



TOSOH CORPORATION

Advanced Ceramics Department
3-8-2, Shiba, Minato-ku, Tokyo 105-8623, Japan
Tel: +81 3 5427 5170 Fax: +81 3 5427 5217
E-mail: zirconia@tosoh.co.jp
www.tosoh.com

TOSOH USA, INC.

3600 Gantz Road, Grove City, OH 43123-1895, USA
USA Toll Free: +1 866 844 6953 Fax: +1 614 875 8066
E-mail: info.tusa@tosoh.com
www.tosohusa.com

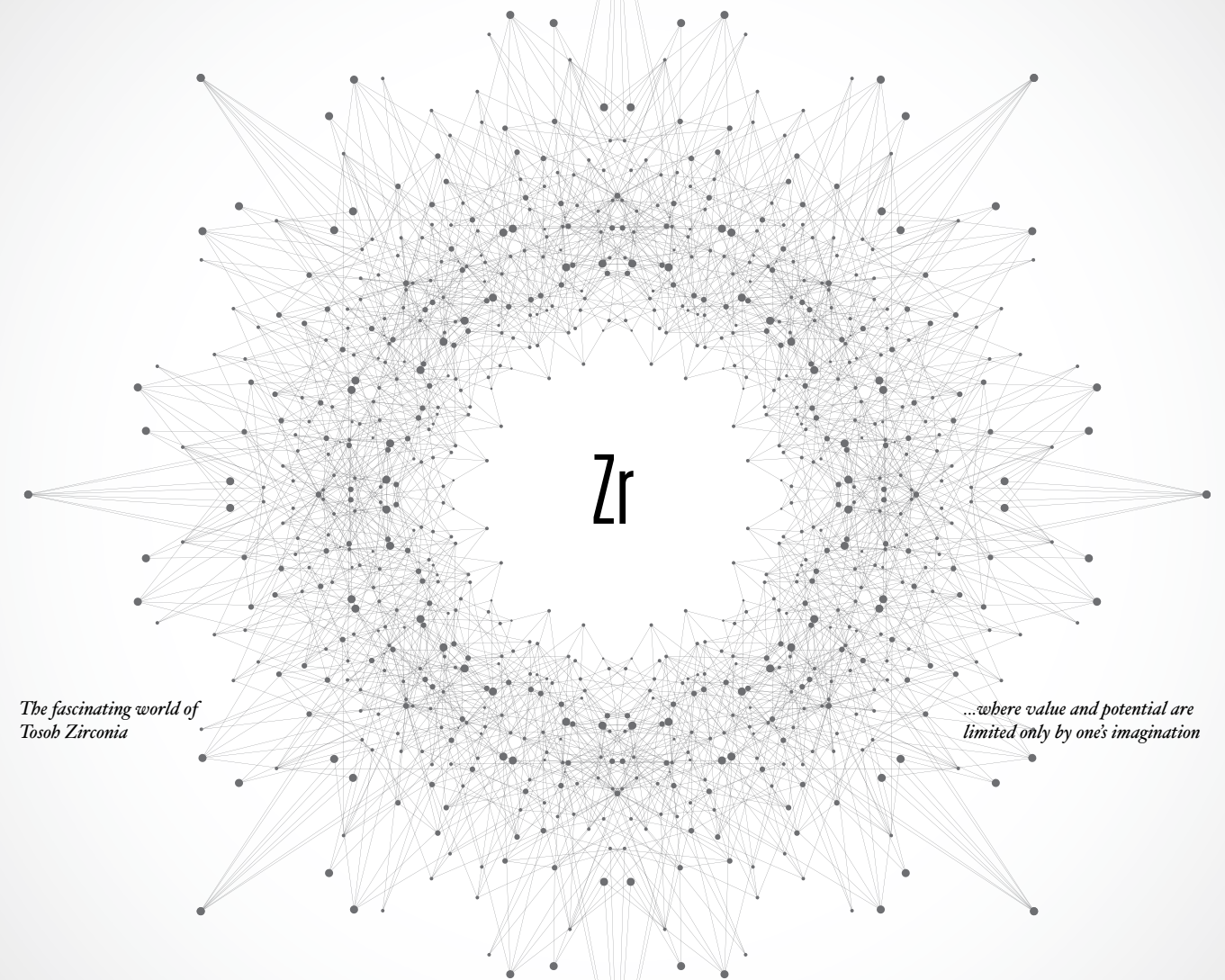
TOSOH EUROPE B.V.

Rembrandt Tower, Amstelplein 1
1096 HA Amsterdam, The Netherlands
Tel: +31 20 565 0010 Fax: +31 20 691 5458
E-mail: info.tse@tosoh.com
www.tosoheurope.com

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Z I R C O N I A



*The fascinating world of
Tosoh Zirconia*

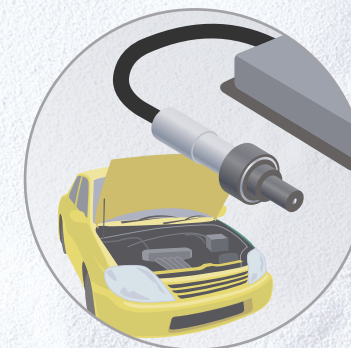
*...where value and potential are
limited only by one's imagination*

Yttria-stabilized Zirconia (YSZ)

- ◇ Zirconia powder
- ◇ Color zirconia
- ◇ Compounds for injection molding and ceramic components
- ◇ Zirconia fine beads
- ◇ Zirconia grinding and dispersion media

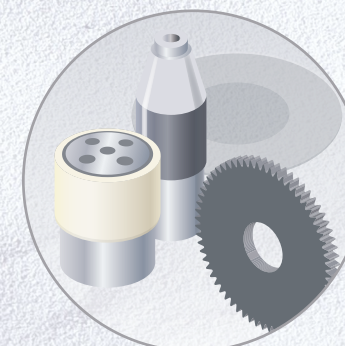
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ZIRCONIA



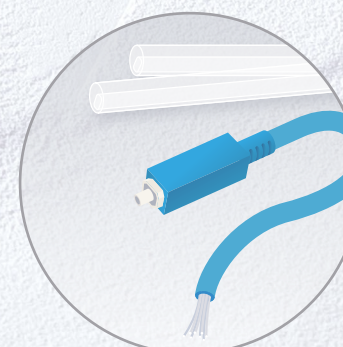
Environmentally Friendly and Energy-Efficient

OXYGEN-ION CONDUCTIVITY is a **UNIQUE QUALITY** of zirconia. This fascinating characteristic makes zirconia useful in environmental applications for solid oxide fuel cells, which generate pollution-free electricity, as well as oxygen and NOx sensors used in the automotive field.



Mechanical Parts

Zirconia is **RESISTANT** to **RUST, CORROSION**, and **CHEMICAL REACTIONS**, and therefore is used in a variety of machines and other industrial equipment. Zirconia excels in heat shielding applications, providing heat insulation 10 times that of standard ceramics and 100 times that of iron.



Indispensable for Fiber-Optic Networks

The information age of today and tomorrow is being built on global fiber-optic networks. Zirconia is an indispensable material used in the connectors within those networks.

STRONG, FLEXIBLE, and **EASY** to **PROCESS**, zirconia is the world standard for fiber-optic connectors – providing the maximum amount of data transmission with minimal loss.

The future of ZIRCONIA IS JUST BEGINNING...



Daily Life

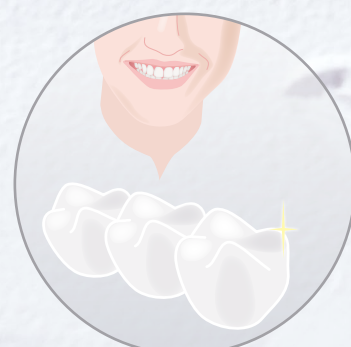
INCREDIBLY DURABLE and **SOFT** to the **TOUCH**, zirconia is used in consumer goods, such as luxury watches. For professional chefs, zirconia knives don't rust and stay extremely sharp.



Grinding Media

SUPERIOR STRENGTH and **DURABILITY**

Tosoh's zirconia grinding media is primarily spherical and comes in a variety of sizes from 0.03 mm to 25 mm. It is used to process materials for not only machines and industrial parts, but also plays a vital role in the production of materials that comprise the micron-thin layers of electronics for mobile phones, as well as the processing of pigments in printing inks.



Dental Materials

COMBINING STRENGTH and **NATURAL BEAUTY**

Replicating the natural look and feel of real teeth without compromising strength, zirconia is now gaining attention as a new dental material.

The Unlimited Possibilities for Zirconia

Zirconia is a unique advanced ceramic — a chemical compound having the formula ZrO_2 . Products manufactured from Tosoh's yttria-stabilized zirconia (YSZ) powder exhibit superior mechanical properties such as high strength and flexibility. As a technological breakthrough, YSZ surpasses the strength limitations of traditional fine ceramics. Heat insulating properties and oxygen-ion conductivity indicate zirconia has potential for use in a wide variety of applications — everything from telecommunications and environmental products to the new energy of the future.

**Quality Worthy
of Market Share**

Tosoh is a pioneer in the development of YSZ and has become a major supplier to the world. Earning a solid reputation for consistent high purity and quality that customers can depend on, Tosoh continues to focus resources in R&D and customer services for the ultimate evolution of zirconia.

A Global Brand Earned with Quality You Can Trust

Zirconia Powder TZ Series

Using the latest hydrolysis processes and nano technologies, Tosoh has created the TZ Series of zirconia powders. Through complete control over materials and production processes, Tosoh can maintain consistent high quality and purity. The TZ Series, the ultimate zirconia powder, delivers added value and product improvements to the customer.

Basic Grades

Fine Ceramics

◆TZ-3Y-E

Partially-stabilized zirconia powder with uniform dispersion of 3 mol % yttria. TZ-3Y-E exhibits superior sintering properties and higher aging resistance at a lower sintering temperature of 1300°C. Sintered bodies produced with TZ-3Y-E show a fine crystal grain structure resulting in greater improvements in strength, fracture toughness, as well as resistance to wear and aging. TZ-3Y-E has numerous applications including materials for industrial parts and everyday products.

Solid Electrolyte with Oxygen-Ion Conductivity

◆TZ-4Y TZ-6Y TZ-8Y TZ-10Y

Fully stabilized zirconia powder with uniform dispersion of 4~10 mol % yttria. Sintered bodies produced from these powders exhibit oxygen-ion conductivity and heat insulating properties. These grades have proven to be suitable for use in oxygen sensor applications, electrolytes in solid oxide fuel cells, materials for heat insulation, and many others.

Binder Grades "B"

Tosoh's binder added grades are perfect for mechanical pressing and Cold Isostatic Press (CIP). "B" grades can be used "as is," thereby eliminating the binder addition and spray drying steps in customers' processes.

Easy Moldability Grades "S"

"S" grades have a smaller surface area that contributes to a smooth flow for the compound or slurry during injection molding, tape casting, and other molding methods. Therefore, "S" grades are highly recommended for producing large parts with a mechanical press or CIP.

ATZ Grades "A"

"A" grades contain uniformly dispersed 3 mol % yttria, 20 wt% alumina, and exhibit extremely high mechanical strength after Hot Isostatic Pressing (HIP). This grade is most commonly used to produce industrial parts in high strength, high wear resistance applications.

High Translucent Grade

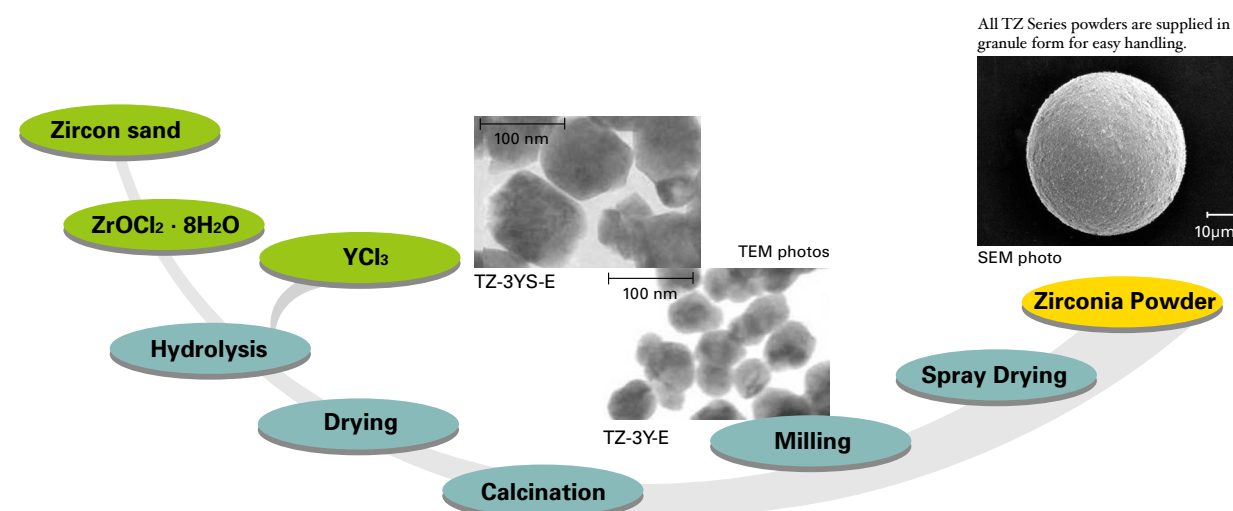
Dental restorations with the natural look and feel of real teeth can be produced with Zpex. Zpex Smile is a newly developed grade for anterior applications. Powder grades for dental color shades are also available.

Color Zirconia

Tosoh's color zirconia shows a deep tone that emulates jewels. Other uses include mechanical and optical anti-reflection parts.

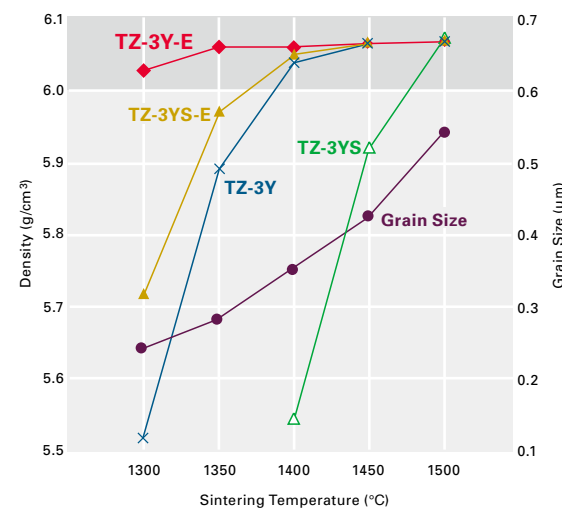
Tosoh also supplies a high purity, non-stabilized zirconia powder, TZ-o. For the development of custom powders, please contact your nearest Tosoh sales office.

Tosoh Zirconia Manufacturing Process



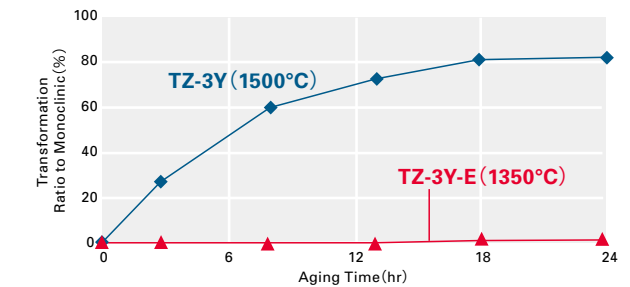
Easy Sintering (TZ-3Y-E)

● TZ-3Y-E can be sintered at a lower temperature of 1300°C.

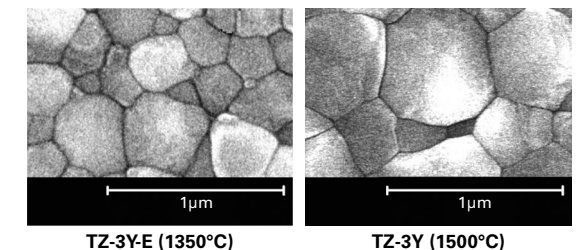


Molding method: Cold Isostatic Pressing
Molding pressure: 1,000 kg/cm²
Holding time (sintering): 2hrs

● TZ-3Y-E has superior hydrothermal aging resistance.



● High quality, fine grained sintered bodies, which exhibit superior hydrothermal aging resistance, can be produced from TZ-3Y-E when sintered under 1350°C

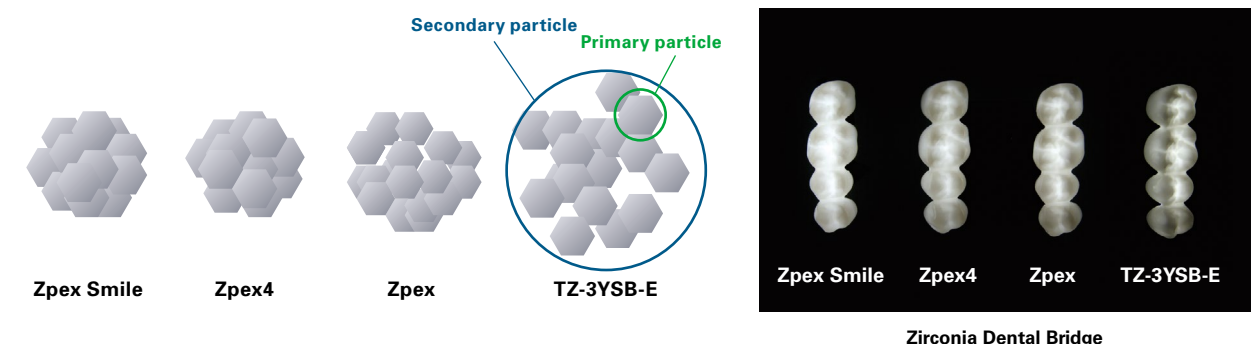


High Translucent (Zpex and Zpex Smile)

● Zpex and Zpex Smile have high all light transmittance in addition to superior hydrothermal aging resistance.



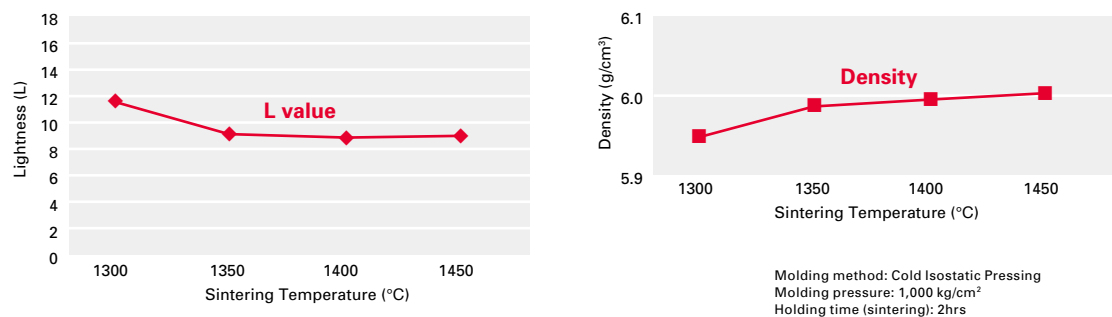
● Zpex and Zpex Smile have achieved high all light transmittance by improving the aggregation of particles.



Zpex and Zpex Smile are registered trademarks of Tosoh Corporation in Japan, the United States, and other countries.

Color stability (TZ-Black)

- Color stability can be achieved within a wide sintering temperature range.



Powder Characteristics and Properties

	TZ-3Y-E (TZ-3YB-E)	TZ-3YS-E (TZ-3YSB-E) (TZ-3YSB-C)	TZ-4Y	TZ-6Y	TZ-8Y	TZ-10Y	TZ-3Y20A (TZ-3Y20AB)	Zpex	TZ-Black (TZ-Black-B)	TZ-0
Y ₂ O ₃ (mol%)	3	3	4	6	8	10	3	3	3	0
Actual Particle Size (μm)	0.04 (40nm)	0.09 (90nm)	0.04 (40nm)				—	0.04 (40nm)	0.09 (90nm)	0.04 (40nm)

Powder Characteristics

Y ₂ O ₃ (wt%)	5.2±0.5		7.0±0.6	10.3±0.6	13.3±0.6	15.9±0.7	3.9±0.3	5.35±0.2	5.0±1.0	—
HfO ₂ (wt%)	< 5.0									
Al ₂ O ₃ (wt%)	0.1 ~ 0.4		≦ 0.1				18 ~ 22	≦ 0.1	—	≦ 0.1
SiO ₂ (wt%)	≦ 0.02								≦ 0.05	≦ 0.02
Fe ₂ O ₃ (wt%)	≦ 0.01								—	≦ 0.01
Na ₂ O (wt%)	≦ 0.04		≦ 0.06	≦ 0.12			≦ 0.04			
Pigment (wt%)	—								≦ 5.0	—
Specific Surface Area (m ² /g)	16±3	7±2	16±3			13±3	15±3	13±3	10±3	14±3

Typical Properties of Sintered Body

Density (g/cm ³)	6.05		6.02	5.90	5.80	5.50	6.08	6.00	—	
Bending Strength R.T. (MPa)*1	1200		1000	500	300	200	2000 (HIPing)	1100	1200	—
Hardness (Hv 10)*2	1250					1400	1250	1200	—	

*1: JIS R1601 (3-point bending test)

*2: JIS R1610 (Loads: 98.07N)

Legend for grade names

<Example> TZ - 3Y S 20A B - E
I II III IV V
I : mol % of yttria
II : easy moldability grades
III : ATZ grades - 20 wt% alumina
IV : binder grades
V : easy sintering grades

Jewel-like Dignity and Elegance

Color Zirconia TZ Color

Integrity and depth of color in zirconia exudes elegance comparable to precious stones. Superior wear resistance means the brightness never fades. Color zirconia will provide the sparkle that customers need for development of new products.

Typical Applications

- Watch parts (case, band)
- Exterior cellular phone parts
- Optical anti-reflection parts for image recognition
- Various machine parts

Available Colors

- In addition to colored powder, compound for injection molding and sintered products are also available.



TZW001
White



TZW002
White



TZW003
White



TZO001
Orange



TZR007
Opaque Pink



TZV003
Lavender



TZV001
Dark Violet



TZG005
Olive Green



TZC011
Sky Blue



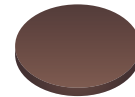
TZC012
Steel Blue



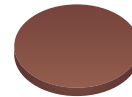
TZC007
Dark Blue



TZC010
Dark Blue



TzM001
Brown



TzM002
Sepia



Tzs006
Opaque Gray



TZS007
Ash Gray



TZB001
Black

Above colors may differ from actual colors.

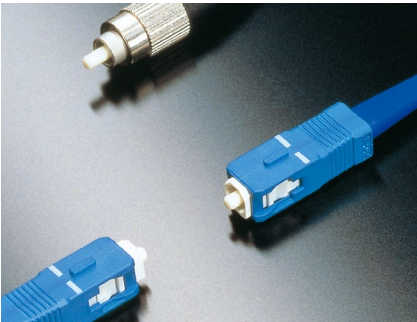
Above color codes are reference numbers.

Please contact your nearest Tosoh sales office for more information or the development of a custom color.

Proven Technology and Achievements

Compound for Injection Molding PXA Series and Ceramic Components

Tosoh supplies various injection molded components produced by Tosoh Ceramics Co., Ltd. Tosoh, in addition to powder production, is an injection molding compound manufacturer with extensive experience in the mass production of sintered bodies. Based on this know-how, Tosoh has developed the PXA Series delivering high quality, easy sintering, and superior handling features.



Standard Grades

PXA-211P

Zirconia compound based on TZ-3Y-E. Compound for de-waxing with good flow; used for precision parts as well as irregular shape parts.

PXA-233P

Zirconia compound based on TZ-3YS-E. This compound can be de-waxed in air and feature excellent de-waxing properties with good flow; used for larger parts.

PXA-321P

Zirconia compound based on TZ-Black. Black color stability can be achieved. Compound for de-waxing with good flow; used for larger parts as well precision parts.

PXA-300P Series

Color zirconia compound.

PXA-400P Series

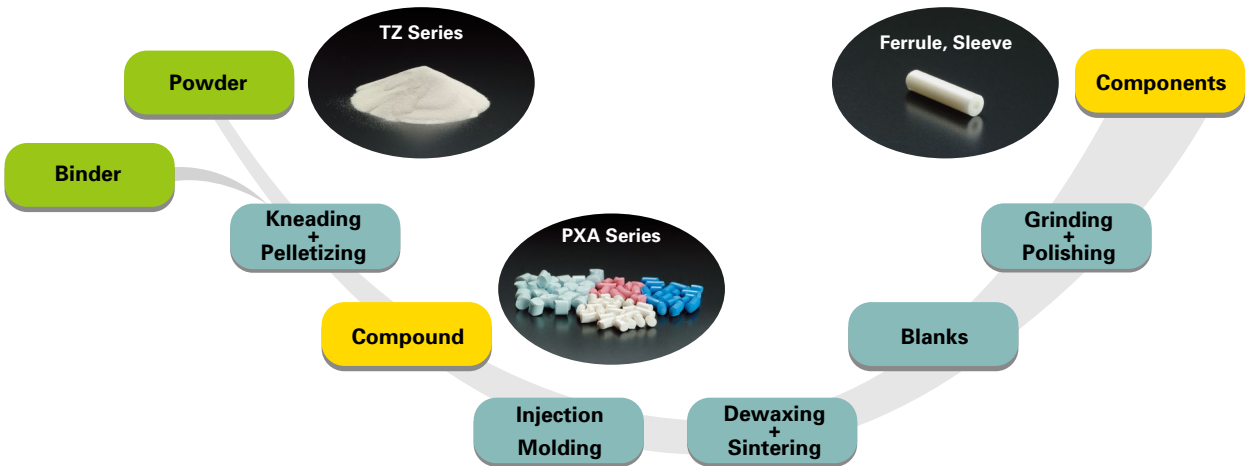
Zirconia compound based on fully stabilized zirconia powder.

Typical Applications

- Optical fiber connector ferrule and sleeve blanks
- Watch parts
- Exterior cellular phone parts
- Auto parts
- Structural parts for medical devices
- Various machine parts

Tosoh offers customized special compound to meet customer requirements, such as ceramic compound based on materials other than zirconia. Please contact your nearest Tosoh sales office for more information.

Manufacturing Process



PXA is a registered trademark of Tosoh Corporation in Japan.

Compound Characteristics and Properties

	PXA-211P	PXA-233P	PXA-321P	PXA-304P	PXA-410P
Base Powder	Zirconia (Y ₂ O ₃ = 3mol%)			Zirconia(Y ₂ O ₃ = 3mol%) +Al ₂ O ₃ (20wt%)	Zirconia (Y ₂ O ₃ = 8mol%)

Compound Characteristics

Ash Content (wt%)	81.95±0.15	84.55±0.15	84.40±0.15	83.10±0.15	82.90±0.15
Flow Rate (ml/sec)	0.12±0.05 (160°C)	0.15±0.15 (160°C)	0.20±0.15 (160°C)	0.30±0.15 (160°C)	0.008±0.005 (130°C)
De-waxing (°C)	450°C (Air)				
Sintering (°C)	1,350°C	1,450°C	1,400°C	1,500°C	1,500°C

Typical Properties of Sintered Body

Density (g/cm³)	6.05	6.00	5.50	5.90
Bending Strength R.T.(MPa)*1	1,200			300
Hardness (Hv10)*2	1,250	1,200	1,400	1,250
Color	Milk White	Black	White	Milk White

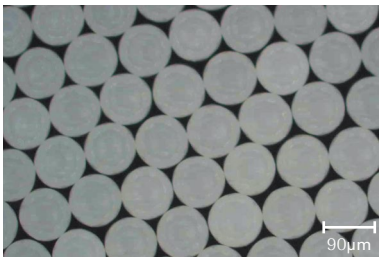
*1: JIS R1601 (3-point bending test)

*2: JIS R1610 (Loads: 98.07N)

30 Microns with Great Potential

Zirconia Fine Beads TZ-B Series

Tosoh's high-end manufacturing technology has yielded zirconia fine beads that exhibit superior strength and fracture toughness. The TZ-B Series is now used in many applications such as blasting, shot peening, and placing sand.



TZ-B90

Standard Grades

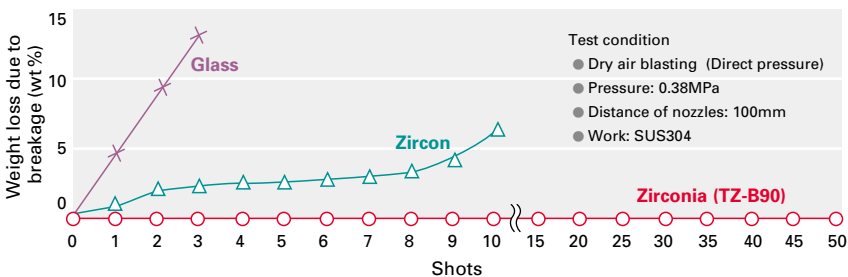
Grade	Size
TZ-B30	20 ~ 38 µm ≥ 95 %
TZ-B53W	25 ~ 106 µm ≥ 95 %
TZ-B53	38 ~ 75 µm ≥ 95 %
TZ-B90	75 ~ 106 µm ≥ 95 %
TZ-B125	106 ~ 150 µm ≥ 95 %
TZ-B180	150 ~ 212 µm ≥ 95 %
TZ-B250	212 ~ 300 µm ≥ 95 %

For other sizes, please contact the nearest Tosoh sales office.

Typical Applications

- Shot blasting (matte finishing, deburring)
- Shot peening
- Filler for various resins
- Placing sand (sintering, annealing)
- Spacer

Durability Comparison (TZ-B90)

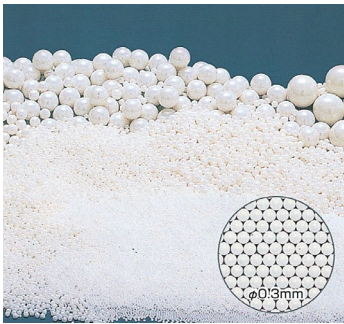


Test data shows the result of shot blasting SUS304 using various types of beads equivalent to TZ-B90. During the 50 blasts, the crushing ratio of TZ-B90 hardly rose. This shows the superior crushing strength that the TZ-B Series provides.

Eco-Products with Superior Grinding Efficiency

Zirconia Grinding and Dispersion Media YTZ

YTZ grinding media, produced from yttria-stabilized zirconia powder, exhibits high crushing strength, fracture toughness and wear resistance. It is produced by the Nikkato Corporation, one of Japan's leading ceramic manufacturers and a pioneer in the development of strength-enhanced zirconia ceramics. YTZ grinding media, from raw materials to finished product, continues to be thoroughly evaluated from all possible viewpoints with the goal of superior quality.



Ceramic Media Properties

Due to the unique properties of ceramics, YTZ grinding media is resistant to rust and corrosion, and thus compatible with water-based processing. Additionally, YTZ grinding media, produced from yttria-stabilized zirconia “YSZ” powder, exhibits superior grinding efficiency because of higher density, and superior wear resistance due to high crushing strength and fracture durability.

Typical Applications

Through a comprehensive quality system, YTZ grinding media has a solid reputation for the grinding and dispersion of pharmaceutical and foodstuffs as well as those of ultra-fine materials for electronic parts or inks.

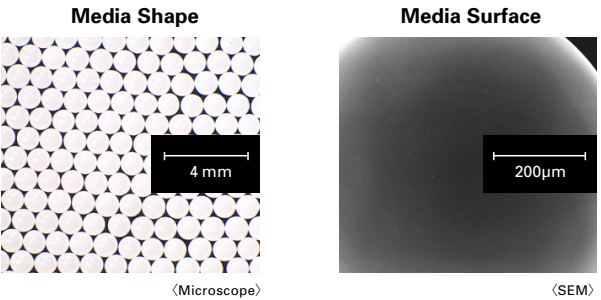
- Dielectric, piezoelectric and magnetic materials
- Pigment, inks, dyes, paint and coating materials
- Battery and fluorescent materials
- High purity advanced ceramic materials, frits and glazes
- Pharmaceutical, dental, cosmetics and foodstuffs

YTZ Properties

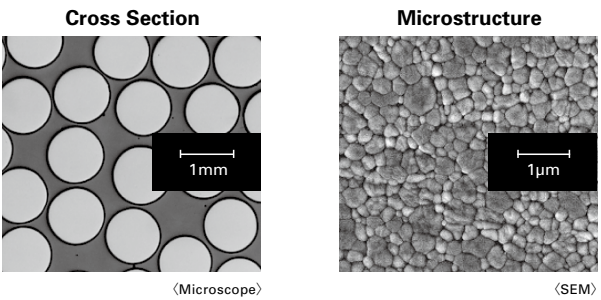
Chemical Composition	ZrO ₂ , Y ₂ O ₃
Specific Density	6.0 g/cm ³
Bending Strength	1200 MPa
Hardness (Hv10)	1250
Modulus of Elasticity	210 GPa
Fracture Toughness	6.0 MPam ^{0.5}

YTZ Qualities

YSZ powder used for starting materials is produced by the latest hydrolysis process, known as the “Tosoh process” achieving consistent high quality. YTZ grinding media consists of high purity YSZ absent of any heavy metals. Moreover YTZ grinding media exhibits high wear resistance, which combined with its smooth surface minimizes product contamination from both media and mill wear.



YTZ grinding media, having a narrow size distribution and nearly spherical shape, enables more efficient and precise grinding and dispersion.



YTZ grinding media consists of extremely uniform fine grains and has virtually no internal defects, resulting in outstanding wear resistance. Significant cost and waste reduction is realized as a result of less media chipping and less frequent media replacement.

Available Sizes

● Ball

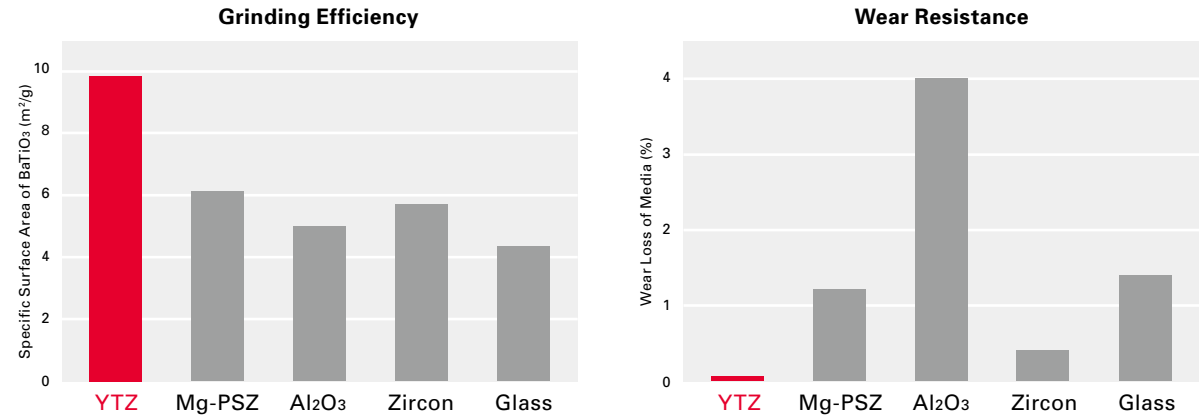
Size (φ, mm)	Bulk Density (kg/ℓ)	Size (φ, mm)	Bulk Density (kg/ℓ)
0.03	3.5	1.5	3.8
0.05	3.55	1.75	3.7
0.1	3.7	2	3.7
0.2	3.7	2.3	3.7
0.3	3.9	2.7	3.7
0.4	3.9	3	3.7
0.5	3.9	5	3.6
0.65	3.8	10	3.5
0.8	3.8	15	3.4
1	3.8	20	3.3
1.25	3.8	25	3.2

● Cylinder

Size (inch)	Bulk Density (kg/ℓ)
3/8	3.6
1/2	3.6

Please contact your nearest Tosoh sales office with requests for other sizes.

Grinding Efficiency and Wear Resistance



The test data above is a result of wet milling BaTiO₃ powder with a starting surface area of 1.8m²/g. Grinding was conducted with several types of media in a vertical sand mill over a set period of time. As can be seen, YTZ has superior grinding efficiency with the highest wear resistance. The highest surface area of the ground material was achieved with YTZ over the same period of time under identical conditions. This is a clear indication of the high milling efficiency that YTZ provides.

Environment, Safety and Comprehensive Quality System

- YTZ grinding media is produced under a stringent audit system, and has obtained ISO 9001 quality assurance and ISO 14001 environmental management system certifications.
- Traceability



YTZ grinding media can be completely traced from raw materials to the finished products.