

# ZYC

## Silica Bonded Yttria Stabilized Zirconia Fiber Cylinder

The Unrivaled Industry Leader  
of ZrO<sub>2</sub> Insulation

Sizes Available Up To  
12" ID x 13" OD x 12" L

Custom Sizes & Machining  
Available to Suit Your  
Application Requirements

### ZYC Features

- Manufactured Using Our Own ZYBF Bulk Fibers
- Dimensionally Stable up to 1650 °C (3002 °F)
- Good Hot Strength to 1370 °C
- Phase Stabilized with 10 wt% Yttria
- High Purity
- 100% Inorganic, No Off-Gassing or Odors
- Low Thermal Conductivity (K)
- Usable in Multiple Atmospheres
- Can be Lap-Joined for Longer Lengths

### 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



### Silica Bonded... Great Thermal Shock Resistance...

Rigid ZrO<sub>2</sub> advanced insulation for continuous applications to 1650 °C.

### Product Information

**Zircar** Zirconium Oxide Cylinders Type ZYC are firm, rigid, free standing refractory structures composed of yttria stabilized zirconia fibers evenly bonded with amorphous silica, allowing intricate shapes to be machined to tight tolerances. ZYC is manufactured with our own unique **Zircar** ZYBF Bulk Fibers which are made using the original ZIRCAR Process at our plant in Florida, NY, USA. ZYC cylinders possess low thermal conductivity and good resistance to thermal shock. ZYC is manufactured using a proprietary vacuum forming technique which includes pre-treatment of the **Zircar** ZYBF fiber prior to establishment of the silica bond. The formed product is further processed in a controlled environment then fired resulting in a ceramic with insulating properties that excel at extremely high temperatures.

ZYC is dimensionally stable to 1650 °C (3002 °F) although it can be used at higher temperatures as back-up insulation or in areas where additional sintering can be tolerated. Type ZYC has good hot strength up to 1370 °C (2498 °F) and can be used to support loads up to this temperature. The material is resistant to attack by most molten metals and has a high resistance to reaction with other oxide materials.

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

## Properties & Characteristics

Properties (Nominal)	ZYC
Bulk Density, lb/ft <sup>3</sup> (g/cm <sup>3</sup> )	30 (0.48)
Porosity, %	91
Melting Point, °C (°F)	2200 (3992)
Continuous Maximum Use Temperature, °C (°F) <sup>(1)</sup>	1650 (3002)
Intermittent Maximum Use Temperature, °C (°F) <sup>(1)</sup>	1700 (3092)
Flexural Strength, MPa (psi) - Normal to Fiber Plane	0.55 (81)
Compressive Strength, MPa (psi) @ 10% Compression - Normal to Fiber Plane	0.21 (31)
Outgassing in Vacuum	Nil
Dilatometric Softening Temperature at 10 psi, °C (°F)	950 (1740)
Thermal Expansion Coefficient RT- 1425 °C (2600 °F)	9x10 <sup>-6</sup> /°C (5x10 <sup>-6</sup> /°F)
<b>Linear Shrinkage, % (Perpendicular to Thickness)</b>	
1 hour at 1650 °C (3002 °F)	2.5
24 hours at 1650 °C (3002 °F)	4
<b>Thermal Conductivity, k (Parallel to Thickness)</b>	
W/mk (BTU/hr ft <sup>2</sup> °F/inch) at 400 °C (752 °F)	0.08 (0.6)
W/mk (BTU/hr ft <sup>2</sup> °F/inch) at 800 °C (1472 °F)	0.11 (0.8)
W/mk (BTU/hr ft <sup>2</sup> °F/inch) at 1100 °C (2012 °F)	0.14 (1.0)
W/mk (BTU/hr ft <sup>2</sup> °F/inch) at 1400 °C (2552 °F)	0.19 (1.3)
W/mk (BTU/hr ft <sup>2</sup> °F/inch) at 1650 °C (3002 °F)	0.23 (1.6)
<b>Chemical Composition (Nominal)</b>	
<b>Oxide</b>	<b>Wt%</b>
ZrO <sub>2</sub> <sup>(2)</sup>	85
Y <sub>2</sub> O <sub>3</sub>	10
SiO <sub>2</sub>	5

<sup>(1)</sup> Maximum use temperature is dependent of variables such as chemical environment and stresses; both thermal and mechanical.

<sup>(2)</sup> 1-2% weight hafnia (HfO<sub>2</sub>) occurs naturally with zirconia (ZrO<sub>2</sub>) and does not affect performance.



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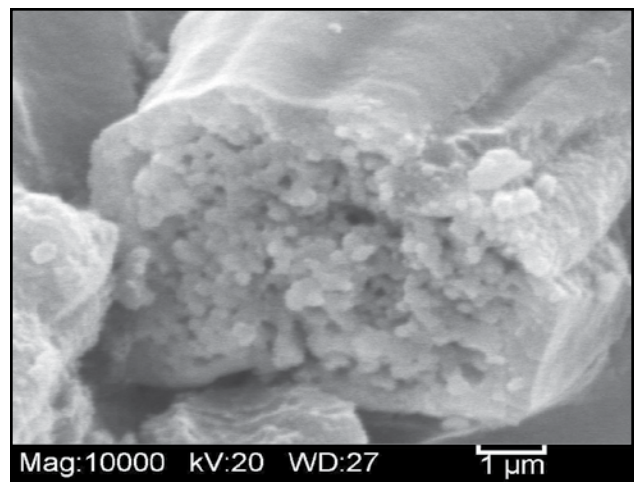
## What Makes Our ZYC Unique?

At high temperatures, heat transfer by radiation dominates over conduction and convection. **Zircar** zirconia fibers are the best in the industry at reflecting and radiating heat while not storing it. They facilitate steep temperature gradients and outperform all others when challenged with extreme temperatures and severe environments. The serrated fiber shape and high porosity give **Zircar** zirconia very low thermal conductivity.

ZYC has silica uniformly distributed over the zirconia fibers providing improved thermal shock resistance. X-ray diffraction analysis (XRD) indicates that the silica in ZYC as delivered is amorphous. Very little monoclinic zirconia (Baddeleyite) is detected by this analysis.

XRD of ZYC, After substantial heat treatment, shows no amorphous or crystalline silica and greater than 97% cubic zirconia. An x-ray dot map and EXD elemental analysis show the previously detected silica dispersed uniformly in the zirconia matrix.

### Product Micrographs



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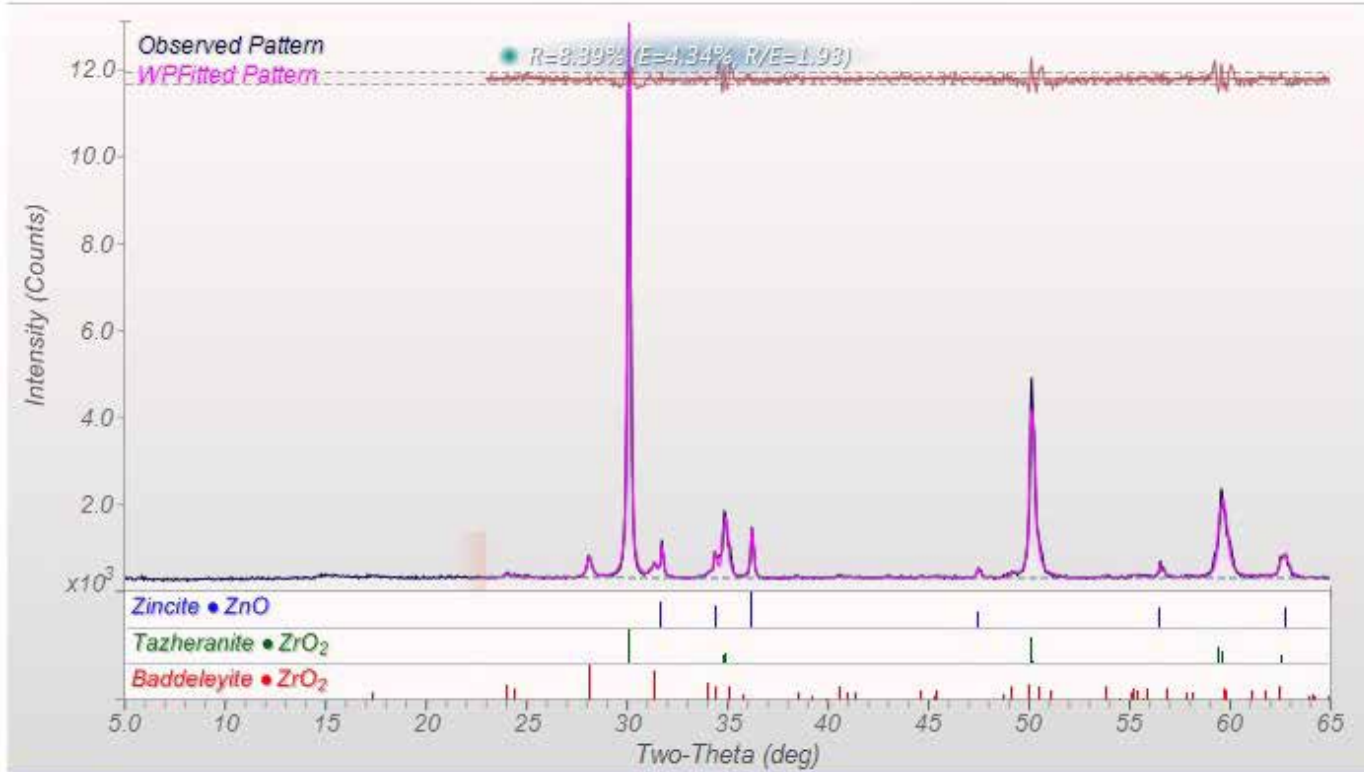
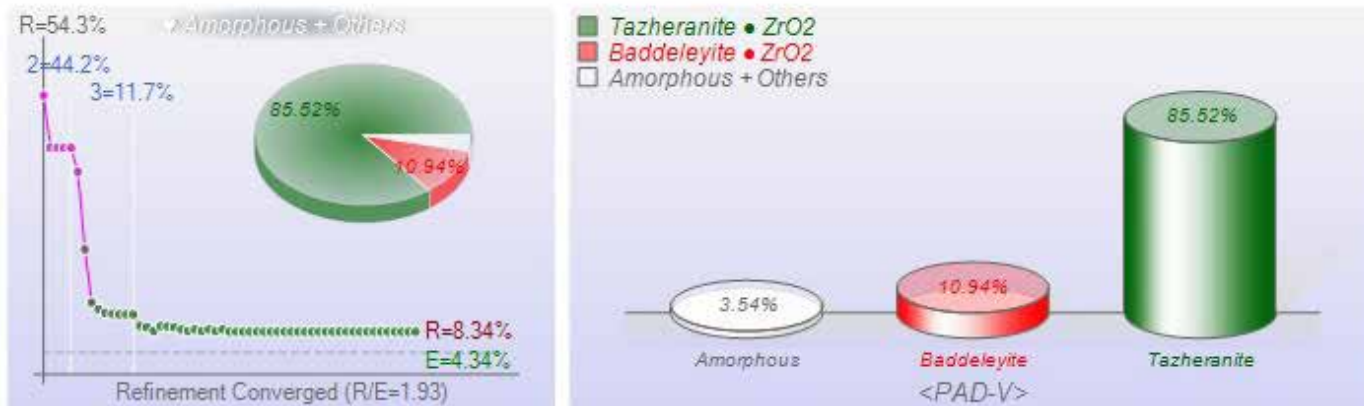
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## Product Analysis

Phase ID (3)	Chemical Formula	PDF-#	Wt% (esd)	RIR	$\mu$
Zincite	ZnO	04-005-4711	12.87 (std)	5.38	287.0
Tazheranite	ZrO <sub>2</sub>	01-070-8758	85.52 (2.85)	9.84	656.5
Baddeleyite	ZrO <sub>2</sub>	04-005-4252	10.94 (0.69)	4.79	628.8
Amorphous + Others	SiO <sub>2</sub>		3.54 (2.60)	0.00	

XRF(Wt%): ZrO<sub>2</sub>=96.5%, ZnO=12.9%, SiO<sub>2</sub>=3.5%

Refinement Converged (R/E=1.93), Round=3, Iter=3, P=23, R=8.39% (E=4.34%, EPS=0.5)



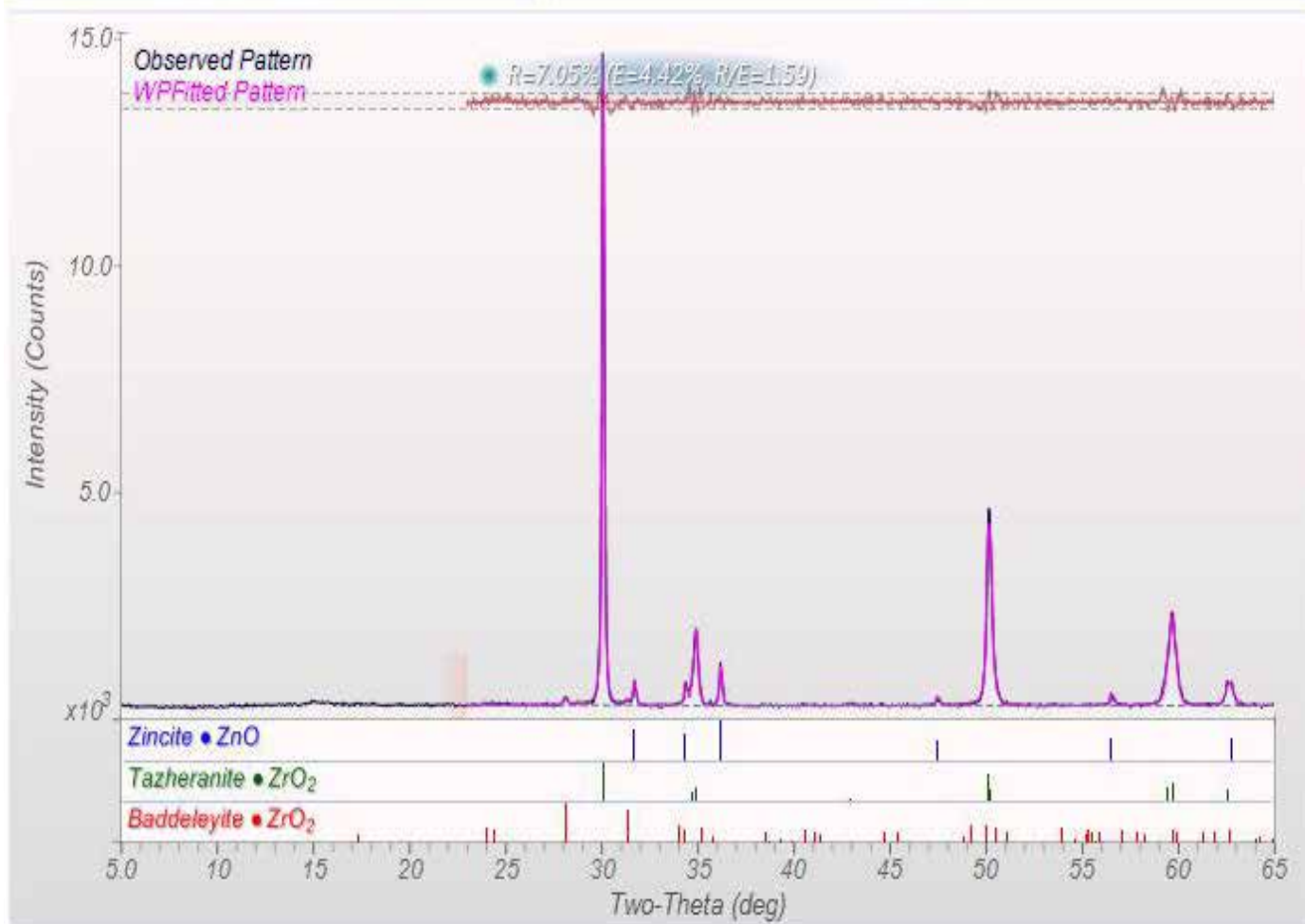
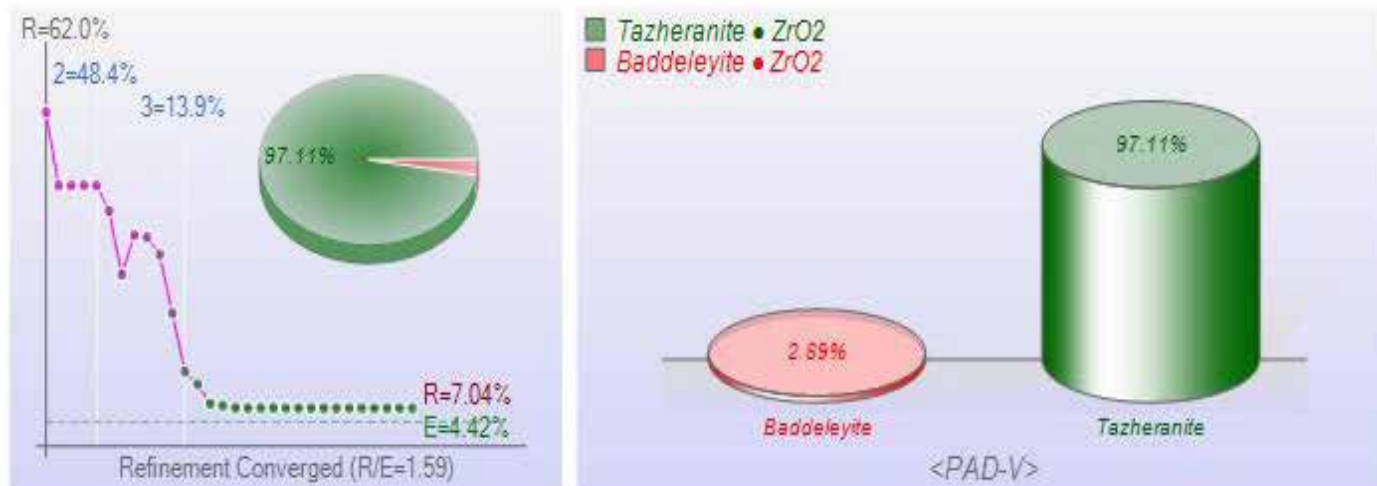
X-Ray diffraction analysis (XRD) of ZYC as delivered.



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## Product Analysis (cont.)

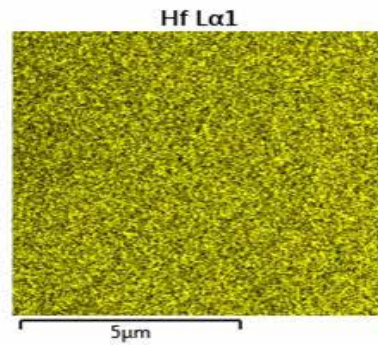
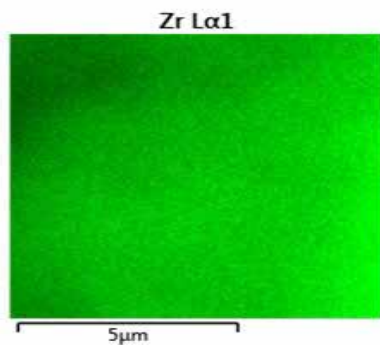
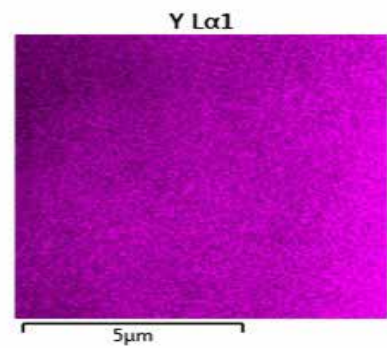
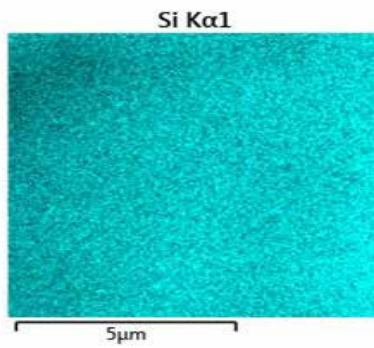
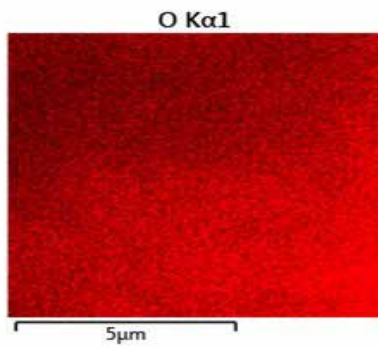
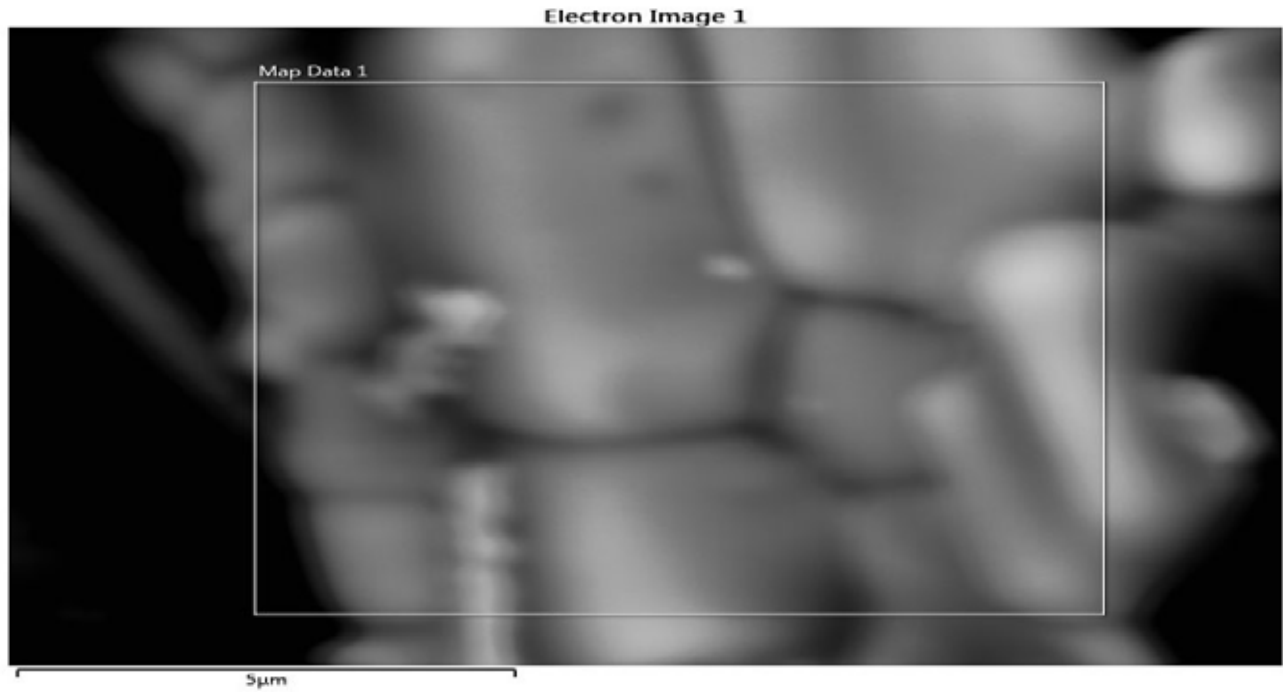


XRD of ZYC after high temperature service.



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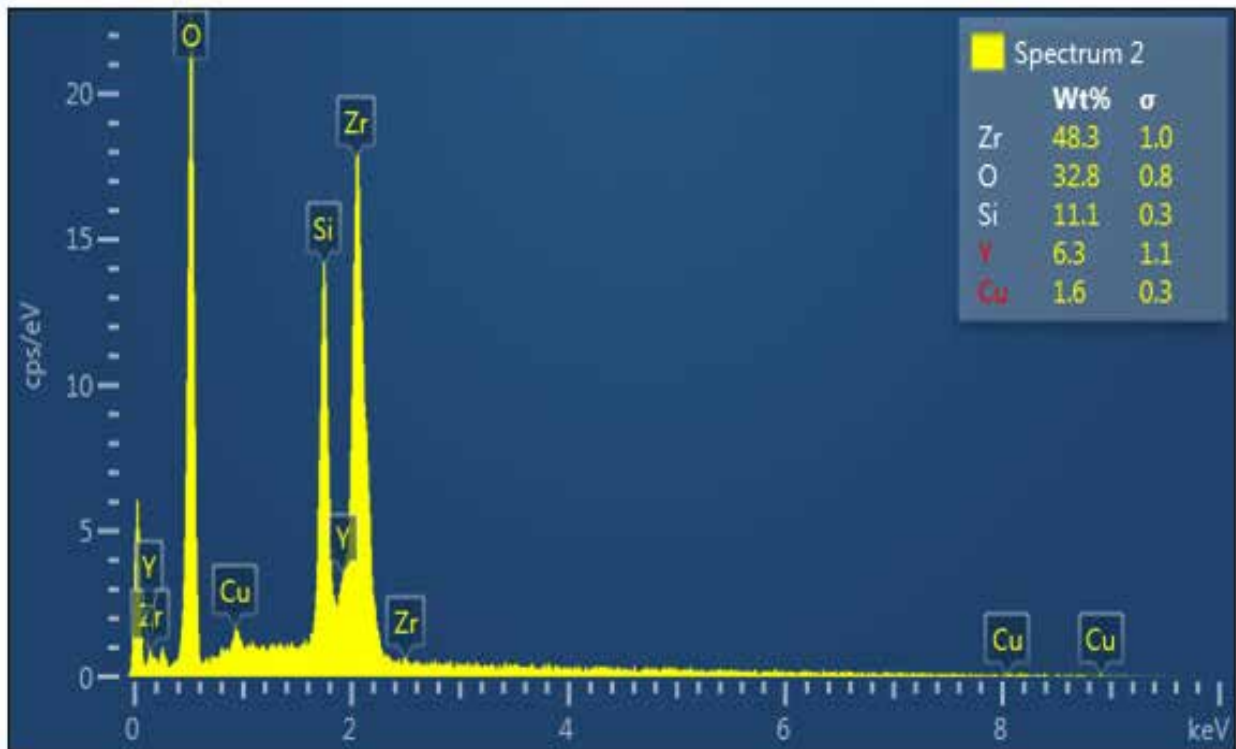
EXD elemental analysis to shows a very uniform solid solution.



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## Product Analysis (cont.)

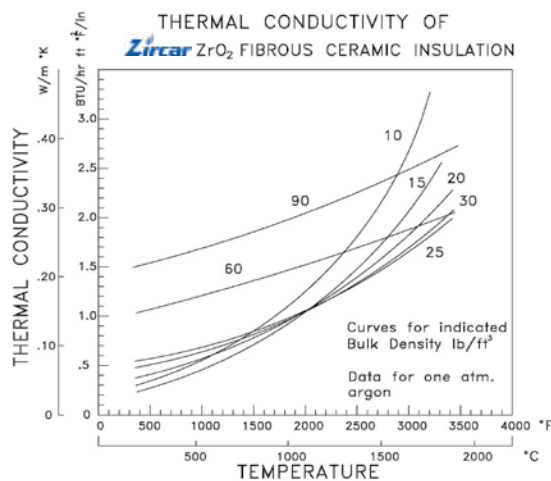


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## Facts About Our Zirconium Oxide

- **Zircar** ZrO<sub>2</sub> fibrous ceramics are manufactured using the original ZIRCAR Process which was developed 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<sub>2</sub>, occurs naturally with zirconium oxide. Hafnia is sometimes referred to as zirconia's twin because of structural 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<sub>2</sub> 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<sub>2</sub> is phase stabilized with 10 wt% Y<sub>2</sub>O<sub>3</sub>.

## Applications

### RESISTANCE HEATED AND INDUCTION FURNACES

ZYC is used in both resistance heated and induction furnaces. It is particularly suited for insulation in hot pressing, crystal growing and annealing furnaces.

### RADIATION SHIELDING

ZYC is used as radiation shielding in vacuum furnaces, replacing five or six metalshields without loss of insulation value. In processes where carbon contamination cannot be tolerated, **Zircar's** products are used instead of graphite felts and carbon black as insulation.

### HIGH TEMPERATURE INSULATION

ZYC is excellent insulation for pipes or molten metal transporting and feed tubes. For cylindrical applications where silica is undesirable, our zirconia bonded fiber materials ZYFB and/or FBD are recommended.

ZYC Cylinders are phase stabilized with yttria and therefore do not undergo the usual phase transitions associated with zirconia. Electrical conductivity at elevated temperatures is also minimized with low density Zirconia fibers whereas dense Zirconia is an effective conductor at elevated temperatures. ZYC does not couple with radio frequency (RF) radiation used in induction heating, but does couple with microwave energy. ZYC has no organic binders and will produce no smoke or odor when heated.

## Machining

ZYC is manufactured using a proprietary vacuum forming technique which includes pre-treatment of the **Zircar** ZYBF fiber prior to establishment of the bonded finished product. Vacuum forming the ceramic fiber cylinders, with their fibers aligned perpendicular to the radius of the cylinder is then followed by a drying period on a mandrel.

Inside diameters are typically determined during the forming process. Outside diameters are machined to a tolerance within our standard +/- 0.060" on a precision tool post grinder. Tighter tolerances can be achieved and customers are welcomed to take advantage of our 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 #
ZYC	SAMPLE-AG

Samples measure 1"ID x1.8"OD x1/2"Thick



## Custom Design Quotations

### Contact Us For A Quotation For Your Custom Part

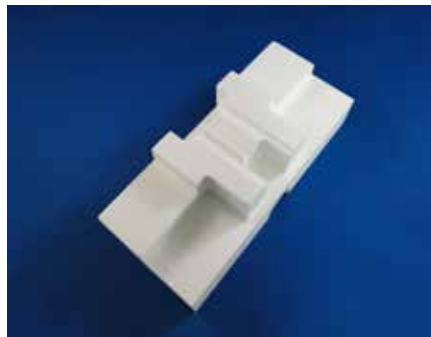
Call: 845-651-3040

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**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



**Zircar** welcomes our customers to take advantage of our machining department's expertise for all your custom machining needs.



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## Standard Product Sizes & Ordering

ZYC is available in the standard sizes shown below.

Please contact our Sales Department for pricing and availability.

### To Place an Order

Call: 845-651-3040

email: [sales@zircarzirconia.com](mailto:sales@zircarzirconia.com)

### ZYC Cylinders

Size	Item Number
1" ID x 2" OD x 6"L	AG501
1" ID x 2" OD x 12"L	AG502
2" ID x 3" OD x 6"L	AG503
2" ID x 3" OD x 12"L	AG504
3" ID x 4" OD x 6"L	AG505
3" ID x 4" OD x 12"L	AG506
4" ID x 5" OD x 6"L	AG507
4" ID x 5" OD x 12"L	AG508
5" ID x 6" OD x 6"L	AG509
5" ID x 5" OD x 12"L	AG510
6" ID x 7" OD x 6"L	AG511
6" ID x 7" OD x 12"L	AG512
7" ID x 8" OD x 6"L	AG513
7" ID x 8" OD x 12"L	AG514
8" ID x 8" OD x 12"L	AG515
9" ID x 10" OD x 12"L	AG516
10" ID x 11" OD x 12"L	AG517
11" ID x 12" OD x 12"L	AG518
12" ID x 13" OD x 12"L	AG519



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