



**BIRD
PRECISION**

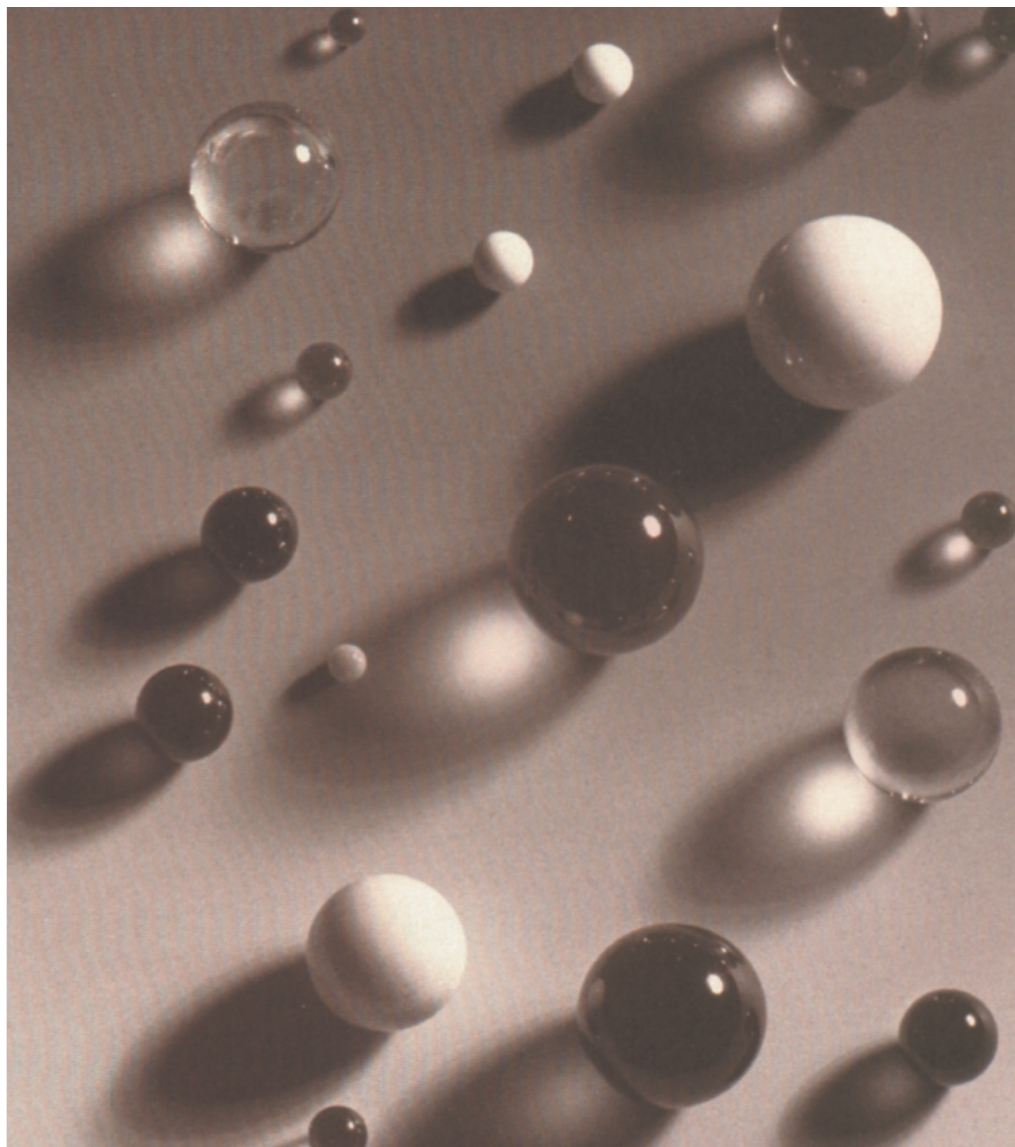
SAPPHIRE & RUBY BALLS PLUS CERAMIC & GLASS

Synthetic Sapphire and, particularly, Synthetic Ruby materials are quickly becoming the jewels of the industry.

For companies who are producing a specific product, these materials make an immediate statement about quality. For instance, watches often feature, on their face, that all movements are fully jeweled. Furthermore, many ball point companies exclusively use ruby ball tips which offer a smoother and finer writing quality.

Not surprisingly, these synthetic sapphire and ruby balls deliver better quality because of their superior qualities. They bring extreme abrasive resistance (5 times that of carbide). Both exhibit the ability to add an extremely smooth finish. Due to their zero porosity and crystal structure, micro-finishes of 2 are easily attained. Extreme hardness, chemical inertness (even to hydrofluoric, hf acid), a low friction coefficient, high thermal conductivity and remarkable wear resistance are some of the reasons these balls are on a roll in the industry.

Their numerous advantageous properties make them prime candidates for literally hundreds of applications.



Ruby balls are currently used in chemical pump check valves, wind indicators, probe and test measurement tips, medical check valves, ball point pens, master ball gauging sets, ball plug gauges, sapphire fiber optic lens systems, tracer tips, gyroscopic wear points and precision metering valve assemblies.

Sapphire balls can be drilled and used as precision jeweled

bearing rollers for low friction and long wear applications. They can also be implemented in high heat applications; their melting point is 2,000 degrees centigrade yet oxidation of the material isn't a problem. Sapphire also offers good temperature and optical qualities, as well as superior stability.

If you want more direct evidence of how they're being applied, just take a look.

Tracer Tips and Gauge Contact Points: Perfect here because of its hardness, wear resistance, dimensional stability and smooth surface texture. It is aesthetically attractive. It can also be machined to micron tolerance in roundness and diameter.

Chemical and Medical Valves: Ideal because of its extreme resistance to chemical corrosion. It's also inert to most acids, non-toxic, and offers zero porosity and resistance to thermal shock.

Ball Point Pens & Stylus Tips: Smooth surface and high abrasion resistance enable it to stand up to harsh surfaces, such as mylar.

Ball and Roller Bearings: Low coefficient of friction, long wear, low elastic deformation and heat and chemical resistance properties give it a longer life span.

Fiber Optic Lens Systems: Its scratch resistance, good refraction index (1.76 microns at 20°C), 80% to 90%

transmission in infrared wavelengths, strength and temperature stability make it perfect in meticulous applications.

Ball Gauge and Probe Tips: Delivers dimensional stability without wear since it's harder than most surfaces to be gauged. They're also attractive, readily available and can be machined down to micron tolerances.

QUALITY CONTROL

A.F.B.M.A. GRADE TOLERANCES AND TERMINOLOGY

A.F.B.M.A Grade	Diameter Tolerance per Ball Sphericity	Diameter Tolerance per Unit Container	Basic Diameter Tolerance	Marking Increments
	Inch	Inch	Inch	Inch
3	.000003	.000005	± .00003	.000003
5	.000005	.00001	± .00005	.000005
10	.000010	.00002	± .0001	.000010
15	.000015	.00003	± .0001	.000015
25	.000025	.00005	± .0001	.000025
50	.00005	.0001	± .0002	.00005
100	.0001	.0002	± .0005	.0001
200	.0002	.0004	± .0010	.0002



Characteristics of the colorless synthetic sapphire, i.e. corundum single crystal

Physical Properties	crystal system chemical formula purity cleavage specific gravity dislocation density	hexagonal Al ₂ O ₃ 99.99% conchoidal 3.99 ÷ 3.98 10 ⁵ ÷ 10 ⁴ /cm ²
Thermal Properties	melting point softening point specific heat at 25°C thermal conductivity at 25°C thermal expansion face ⊥ to c axis face = to c axis	2050°C 1800°C 0.18cal/g 0.1 cal/sec · cm · °C 5.4 · 10 ⁻⁶ /°C 6.2 · 10 ⁻⁶ /°C
Mechanical Properties	Hardness Mohs Knoop scale face ⊥ to c axis Knoop scale face = to c axis modulus of elasticity modulus of rupture at 25°C compressive strength at 25°C ultimate tensile strength chemical resistance	9 1800 2200 4.4 x 10 ⁹ kg/cm ² ± 1% Young E 4000 kg/cm ² 21000 kg/cm ² 1900 kg/cm ² unattacked by common acids or NaOH
Chemical Properties	acids & alkalis attack at 300°C porosity	0 0
Electrical Properties	dielectric constant (permittivity) electrical resistance at 500°C electrical resistance at 1000°C electrical resistance at 2000°C	7.5 at 10.5 10 ¹¹ ohm/cm 10 ⁸ ohm/cm 10 ⁹ ohm/cm

STANDARD STOCK SIZES FOR INDUSTRIAL APPLICATIONS

Sapphire & Ruby		Glass		Ceramic-A99	
Ø Inch	Ø mm	Ø Inch	Ø mm	Ø Inch	Ø mm
.005			1.00		1.50
	0.15	3/64"		1/16"	
	0.20		1.20		
	0.25		1.25		2.00
	0.30		1.50	3/32"	
	0.40	1/16"			2.50
	0.50-1.00		1.75		3.00
3/64"			2.00	1/8"	
	1.20	3/32"			3.50
	1.25		2.50		
	1.50		3.00	5/32"	
1/16"		1/8"			4.00
	1.75		3.50		4.50
	2.00	5/32"		3/16"	
3/32"			4.50		5.00
	2.50	3/16"		7/32"	
	3.00		5.00		
1/8"		7/32"			6.00
	3.50		6.00	1/4"	
5/32"		1/4"			6.50
	4.00		6.50		7.00
	4.50		7.00	5/16"	
3/16"		9/32"			8.00
	5.00		7.50	11/32"	
7/32"		5/16"			9.00
	6.00		8.00		9.50
1/4"			8.50	3/8"	
	6.50	11/32"			10.00
	7.00		9.00		11.00
9/32"			9.50	7/16"	
	7.50	3/8"			12.00
5/16"			10.00	1/2"	
	8.00		11.00		13.00
	8.50	7/16"			14.00
	9.00		12.00	9/16"	
	9.50	1/2"			15.00
3/8"				5/8"	
	10.00				16.00
	11.00				17.00
7/16"					18.00
	12.00				19.00
1/2"				3/4"	
					20.00
					25.00
				1"	
					30.00
				1.25"	



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