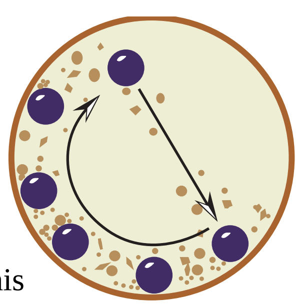
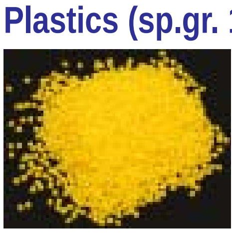
MEDIA - everything you ever wanted to know (and hardly knew you needed!)

The word "media" has a number of definitions: As well as being the name of a city in ancient Persia and the collective noun that we use to describe a means of mass communication, the definition that we are most interested in is "An intervening substance through which something else is transmitted or carried on".

In our world, grinding media is the substance through which the force of a mill (either rotational or vibrational) is transmitted to the material to be milled. The kinetic energy stored in the media when it is moving is converted to mechanical energy when it hits the product, which is fractured by this force. Grinding media is available in a variety of materials and sizes to suit specific process needs. Listed here are most of the common ones, sorted by increasing specific gravity.



Plastics (sp.gr. 1.0 to 1.2)



Polystyrene, polyamide, polycarbonate, acrylic. Typically low cost, media (balls and cubes) from 150 microns to fractional inch sizes.

Natural quartz products (sp.gr. 2.5)

Both sand and flint pebbles are available for low cost, low precision grinding. The sand and pebbles are not processed other than to put them into size ranges. Hard, abrasive, irregularly shaped.

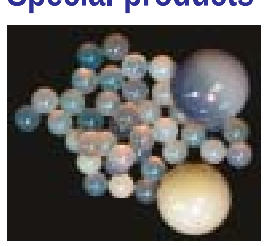
Glass (sp.gr. 2.2 to 3.0)

The first of the "engineered" class of grinding media, glass beads (small balls) and balls were developed specifically for grinding applications where sand wasn't available. Glass is manufactured in various grades (Lead-free Soda Lime, borosilicate, low alkali, black glass, and others) in sizes from 1 micron to 2 inches.

Good wear properties coupled with reasonable roundness means this is the best material to start with when conducting grinding trials. Low cost.

Glass balls are also available in precision grades and are used in optical resolution systems and as "spacers" for precision electronics. Colored glass balls are used for both engineering and decorative applications.

Special products (sp.gr. 2.5 to 3.8)



Developed for extreme environments this group of materials share one feature - high cost, up to $500/kg! Boron carbide ($B_4C$, sp.gr. 2.5), Agate - shown here (SiO_2, 2.6), Silicon carbide (SiC, 3.1), Silicon nitride (Si_3N_4, 3.2), Sapphire/Ruby (Al_2O_3, 3.8)

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Tech Tips 9

The MEDIA* issue

*No, not movies, TV, Hollywood and all that jazz! We're talking about beads, balls, cylinders, diagonals, satellites, ballcones, spheres and more!

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MEDIA - more than you ever thought you needed!

Alumina (sp.gr. 2.8 to 3.9)

Available in a range of specific gravities which rises as the alumina (Al_2O_3) content increases. The media is actually alumina particles held in place by an SiO_2 glass phase. Sizes from 400 microns to over 1 inch in beads, balls, satellites (ball with bands) and cylinders. Low to medium cost, small sizes are more costly.

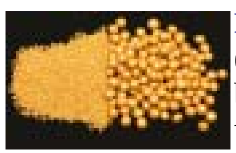
Zirconia (sp.gr. 3.8 to 6.1)

Although grouped together here, this set of products actually encompasses a wide variety of manufacturing styles and core materials.

Fused Zirconium oxide (sp.gr. 3.8) Smooth surface leads to low mill wear and longevity. Sizes from 200 microns to 2.5mm. Medium cost.

Sintered Zirconium silicate (sp.gr. 4.0-4.6) $ZrO_2 + SiO_2 + Al_2O_3$, with and without Y_2O_3 stabilizer. Tight size spreads from 200 microns to 2.6mm. Low to medium cost.

High density Zirconium oxide (sp.gr. 5.5) 95% ZrO_2 + MgO stabilizer. Beads from 400 microns to 3.35mm. Cylinders and satellites to 1-1/4". Medium cost.



Rare Earth stabilized Zirconium oxide (sp.gr. 5.8 to 6.1) ZrO_2 + CeO. Yellow or black, very hard. Sizes from 400 microns to 2". Medium cost.

Yttrium stabilized Zirconium oxide (sp.gr. 6.0) 95% ZrO_2 + 5% Y_2O_3. Best wear properties of all media, very round and very smooth, narrow size spreads. High cost is offset by low wear and minimal contamination.

Steel (sp.gr. 7.8)

Various alloys available (low carbon, high carbon, chrome steel, stainless steel, etc.) in a variety of forms:

Ball bearings Good wear, very round but will result in metallic contamination. Cost directly related to material and inversely proportional to size. 1/16" to 6".

Shot Irregular shapes with lumps and bumps, but only cost effective alternative for steel in sizes less than 1mm. Inexpensive, sizes from 90 microns to 3mm.

Other forms Steel wire can be cut and formed to produce diagonals, ballcones (looks like a flattened ice cream cone), pins (rods), oval balls and other shapes.

Tungsten carbide (sp.gr. 15)

Highest density material available for milling applications. Available as small pellets (not spherical), satellites (balls with bands) and round balls. Cost, medium to high, varies with roundness and size.

MEDIA SELECTION

Selection of the correct media leads to another discussion (almost too big for this forum). To appreciate the situation the following variables need to considered:

- **Chemical compatibility** Will the media contaminate my product and if so, what level of contamination is acceptable?
- **Physical compatibility** Is the media too soft or too hard for my application and equipment?
- **Media density** Do I need dense media to work in a viscous environment? Should I use smaller media of a higher density to get the same momentum transfer and a finer grind?
- **Bead diameter** Larger media is needed for handling larger initial sizes. Smaller beads will be needed for fine and ultra-fine grinding.

For more information on media, ball mills, jar mills, bead mills and the other 50+ mills, mixers and sampling devices we sell contact Glen Mills Inc., Tel: 973-777-0777 or staff@glenmills.com

Now I know about media - where would I use it?

Primarily the media we discussed is used in equipment known generically as "Ball Mills". Ball Mills fall into several categories:

Commercial Ball Mills start in size at around 10 gallons and go up to machines handling thousands of gallons. Balls tumble around inside a rotating cylinder breaking anything sandwiched between the balls and the walls of the cylinder (see illustration on first page). Systems can be wet or dry and typically uses media 1/2" and larger.

Jar Mills are designed to meet the need of processing smaller quantities with the same tumbling action of larger ball mills. GLEN MILLS' jar mills are available in different lengths, in single and multiple tiers to handle from as little as one small jar to 15 or more simultaneously moving jars. Jars in plastic, steel (lined and unlined) and various grades of ceramic cover nearly all applications.

High Speed Mixer Mills are desktop units that utilize balls moving rapidly side-to-side inside a cylindrical grinding jar. One or two jars move at up to 1800 cycles per minute resulting in short processing times. Ideal for small samples from 0.1ml to about 40ml. 96-well titer plate option also available. Grinding to 10 microns and below possible.

Planetary Ball Mills are designed for ultra-fine grinding to single digit microns and below. These units provide true planetary motion where each station rotates counter to the sun disc on which they are mounted. The jar is in motion in two directions with constantly changing centrifugal forces acting on the balls - this imparts tremendous energy to the balls which in turn transfer that energy to the material to be ground. Single, twin and four station models are available for handling samples as small as a few grams, to as much as a liter or more at a time.

Bead (or Media) Mills such as the Dyno®-Mill are a different type of device. Here the cylinder is stationary and the media is moved by means of rotating agitators. Bead mills use smaller media in wet systems to produce very fine grinding of suspensions such as paints, inks, fertilizers, and pharmaceuticals. The Dyno-Mill can be used in either batch or continuous mode and can be scaled up from lab sized to production units easily and accurately. Internal impellers agitate a bath of media at speeds of up to 16 m/sec. to provide literally thousands of individual impacts, producing the ultimate in fine grinding - as small as 100nm!