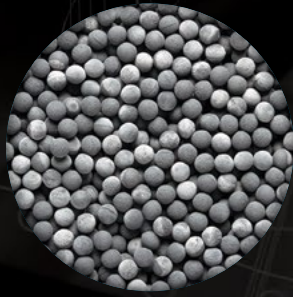
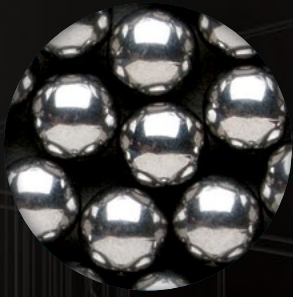
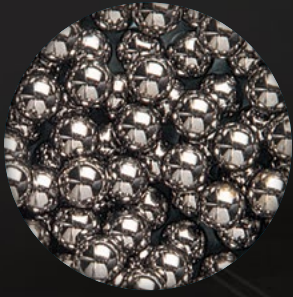


YOUR ONE SOURCE FOR GRINDING MEDIA



VISUAL GLOSSARY



BALL



SATELLITE



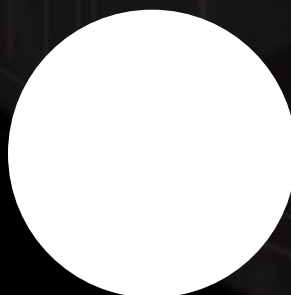
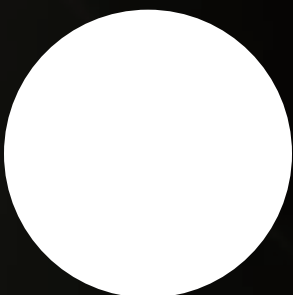
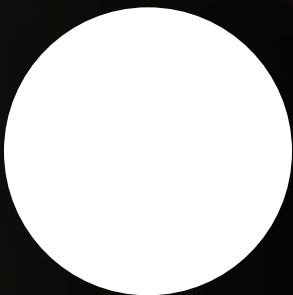
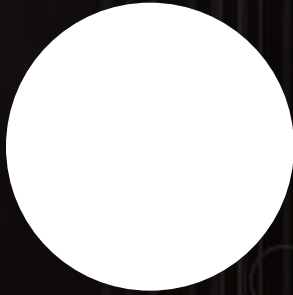
BALCONE



CYLINDER

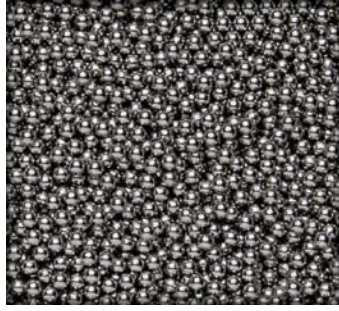


DIAGONAL

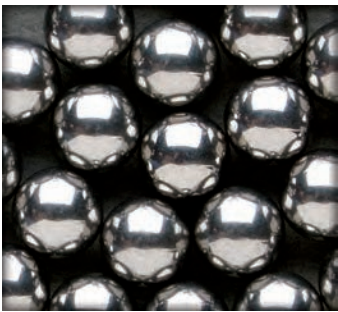




CARBON STEEL BALLS



CHROME STEEL BALLS



STAINLESS STEEL BALLS



THROUGH-HARDENED STEEL SHOT



FORGED STEEL BALLS



HIGH CHROME CAST BALLS



ALUMINA SATELLITES



ALUMINA BEADS



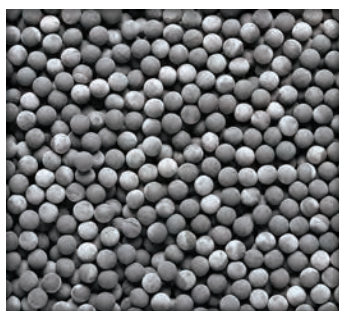
CERAMIC (STEATITE) SATELLITES



GLASS BEADS (LEAD FREE)



SILICON CARBIDE BALLS



SILICON NITRIDE BALLS



TUNGSTEN CARBIDE SATELLITES



**ZIRCONIUM OXIDE – 95%
(Y2O3 STABILIZED) BALLS**



**ZIRCONIUM OXIDE – 93%
(Y2O3 STABILIZED) BEADS**



**ZIRCONIUM OXIDE
(CEO2 STABILIZED) BEADS**



ZIRCONIUM SILICATE BEADS

METALLIC

USE WITH:

ATTRITORS • BEAD MILLS
BALL MILLS • BASKET MILLS
VIBRATORY MILLS

NON-METALLIC



**GRINDING
MEDIA**

SELECTING THE RIGHT GRINDING

Grinding media comprise a wide range of objects such as grinding balls, beads and satellites, as well as more rare shapes like cylinders, diagonals and balcones. The media itself can be composed of a variety of materials, including carbon steel, stainless steel, chrome steel and non-metallics like steatite or ceramics. Selecting the right grinding media for a specific application depends upon several factors, some of which are interrelated:

INITIAL FEED SIZE: Smaller media cannot easily break up large particles.

FINAL PARTICLE SIZE: Smaller media are more efficient when ultrafine particles are desired.

SPECIFIC GRAVITY: In general, high-density media give better results. The media should be more dense than the material to be ground. Also, highly viscous materials require media with a higher density to prevent floating.

HARDNESS: The harder the media, the better the grinding efficiency and, consequently, the longer the wear.

DISCOLORATION: Some media may cause light-colored slurry to turn gray.

pH: Some strong acid or basic slurries may react with certain metallic media.

CONTAMINATION: Material resulting from the wear of the media may affect the product and may need to be removed by a magnetic separator, chemicals, or a sintering process.

CONSISTENCY IN SIZE: Although more important with mini media, ideally one wants all the same size. In these small sizes, there are ranges because, due to the manufacturing process, the media must be classified or screened.

COSTS: Media that may be 2–3 times more expensive may last considerably longer, and therefore, be well worth the extra cost over the long run.

The type of mill also can affect the selection of grinding media. Ball Mills use very large media while Attritors employ media ranging in size from 1/8" to 3/8". Horizontal mills require much smaller media, as small as 0.3 mm to 2 mm.

METALLIC

THROUGH-HARDENED CARBON STEEL BALLS TYPE 1065

Through-Hardened Carbon Steel Balls are magnetic and can be used in the food industry along with 440C stainless steel media. They are a low-cost media that are superior and recommended over case-hardened carbon steel media which have a soft core. They are packaged with no oil finish—always dry packed—as they will rust in water.

CHROME STEEL BALLS TYPE 52100

Chrome Balls (steel type 52100) are through-hardened and tempered steel balls designed to achieve maximum strength and quality. Ball hardness is in the 60–67 HRC range. They wear better than 440C stainless steel and through-hardened carbon steel. They are also recommended for applications where a through-hardened steel ball is needed in larger sizes (1/2" and larger). They are sometimes packaged with a very light oil finish to reduce rust due to humidity.

440C STAINLESS STEEL BALLS

440C Stainless Steel Balls are through-hardened and tempered throughout for maximum strength and quality. They are magnetic, and corrosion-resistant (generally rust-resistant). They are recommended for food applications and lighter colored slurries.

CARBON STEEL SHOT

Carbon Steel Shot media is through-hardened and very low cost. As such, they are not uniformly spherical and often can leave a gritty black residue.

FORGED STEEL BALLS — LARGE DIAMETER

Forged Steel Balls are used for gold mining, cement factories, oil processing and large scale industrial applications. They are made by machine (standard) sizes 20mm–75mm. They are manually made (hit by air hammer) sizes 75mm–125mm. They have hardness 55–63 HRC. All forged balls are through-hardened, and shipped in 55-gallon steel drums. They range in sizes from 20mm–125mm. Standard lead time is 6–8 weeks FOB Akron, Ohio USA.

HIGH CHROME CAST STEEL BALLS

High Chrome Steel Balls can be used for many different applications. They are available in two grades—10–13% chrome (surface hardness \geq 60 HRC, core hardness \geq 58 HRC), and 14–18% chrome (surface hardness \geq 62 HRC, core hardness \geq 60 HRC). They have a very rough black finish which quickly wears off during initial milling. After that, they have an excellent wear rate. They are available in sizes 6mm–120mm. They are shipped in 55-gallon steel drums with standard lead time of 6–8 weeks FOB Akron, Ohio USA.

GRINDING MEDIA FOR YOUR APPLICATION

NON-METALLIC

90% ALUMINA SATELLITES

90% Alumina media comes in satellite shape-spheres with a slightly raised band around the middle. They are also available in rod/cylinder shape.

ALUMINA BALLS AND SATELLITES

Union Process is the one source for 90%, 94%, 99.5% and 99.9% alumina media. 90% alumina is available in satellites and rod/cylinders. 94% alumina balls have excellent wear resistance with higher impact strength to save running costs with less contamination. They have great wear rate generally better than 90% or 99.5%. 99.5% alumina balls have the highest alumina content for a moderate price. The .5% impurity is MgO that is added to inhibit grain growth during sintering in the kiln. There is less than 0.1% silica in the media. 99.9% alumina balls are made of very pure and reactive (expensive) raw materials. They are for high purity alumina applications where contamination is a factor.

ALUMINA BEADS

Alumina Beads are specially formulated to be used in high-energy mills in which a high degree of fineness is required. They are used in various industrial fields such as inks, paints, advanced ceramics, mining, cosmetics and pharmaceutical industries. They are a perfectly spherical shape with high mechanical properties and high wear resistance at a moderate price.

BURUNDUM CYLINDERS

Burundum is a high-density alumina media available in cylinders. It comes in 90%, 96% and 99% alumina compositions. Cylinder sizes range from ¼" x ¼" to 1 ¼" x 1 ¼". They are an ultra-high fired media that are unaffected by most acids and alkalis, chip-resistant and non-porous.

CERAMIC SATELLITES (STEATITE)

Ceramic Steatite is a very cost-efficient media. They are a satellite shape with composition of MgO 27.5% and SiO₂ 61.4% along with other minimal materials.

GLASS BEADS

This grade is used for milling applications with 85% roundness. All Glass Beads are lead-free and less expensive.

NYLON PELLETS

Nylon Pellets are a very light density, low impact, low-cost media available in ⅛" size.

SILICON CARBIDE BALLS

Silicon Carbide Balls are very high-cost grinding media that are used for milling same materials (silicon carbide ball to mill silicon carbide materials) to avoid contamination. They are only available in 5mm, 10mm, 15mm and 20mm sizes. They are a special order item.

SILICON NITRIDE BALLS

Silicon Nitride Balls are very high-cost grinding media that are used for milling same materials (silicon nitride ball to mill silicon nitride materials) to avoid contamination. They are now available in 2mm and 3mm and sizes up to 25mm. They are a special order item.

TUNGSTEN CARBIDE SATELLITES/BALLS

Tungsten Carbide media is the hardest and densest (highest specific gravity) media and is available in both satellites and balls upon request. They are now available in sizes 0.5mm, 0.6mm, etc., up to 1" diameter. They are a high-cost media and are a special order item.

ZIRCONIUM OXIDE BALLS (YTTRIA STABILIZED) HIGH PURITY 95% ZrO₂

Zirconium Oxide Balls (95% ZrO₂) are the strongest, best wearing ceramic media for metal-free, pharmaceutical and food processing grinding. These balls have a white, shiny appearance. They are also available in ⅜" and ½" cylinders. This 95% grade is high-cost.

ZIRCONIUM OXIDE BEADS (YTTRIA STABILIZED) 93% ZrO₂

93% Zirconium Oxide Beads are another option for metal-free applications that are lower cost than 95% ZrO₂.

ZIRCONIUM OXIDE SATELLITES/BEADS — CeO₂ RARE EARTH STABILIZED

Zirconium Oxide Satellites—Ceria stabilized (rare earth)—are a cheaper zirconium oxide alternative for metal-free applications. They are a brown, shiny ball media that come in size ranges in the smallest sizes (ex: 0.4–0.6mm), then at 6mm come in uniform sizes (6mm, 8mm, etc.) up to 31mm.

ZIRCONIUM SILICATE BEADS (FUSED AND SINTERED)

Zirconium Silicate Beads are available in fused 68% ZrO₂ beads which are a standard reliable media at low cost, and sintered 58% ZrO₂ beads which have high breakage resistance, are durable and cost effective. They are used to microgrind paints, inks, dyes, magnetic coatings, minerals, agrochemicals and ceramics.

GRINDING MEDIA SPECIFICATIONS

SIZES SHOWN IN RED INDICATE MEDIA THAT ARE 2MM OR SMALLER

DESCRIPTION	SPECIFIC GRAVITY	HARDNESS	RELATIVE COST	SIZES AVAILABLE
METALLIC				
Carbon Steel Balls (SAE 1065 – Through-Hardened)	7.8	ROCKWELL C 60 – 62	Low	$\frac{1}{8}$ " , $\frac{3}{16}$ " , $\frac{1}{4}$ " , $\frac{5}{16}$ " , $\frac{3}{8}$ " , $\frac{1}{2}$ " , $\frac{3}{4}$ "*
Chrome Steel Balls (SAE 52100)	7.8	ROCKWELL C 60 – 67	Low to Moderate	1mm, 2mm, $\frac{1}{8}$ " , $\frac{5}{32}$ " , $\frac{3}{16}$ " , $\frac{7}{32}$ " , $\frac{1}{4}$ " , $\frac{5}{16}$ " , $\frac{3}{8}$ " , $\frac{1}{2}$ " , $\frac{3}{4}$ " , 1"
Stainless Steel Balls (AISI 440-C)	7.7	ROCKWELL C 58 – 65	Moderate	2mm* , $\frac{1}{8}$ " , $\frac{5}{32}$ " , $\frac{3}{16}$ " , $\frac{7}{32}$ " , $\frac{1}{4}$ " , $\frac{5}{16}$ " , $\frac{3}{8}$ " , $\frac{1}{2}$ " , $\frac{3}{4}$ " , 1"
Steel Shot, Through-Hardened	7.6	ROCKWELL C 55 – 60	Low	0.25mm, 0.50mm, 0.60mm, 0.71mm, 0.85mm, 1mm, 1.18mm, 1.40mm, 1.70mm, 2mm, 2.36mm, 2.80mm
Forged Steel Balls	N/A	55 – 63HRC	Very Low	20mm, 25mm, 30mm, 40mm, 50mm, 60mm, 65mm, 75mm, 90mm, 100mm, 125mm
High Chrome Cast Balls 10–13%	N/A	Surface \geq 60HRC Core \geq 58HRC	Very Low	6mm, 8mm, 10mm, 12mm, 15mm, 17mm, 20mm, 25mm, 30mm, 40mm, 50mm, 60mm, 70mm, 80mm, 90mm, 100mm, 110mm, 120mm
High Chrome Cast Balls 14–18%	N/A	Surface \geq 62HRC Core \geq 60HRC	Very Low	6mm, 8mm, 10mm, 12mm, 15mm, 17mm, 20mm, 25mm, 30mm, 40mm, 50mm, 60mm, 70mm, 80mm, 90mm, 100mm, 110mm, 120mm
NON-METALLIC				
Alumina 99.9% — Balls	3.9	Hv ₁₀ = 1800	High	0.5mm, 1mm, 2mm, 3mm, 5mm, 10mm, 15mm, 20mm, 25mm
99.5% — Balls	3.8	Hv 1300 kg/mm ²	Moderate	0.2mm, 0.3mm, 0.5mm, 1mm, 2mm, 3mm, 5mm, 8mm, 10mm, 15mm, 20mm
94% — Balls	3.59	Hv 1200 kg/mm ²	Low to Moderate	0.5mm, 1mm, 2mm, 3mm, 4mm, 5mm, 6mm, 8mm, 10mm, 13mm, 15mm, 20mm
90% — Beads and Satellites	3.4 – 3.7	ROCKWELL 45N 75	Low	3mm, $\frac{7}{32}$ " , $\frac{1}{4}$ " , $\frac{3}{8}$ " , $\frac{1}{2}$ " <i>Note: 3mm size are Beads-remaining four sizes are satellites</i>
Alumina Beads	N/A	Mohs 9 VICKERS (0.5 kg) 1200 \pm 50	Low to Moderate	0.25–0.34mm, 0.34–0.44mm, 0.4–0.6mm, 0.8–1.2mm, 1.2–1.6mm, 1.4–1.6mm, 1.6–1.8mm, 1.8–2.0mm, 2.0–2.5mm, 2.5–3.0mm
Burundum Cylinders Alumina 90% — (White)	3.42	Mohs 9	Moderate	$\frac{1}{4}$ " , $\frac{1}{2}$ " , $\frac{13}{16}$ " , $1\frac{1}{4}$ "
96% — (White)	3.65	Mohs 9+	Moderate	$\frac{1}{4}$ " , $\frac{1}{2}$ " , $\frac{13}{16}$ " , $1\frac{1}{4}$ "
99% — (Tan)	3.85	Mohs 9+	Moderate	$\frac{1}{2}$ " , $\frac{13}{16}$ " , 1" , $1\frac{1}{4}$ "
Ceramic (Steatite) Satellites	2.6 – 2.7	ROCKWELL 45N 60 – 65	Low to Moderate	$\frac{1}{4}$ " , $\frac{5}{16}$ " , $\frac{3}{8}$ " , $\frac{1}{2}$ " , 20mm, 25mm
Glass Beads (Lead Free)	2.5	KNOOP 515 kg/mm ²	Low	0.25–0.50mm, 0.40–0.60mm, 0.6–0.8mm, 0.75–1.0mm, 0.80–1.0mm, 1mm, 1.5mm, 1.0–1.25mm, 1.25–1.55mm, 1.55–1.85mm, 1.7–2.0mm, 2mm, 2.0–2.4mm, 2.4–2.9mm, 2.85–3.45mm, 3mm, 3.5mm, 3.6–4.1mm, 3.8–4.1mm, 4mm, 5mm, 6mm, 7mm, 8mm, 9mm, 10mm, 12mm, 14mm, 16mm
Nylon Pellets	0.7 – 1.2		Low to Moderate	$\frac{1}{8}$ "
Silicon Carbide Balls	3.1	Hv 2500 kg/mm ²	Very High	5mm, 10mm, 15mm, 20mm
Silicon Nitride Balls	3.2	Hv ₁₀ = 1300	Very High	2mm, 3mm, 5mm, 10mm, 15mm, 20mm, 25mm
Tungsten Carbide Satellites or Balls	14.4 – 14.8	92.0 \pm 0.5 Hra	Moderate to High	$\frac{3}{32}$ " , $\frac{1}{8}$ " , $\frac{5}{32}$ " , $\frac{3}{16}$ " , $\frac{7}{32}$ " , $\frac{1}{4}$ " , $\frac{9}{32}$ " , $\frac{5}{16}$ " , $\frac{3}{8}$ " , $\frac{7}{16}$ " , $\frac{1}{2}$ " , $\frac{9}{16}$ " , $\frac{3}{4}$ " , 1" <i>Note: Smaller sizes beginning at 0.5mm available upon request.</i>
Zirconium Oxide, High-Purity (Y ₂ O ₃ Stabilized) 95% — Balls	6.0	Hv 1150 kg/mm ²	High	0.03mm, 0.05mm, 0.1mm, 0.2mm, 0.3mm, 0.4mm, 0.5mm, 0.65mm, 0.8mm, 1mm, 1.25mm, 1.5mm, 2mm, 3mm, 5mm, 6mm, 8mm, 10mm, 15mm, 20mm, 25mm <i>Note: 6mm and 8mm limited availability. Cylinders available in $\frac{3}{8}$" and $\frac{1}{2}$" sizes.</i>
93% — Beads	6.0	Hv 1250 HV1	Moderate	0.1mm, 0.15–0.28mm, 0.25–0.35mm, 0.35–0.45mm, 0.45–0.55mm, 0.6mm, 0.8mm, 1.0mm, 1.25mm, 1.5mm, 1.75mm, 2.0mm, 2.3mm
Zirconium Oxide (CeO ₂ Rare Earth-Stabilized) Sizes up to 2.8–3.3mm are beads, 6mm and larger are satellites.	6.0	Hv 1200 – 1250	Moderate	0.4–0.6mm, 0.6–0.8mm, 0.8–1.0mm, 0.7–1.2mm, 1.0–1.2mm, 1.2–1.4mm, 1.4–1.6mm, 1.7–2.4mm, 2.4–2.8mm, 2.8–3.3mm, 6mm, 8mm, 10mm, 12.5mm, 16mm, 21mm, 26mm, 31mm
Zirconium Silicate Beads Sintered (58% ZrO ₂ , 37% SiO ₂)	4.0	800 HV1	Moderate	0.8–1.0mm, 1.0–1.2mm, 1.2–1.4mm, 1.4–1.6mm, 1.6–1.8mm, 1.8–2.0mm, 2.0–2.2mm, 2.2–2.4mm, 2.4–2.6mm, 2.5–2.8mm
Fused (68% ZrO ₂ , 30% SiO ₂)	3.8	700 HV1	Moderate	0.1–0.2mm, 0.2–0.3mm, 0.3–0.4mm, 0.4–0.6mm, 0.6–0.8mm, 0.8–1.0mm, 1.0–1.25mm, 1.25–1.6mm, 1.6–2.0mm, 2.0–2.5mm

*These sizes are available in large quantities only as a special order.



Union Process®

1925 Akron-Peninsula Road • Akron, Ohio 44313-4896

Phone: 330.929.3333 • Fax: 330.929.3034

unionprocess@unionprocess.com • www.unionprocess.com