Zircosil®
Jyoti

ZIRCONIUM SILICATE MICRO MILLING MEDIA

Upper Medium Density (≥ 4.4 g/cm^3)

Cost Effective

Milling Medium - Low

Viscous Formulation

VERSATILE INDUSTRIAL APPLICATIONS

MINERALS

WATER BASED PAINTS

PRINTING INKS

TEXTILE DYES

AGRO

JYOTI® CERAMIC

Zircosil®
Jyoti

ZIRCONIUM SILICATE MICRO MILLING MEDIA

Zircosil is the registered name of Jyoti Ceramic Industries Pvt. Ltd. for their proprietary formulated Zirconium Silicate composite, specially developed for upper medium density (4.4 g/cm^3) ceramic micro milling beads used for wet milling/dispersion of formulation.

Looking to the market needs for medium density, long-lasting, cost-effective ceramic milling beads, we started an extensive research to develop suitable ceramic milling beads to the specific segment of customers who have bead mills but not suitable to carry the load of Zirconox high density (6.2 g/cm^3) beads. We finally succeeded in developing Zircosil ceramic micro milling beads.

Generally for dispersion or particle size reduction of substances, ceramic-glass beads are used world over in bead mills, pearl mills or in agitating attritor mills. Zircosil beads can conveniently replace glass and most of ceramic beads due to their superior features and cost economics. Zircosil beads are most ideally suited for dispersion and micro fine milling of low and medium viscous **Agro chemicals** : Fungicides, Herbicides pesticides. **Dyestuff** : Textile dyes, Textile Inks. **Cosmetics**. **Food Stuff. Inks :** Printing inks, Inkjet - Magnetic inks, Tattoo inks. **Minerals** : Calcium Carbonate, Talc. **Oxides** : Titanium Dioxide. **Paints & Varnishes** : Auto & allied paints, Decorative & Marine paints. **Pharmaceuticals.**

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

CHEMICAL PROPERTIES

ZrO_2	:	60%
SiO_2	:	30%
Others	:	10%

PHYSICAL PROPERTIES

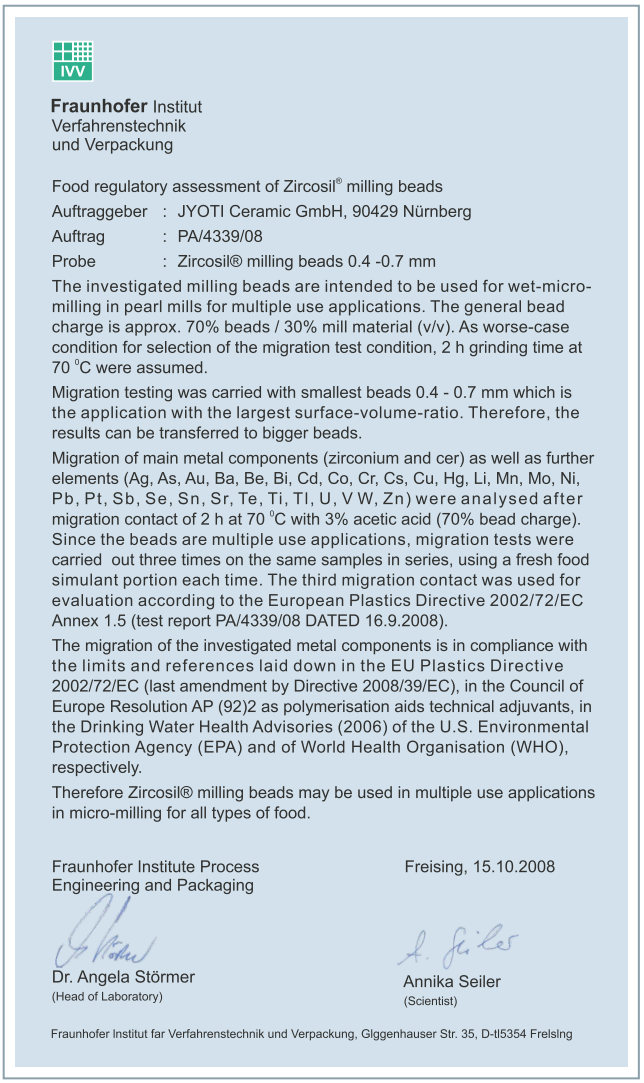
Colour	:	Light Grey
Surface Finish	:	Glossy, Satin Smooth
Density	:	4.4 ±0.05 g/cm^3
Bulk Density	:	2.70 ±0.05 kg/ltr
Porosity	:	Nil
Water absorption	:	Nil
Hardness on Moh's scale	:	9
Hardness on Vicker's scale (Hv_5)	:	1100-1150
Crushing strength (Ø 1.5mm bead)	:	72.5 kgf
Bead Sphericity 90%	:	≥ 0.95

% CUMULATIVE WEIGHT LOSS / HR.

After 24 hrs.	:	0.0063
After 96 hrs.	:	0.00582

(wear test conducted with water)

CERTIFICATE



IVV

Fraunhofer Institut
Verfahrenstechnik
und Verpackung

Food regulatory assessment of Zircosil® milling beads

Auftraggeber : JYOTI Ceramic GmbH, 90429 Nürnberg
Auftrag : PA/4339/08
Probe : Zircosil® milling beads 0.4 -0.7 mm

The investigated milling beads are intended to be used for wet-micro-milling in pearl mills for multiple use applications. The general bead charge is approx. 70% beads / 30% mill material (v/v). As worse-case condition for selection of the migration test condition, 2 h grinding time at 70 °C were assumed.

Migration testing was carried with smallest beads 0.4 - 0.7 mm which is the application with the largest surface-volume-ratio. Therefore, the results can be transferred to bigger beads.

Migration of main metal components (zirconium and cer) as well as further elements (Ag, As, Au, Ba, Be, Bi, Cd, Co, Cr, Cs, Cu, Hg, Li, Mn, Mo, Ni, Pb, Pt, Sb, Se, Sn, Sr, Te, Ti, Tl, U, V W, Zn) were analysed after migration contact of 2 h at 70 °C with 3% acetic acid (70% bead charge). Since the beads are multiple use applications, migration tests were carried out three times on the same samples in series, using a fresh food simulant portion each time. The third migration contact was used for evaluation according to the European Plastics Directive 2002/72/EC Annex 1.5 (test report PA/4339/08 DATED 16.9.2008).

The migration of the investigated metal components is in compliance with the limits and references laid down in the EU Plastics Directive 2002/72/EC (last amendment by Directive 2008/39/EC), in the Council of Europe Resolution AP (92)2 as polymerisation aids technical adjuvants, in the Drinking Water Health Advisories (2006) of the U.S. Environmental Protection Agency (EPA) and of World Health Organisation (WHO), respectively.

Therefore Zircosil® milling beads may be used in multiple use applications in micro-milling for all types of food.

Fraunhofer Institute Process Engineering and Packaging

Freising, 15.10.2008

Dr. Angela Störmer
(Head of Laboratory)

Annika Seiler
(Scientist)

Fraunhofer Institut far Verfahrenstechnik und Verpackung, Glggenhauser Str. 35, D-tl5354 Frelsing

Fraunhofer Institute, Freising, Germany has approved Zircosil ceramic micro milling beads for milling of food in accordance with the regulations of the European Community.

Zircosil ceramic beads are :

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

GUIDELINES FOR USING ZIRCOSIL MICRO MILLING BEADS

- To avoid fracture or shearing of beads or flattened plate shape beads, ensure that the gap between the mill chamber walls and the bottom of mill vessel to the agitating stator arm must be maintained minimum 3 to 5 times larger than the largest bead size.
- To avoid passage of beads in the slurry ensure that the size of strainer aperture is min. 2 times smaller than the average size of beads.
- Before charging the mill with Zircosil beads, it is strongly recommended to thoroughly check the capacity and volume of the bead mill chamber to assess the right quantity of Zircosil beads required for the mill (i.e. 60 to 85% volume of mill X packing density of Zircosil beads = Quantity).

CALCULATION OF MEDIA LOAD

Type of Media Load	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 bead. For vertical closed type mill it works out to = 35 ltr (70% of mill vol.) x 2.70 kg/ltr (Packing density of Zircosil beads). That is 95 kg. Zircosil bead charge required for a 50 ltr capacity closed vertical mill.

ZIRCOSIL BEAD CHARGE WEIGHT SUGGESTED FOR DIFFERENT CAPACITY MILLS

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

ZIRCOSIL 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 0.4 - 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 1.6 - 2.0 mm	Ø 2.0 - 2.4 mm

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

ZIRCOSIL BEADS BULK DENSITY

Dia (mm)	kg/ltr
Ø 0.40 - 0.70 mm	2.70 ± 0.05 kg/ltr
Ø 0.70 - 1.20 mm	2.70 ± 0.05 kg/ltr
Ø 1.20 - 1.70 mm	2.70 ± 0.05 kg/ltr
Ø 1.70 - 2.40 mm	2.75 ± 0.05 kg/ltr
Ø 2.40 - 2.80 mm	2.75 ± 0.05 kg/ltr
Ø 2.80 - 3.30 mm	2.75 ± 0.05 kg/ltr

VOLUME OF GRIDNING CHAMBER (LTR)	QTY. OF ZIRCOSIL MICRO BEADS (KGS)		
	CLOSED HORIZONTAL MILL	CLOSED VERTICAL MILL	OPEN VERTICAL MILL
8.0	16 - 18	15 - 17	13 - 15
15.0	30 - 34	28 - 32	24 - 28
30.0	61 - 69	57 - 65	49 - 57
45.0	85 - 91	85 - 97	73 - 85
60.0	121 - 138	113 - 130	97 - 113
115.0	233 - 264	217 - 248	186 - 217
225.0	456 - 516	425 - 486	365 - 425

DETAILS OF BEAD MILL USED FOR CONDUCTING THE WEAR TEST

Mill Type	Horizontal Lab Bead Mill	Make	NETZSCH, Germany
Model	LME - 1	Mill Container	Polyurethane
Mill Capacity	0.61 Ltr	Mill Agitator Speed	3000 RPM
Ceramic Media (Qty.)	1.65 kg.	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

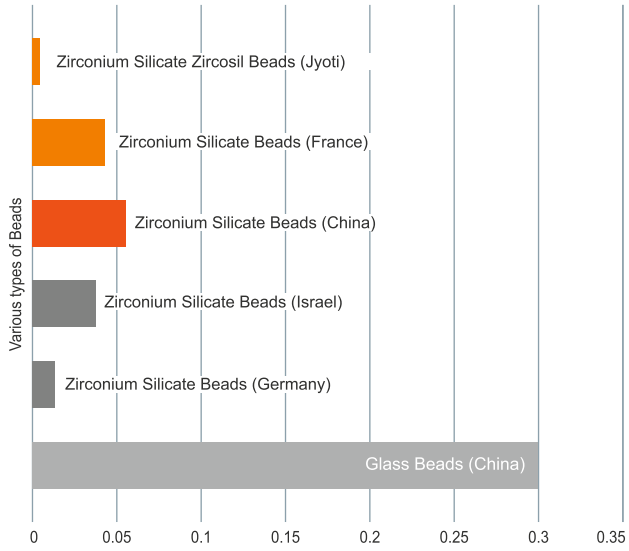
The weight loss of Zircosil micro beads was found insignificant as well as caused lowest wear on mill contact parts. The percentage cumulative weight loss of Zircosil beads was observed to be 0.0063% per hour in the 24 hour test. The percentage cumulative weight loss came down to 0.00582% per hour in the 96 hour test.

High Speed Bead Mill for Wear Test

COMPARATIVE TYPICAL PROPERTY AND WEAR RATE CHART

CHARACTERISTICS	UNITS	ZIRCONIUM SILICATE BEADS					GLASS BEADS
		JYOTI (ZIRCOSIL)	FRANCE	CHINA	ISRAEL	GERMANY	
Colour Shade	--	Light Grey	Off White	White	White	Off White	Transparent
Density	g/cm^3	≥ 4.4	3.84	3.75	4.08	4.13	2.25
Bulk Density	kg/ltr	2.70 ±0.05	2.44	2.38	2.47	2.46	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	9.00	7.50	7.50	8.50	8.0	5.5
Hardness of Vicker's Scale	Hv_5	1100-1150	690	650	962	1080	500-550
Avg. Bead size taken for crushing strength	mm	Ø 1.50	Ø 1.49	Ø 1.51	Ø 1.50	Ø 1.40	Ø 1.66
Crushing Load	Kgf	72.50	47.30	51.00	70.22	58.21	45.00
Sphericity for 90% of the beads	--	> 0.95	> 0.9	> 0.9	> 0.9	> 0.9	0.95
% Cumulative Weight Loss Per Hour of Wear Test (Wear Test conducted with Water)	After 24 Hrs.	0.0063	0.0255	0.032	0.0191	0.0206	0.2724
	After 96 Hrs.	0.00582	0.041	0.056	0.034	0.0128	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 Pin holes & broken beads observed	Glossy Satin smooth surface with Pin holes & bead fused with other bead observed	Dull surface finish beads with Pin holes observed	Glossy Satin smooth surface finish observed	Dull surface finish observed

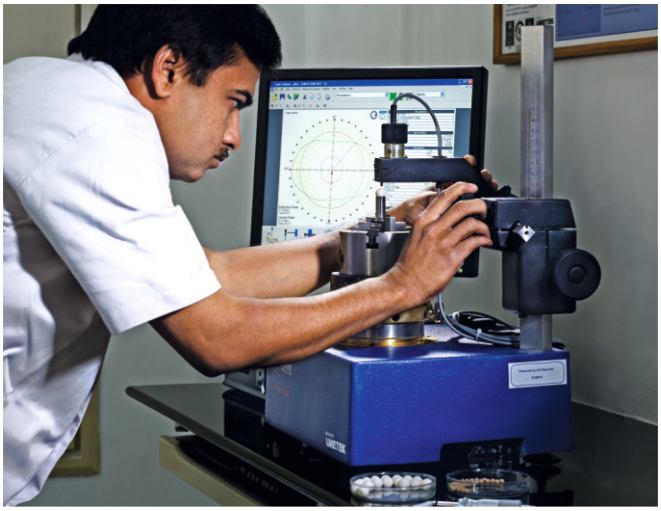
GRAPHICAL REPRESENTATION OF WEAR TEST RESULTS



% CUMULATIVE WEIGHT LOSS PER HOUR AFTER 96 HRS. OF WEAR TEST

MEDIA TYPE	% CUMULATIVE WEIGHT LOSS / HR	
	AFTER 24 HRS.	AFTER 96 HRS.
Zirconium Silicate Zircosil Beads (Jyoti)	0.0063	0.00582
Zirconium Silicate Beads (France)	0.0255	0.041
Zirconium Silicate Beads (China)	0.032	0.056
Zirconium Silicate Beads (Israel)	0.0191	0.034
Zirconium Silicate Beads (Germany)	0.02059	0.0128
Glass Beads (China)	0.2724	0.2982

QUALITY ASSURANCE & CUSTOMER CARE

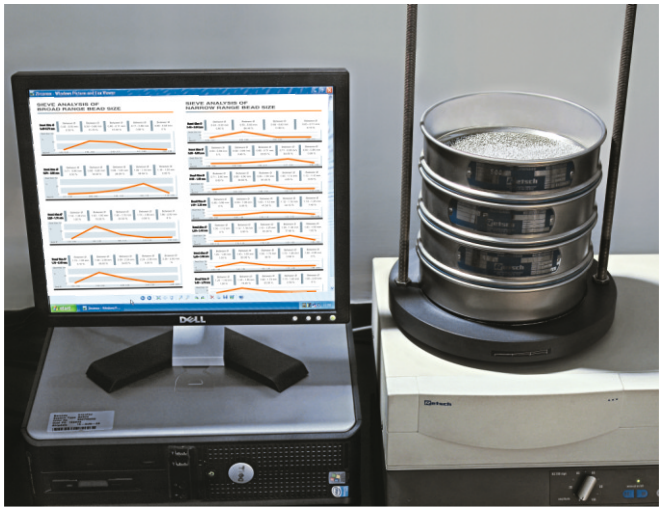


Laser Roundness Measuring Instrument

Bead Crushing, Strength Testing Instrument

20 Kg net weight of Zircosil micro beads are packed in polythene lined plastic pails, 20 such pails are packed in multiples in strong wooden crates.

Mode of Packing



Bead Sieve Analyser

BENEFITS OF USING ZIRCOSIL MICROBEADS

Zircosil beads, are of upper medium density (4.4 g/cm^3) tough and sapphire hard (9 Moh's scale), ideally suited for speedy dispersion / milling of hard and soft substances in high-low speed, horizontal and vertical type bead mills, atrritor, turbo and pearl mills.

- Zircosil beads being of low co-efficient of friction, having glossy satin smooth surface and are most gentle to expensive mill parts.
- Zircosil are free from pin holes or cracks, bead fused with other bead resulting in reduced downtime, and greater process safety. During change of formulation process cleaning and washing of beads is faster & less cumbersome.
- Zircosil micro beads have dense homogeneous internal microstructure, due to this property beads maintain satin smooth surface finish and do not crack or shatter easily.

CHEMICAL RESISTANCE DATA OF ZIRCOSIL MICRO BEADS AT 25^{0}C TEST TIME 24 HRS.

Chemical Medium	Concentration	% Weight Loss per hour
Acetic Acid (CH_3COOH)	50%	0.00
Chromic Acid (H_2CrO_4)	25%	0.00
Formic Acid (CH_2O_2)	25%	0.00
Hydrochloric Acid (HCl)	18%	0.00
Hydrofluoric Acid (HF)	24%	0.12
Nitric Acid (HNO_3)	35%	0.00
Perchloric Acid ($HClO_4$)	25%	0.00
Phosphoric Acid (H_3PO_4)	25%	0.00
Sulphuric Acid (H_2SO_4)	50%	0.00
Saturated Sodium Hydroxide Acid (NaOH)	50%	0.00

** With the exception of Hydrofluoric acid Zircosil beads maintain their integrity.*

VARIOUS MILLS SUITABLE FOR ZIRCOSIL BEADS

CHEMFILT BEAD MILL

GETZMANN BEAD MILL

VOLLRATH BEAD MILL

LONGLY NANTOSTAR BEAD MILL

SUPERMILL PLUS 45 BEAD MILL

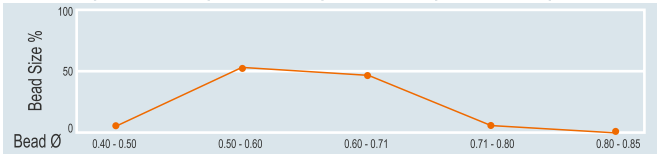
WAB BEAD MILL

SUPERMILL PLUS 45 BEAD MILL

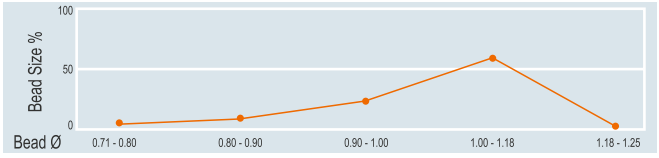
IEC HE30 BEAD MILL

SIEVE ANALYSIS OF BROAD RANGE BEAD SIZE

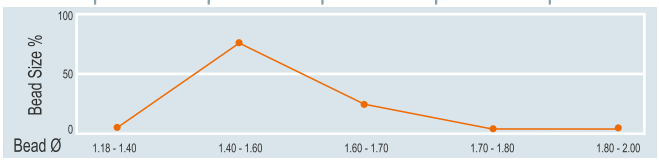
Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
0.40-0.70 mm	0.40 - 0.50 mm	0.50 - 0.60 mm	0.60 - 0.71 mm	0.71 - 0.80 mm	0.80 - 0.85 mm
	0.50 %	51.70 %	47.00 %	0.80 %	0 %



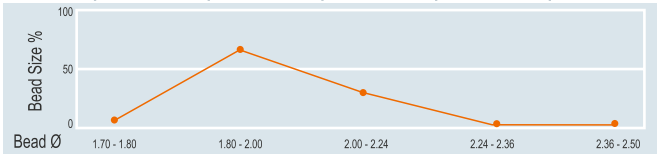
Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
0.70 - 1.20 mm	0.71 - 0.80 mm	0.80 - 0.90 mm	0.90 - 1.00 mm	1.00 - 1.18 mm	1.18 - 1.25 mm
	0.50 %	10.00 %	28.80 %	59.90 %	0.80 %



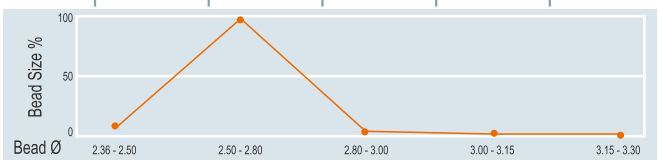
Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
1.20 - 1.70 mm	1.18 - 1.40 mm	1.40 - 1.60 mm	1.60 - 1.70 mm	1.70 - 1.80 mm	1.80 - 2.00 mm
	1.20 %	75.00 %	23.30 %	0.50 %	0 %



Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
1.70 - 2.40 mm	1.70 - 1.80 mm	1.80 - 2.00 mm	2.00 - 2.24 mm	2.24 - 2.36 mm	2.36 - 2.50 mm
	0.10 %	65.00 %	34.60 %	0.30 %	%



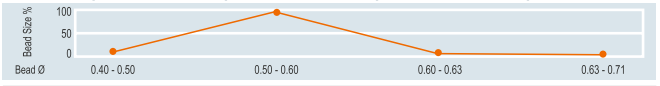
Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
2.40 - 2.80 mm	2.36 - 2.50 mm	2.50 - 2.80 mm	2.80 - 3.00 mm	3.00 - 3.15 mm	3.15 - 3.30 mm
	3.50 %	96.00 %	0.50 %	0 %	0 %



Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø
2.80 - 3.30 mm	2.60 - 2.80 mm	2.80 - 3.15 mm	3.15 - 3.35 mm	3.35 - 4.00 mm
	0.85 %	97.65 %	1.5 %	0 %

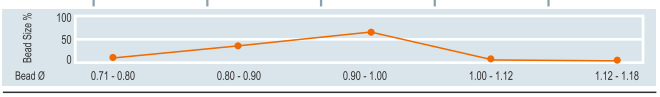
SIEVE ANALYSIS OF NARROW RANGE BEAD SIZE

Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø
0.40 - 0.60 mm	0.40 - 0.50 mm	0.50 - 0.60 mm	0.60 - 0.63 mm	0.63 - 0.71 mm
	0.95 %	86.40 %	11.90 %	0.75 %

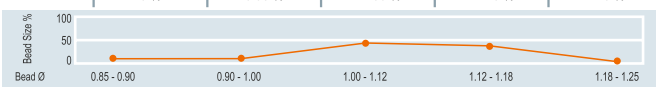


Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
0.60 - 0.80 mm	0.50 - 0.56 mm	0.56 - 0.60 mm	0.60 - 0.71 mm	0.71 - 0.80 mm	0.80 - 0.85 mm
	0 %	0.80 %	33.60 %	64.65 %	0.90 %

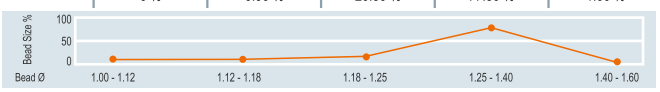
Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
0.80 - 1.00 mm	0.71 - 0.80 mm	0.80 - 0.90 mm	0.90 - 1.00 mm	1.00 - 1.12 mm	1.12 - 1.18 mm
	0.80 %	38.00 %	57.20 %	4.00 %	0.00 %



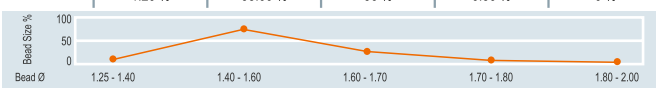
Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
1.00 - 1.20 mm	0.85 - 0.90 mm	0.90 - 1.00 mm	1.00 - 1.12 mm	1.12 - 1.18 mm	1.18 - 1.25 mm
	0 %	0.95 %	47.50 %	44.10 %	7.40 %



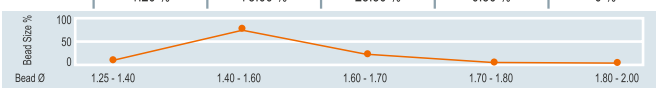
Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
1.20 - 1.40 mm	1.00 - 1.12 mm	1.12 - 1.18 mm	1.18 - 1.25 mm	1.25 - 1.40 mm	1.40 - 1.60 mm
	0 %	0.90 %	20.30 %	77.80 %	1.00 %



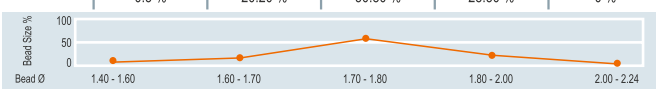
Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
1.40 - 1.60 mm	1.25 - 1.40 mm	1.40 - 1.60 mm	1.60 - 1.70 mm	1.70 - 1.80 mm	1.80 - 2.00 mm
	1.20 %	95.00 %	56 %	0.50 %	0 %



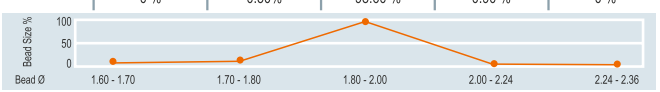
Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
1.40 - 1.70 mm	1.25 - 1.40 mm	1.40 - 1.60 mm	1.60 - 1.70 mm	1.70 - 1.80 mm	1.80 - 2.00 mm
	1.20 %	75.00 %	23.30 %	0.50 %	0 %



Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
1.60 - 2.00 mm	1.40 - 1.60 mm	1.60 - 1.70 mm	1.70 - 1.80 mm	1.80 - 2.00 mm	2.00 - 2.24 mm
	0.5 %	20.20 %	50.80 %	28.50 %	0 %



Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø	Between Ø
1.70 - 2.00 mm	1.60 - 1.70 mm	1.70 - 1.80 mm	1.80 - 2.00 mm	2.00 - 2.24 mm	2.24 - 2.36 mm
	0 %	0.50%	98.60 %	0.90 %	0 %



Bead Size Ø	Between Ø	Between Ø	Between Ø	Between Ø
2.00 - 2.40 mm	1.80 - 2.00 mm	2.00 - 2.24 mm	2.24 - 2.36 mm	2.36 - 2.50 mm
	1.20 %	96.60 %	2.20 %	0 %

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