiber plane parallel to their faces, cylinders have their fibers aligned perpendicular to the radius of the cylinder. Custom cylinders and boards can be manufactured with fiber orientation as required for your application.

The micrographs on the bottom show the highly sintered exterior and porous interior structure of the individual fibers. Note that because FBD is processed at a very high temperature, the individual fiber grains grow to be almost as large as the fiber diameter and meld into a very smooth, highly sintered microstructure.

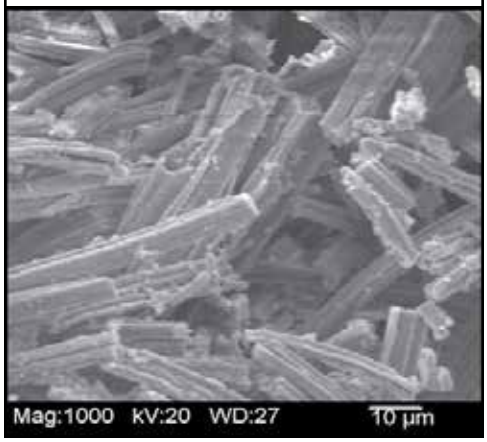
Product Micrographs

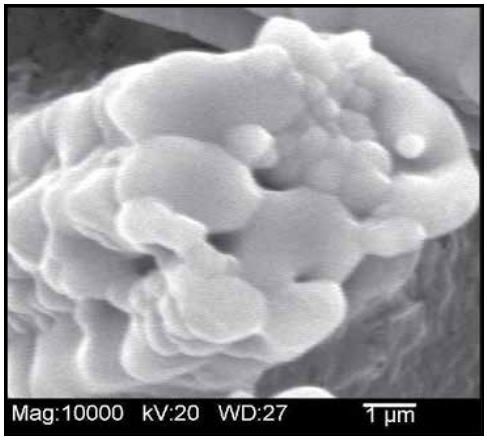
ZYFB-3



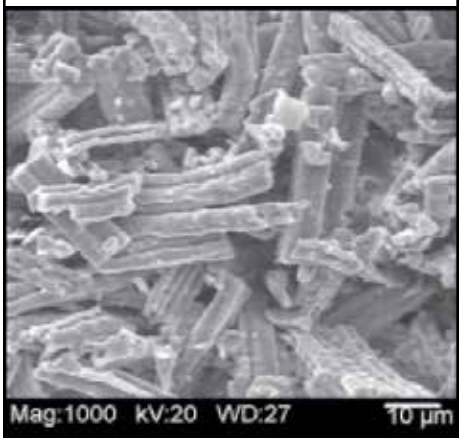


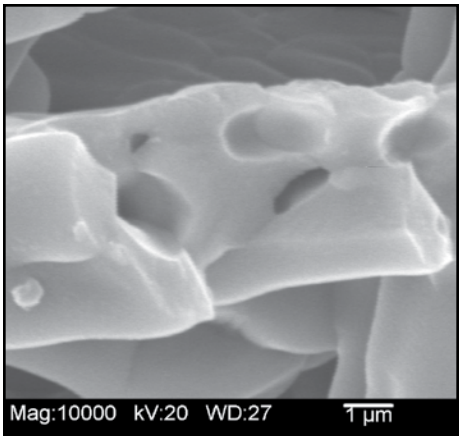
ZYFB-6





FBD





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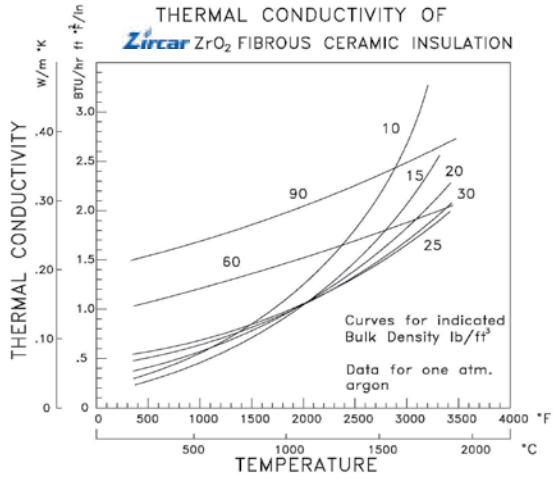
Facts About Our Zirconium Oxide

- Zircar ZrO_2 fibrous ceramics are manufactured using the original ZIRCAR Process which was devloped by Bernie H. Hamling (BHH) while at Union Carbide Corp. in Sterling Forest, NY. In 1974 BHH purchased the patents for the process and began ZIRCAR Products, Inc. Over the years the name ZIRCAR became synonymous with high quality advanced fibrous ceramics. In July 2000 Zircar Zirconia, Inc. purchased Bernie's zirconia business and to this day still uses his original process. Although Bernie is no longer with us, we think of him often and are grateful for the opportunity to continue his legacy in the ceramics industry. Thank you BHH.
- At very high temperatures in vacuum and inert or reducing atmospheres, zirconia loses a small amount of oxygen. The reaction results in a color change from white to gray but most other properties remain essentially unchanged and insulation effectiveness is not impaired.
- 1 to 2% hafnium oxide, HfO_2, occurs naturally with zirconium oxide. Hafnia is sometimes referred to as zirconia's twin because of structrual similarities.
- Zirconia has the lowest thermal conductivity of any commercial refractory and is one of the most studied ceramic materials in the world.



- Upon heating unstabilized zirconia undergoes disruptive phase changes. At room temperature unstabilized ZrO_2 adopts a monoclinic crystal structure and transitions to tetragonal and cubic at higher temperatures. The volume expansion caused by the cubic to tetragonal to monoclinic transformation induces large stresses which cause cracking on cooling. The addition of yttria eliminates the phase transitions by stabilizing the tetragonal and cubic phases. Zircar ZrO_2 is phase stabilized with 10 wt% Y_2O_3.

Applications

ZYFB-3 as hot face insulation in fused quartz processing.

ZYFB-3 as the zone separator in directional solidification furnaces used to manufacture jet turbine blades.

ZYFB-6 as the IR source insulation in FTIR Spectrometer.

ZYFB-6 & FBD as insulation in nuclear meltdown experiments.

FBD as gasketing in high temperature wind tunnels.

FBD as insulation for laser machining applications.

FBD as hotface insulation in solar thermochemical reactors.

FBD as crucible insulation in crystal growth stations.

FBD as oxygen / carbon protector sleeve in industrial sensors.

ZYFB-3, ZYFB-6 & FBD as machinable insulation for setters and fixtures in continuous and batch high temperature processes.

ZYFB-3, ZYFB-6 & FBD is best anywhere a lightweight, low thermal conductivity, high temperature, ZrO_2 advanced fibrous ceramic insulation is required.

Cutting & Machining Instructions

For manual cutting, place the part on a smooth clean surface and hold it in place with gentle pressure. Small holes can be drilled in the softer ZYFB-3 & 6 by hand with a standard high speed steel twist drill rotated between the fingers. Boards can be cut with a backsaw. If close tolerances are needed, and for FBD, use a drill press and a radial arm saw. Table saws are not recommended without a carrier board since the motion of the material over the saw bed will tend to abrade away the material. For very close tolerances and large amounts of cutting, CNC machining with solid carbide, carbide tipped or diamond tipped tooling is recommended. Slow feeds and high tool rotation rates are best. It should be noted that the material is very abrasive and will cause rapid wear of high speed steel tooling which could result in an out of tolerance condition in a short period of time. Vacuum hold down is best. For FBD, very small amounts of hot glue can be used but is not recommended for ZYFB because material can be pulled away on removal. Zircar welcomes our customers to take advantage of our machining department's expertise for all your custom machining needs.

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Product Samples

FREE SAMPLES

Call: 845-651-3040
email: sales@zircarzirconia.com

Product Type	Item #
ZYFB-3	SAMPLE-AA
ZYFB-6	SAMPLE-AB
FBD	SAMPLE-AD

Samples measure 1.8" x 2.8" x 1/2" Thick.

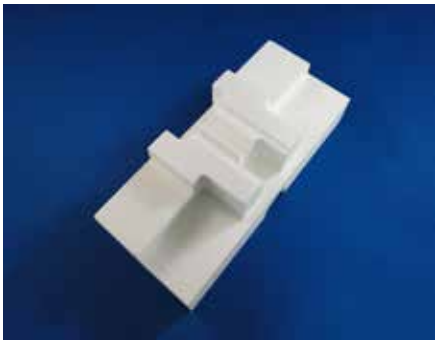
Custom Design Quotations

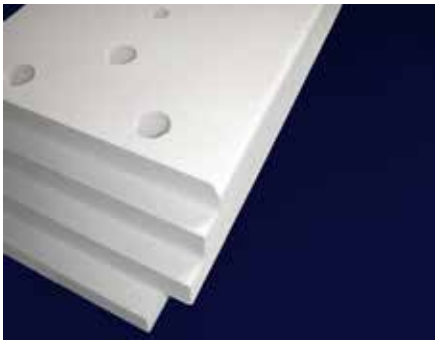
Contact Us For A Quotation For Your Custom Part

Call: 845-651-3040
email: sales@zircarzirconia.com

Zircar machines custom shapes to your design specifications.
Our capabilities include:

- 3D CNC Machining
- Layered Configurations
- Lap Joined Boards and Cylinders
- Diamond Wire Splitting of Cylinders





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Standard Product Sizes & Ordering

FBD, ZYFB-6 and ZYFB-3 boards are available in the standard sizes shown below. We do maintain a small inventory of boards for immediate shipment, lead time for standard boards not in inventory can be as short as 1 week. Please contact our Sales Department to discuss your requirements.

To Place an Order

Call: 845-651-3040
email: sales@zircarzirconia.com

Zirconia Boards

Size	Item Number		
	ZYFB-3	ZYFB-6	FBD
3.00"W x 3.00"L x 0.25"TK			AD009
3.00"W x 3.00"L x 0.50"Tk			AD001
3.00"W x 3.00"L x 0.75"Tk			AD002
3.00"W x 3.00"L x 1.00"Tk			AD003
6.00″W x 6.00″L x 0.25″Tk	AA00.01	AB00.01	AD008
6.00″W x 6.00″L x 0.50″Tk	AA00.02	AB00.02	AD004
6.00″W x 6.00″L x 0.75″TK	AA00.03	AB00.03	AD005
6.00″W x 6.00″L x 1.00″Tk	AA00.04	AB00.04	AD006
6.00″W x 6.00″L x 1.50″Tk	AA00.05	AB00.05	AD076
12.00″W x 12.00″L x 0.25″Tk			AD034
12.00″W x 12.00″L x 0.50″Tk	AA009	AB009	AD035
12.00″W x 12.00″L x 0.75″Tk	AA010	AB010	AD036
12.00″W x 12.00″L x 1.00″Tk	AA011	AB011	AD037
12.00″W x 12.00″L x 1.50″Tk	AA012	AB012	AD077
9.00″W x 18.00″L x 0.25″Tk			AD070
9.00″W x 18.00″L x 0.50″Tk			AD071
9.00″W x 18.00″L x 0.75″Tk			AD072
9.00″W x 18.00″L x 1.00″Tk			AD073

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Zirconia Cylinders

ZYFB-6 cylinders are also available in numerous sizes.
Contact us for prices and for lead time.

FBD Cylinder Size	Item Number
0.50″ ID x 0.75″ OD x 6.00″ L	AD5003
0.50″ ID x 1.00″ OD x 6.00″ L	AD5006
0.50″ ID x 1.50″ OD x 6.00″ L	AD5009
0.75″ ID x 1.00″ OD x 6.00″ L	AD500C
0.75″ ID x 1.25″ OD x 6.00″ L	AD500F
0.75″ ID x 1.75″ OD x 6.00″ L	AD500J
1.00″ ID x 1.25″ OD x 6.00″ L	AD500M
1.00″ ID x 1.50″ OD x 6.00″ L	AD500Q
1.00″ ID x 2.00″ OD x 6.00″ L	AD500T
1.00″ ID x 3.00″ OD x 6.00″ L	AD5010
1.50″ ID x 1.75″ OD x 6.00″ L	AD5013
1.50″ ID x 2.00″ OD x 6.00″ L	AD5016
1.50″ ID x 2.50″ OD x 6.00″ L	AD5019
1.50″ ID x 3.50″ OD x 6.00″ L	AD501C
2.00″ ID x 2.25″ OD x 6.00″ L	AD501F
2.00″ ID x 2.50″ OD x 6.00″ L	AD501J
2.00″ ID x 3.00″ OD x 6.00″ L	AD501M
2.00″ ID x 4.00″ OD x 6.00″ L	AD5020
3.00″ ID x 3.25″ OD x 6.00″ L	AD5023
3.00″ ID x 3.50″ OD x 6.00″ L	AD5026
3.00″ ID x 4.00″ OD x 6.00″ L	AD5029
3.00″ ID x 5.00″ OD x 6.00″ L	AD5030
4.00″ ID x 4.25″ OD x 6.00″ L	AD5033
4.00″ ID x 4.50″ OD x 6.00″ L	AD5036
4.00″ ID x 5.00″ OD x 6.00″ L	AD5039
4.00″ ID x 6.00″ OD x 6.00″ L	AD5040
5.00″ ID x 5.25″ OD x 6.00″ L	AD5043
5.00″ ID x 5.50″ OD x 6.00″ L	AD5046
5.00″ ID x 6.00″ OD x 6.00″ L	AD5049
5.00″ ID x 7.00″ OD x 6.00″ L	AD504C
6.00″ ID x 6.25″ OD x 6.00″ L	AD504F
6.00″ ID x 6.50″ OD x 6.00″ L	AD504J
6.00″ ID x 7.00″ OD x 6.00″ L	AD504M
6.00″ ID x 8.00″ OD x 6.00″ L	AD504Q
8.00″ ID x 10.00″ OD x 6.00″ L	AD510

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New

Zircar FBD is now available in a new larger size, 9" x 18", and up to 3" thick. FBD is the highest purity, strongest, highest density, highest temperature rated zirconia fiber board on the market.

Zircar Zirconia, Inc.
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