DATA SHEET
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Zirconium Oxide Fibre

Summary

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Overview

Zirconium oxide fibres products by Zircar Zirconia have high temperatures strength and a high resistance against chemical agents. Zirconium oxide fibre has the lowest thermal conductivity of any refractory fibrous products available on the market. The maximum operating temperature is 2,200 °C and the melting begins at 2,500 °C (depending on the products). The fabrics are constructed of continuous individual filaments and don't require organic binders.

Manufacturing

ZYBF fibre is the result of the Zircar Process which transforms an organic fibre into a ceramic one. The new fibre usually has a diameter of 6 to 10 µm and a serrated outer surface.

All zirconia bulk fibres are made of nearly 100 % zirconia phase stabilized with 10 % yttria. The yttria stabilizes the tetragonal / cubic structure by preventing the monoclinic to tetragonal crystal transformation that occurs at 1,170 °C in pure un-stabilized or insufficiently stabilized zirconia. This undesirable transformation causes an 11 % volume change in the crystal unit cell size that can cause micro-cracking and reduced physical strength in the bulk solid.

Yttria stabilized zirconia is an electrical semiconductor at elevated temperatures. This conductivity arises from the different valences of ionic Zr^{4+} and Y^{3+}. Electricity is conducted at elevated temperatures (700-800 °C) as oxygen ions are induced to flow through the stabilized zirconia structure. This phenomenon forms the basis of zirconia oxygen sensors.

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Applications

- Thermal insulation in crystal growth furnaces
- Hot gas filtration
- Separator in nickel/hydrogen batteries
- Separator in high-temperature fuel cells
- Catalyst support
- Reinforcement for ablative materials

General Characteristics

Key Properties

- Low thermal conductivity
- High purity
- Extreme high temperature stability
- Stabilized with 10 wt. % of yttria

Thermal Properties

- Can be used up to 2,200 °C
- Melting point: 2,500 °C
- Exceptional thermal insulation

Health & Safety

- Storage as a non-toxic product

Chemical Properties

- Very good resistance to molted metals
- No wetting by molten metals: aluminum, steel, copper, etc.
- Resistance to boiling mineral acids for short periods

Benefits

- Low thermal conductivity
- Low heat stockage
- High thermal stability
- Phase stabilized with 10 wt % yttria
- Light structure
- Excellent in corrosive, oxidizing and reducing atmospheres
- Very good flexibility at 1,350 °C

Product range

ZYF Felt

ZYF is a flexible, light weight, porous, needled felt comprised of 4 to 6 µm diameter fibers and is nearly 100 % zirconia phase stabilized with yttria. ZYF is an excellent all-purpose high temperature insulation that can be used in methods of crystal growing as iridium and platinum crucible insulation, and precious metal condensate reclamation material. These felts are inorganic and do not require organic binders.

Because zirconium oxide fibers are yttria stabilized, they do not undergo the disruptive phase transition of pure zirconia. ZYF is non-reactive to alkali vapors, salts or strong hot solutions and is not wet by most molten metals. ZYF excels at extremely high temperatures and in severe environments such as corrosive, oxidizing and reducing atmospheres.

Property		Unit	ZYF-50	ZYF-100	ZYF-150
Composition	ZrO_2* + Y_2O_3	Wt %	99 +	99+	99+
	Al_2O_3		< 0.01	< 0.01	< 0.01
	SiO_2		< 0.02	< 0.02	< 0.02
Thickness		mm	1.27	2.54	3.81
Bulk Porosity		%	96	96	96
Bulk Density		g/cm³	0.24	0.24	0.24
Tensile Strength		g/cm	107	286	357
Area Density		g/m²	342	635	1,123
Melting Point		°C	2,593	2,593	2,593
Operating Temperature		°C	2,000	2,000	2,000
Minimum Wrapping Diameter before Breaking		mm	6.35	19.05	76.20
Heat Capacity	at 93 °C	J/kg/K	544	544	544
	at 2,371 °C		754	754	754
Vapour Pressure at 1,371 °C		Torr	8.10^{-12}	8.10^{-12}	8.10^{-12}
% Shrinkage after 1 hr at 1,679 °C		%	5	4	4

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

Other versions with alumina, silica or zirconia available on request.

Zirconium Oxide Fibre

ZYC Cylinder

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. These products do not require organic binders and will produce no smoke or odor when heated.

ZYC cylinders possess low thermal conductivity and good resistance to thermal shock. ZYC is manufactured using a proprietary vacuum forming technique. It is dimensionally stable to 1,650 °C.

Property		Unit	ZYC
Composition	ZrO_2*	Wt. %	85
	Y_2O_3		10
	SiO_2		5
Bulk Density		g/cm³	0.48
Bulk Porosity		%	91
Melting Point		°C	2,200
Operating Temperature**		°C	1,650
Peak Temperature		°C	1,700
Flexural Strength, MPa (psi) - Normal to Fiber Plane		MPa	0.55
Compressive Strength - Normal to Fiber Plane, at 10 % compression		MPa	0.21
Outgassing in Vaccum			Nul
Dilatometric Softening Temperature at 10 psi		°C	950
Thermal Expansion Coefficient RT at 1,425 °C			$9.10^{-6}.K^{-1}$
Linear Shrinkage (Perp. to Thickness)	1 h at 1,650 °C	%	2.5
	24 h at 1,650 °C		4
Thermal Conductivity, (Parallel to Thickness)	at 400 °C	$W.m^{-1}.K^{-1}$	0.08
	at 800 °C		0.11
	at 1,100 °C		0.14
	at 1,400 °C		0.19
	at 1,650 °C		0.23

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Zirconium Oxide Fibre

FBD Boards and Cylinder

FBD is our strongest, highest density, premium product of the Zircar Zirconia range. FBD boards and cylinders are rigid refractory structures composed of ZYBF bulk fibers stabilized with yttria. Fibers used to manufacture FBD undergo 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.

They have extremely high stability for use as high as 2,000 °C and can be exposed to significantly higher temperatures, depending on the application. It has good hot strength up to 1,700 °C, and can used as protection sleeve, insulation for industrial furnaces or setter for loads up to twice its weight.This product can be machined with conventional tooling.

Property		Unit	FBD
Composition	ZrO_2*	Wt. %	90
	Y_2O_3		10
Typical Impurities	HfO_2	Wt. %	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
Color			white
Bulk Density		g/cm³	1.4
Porosity		%	76
Operating Temperature**		°C	2,000
Peak Temperature		°C	2,200
Melting Point		°C	2,590
Flexural Strength, Normal to Fiber Plane		MPa	8.27
Compressive Strength, Normal to Fiber Plane, at 10 % compression		MPa	5.52
Outgassing in Vacuum			None
Dilatometric Softening Temperature		°C at 10 psi	1,400
Thermal Expansion Coefficient RT to 1,180 °C (Perpendicular to Thickness)			$10,7.10^{-6}.K^{-1}$
Linear Shrinkag (Perpendicular to Thickness)	1 h at 1,650 °C	%	0.0
	24 hrs at 1,650 °C		0.9
Thermal Conductivity (Parallel to Thickness)	at 400 °C	$W.m^{-1}.K^{-1}$	0.24
	at 800 °C		0.26
	at 1,100 °C		0.31
	at 1,400 °C		0.33
	at 1,650 °C		0.35

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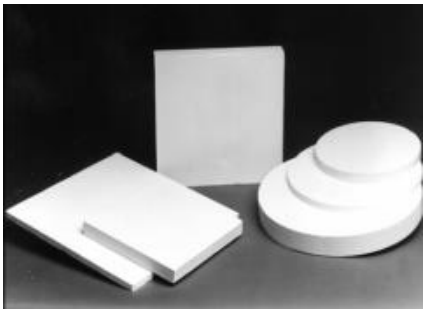
Zirconium Oxide Fibre

ZYBF Boards and Cylinder



Zirconium oxide boards and cylinders types ZYFB-3 & ZYFB-6 are rigid refractory structures composed of ZYBF bulk fibers which are nearly 100 % zirconia phase stabilized with yttria. These ceramics have high insulating properties that excel at extremely high temperatures and in severe environments such as corrosive, oxidizing and reducing atmospheres.

Fibers used to manufacture these ZYBF-3 and ZYBF-6 products undergo multiple processing and heat treatments. They have a good dimensional stability up to 1,650 °C and can be used as insulation in fused quartz processing, heat shield and setter for loads up to twice its weight at temperature up to 1,400 °C.

ZYBF boards and cylinders are available at two different densities:

- **ZYFB-3** is our lowest density product at 0.48 g/cm^3 and benefits of an extremely low thermal conductivity.
- **ZYFB-6** is medium density product at 0.96 g/cm^3 and has a better mechanical strength than ZYBF-3 products.

Property		Unit	ZYFB-3	ZYFB-6
Composition	ZrO_2*	Wt. %	90	90
	Y_2O_3		10	10
Typical Impurities	HfO_2	Wt. %	1 to 2	1 to 2
	SiO_2		0.12	0.12
	TiO_2		0.14	0.14
	CaO		0.09	0.09
	MgO		0.03	0.03
	Fe_2O_3		0.04	0.04
	Al_2O_3		0.01	0.01
	Na_2O		0.01	0.01
Color			white	white
Bulk Density		g/cm^3	0.48	0.96
Porosity		%	92	84
Operating Temperature**		°C	1,800	1,800
Peak Temperature		°C	2,200	2,200
Melting Point		°C	2,590	2,590
Flexural Strength (Parallel to Fiber Plane)		MPa	0.60	2.10
Compressive Strength at 10 % compression (Parallel to Fiber Plane)		MPa	0.29	1.59
Outgassing in Vacuum			None	None
Dilatometric Softening Temperature at 10 psi		°C	1,180	1,240
Thermal Expansion Coefficient RT to 1,180 °C (Perpendicular to Thickness)		$10^{-6}.K^{-1}$	10.7	10.7

Zirconium Oxide Fibre

Property		Unit	ZYFB-3	ZYFB-6
Linear Shrinkage	1 h at 1,650 °C	%	1.2	1.0
	24 hrs at 1,650 °C		2.8	1.7
Thermal Conductivity (Parallel to Thickness)	at 400 °C	$W.m^{-1}.K^{-1}$	0.08	0.6
	at 800 °C		0.11	0.19
	at 1,100 °C		0.14	0.22
	at 1,400 °C		0.19	0.25
	at 1,650 °C		0.24	0.27

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

ZYP Powders

Zirconium oxide powders type ZYP are fine, highly reactive powders composed of nearly 100 % zirconia phase stabilized with yttria. It is offered with three different specific surface areas:

- **ZYP-30 :** specific surface area from 25 to 35 m^2/g
- **ZYP-40 :** specific surface area from 35 to 45 m^2/g
- **ZYP-55 :** specific surface area from 50 to 60 m^2/g

Sintering of ZYP powder particles begins at around 900 °C and zirconia ceramic bodies approaching theoretical density can be achieved using ZYP as low as 1,450 °C.

ZYP powders are used as a filtration media, thermal barrier coatings, polishing ans oxygen sensors.

Property		Unit	ZYP-30	ZYP-40	ZYP-55
Composition	ZrO_2*	Wt. %		90	
	Y_2O_3			10	
	Trace Elements			< 1	
Ignition Loss		Wt. %	1.8	2.2	3.1
BET Specific Surface Area		m^2/g	25-35	35-45	50-60

ZYBF Bulk Fibre

Bulk fibers type ZYBF are available in three different forms, all having useful properties up to 2,200 °C. These polycrystalline fibers can be vacuum formed into rigid shapes, placed into cavities as loose fill insulation, or added to ceramic bodies and coatings for reinforcement.

ZYBF is characterized by the length of the fibres, its specific surface area and the size and porosity of the cristal units. ZYBF is 6 to 10 microns in diameter, is nearly 100% zirconia phase stabilized with 10 % yttria.

Zirconium Oxide Fibre

Property		Unit	ZYBF-1	ZYBF-2	ZYBF-3
Composition*	ZrO_2	Wt. %	90	90	90
	Y_2O_3		10	10	10
	Trace Elements		< 1	< 1	< 1
Bulk Density		g/cm³	0.12	0.34	0.25
H_2O		Wt. %	2-3	0.05-0.2	0.05-0.2
Cl^-		Wt. %	1.5-2.0	< 0.1	< 0.1
Ignition Loss, ½ hr at 950 °C		Wt. %	4-6	0.1-0.4	0.1-0.4
Specific Surface		m²/g	75	4	0.4
Peak Temperature		°C	2,200	2,200	2,200
Pierce Adsorption Mesopore	Median Pore Diameter[1]	Å	75	1,300	2,600
	Standard Deviation[1]		29	94	110
	Median Pore Diameter[2]		50	27	23
	Standard Deviation[2]		19	15	12
Pierce Desorption Mesopore	Median Pore Diameter[1]	Å	60	1,100	2,700
	Standard Deviation[1]		23	85	160
	Median Pore Diameter[2]		49	28	34
	Standard Deviation[2]		75	1,300	2,600

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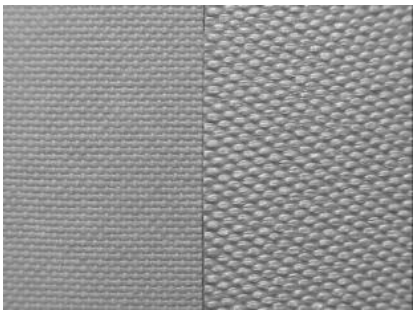
ZYW Fabrics



Zirconium oxide fabrics type ZYW are flexible textiles composed of yttria stabilized zirconia fibers. They are constructed of continuous individual filaments mechanically interlocked in a woven structure. This construction offers extreme temperature and chemical resistance in a flexible form.

ZYW fabrics provide the lowest thermal conductivity of any commercially available refractory material in their class. They are ideal for temperatures up to 2,200 °C and are suitable for applications such as high energy battery separators, thermal insulation in crystal growing furnaces, and hot gas filtration. They are easily cut into fitted portions.

Property		Unit	ZYW-15	ZYW-30A
Composition	ZrO2*	Wt. %	90	90
	Y_2O_3		10	10
	Trace Impurities		< 0.25	< 0.25
Thickness		mm	0.38	0.64
Bulk Porosity		%	87	83
Bulk Density		g/cm³	1.02	0.94
Tensile Strength		g/cm	154	872
Density		g/m²	291	772
Melting Point		°C	2,590	2,590

Zirconium Oxide Fibre

Property		Unit	ZYW-15	ZYW-30A
Peak Temperature		°C	2,200	2,200
Specific Heat	at 93 °C	$J\ K^{-1}\ kg^{-1}$	544	544
	at 2,371 °C		754	754
Vapor Pressure at 1,371 °C		Torr	8.10^{-12}	8.10^{-12}
Shrinkage after 1 hr at 1,679 °C		%	5.5	3.9

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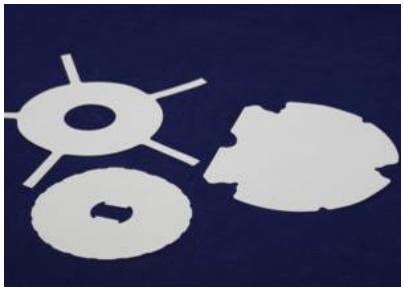
ZYK-Knit



Zirconium oxide cloth ZYK-15 is made using the original Zircar Process by Zircar Zirconia, and is comprised of continuous individual filaments fabricated in a tricot knit form that is nearly 100 % zirconia phase stabilized with yttria. Its thermal conductivity is the lowest of all similar products on the market. It can withstans operating temperatures up to 2,200 °C without any outgassing and stays flexible up to 1,350 °C. ZYK-15 is only available in sheets.

It is suitable for applications such as high energy battery separators, thermal insulation in crystal growing furnaces, and for the filtration of hot gasses.

Property		Unit	ZYK-15
Nominal Composition	ZrO_2*	Wt %	90
	Y_2O_3		10
	Trace Impurities		< 0.25
Thickness		mm	0.30
Bulk Porosity		%	85
Bulk Density		g/cm^3	0.68
Tensile Strength		g/cm	166
Density		g/m^2	207
Melting Point		°C	2,590
Peak Temperature**		°C	2,200
Specific Heat	at 93 °C	$J.kg^{-1}./K^{-1}$	544
	at 2,371 °C		754
Vapor pressure at 1,371 °C		Torr	8.10^{-12}
Linear Shrinkage after 1 hr at 1,679 °C		%	4.3

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