



THE WONDER CERAMIC MICRO-MACRO MILLING MEDIA

Ceria Stabilized Zirconium Oxide

High Density ($\geq 6.20 \text{ g/cm}^3$)

Milling High / Medium

Viscous Formulations

Long-Lasting



VERSATILE INDUSTRIAL APPLICATIONS



PRINTING INK



GOLD



AUTOMOTIVE PAINT



CHOCOLATE



PHARMA



THE WONDER CERAMIC MICRO-MACRO MILLING MEDIA

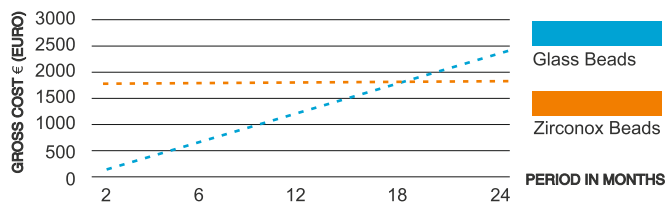
Jyoti Ceramic is a proud manufacturer of Zirconox milling media, exporting 70% of its production to 55 countries for over three decades. In a variety of industries, Zirconox milling media has proven to be the most efficient and cost-effective milling media.

Zirconox was formulated in the 1990s from micro-fine monoclinic zirconia powder stabilized with rare earth Cerium Oxide transformed to tetragonal polycrystals.

Zirconox has become synonymous with milling beads as a result of its unique features, and it is now regarded as the wonder ceramic milling beads.

ADVANTAGES OF ZIRCONOX MICROBEADS

- Zirconox microbeads have a density of 6.20 g/cm³ and a bulk density of 3.85 kg/ltr hardness 9 on Mohs scale. The combination of high density and hardness of Zirconox microbeads allows for faster achievement of the required particle size of pigment or slurry, resulting in higher material yield with reduced milling time.
- Zirconox microbeads are the most cost-effective for speedy dispersion and micro-fine milling of high viscous (15000-50000 cPs) hard and soft substances with insignificant contamination from media wear.
- Zirconox beads are free from pinholes, cracks, bead fused with other bead resulting in reduced downtime and greater process safety.
- Zirconox microbeads have a dense, homogeneous internal microstructure. Due to microfine grain size beads have a satin-smooth surface finish and do not crack or shatter easily. The wear rate of Zirconox micro beads decreases as the milling hours progress and the surface finish of the beads appears glossier.
- Zirconox microbeads are extremely gentle to expensive mill parts. The wear of mill parts is extremely low with the use of Zirconox beads.
- Zirconox 90% beads maintain sphericity ≥ 0.95 . Due to greater sphericity and satin-smooth surface, media flow improves and decreases abrasion. Zirconox beads last 300-350 times longer than glass beads, 25-30 times longer than MgO stabilized beads, and 20-30 times longer than Zirconium Silicate beads.



TEST CONDUCTED BY TECHNOPLAN FABRITECHNIK GMBH & CO. KG GERMANY.

Practical Wear test with Zirconox - milling media (1.7-2.4 mm)

In comparison to glass beads.

IN REFERENCE TO THE GRAPH

Initially the cost of Zirconox may be higher by about 17 times than the glass beads.

In the course of usage of the mill for about 18 months, it is realized that the amount spent on both types of micro media is the same.

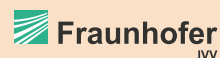
At the end of 24 months it is observed that the cost of glass beads is higher by about 40% than Zirconox.

COMMENTS

The above trend is mainly due to the exorbitantly high wear of glass beads in comparison to Zirconox beads.

Figures from the graph indicate that the glass beads wear is about 300 times more than that of Zirconox.

CERTIFICATE



Food regulatory assessment of Zirconox® mill beads
Client : JYOTI Ceramic GmbH, 90429 Nurnberg
Order : PA/4325/18
Sample : Zirconox Micro Beads, dia. 0.4 -0.6 mm

The investigated zirconox-cerium-material is used as mill beads (repeated contact) in mills to grind food. Thereby various sizes of beads are available. Beads with a diameter of 0.4-0.6 mm were used for the analysis. The results can be transferred to beads with a larger diameter. The receipt of the beads was disclosed to Fraunhofer IVV.

Since the mill beads are used as repeated use articles, the migration contact was repeated two times with fresh simulants (3 % acetic acid) at the test conditions 2 h / 70 °C following the rules for migration testing of the European Regulation (EU) No 10/2011 (Fraunhofer IVV test report PA/4157/18). For the assessment of the possible migration of the investigated metals zirconium, cerium, lead, cadmium, chromium, mercury, arsenic, nickel and tin the European Resolution AP(2) of the Council of Europe for aids to polymerisation and technological coadjuvants are being used.

The migration of the investigated metals zirconium, cerium, lead, cadmium, chromium, mercury, arsenic, nickel and tin is in compliance with the requirements of the European Resolution AP 92 (2) of the Council of Europe for aids to polymerisation and technological coadjuvants for repeated use at the chosen test conditions. Because of the good solubility of the components in the simulants 3 % acetic acid, the results can be transferred to the assessment for all types of food. In conclusion, there is no safety concern related to the use of the Zirconox- cerium based mill beads for the grinding of food.

Fraunhofer Institute Process
Engineering and Packaging

Freising, 18.04.2018

Dr. Diana Kemmer
(Dep. Head of Migration Laboratory)

Maria Obermeier
(Scientist in Charge)

Fraunhofer Institut für Verfahrenstechnik und Verpackung, Gilgenhauser Str. 35, D-85354 Freising

Fraunhofer Institute, Freising, Germany has approved Zirconox micro media for milling of foodstuff in accordance with the regulations of the European Community.

National Radiological Protection Board (NRPB), Great Britain has confirmed that the radioactivity of Zirconox is within the regulations established by the European Community.

Zirconox milling media are :

- Non-contaminative, Non-toxic and Non-magnetic.
- Chemically inert and non-radioactive.
- Resistant to all acids and alkalis except hydrofluoric acid.

PHYSICAL PROPERTIES

Colour	: Golden Brown
Surface Finish	: Glossy, Satin Smooth
Density	: 6.20 ± 0.05 g/cm ³
Bulk Density	: 3.85 ± 0.15 kg/ltr
Porosity	: Nil
Water absorption	: 0 %
Hardness on Mohs scale	: 9
Hardness on Vicker Scale	: 1250 - 1300 Hv ₅
Flexural Strength 3 P.B.(@ Room Temp.)	: 500 MPa
Compressive Strength (@ Room Temp.)	: 2000 MPa
Young's Modulus	: 200 GPa
Crushing Strength(@ R. Temp. Ø1.5mm bead)	: 215 kgf
Bead Sphericity 90%	: ≥ 0.95

% Cumulative Weight Loss / Hr
(Wear test conducted in high-speed Bead mill @ 3000 rpm with water. Bead size Ø 1.2-1.7 mm)

After 24 Hrs. : 0.0015

After 96 Hrs. : 0.0010

Max Temperature of use (No Load Condition): 1350 °C (2462 °F)

APPLICATION OF ZIRCONOX MICROBEADS

Zirconox microbeads are being used in varied industries for micro-fine wet milling & dispersion of :

Agro chemicals : Fungicides, Herbicides, Pesticides.

Adhesive, Sealants & Glues.

Ceramics : Ceramic Inks, Engobes, Glazes, Frits, Enamels, Pigments.

Cosmetics : Pigment colours for Lipstick, Foundation cream, Nailpolish and personal care products.

Dyestuff : Textile dyes, Textile Inks.

Electronic materials : Lithium Iron Phosphate battery.

Food Stuff : Soyabeans, Cocoa, Spices.

CHEMICAL PROPERTIES

ZrO₂ : 83%

CeO₂ : 17%

CHEMICAL RESISTANCE DATA OF ZIRCONOX MICROBEADS AT 25°C TEST TIME 24 HRS.

Chemical Medium	Concentration	% Weight Loss per hour
Acetic Acid (CH ₃ COOH)	50%	0.00
Chromic Acid (H ₂ CrO ₄)	25%	0.00
Formic Acid (CH ₂ O ₂)	25%	0.00
Hydrochloric Acid (HCl)	18%	0.00
Hydrofluoric Acid (HF)	24%	0.01
Nitric Acid (HNO ₃)	35%	0.00
Perchloric Acid (HClO ₄)	25%	0.00
Phosphoric Acid (H ₃ PO ₄)	25%	0.00
Sulphuric Acid (H ₂ SO ₄)	50%	0.00
Saturated Sodium Hydroxide Acid (NaOH)	50%	0.00

* With the exception of Hydrofluoric acid Zirconox beads did not lose its gloss or colour

Inks : Printing inks, Inkjet - Magnetic inks, Tattoo inks, Rotogravure inks, Flexographic inks.

Minerals : Calcium Carbonate, Carbon Black.

Metal : Gold, Silver, Platinum.

Oxides : Titanium Dioxide, Zirconium Oxide.

Paints & Varnishes : Auto & allied paints, Decorative & Marine paints, Nitro Cellulose Paints.

Pharmaceuticals : Nanosizing of pharmaceutical slurries

Zirconox beads are also used for shot peening treatment on metal surfaces, jewellery, and metal polishing, contact eye lens polishing, and a host of many other applications.

VARIOUS MILLS SUITABLE FOR ZIRCONOX BEADS



WAB BEAD MILL



NIEMANN BASKET MILL



GETZMANN BEAD MILL



VOLLRATH BEAD MILL



CMC SMP-45 BEAD MILL



IEC BASKET MILL



CHEMFILT BEAD MILL



HCP IMMERSION MILL



CMC SMP-45 II BEAD MILL



IEC HE30 BEAD MILL

GUIDELINES FOR USING ZIRCONOX MICRO MILLING BEADS

Zirconox beads have a density of $\geq 6.20 \text{ g/cm}^3$, which is around three times that of glass beads, 1.6 times that of Zirconium Silicate beads, and 1.1 times that of MgO PSZ beads.

As Zirconox beads possess a higher density than any other ceramic micro milling beads, they can generate significant heat during the milling process, which may affect the physical properties of the ingredients being milled. Therefore, an appropriate cooling system for the mill chamber is strongly recommended to monitor the dissipation of heat generated during the milling process.

Following are the strong recommendation for use of Zirconox high-density milling beads :

- In the use of Viscous Formulations.
- To avoid passage of beads into the slurry, ensure that the size of the strainer aperture is at least 2 times smaller than the average size of beads.
- To avoid fracture, shearing of beads or flattening of plate-shaped beads, ensure that the gap between walls & bottom of mill vessel to the stator/agitating arm is maintained at a minimum of 3 to 5 times larger than the average bead size.
- Smaller the media size greater the number of contact points resulting in reduced milling time enhanced productivity and intensity of the pigment colour.
- Before charging the mill with Zirconox beads, it is strongly recommended to thoroughly check the capacity and volume of the bead mill chamber to assess the quantity of Zirconox beads required for the mill (i.e. 60 to 85% volume of mill x Bulk Density of Zirconox beads = Quantity).

ZIRCONOX BEADS BULK DENSITY

Dia (mm)	kg/ltr
Ø 0.40 - 0.70 mm	3.75 ± 0.15 kg/ltr
Ø 0.70 - 1.20 mm	3.75 ± 0.15 kg/ltr
Ø 1.20 - 1.70 mm	3.85 ± 0.15 kg/ltr
Ø 1.70 - 2.40 mm	3.85 ± 0.15 kg/ltr
Ø 2.40 - 2.80 mm	3.95 ± 0.15 kg/ltr
Ø 2.80 - 3.30 mm	3.95 ± 0.15 kg/ltr

ZIRCONOX BEADS ARE AVAILABLE IN FOLLOWING FRACTION SIZES

Broad Fraction Size	
Ø 0.4 - 0.7 mm	Ø 0.7 - 1.2 mm
Ø 1.2 - 1.7 mm	Ø 1.7 - 2.4 mm
Ø 2.4 - 2.8 mm	Ø 2.8 - 3.3 mm
Narrow Fraction Size	
Ø 0.05 - 0.1 mm	Ø 0.1 - 0.2 mm
Ø 0.2 - 0.4 mm	Ø 0.4 - 0.6 mm
Ø 0.6 - 0.8 mm	Ø 0.8 - 1.0 mm
Ø 1.0 - 1.2 mm	Ø 1.2 - 1.4 mm
Ø 1.4 - 1.6 mm	Ø 1.4 - 1.7 mm
Ø 1.6 - 2.0 mm	Ø 1.7 - 2.0 mm
Ø 2.0 - 2.4 mm	Ø 3.5 - 4.0 mm

* We also offer custom fraction size beads, if found feasible for production.

CALCULATION OF MEDIA LOAD

Type of Mill	Bead Charge
Closed Horizontal	75% - 85% of Volume
Closed Vertical	70% - 80% of Volume
Open Vertical	60% - 70% of Volume

E.g. : Bead mill net volume capacity is 50 ltr. Charging with Ø 1.2 - 1.7 mm beads. For closed vertical type mill it works out to = 35 ltr (70% of mill vol.) x 3.85 kg/ltr (Bulk Density of Zirconox beads) that is 135 kg. of Zirconox micro beads charge required for a 50 ltr capacity closed vertical mill.

Considering bead Ø 1.2 - 1.7 mm & bead charge of 75-85% of volume of the grinding chamber for the closed horizontal mill, 70-80% of volume for closed vertical mill & 60-70% of volume for open vertical mill.

ZIRCONOX BEAD CHARGE WEIGHT SUGGESTED FOR DIFFERENT CAPACITY MILLS

VOLUME OF GRINDING CHAMBER (LTR)	QTY. OF ZIRCONOX MICRO BEADS (KGS)		
	FOR CLOSED HORIZONTAL MILL	FOR CLOSED VERTICAL MILL	FOR OPEN VERTICAL MILL
8.0	23 - 26	22 - 25	18 - 22
15.0	43 - 49	40 - 46	35 - 40
30.0	87 - 98	81 - 92	69 - 81
45.0	130 - 147	121 - 139	104 - 121
60.0	173 - 196	162 - 185	139 - 162
115.0	332 - 376	310 - 354	266 - 310
225.0	650 - 736	606 - 693	520 - 606

DETAILS OF BEAD MILL USED FOR CONDUCTING THE WEAR TEST

Mill Type	Horizontal Closed Bead Mill
Model	LME - 1
80% of Mill Volume	0.61 Ltr
Ceramic Media (Qty.)	2.35 kgs.

Make	NETZSCH, Germany
Mill Container	Polyurethane
Mill Agitator Speed	3000 RPM
Media (Milled with)	Water

After milling for 24 & 96 hours at 3000 RPM (10.0 m/s), beads were collected, washed and dried thoroughly, weighed on sensitive electronic balance (Resolution : 100 mg) & the percentage weight loss was calculated as.

$$P = \frac{W1 - W2}{W1} \times 100\%$$

Where
P = Percentage Weight Loss
W1 = Initial Weight of Beads
W2 = Final Weight of Beads

The weight loss of Zirconox micro beads was found insignificant as well as caused the lowest wear on mill contact parts. The percentage cumulative weight loss of Zirconox beads was observed to be 0.0015% per hour in the 24-hour test. The percentage cumulative weight loss came down to 0.0010% per hour in the 96-hour test.

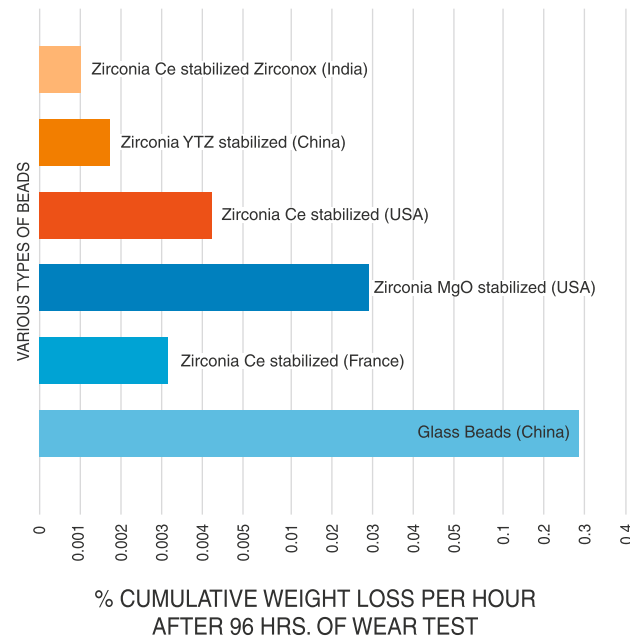


High-Speed Bead Mill for Wear Test

COMPARATIVE TYPICAL PROPERTY AND WEAR RATE CHART

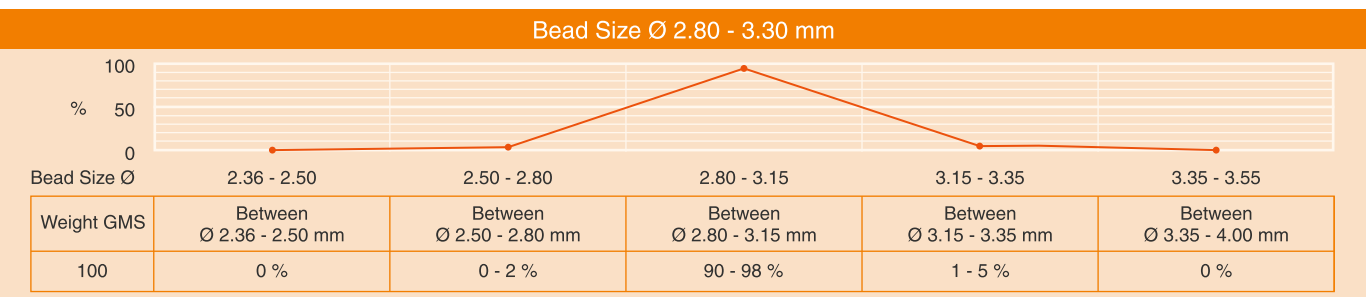
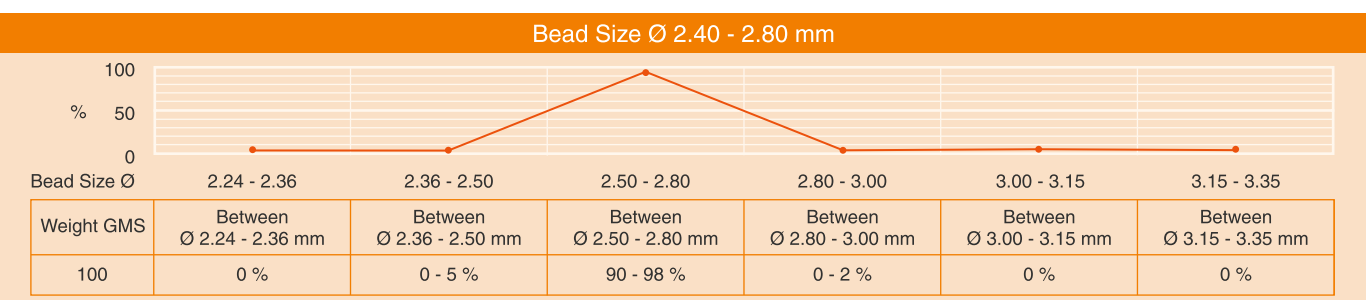
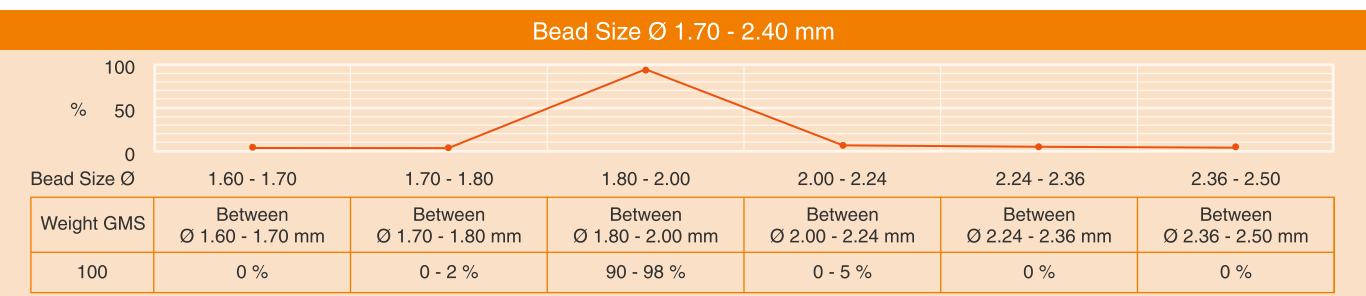
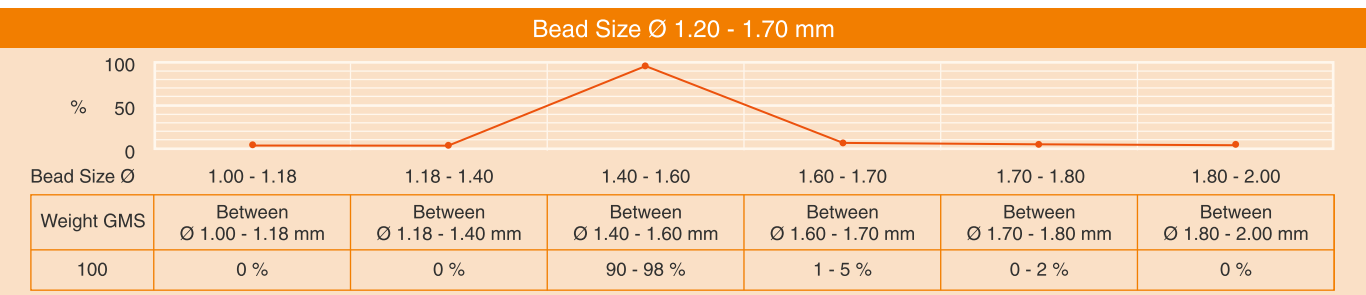
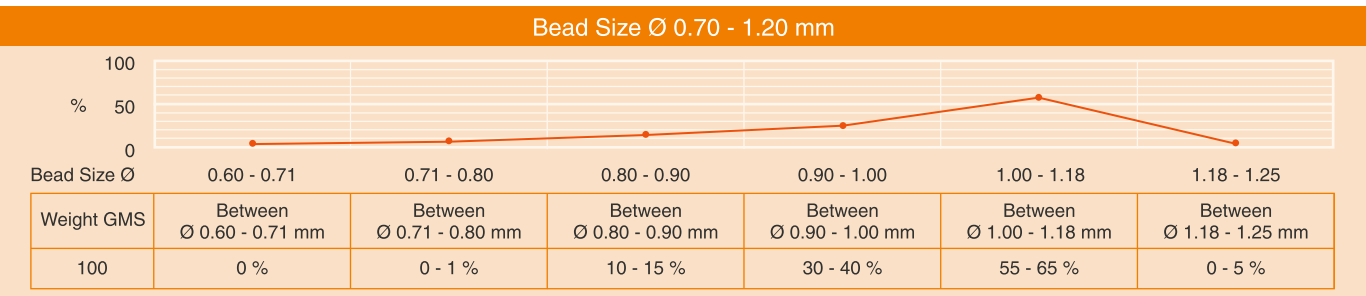
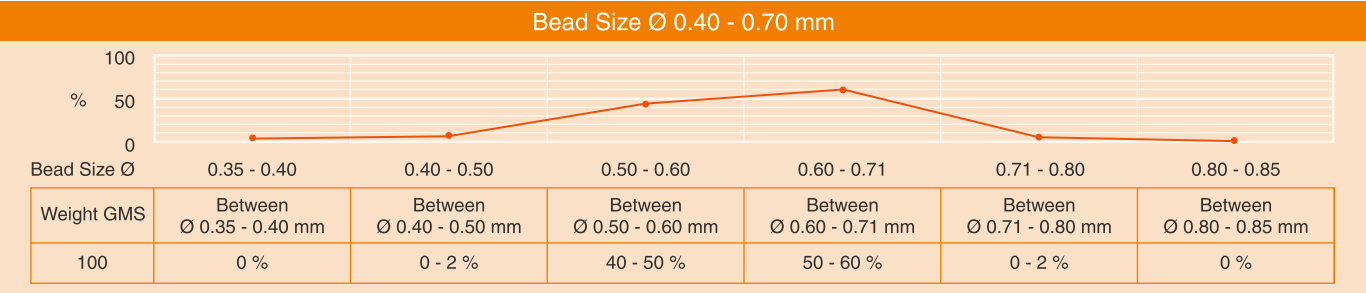
CHARACTERISTICS	UNITS	ZIRCONIA Ce STABILIZED ZIRCONOX (INDIA)	YTTRIA STABILIZED ZIRCONIA (CHINA)	Ce STABILIZED ZIRCONIA BEADS (USA)	MgO STABILIZED ZIRCONIA BEADS (USA)	Ce STABILIZED ZIRCONIA (FRANCE)	Glass Beads (CHINA)
Colour Shade	--	Golden Brown	White	Brown	Golden Yellow	Black	Transparent
Density	g/cm³	≥ 6.20	6.0	6.17	5.73	6.2	2.24
Bulk Density	kg/ltr	3.85 ± 0.15	3.81	3.60	3.59	3.81	1.55
Porosity	%	0.00	0.00	0.00	0.00	0.00	0.00
Water Absorption	%	0.00	0.00	0.00	0.00	0.00	0.00
Hardness on	Moh's scale	9	9	9	8	9	5.5
Hardness on Vicker's Scale	Hv _s	1310	1350	1150-1200	900-950	1250	500-550
Average Bead size taken for crushing strength	mm	Ø 1.496	Ø 1.615	Ø 1.44	Ø 1.55	Ø 1.52	Ø 1.66
Crushing Load	Kgf	215.50	233.82	200.00	81.00	159.57	45.00
Sphericity for 90% of the beads	--	≥ 0.96	0.98	0.90	> 0.95	0.96	0.95
% Cumulative Weight Loss Per Hour of Wear Test (Wear Test conducted with Water at 3000 RPM)	After 24 Hrs.	0.0015	0.00213	0.00233	0.0236	0.00329	0.2724
	After 96 Hrs.	0.0010	0.00175	0.00418	0.0273	0.00309	0.2982
Surface Condition of Beads observed after 96 Hrs. of Wear Test in water	--	Glossy Satin smooth surface, free from pin holes & no broken beads	Glossy Satin smooth surface, few beads with pinholes & few broken beads observed	Satin smooth few beads with pinholes & few broken beads observed	Satin smooth surface, few broken beads observed	Dull surface finish observed	Dull surface finish observed

GRAPHICAL REPRESENTATION OF WEAR TEST RESULTS



MEDIA TYPE	% CUMULATIVE WEIGHT LOSS / HR	
	AFTER 24 HRS.	AFTER 96 HRS.
Zirconia Ce stabilized Zirconox (India)	0.0015	0.0010
Zirconia YTZ stabilized (China)	0.00213	0.00175
Zirconia Ce stabilized (USA)	0.00233	0.00418
Zirconia MgO stabilized (USA)	0.0236	0.0273
Zirconia Ce stabilized (France)	0.00329	0.00309
Glass Beads (China)	0.2724	0.298

SIEVE ANALYSIS OF BROAD FRACTION BEAD SIZE



SIEVE ANALYSIS OF NARROW FRACTION BEAD SIZE







ZIRCONOX MACRO MILLING MEDIA

Zirconox macro milling media are manufactured from micro-fine Zirconia powder stabilized with rare earth Cerium Oxide, transformed to tetragonal polycrystals. Zirconox macro media have a density of 6.1g/cm³, are tough sapphire hard, and have a glossy satin-smooth surface finish. After Tungsten Carbide, Zirconox macro milling media are considered to have the highest density and the lowest in coefficient of friction among the ceramic materials. Due to its unique features, Zirconox milling media mills hard and soft highly viscous formulations faster with insignificant contamination from its wear.

Zirconox macro milling media are ideal for particle size reduction, dispersion of hard and soft substances in Attritor mills, Jar mills, Vibro Energy Mills, Lab scale and bulk production Ball Mills.

ZIRCONOX MACRO MEDIA ARE AVAILABLE IN FOLLOWING SIZES AND SHAPES

Type of Zirconox Macro Milling Media	Shapes	Available Sizes	Suggested Mill Type
Uniaxial pressed sphere Satellite type		Dia 6, 8, 10, 12.5 mm	Jar Mills & Low speed attritor
Iso pressed sphere		Dia 16, 21, 26, 31 mm	Jar Mills & Ball Mills
Radius end Cylinder (REC)		Dia 6, 8, 10, 12.5 mm	Vibro Energy Mills
Radius end Corner Cylinder (RCC)		Dia 6, 8, 10, 12.5, 15, 20, 25 mm	Vibro Energy Mills

Zirconox macro milling media lasts longer due to its dense, homogeneous internal microstructure, higher toughness, and micro-fine grain size. Zirconox media are extremely gentle on mill contact parts.

CHEMICAL PROPERTIES

ZrO ₂	: 83%
CeO ₂	: 17%

PHYSICAL PROPERTIES

Colour	: Golden brown
Surface Finish	: Glossy, Satin Smooth
Density	: 6.1 ±0.05 g/cm ³
Bulk Density	: 3.95 ±0.05 kg/ltr
Water absorption	: Nil
Hardness on Mohs scale	: 9
Hardness on Vickers scale	: 1100 Hv _s
Flexural strength at Room Temp	: 5000 kg/cm ²

APPLICATION OF ZIRCONOX MACRO MILLING MEDIA

Zirconox macro milling media are an excellent choice & used in a variety of applications that requires contamination-free speedy microfine milling of substances such as :

- Auto and allied paints.
- Printing inks, Colors, Pigments, Chemicals
- Minerals, Calcium Carbonate, Enamels, Glazes & Frits.
- Advanced ceramic material, Dielectric and piezoelectric formulations, Battery graphite powder.
- Foodstuff, Cosmetics, and Pharmaceutical.



Attritor Mill



Jar Mill



Vibro Mill



JYOTI CERAMIC INDUSTRIES PVT. LTD.

Head Office : C-21, N.I.C.E, Satpur, Nashik - 422 007, Maharashtra, India.
Tel.: +91 (0) 253 6918111, 2350120 / 338 / 729, 2351251 • E-mail: info@jyoticeramic.com

Europe : Jyoti Ceramic GmbH, Frankenstr. 12, 90762 Fürth, Germany.
Tel.: +49 (0) 911 78 71 20 83 / 84 / 85 • Fax : +49 (0) 911 78 71 20 82 • E-mail : sales@jyoticeramic.com

U.S.A. : Techno Ceramic Inc., P.O. Box 333, New Hampton, NY 10958, USA.
Tel.: +1 (0) 845 547 2219 / 1 845 547 2220 • Fax: +1 (0) 845 547 2221 • Email: jcw@tci-jyoti.com

Jyoti Ceramic CZ s.r.o., Na Okrouhliku 1781, 530 03 Pardubice, Czech Republic
Tel.: +420 777324227 • Email: lea.tomasova@jyoticeramic.cz

Klausen Pty Ltd, PO Box 4013, Warrimoo, NSW 2774, Australia
Tel: +61 409816679 • Email: klausen@klausen.com.au



Disclaimer: Information contained herein is true and accurate to the best of our knowledge and is based upon measurements made in our R & D laboratory. Recommendations, suggestions and data are practical guidelines and not guarantees. Actual results may vary with conditions of use and with variations in the methods of manufacture, size, and shape of the ceramic. We disclaim any liability that may be incurred in connection with the use of suggestions or data. This publication is not to be taken as a license to operate under or infringe upon any patents. Observation of all legal regulations and patents is the responsibility of the user.