AISI 1010/1015 LOW CARBON STEEL CEMENTED BALLS

Low cost carbon steel balls, case-hardened only. The thickness of the case hardened layer depends on the diameter of the ball.

Applications

Furniture rails and rollers, drawers and rolling bearings, locks, oilers and greasers, skates, caddies, toys, belt and roller conveyors, tumble finishing.

Chemical composition

Type	%C	%Si	%Mn	%P	%S						
1010	0,08-0,13	0,10-0,35	0,30-0,60	0,040 max	0,050 max	-	-	-	-	-	-
1015	0,12-0,18	0,10-0,35	0,30-0,60	0,040 max	0,050 max	-	-	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JPN
C10	1010	1.1121	CC10	040A10	10	10	S10C
C15	1015	1.1141	XC12	080M15	15	15	S15C

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,82
Young's modulus	E	GPa	Mechanical	-	200
Specific heat	c	J/kg-K	Thermal	Room temp.	468
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	11,8
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	57,9
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	155
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 500

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	55 - 65	-	-
Ultimate tensile strength	Mechanical	MPa	300 - 400	psix10^3	43 - 58
Service temperature	Thermal	°C	-40 / 500	°F	-40 / 932

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
1,500 - 300,000	mm	1/16 - 12	"	G100-200-300-500-600-700-1000

www.rgpballs.com

AISI 1010/1015 LOW SOFT UNHARDENED CARBON STEEL BALLS

Unhardened low carbon steel balls.

Applications

Caddies, wrought iron work, curtain mechanisms, steel shots, munitions, stirrers and mixers in not aggressive environments, welding appliances.

Chemical composition

Type	%C	%Si	%Mn	%P	%S	-	-	-	-	-	-
1010	0,08-0,13	0,10-0,35	0,30-0,60	0,040 max	0,050 max	-	-	-	-	-	-
1015	0,12-0,18	0,10-0,35	0,30-0,60	0,040 max	0,050 max	-	-	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
C10	1010	1.1121	CC10	040A10	10	10	S10C
C15	1015	1.1141	XC12	080M15	15	15	S15C

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,82
Young's modulus	E	GPa	Mechanical	-	200
Specific heat	c	J/kg-K	Thermal	Room temp.	468
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	11,8
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	57,9
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	155
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 500

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRB	60 - 90	-	-
Ultimate tensile strength	Mechanical	MPa	200 - 300	psix10^3	29 - 43
Service temperature	Thermal	°C	-40 / 500	°F	-40 / 932

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (AFBMA)
1,500 - 300,000	mm	1/16 - 12	"	G1000-2000

AISI 1085 HIGH CARBON STEEL BALLS

High carbon steel balls, are through hardened. They feature by very good hardness and wear resistance.

Applications

Low precision bearings, furniture bearings, bicycle and automotive components, agitators, sliding rails, drawer rails, skates, roller conveyors, castors, locks, bearing units, polishing and milling machines.

Chemical composition

Standard	%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	%(Cu+Sn)	%Al	-
1085	0,80-0,93	0,60 max	0,70-1,00	0,040 max	0,050 max	-	-	-	-	-	-
1.0616	0,83-0,88	0,10-0,30	0,50-0,80	0,030 max	0,030 max	0,15 max	0,20 max	0,050 max	0,25 max	0,010 max	-
82B	0,79-0,86	0,15-0,35	0,60-0,90	0,030 max	0,030 max	-	-	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
C90	1085	1.0616	XC90	C85S	85 (A)	82B	SWRH87B

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,85
Young's modulus	E	GPa	Mechanical	-	200
Specific heat	c	J/kg-K	Thermal	Room temp.	470
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	12,8
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	33,9
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	175
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 200

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	59 - 66	-	-
Ultimate tensile strength	Mechanical	MPa	700 - 800	psix10^3	100 - 115
Service temperature	Thermal	°C	-40 / 500	°F	-40 / 932

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
1,500 - 300,000	mm	1/16 - 12	"	G28-40-48-50-60-80-100-200-300-500-600-700-1000

AISI 52100 100Cr6 CHROME STEEL BALLS

Low alloy martensitic chrome steel, AISI 52100 thanks to its high hardness, wear resistance, surface finishing and dimensional precision, it is widely used to manufacture mechanical components.

Applications

Precision bearings, automotive components (brakes, steering, line shaft), bicycle, agitators, appliances, sliders, quick couplings, machine tool, lock mechanisms, conveyor belts, skates, pens, pumps, castors, measurement instruments, valves.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	%Cu	-	-	-
0,95-1,05	0,15-0,35	0,25-0,45	0,025 max	0,025 max	1,40-1,65	0,30 max	0,08 max	0,20 max	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
100Cr6	52100	1.3505	100C6	534A99	9Ch1	GCr15	SUJ2

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,80
Young's modulus	E	GPa	Mechanical	-	200
Specific heat	c	J/kg-K	Thermal	Room temp.	464
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	12,3
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	42,4
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	215
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 300

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	60 - 66	-	-
Ultimate compressive strength	Mechanical	MPa	2500 - 2600	psix10^3	362 - 377
Service temperature	Thermal	°C	-60 / 150	°F	-76 / 302

Range

Diameters	U.o.M.	Diameters	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
0,250 - 300,000	mm	1/64 - 12	"	G10-15-16-20-24-25-28-40-48-50-60-80-100-200-300-500-600-700-1000

LOW NOISE AISI 52100 HIGH PRECISION CHROME STEEL BALLS

High precision AISI 52100 chrome steel balls feature the lowest tolerances and noise levels.

Applications

High precision & aircraft bearings, recirculating ball screws, high precision spindles & gears, bearings for electric motors.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	%Cu	-	-	-
0,95-1,05	0,15-0,35	0,25-0,45	0,025 max	0,025 max	1,40-1,65	0,30 max	0,08 max	0,20 max	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
100Cr6	52100	1.3505	100C6	534A99	9Ch1	GCr15	SUJ2

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,80
Young's modulus	E	GPa	Mechanical	-	200
Specific heat	c	J/kg-K	Thermal	Room temp.	464
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	12,3
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	42,4
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	215
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 300

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	60 - 66	-	-
Ultimate compressive strength	Mechanical	MPa	2500 - 2600	psix10^3	362 - 377
Service temperature	Thermal	°C	-60 / 150	°F	-76 / 302

Range

Diameters	U.o.M.	Diameters	U.o.M.	Precision grades (ISO 3290-1)
1,000 - 16,000	mm	3/64 - 5/8	"	G5

100CrMn6 CHROME STEEL BALLS

100CrMn6 steel allows to get higher core hardness than standard AISI 52100. Generally used for large diameter balls only.

Applications
Windmills and large bearing diameters.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Cu	%Mo	%Al	%O	-	-
0,93-1,05	0,45-0,75	1,00-1,20	0,025 max	0,015 max	1,40-1,65	0,30 max	0,10 max	0,050 max	0,0015 max	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
100CrMnSi6-4	-	1.3520	100CM6	535A99	SHKH15SG	GCr15SiMn	SUJ3

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,85
Young's modulus	E	GPa	Mechanical	-	210
Specific heat	c	J/kg-K	Thermal	Room temp.	475
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	12,6
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	35,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	220
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 300

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	60 - 66	-	-
Ultimate compressive strength	Mechanical	MPa	2500 - 2600	psix10^3	362 - 377
Service temperature	Thermal	°C	-60 / 150	°F	-76 / 302

Range

Diameters	U.o.M.	Diameters	U.o.M.	Precision grades
45,000 - 300,000	mm	1-3/4 - 12	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

100CrMo7-3 CHROME STEEL BALLS

Bearing steel balls with a small percentage of Mo in the chemical composition, as 100CrMn6 this steel guarantees a high core hardness for balls of large diameters. The structure is bainitic (martensitic for 100CrMn6).

Applications

As for other bearing steels, they are useful when high hardness, wear resistance and fatigue resistance are required.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Mo	%Cu	%Al	%O	-	-
0,93-1,05	0,15-0,45	0,60-0,80	0,025 max	0,015 max	1,65-1,95	0,20-0,35	0,30 max	0,050 max	0,0015 max	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
100CrMo7-3	K19965	1.3536	100CrMo7-3	100CrMo7-3	-	100CrMo7-3	SUJ5

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,82
Young's modulus	E	GPa	Mechanical	-	205
Specific heat	c	J/kg-K	Thermal	Room temp.	477
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	13,1
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	42,7
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	218
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 300

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	57 - 65	-	-
Ultimate compressive strength	Mechanical	MPa	2400 - 2550	psix10^3	348 - 369
Service temperature	Thermal	°C	-60 / 150	°F	-76 / 302

Range

Diameters	U.o.M.	Diameters	U.o.M.	Precision grades
45,000 - 300,000	mm	1-3/4 - 12	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

100CrMnMo8 CHROME STEEL BALLS

High performance bearing steel balls, they feature highest Chromium and Molibdenum contents between the hardened steels listed by ISO 683-17 standard. Excellent hardenability on pieces of big diameter.

Applications

Antifriction bearings, they are used when the pieces are subjected to strong mechanical stresses and wear.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Mo	%Cu	%Al	%O	-	-
0,93-1,05	0,40-0,60	0,80-1,10	0,025 max	0,015 max	1,80-2,05	0,50-0,60	0,30 max	0,050 max	0,0015 max	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
100CrMnMoSi8-4-6	-	1.3539	100CrMnMo8	100CrMnMoSi8-4-6	ШХ20СГМ-В	100CrMnMo8	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,80
Young's modulus	E	GPa	Mechanical	-	210
Specific heat	c	J/kg-K	Thermal	Room temp.	470
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	13,3
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	43,4
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	212
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 300

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	55 - 63	-	-
Ultimate compressive strength	Mechanical	MPa	2300 - 2450	psix10^3	334 - 355
Service temperature	Thermal	°C	-60 / 150	°F	-76 / 302

Range

Diameters	U.o.M.	Diameters	U.o.M.	Precision grades
45,000 - 300,000	mm	1-3/4 - 12	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

AISI 420A/420B STAINLESS STEEL BALLS

Martensitic stainless steel hardened balls, they feature good resistance to corrosion and wear. Balls are provided in the passivated condition.

Applications

Similar to that of AISI 420C balls, when required hardness and wear resistance are lower.

Chemical composition

Type	%C	%Si	%Mn	%P	%S	%Cr	-	-	-	-	-
420A	0,16-0,25	1,00 max	1,50 max	0,040 max	0,030 max	12,00-14,00	-	-	-	-	-
420B	0,26-0,35	1,00 max	1,50 max	0,040 max	0,030 max	12,00-14,00	-	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X20Cr13	420A	1.4021	Z 20 C 13	420 S 37	20 Kh 13	2Cr13	420J1
X30Cr13	420B	1.4028	Z 33 C 13	420 S 45	30 Kh 13	3Cr13	420J2

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,73
Young's modulus	E	GPa	Mechanical	-	195
Specific heat	c	J/kg-K	Thermal	Room temp.	450
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	10,2
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	27,4
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	680
Relative magnetic permeability	μ	-	Magnetic	Not hardened	>600

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	48 - 58	-	-
Ultimate tensile strength	Mechanical	MPa	1700 - 1900	psix10^3	250 - 275
Service temperature	Thermal	°C	0 / 400	°F	32 - 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
0,300 - 300,000	mm	1/64 - 12	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

Corrosion Resistance

AISI 420A/420B steels offer a corrosion resistance similar to 420C steel. Balls of these materials resist in contact with water, steam, oil and petrol.

AISI 420C STAINLESS STEEL BALLS

Martensitic hardened stainless steel balls, they feature good hardness, corrosion resistance, wear and abrasion resistance. Balls are provided in the passivated condition.

Applications

Special bearings, anti-friction bearings, special pumps, recirculating balls, lighters, pens, automotive seatbelts & components.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	-	-	-	-	-	-
0,43-0,50	1,00 max	1,00 max	0,040 max	0,030 max	12,50-14,50	-	-	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X46Cr13	420C	1.4034	Z 34 C 14	-	40 Kh 13	4Cr13	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,75
Young's modulus	E	GPa	Mechanical	-	205
Specific heat	c	J/kg-K	Thermal	Room temp.	450
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	10,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	27,6
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	720
Relative magnetic permeability	μ	-	Magnetic	Not hardened	> 600

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	52 - 60	-	-
Ultimate tensile strength	Mechanical	MPa	1700 - 1900	psix10^3	250 - 275
Service temperature	Thermal	°C	0 / 400	°F	32 - 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
0,300 - 300,000	mm	1/64 - 12	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

Corrosion Resistance

Good corrosion resistance in industrial atmosphere, freshwater, steam, alcool, ammonium, several oilfield products and organic compounds, dairy products, mild acid environments. Fairish in foodstuff and alkaline solutions. Fair in salt atmosphere. It does not resist in contact with sea water and strong acids (even if diluted).

AISI 440C STAINLESS STEEL BALLS

Martensitic hardened stainless steel balls, they feature remarkable hardness, wear resistance, surface finishing, narrow dimensional tolerances. For that reason this type of steel is frequently used in precision devices. Balls are provided in the passivated condition.

Applications

Precision bearings, anti-friction bearings, special valves, conveyor belts and rollers, ballpoint pens.

They are used in foodstuff, medical instruments, quick couplings, recirculating ball bearings, knotting devices, oil refinery devices.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Mo	-	-	-	-	-
0,95-1,20	1,00 max	1,00 max	0,040 max	0,030 max	16,00-18,00	0,75 max	-	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X 105CrMo17	440C	1.4125	Z100CD17	-	95X18	9Cr18Mo	SUS440C

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,70
Young's modulus	E	GPa	Mechanical	-	210
Specific heat	c	J/kg-K	Thermal	Room temp.	450
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	10,2
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	19,6
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	680
Relative magnetic permeability	μ	-	Magnetic	Not hardened	> 700

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	57 - 65	-	-
Ultimate tensile strength	Mechanical	MPa	1900 - 2000	psix10^3	275 - 290
Service temperature	Thermal	°C	0 / 400	°F	32 - 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
0,300 - 300,000	mm	1/64 - 12	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

Corrosion Resistance

The material resists to corrosion in contact with freshwater, steam, oil, petrol, alcohol.
They are subjected to pitting corrosion in sea water environments.
Poor corrosion resistance in acid environments.

AISI 431 STAINLESS STEEL BALLS

Martensitic stainless steel balls, they show the best corrosion resistance for this steel family and good mechanical properties, hardness and impact resistance.
Balls are provided in the passivated state.

Applications

Special pumps and valves, they are used in the aircraft, foodstuff and naval field.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	-	-	-	-	-
0,200 max	1,00 max	1,00 max	0,040 max	0,030 max	15,00-17,00	1,25-2,50	-	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X 16 CrNi 1	431	1.4057	Z 15 CN 16 02	431 S 29	20X17H2	1Cr17Ni2	SUS 431

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,75
Young's modulus	E	GPa	Mechanical	-	208
Specific heat	c	J/kg-K	Thermal	Room temp.	460
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	10,8
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	25,1
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	710
Relative magnetic permeability	μ	-	Magnetic	Not hardened	> 700

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	44 - 54	-	-
Ultimate tensile strength	Mechanical	MPa	1550 - 1750	psix10^3	225 - 253
Service temperature	Thermal	°C	0 / 400	°F	32 - 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
2,500 - 75,000	mm	3/32 - 3	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

Corrosion Resistance

Good corrosion resistance in contact with organic acids, mild acids and basis, alkaline solutions, steam, industrial and sea atmospheres.

LESCALLOY BG 42 VIM VAR BALLS®

Martensitic high speed stainless steel balls, they provide the best properties of high speed steels regarding mechanical features and high temperature wear resistance, with the corrosion resistance typical of the best martensitic stainless steels.
VIM-VAR vacuum melting allows to obtain a material with high micro structural cleanliness.

Applications

Aerospace and high performance bearings, bearings used into corrosive environments at high temperature.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	%Cu	%V	-	-
1,05-1,15	0,20-0,40	0,25-0,50	0,015 max	0,010 max	13,70-14,80	0,40 max	3,75-4,25	0,35 max	1,10-1,30	-	-

International standards

Lescalloy BG 42 VIM-VAR® (UNS S42700) is a trade name, from Latrobe Speciality Steel Company, USA.

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,75
Young's modulus	E	GPa	Mechanical	-	221
Specific heat	c	J/kg-K	Thermal	Room temp.	455
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	11,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	22,3
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	720
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 600

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	60 - 66	-	-
Ultimate tensile strength	Mechanical	MPa	2200 - 2400	psix10^3	319 - 348
Service temperature	Thermal	°C	0 / 410	°F	32 / 770

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
1,000 - 150,000	mm	3/64 - 6	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

Corrosion Resistance

Lescalloy BG 42® balls provide a corrosion resistance similar to AISI 440C balls.

AISI 302/304/304L STAINLESS STEEL BALLS

Unhardened austenitc stainless steel balls, they display good mechanical characteristics, toughness and corrosion resistance.
AISI 304L provides lower carbon content, AISI 302 better mechanical characteristics.
Balls are provided in the passivated condition.

Applications

Special bearings and pumps, aerosol pumps, gardening and household sprayers, perfume miniature pumps, seams, medical application valves, agricultural backpack sprayers.

They are used in foodstuff, aerospace and military industry.

Chemical composition

Type	%C	%Si	%Mn	%P	%S	%Cr	%Ni	%N
302	0,150 max	1,00 max	2,00 max	0,045 max	0,030 max	17,00-19,00	8,00-10,00	0,100 max
304	0,080 max	0,75 max	2,00 max	0,045 max	0,030 max	18,00-20,00	8,00-10,50	0,100 max
304L	0,030 max	0,75 max	2,00 max	0,045 max	0,030 max	18,00-20,00	8,00-10,50	0,100 max

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X10CrNi18-8	302	1.4310	Z11CN18-08	301S21	12KH18N9	1Cr18Ni9	SUS301
X5CrNi18-10	304	1.4301	Z7CN18-09	304S15	08KH18N10	0Cr18Ni9	SUS304
X2CrNi18-9	304L	1.4307	Z3CN18-10	304S11	04KH18N10	00Cr19Ni10	SUS304L

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,95
Young's modulus	E	GPa	Mechanical	-	200
Specific heat	c	J/kg-K	Thermal	Room temp.	500
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	17,5
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	15,8
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	710
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,025*

www.rgpballs.com

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	20 - 39 (1)*	HV	100 - 250 (2)*
Ultimate tensile strength	Mechanical	MPa	500 - 1300	psix10^3	72 - 188
Service temperature	Thermal	°C	-196 / 700	°F	-320,8 / 1697

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)**
0,300 - 300,000	mm	1/64 - 12	"	G100-200-300-500-600-700-1000

Corrosion Resistance

Very good corrosion resistance with respect to organic substances, oxidating solutions, foodstuff, sterilizing solutions.

Good resistance with respect to atmospheric corrosion and dyes.

They are subjected to pitting and crevice corrosion in presence of hot chloride solutions and to stress corrosion when temperature exceeds 60°C.

They do not resist to sulfuric acid solutions.

AISI 302 shows slightly best corrosion resistance with respect to AISI 304/304L stainless steels.

Notes

Property	Description
Hardness*	Balls can be supplied in the (1) COLD WORKED (HRC 20-39, standard product) or (2) ANNEALED (HV 100-250, on demand) conditions.
Magnetism	Eventual magnetism of AISI 316 balls and in general of all austenitc stainless steels strictly depends by the manufacturing process, specific inquiries for not magnetic balls should priorly reported.
Precision Grade**	On specifical request and for big quantities, we can supply G10 and G16 precision grade balls. Diameters from 3,000 mm to 1/2".
Precision Grade**	On specifical request we can supply G20-24-25-28-40-48-50-60-80 precision grade balls.

AISI 316/316L STAINLESS STEEL BALLS

Austenitic stainless steel balls with higher corrosion resistance than AISI 304 balls.
They show good toughness.
AISI 316L has a lower carbon content (maximum 0,030%).
Balls are provided in the passivated condition.

Applications

Special bearings, pumps and valves, aerosol and dispenser sprayers.

Utilised in the foodstuff, paper, chemical, rubber, military, textile industry.

Applications in photographic devices, medical instruments, quick couplings, recirculating balls, ink cartridges, jewels.

Chemical composition

Type	%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	-	-	-
316	0,080 max	1,00 max	2,00 max	0,045 max	0,030 max	16,00-18,00	10,00-14,00	2,00-3,00	-	-	-
316L	0,030 max	1,00 max	2,00 max	0,045 max	0,030 max	16,00-18,00	10,10-14,00	2,00-3,00	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X5CrNiMo1712-2	316	1.4401	Z6CND17.11	316S16	08KH16N11M3	0Cr17Ni12Mo2	SUS316
X2CrNiMo1712-2	316L	1.4404	Z3CND17-11-02	316S11	03KH17N14M2	0Cr19Ni12Mo2	SUS316L

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,95
Young's modulus	E	GPa	Mechanical	-	200
Specific heat	c	J/kg-K	Thermal	Room temp.	500
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	17
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	15,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	730
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,020*

www.rgpballs.com

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	20 - 39 (1)*	HV	100 - 250 (2)*
Ultimate tensile strength	Mechanical	MPa	550 - 1250	psix10^3	80 - 180
Service temperature	Thermal	°C	-196 / 600	°F	-320,8 / 1112

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)**
0,300 - 300,000	mm	1/64 - 12	"	G100-200-300-500-600-700-1000

Corrosion Resistance

Very good corrosion resistance with respect to organic substances, good resistance to several strong acids (acetic, phosphoric, sulphuric acid) and on sea water.

They are subjected to pitting and crevice corrosion in presence of hot chloride solutions and to stress corrosion when temperature exceeds 60°C.

They do not resist in contact with hydrochloric and hydrofluoric acids, aqua regia, iron and magnesium chlorides.

Notes

Property	Description
Hardness*	Balls can be supplied in the (1) COLD WORKED (HRC 20-39, standard product) or (2) ANNEALED (HV 100-250, on demand) conditions.
Magnetism	Eventual magnetism of AISI 316 balls and in general of all austenitc stainless steels strictly depends by the manufacturing process, specific inquiries for not magnetic balls should priorly reported.
Precision grade**	On specifical request and for big quantities, we can supply G10 and G16 precision grade balls. Diameters from 3,000 mm to 1/2".
Precision Grade**	On specifical request we can supply G20-24-25-28-40-48-50-60-80 precision grade balls.

AISI 316Ti STAINLESS STEEL BALLS

Not hardenable austenitic stainless steel titanioum stabilized balls, the presence of Ti allows to guarantee a better intercrystalline corrosion resistance with respect to AISI 316/316L grades, mainly at high temperatures. Balls are provided in the passivated condition.

Applications

Ball valves, special pumps and valves, they are used in devices for the foodstuff, chemical, pharmaceutical, naval, medical, textile industry.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	%N	%Ti	-	-
0,080 max	0,75 max	2,00 max	0,045 max	0,030 max	16,00-18,00	10,00-14,00	2,00-3,00	0,0100 max	5x%C-0,70	-	-

International Standard

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X6CrNiMoTi17-12-2	316Ti	1.4571	Z6CNDT17-12	316S51	10Ch17N13M2T	06Cr17Ni12Mo2	SUS 316Ti

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,95
Young's modulus	E	GPa	Mechanical	-	200
Specific heat	c	J/kg-K	Thermal	Room temp.	500
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	15,9
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	15,6
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	740
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,020

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	15 - 35	-	-
Ultimate tensile strength	Mechanical	MPa	650 - 1150	psix10^3	95 - 166
Service temperature	Thermal	°C	-196 / 600	°F	-320,8 / 1112

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
0,300 - 300,000	mm	1/64 - 12	"	G100-200-300-500-600-700-1000

Corrosion Resistance

Similar to that of AISI 316/316L family, they feature better intergranular, stress corrosion cracking and pitting corrosion resistance.

AISI 430/430F STAINLESS STEEL BALLS

Ferritic unhardened stainless steel balls, they show good mechanical features and corrosion resistance better than martensitic stainless steels. Balls are provided in the passivated conditions.

Applications

Special bearings and valves, cosmetic nail polish, sprayers, heat exchangers, measurement instruments.

Chemical composition

Type	%C	%Si	%Mn	%P	%S	%Cr	-	-	-	-	-
430	0,120 max	1,00 max	1,00 max	0,040 max	0,030 max	16,00-18,00	-	-	-	-	-
430F	0,120 max	1,00 max	1,25 max	0,065 max	0,150 min	16,00-18,00	-	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X6Cr17	430	1.4016	Z8C17	430S17	12KH17	1Cr17	SUS 430
X14CrMoS17	430F	1.4104	Z10CF17	441S29	-	YCr17	SUS 430 F

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,73
Young's modulus	E	GPa	Mechanical	-	205
Specific heat	c	J/kg-K	Thermal	Room temp.	450
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	11
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	24,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	625
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 600

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRB	75 - 95	-	-
Ultimate tensile strength	Mechanical	MPa	750 - 950	psix10^3	107 - 140
Service temperature	Thermal	°C	0 / 450	°F	32 / 842

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
0,300 - 180,000	mm	1/64 - 7	"	G100-200-300-500-600-700-1000

Corrosion Resistance

430 balls resist in freshwater, steam, air, detergents, soaps, organic and oxidating acids, alkaline solutions. They do not resist to chloride, fluoride, bromide, iodide solutions. The corrosion resistance is lower than AISI 302/304 steels.

AISI 204 Cu STAINLESS STEEL BALLS

Cr-Mn-Cu austenitic stainless steel balls, Cu addition improves workability but slightly reduces mechanical properties compared to AISI 201 stainless steel. Balls are supplied in the passivated condition and can be supplied both magnetic or not magnetic .

Applications

Special bearings, interiori automotive components, switches, die casting devices. They are widely used in the electronic industry.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Cu	%N	-	-	-
0,15 max	1,00 max	6,50-9,00	0,100 max	0,030 max	14,00-17,50	1,50-3,50	1,80-4,00	0,050-0,250	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X8CrMnCuNB17-8-3	204 Cu	1.4597	X8CrMnCuNB17-8-3	X8CrMnCuNB17-8-3	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,81
Young's modulus	E	GPa	Mechanical	-	200
Specific heat	c	J/kg-K	Thermal	Room temp.	496
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	17,1
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	15,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	163
Relative magnetic permeability	μ	-	Magnetic	Param. / Slightly ferrom.	1,03 / max 10

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	25 - 45	-	-
Ultimate tensile strength	Mechanical	MPa	635 - 1195	psix10^3	92 - 173
Service temperature	Thermal	°C	-196 / 700	°F	-320,8 / 1697

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
0,800 - 180,000	mm	1/32 - 7	"	G100-200-300-500-600-700-1000

Corrosion Resistance

Similar to the corrosion resistance of AISI 302/304 stainless steel in neutral or basic environments, lower corrosion resistance in acid enviroments (for example in contact with sulphuric acid) or in presence of chlorides. Not recommended for use in marine environments.

AISI 303 STAINLESS STEEL BALLS

Austenitic AISI 303 stainless steel balls, it is characterised by the best workability properties between stainless steels, thanks to the high sulphur content. Balls are provided in the passivated state. They are obtained by a hot forging process.

Applications

Special valves.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	-	-	-	-	-
0,15 max	1,00 max	2,00 max	0,200 max	0,150 min	17,00-19,00	8,00-10,00	-	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X8CrNiS18-9	303	1.4305	Z 8 CNF 18-09	303S31	12CH18N10E	Y1Cr18Ni9	SUS303

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,97
Young's modulus	E	GPa	Mechanical	-	198
Specific heat	c	J/kg-K	Thermal	Room temp.	500
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	16,7
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	15,2
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	715
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,020

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HB	170 - 270	-	-
Ultimate tensile strength	Mechanical	MPa	500 - 1300	psix10^3	72 - 188
Service temperature	Thermal	°C	-196 / 200	°F	-320,8 / 392

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
0,800 - 180,000	mm	1/32 - 7	"	G100-200-300-500-600-700-1000

Corrosion Resistance

The corrosion resistance is lower than AISI 302/304 steels, causing to the high S content that favour pitting corrosion. Steel not recommended for sea water applications.

AISI 904L STAINLESS STEEL BALLS

Austenitic stainless steel balls, thanks to the higher Cr, Ni, Mo and Cu content they show the best corrosion resistance properties for this steel family. Balls are provided in the passivated condition.

Applications

Special pumps and valves, applications in the chemical industry in aggressive environments, sea-water applications.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%N	%Mo	%Cu	-	-
0,020 max	1,00 max	2,00 max	0,045 max	0,035 max	19,00-23,00	23,00-28,00	0,100 max	4,00-5,00	1,00-2,00	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X1 NiCrMoCu 25-20-5	904L	1.4539	Z 2 NCDU 25-20	904S13	-	-	SUS 890L

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,98
Young's modulus	E	GPa	Mechanical	-	193
Specific heat	c	J/kg-K	Thermal	Room temp.	475
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	15,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	12,3
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	925
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,001

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRB	65 - 95	-	-
Ultimate tensile strength	Mechanical	MPa	520 - 620	psix10^3	76 - 89
Service temperature	Thermal	°C	-196 / 450	°F	-320,8 / 842

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
2,500 - 40,000	mm	3/32 - 1.9/16	"	G100-200-300-500-600-700-1000

Corrosion Resistance

Excellent corrosion resistance against acetic, phosphoric and sulphuric acids, chloride solutions, warm sea water. They are attacked in contact with hydrochloric and nitric acids.

SUPER DUPLEX 2507 STAINLESS STEEL BALLS

Super duplex (biphasic structure austenite-ferrite) stainless steel balls, they feature good mechanical properties and excellent corrosion resistance in particular in aggressive environment in presence of chlorides.

Applications

Special pumps and valves for application in chemical, power, shipbulding, petrolchemical, oil and gas industry in chemically aggressive environments.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%N	%Mo	%Cu	-	-
0,030 max	0,80 max	1,20 max	0,035 max	0,020 max	24,00-26,00	6,00-8,00	0,240-0,320	3,00-5,00	0,50 max	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X2CrNiMoN25-7-4	F53 / S32750	1.4410	Z3 CN 25.06 Az	2507	08X22H6T	2507	2507

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,79
Young's modulus	E	GPa	Mechanical	-	200
Specific heat	c	J/kg-K	Thermal	Room temp.	475
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	13,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	15,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	825
Relative magnetic permeability	μ	-	Magnetic	Slighlty ferrom.	33

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	25 - 40	-	-
Ultimate tensile strength	Mechanical	MPa	750 - 950	psix10^3	109 - 137
Service temperature	Thermal	°C	-80 / 300	°F	-112 / 572

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G100-200-300-500-600-700-1000

Corrosion Resistance

Good resistance against pitting, crevice, fatigue, erosion and stress corrosion craking in presence of chlorides, even at high temperatures. Good generalized corrosion resistance against diluted hydrochloric and sulphuric acids, acetic, citric, formic and ossalic acids.

CARPENTER 20 CB 3 BALLS

Austenitic stainless steel balls, they provide excellent mechanical features and corrosion resistance.
This alloy is the best choice to be used in sulphuric acid environments. Balls are provided in the passivated condition.

Applications

Special valves, they are used in foodstuff, chemical, petroleum products, plastic, rubber and explosive industry.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	%Cu	%Nb	%Ta	%(Nb+Ta)	%Fe
0,060 max	1,00 max	2,00 max	0,035 max	0,035 max	19,00-21,00	32,50-35,00	2,00-3,00	3,00-4,00	8x%C-1,00	1,00 max	1,00 max	balance

International standards

20Cb-3 (UNS N08020, DIN 2.4660, alloy 20) is a registered trademark of Carpenter Technology Corporation.

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,08
Young's modulus	E	GPa	Mechanical	-	193
Specific heat	c	J/kg-K	Thermal	Room temp.	500
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	14,7
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	20,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	1082
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,002

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRB	90 - 95	-	-
Ultimate tensile strength	Mechanical	MPa	550 - 630	psix10^3	79 - 92
Service temperature	Thermal	°C	-196 / 500	°F	-320,8 / 932

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G100-200-300-500-600-700-1000

Corrosion Resistance

20 CB 3 provides excellent corrosion resistance properties in aggressive environments (sulphuric acid, ferric sulfate), good resistance to nitric, phosphoric, acetic acids, organic acids, sodium hydroxide and pitting, stress, crevice and intergranular corrosion.

Moderate resistance in sea water.

The presence of chloride ions reduces the corrosion resistance of the alloy.

NITRONIC 50 ALLOY BALLS

Austenitic stainless steel Nitronic 50 balls, they provide good corrosion resistance & mechanical features both at low and high temperatures. The alloy is not magnetic even after cold working. Balls are provided in the passivated condition.

Applications

Special pumps and valves, rod riggings, tang systems.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	%N	%Nb	%V	-
0,060 max	1,00 max	4,00-6,00	0,040 max	0,030 max	20,50-23,50	11,50-13,50	1,50-3,00	0,200-0,400	0,10-0,30	0,10-0,30	-

International standards

Nitronic 50 (UNS S20910, WN 1.3964) is a registered trademark of AK Steel company.

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,88
Young's modulus	E	GPa	Mechanical	-	196
Specific heat	c	J/kg-K	Thermal	Room temp.	500
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	15,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	15,6
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	820
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,003

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	35 - 45	-	-
Ultimate tensile strength	Mechanical	MPa	1050 - 1250	psix10^3	152 - 181
Service temperature	Thermal	°C	-196 / 630	°F	-320,8 / 1166

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290-1 / DIN 5401 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G100-200-300-500-600-700-1000

Corrosion Resistance

Better corrosion resistance than AISI 300 stainless steels series, fair resistance in phosphoric, sulphuric, chloridric, sodium hydroxide and sea water.

Good resistance in acetic and nitric acids.

Balls are subjected to stress corrosion cracking in hot chloride environments.

AISI D2 TOOL STEEL BALLS

High carbon and high chromium tool steel balls, they feature good dimensional stability, high mechanical properties and abrasion/wear resistance.

Applications

Special bearings for applications where high mechanical properties in medium aggressive environments are required.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Mo	%V	-	-	-
1,40-1,60	0,10-0,60	0,10-0,60	0,030 max	0,030 max	11,00-13,00	0,70-1,20	0,50-1,10	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X155CrVMo121KU	D2 / T30402	1.2379	Z160CDV12	BD2	-	Cr12Mo1V1	SKD 11

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,67
Young's modulus	E	GPa	Mechanical	-	209
Specific heat	c	J/kg-K	Thermal	Room temp.	460
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	11,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	20,5
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	650
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 500

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	55 - 65	-	-
Ultimate tensile strength	Mechanical	MPa	2100 - 2500	psix10^3	304 - 362
Service temperature	Thermal	°C	0 / 400	°F	32 / 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades
1,000 - 150,000	mm	3/64 - 6	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

Corrosion Resistance

D2 tool steel balls feature a corrosion resistance slightly better than AISI 420C martensitic stainless steel.

AISI M2 TOOL STEEL BALLS

AISI M2 high speed Mo-V tool steel balls, they provide good toughness and abrasion resistance.

Applications

Special bearings, ball screws.

Chemical composition

Type	%C	%Si	%Mn	%S	%Cr	%Mo	%V	%W	-	-	-
Standard	0,78-0,88	0,20-0,40	0,20-0,40	0,030 max	3,75-4,50	4,50-5,00	1,60-2,20	5,00-6,75	-	-	-
High C	0,95-1,05	0,20-0,40	0,20-0,40	0,030 max	3,75-4,50	4,50-5,00	1,60-2,20	5,00-6,75	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
HS 6-5-2	M2 / T11302	1.3343	Z85WDCV06-05-04-02	BM2	R6AM	W6Mo5Cr4V2	SKH51

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,16
Young's modulus	E	GPa	Mechanical	-	218
Specific heat	c	J/kg-K	Thermal	Room temp.	418
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	10,6
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	24,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	570
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 500

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	62 - 66	-	-
Ultimate tensile strength	Mechanical	MPa	2300 - 2500	psix10^3	334 - 362
Service temperature	Thermal	°C	0 / 400	°F	32 / 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades
1,000 - 150,000	mm	3/64 - 6	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

Corrosion Resistance

The corrosion resistance is better than other tool steels, even if there are materials subjected to corrosive attack when they come in contact with aggressive agents.

AISI M50 TOOL STEEL BALLS

AISI M50 high speed tool steel balls, they provide excellent mechanical properties, hardness and wear resistance at elevated temperatures.

Applications

Special bearings for aircraft uses at elevated temperatures.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	%Cu	%Co	%V	%W
0,80-0,85	0,25 max	0,15-0,35	0,015 max	0,008 max	4,00-4,25	0,15 max	4,00-4,50	0,10 max	0,25 max	0,90-1,10	0,25 max

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
X80MoCrV4 4	M50 / T11350	1.3551	Y80DCV42 16	BM50	-	Cr4Mo4V	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,85
Young's modulus	E	GPa	Mechanical	-	210
Specific heat	c	J/kg-K	Thermal	Room temp.	460
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	11,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	25,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	600
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 500

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	60 - 65	-	-
Ultimate tensile strength	Mechanical	MPa	2500 - 2700	psix10^3	363 - 391
Service temperature	Thermal	°C	0 / 425	°F	32 / 797

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades
1,000 - 150,000	mm	3/64 - 6	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

Corrosion Resistance

Better corrosion resistance than S2 tool steel thanks to the presence of the Chromium in a little percentage.

S-2 ROCKBIT TOOL STEEL SHOCK RESISTING BALLS

Alloy steel through hardened balls, they are featured by high toughness and wear/collision resistance. They are specifically indicated for drilling applications.

Applications

Oil-well drilling, well applications, offshore drilling devices.

Chemical composition

%C	%Si	%Mn	%P	%S	%Mo	%V	-	-	-	-	-
0,40-0,55	0,90-1,20	0,30-0,50	0,030 max	0,030 max	0,30-0,60	0,50 max	-	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
-	T41902	-	-	-	Si-Mo	55SiMoVA	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,72
Young's modulus	E	GPa	Mechanical	-	200
Specific heat	c	J/kg-K	Thermal	Room temp.	468
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	10,8
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	19,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	165
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 500

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	54 - 63	-	-
Ultimate tensile strength	Mechanical	MPa	2100 - 2200	psix10^3	305 - 320
Service temperature	Thermal	°C	-40 / 500	°F	-40 / 932

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades
4,500 - 75,000	mm	3/16 - 3	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

Corrosion Resistance

Good corrosion resistance in alkaline solutions, fairish in contact with salts or industrial atmospheres, poor in contact with water and steam, they do not resist in contact with acid substances.

AISI T15 TOOL STEEL BALLS

Super high speed tool steel tungsten steel AISI T15 balls, they are featured by high hardness and excellent wear resistance, even at high temperatures. They show fair toughness, then they are not suitable to support high shocks stresses.

Applications

Special bearings when excellent wear resistence at high temperature is required.

Chemical composition

%C	%Si	%Mn	%Cr	%Mo	%Co	%V	%W	-	-	-	-
1,50-1,60	0,15-0,40	0,15-0,40	3,75-5,00	1,00 max	4,75-5,25	4,50-5,25	11,75-13,00	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
130505 KU	T15	1.3202	Z160 WKCV	BT 15	-	W12Cr4V5Co5	SKH10

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,30
Young's modulus	E	GPa	Mechanical	-	218
Specific heat	c	J/kg-K	Thermal	Room temp.	461
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	9,5
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	20,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	650
Relative magnetic permeability	μ	-	Magnetic	Ferromagnetic	> 500

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	63 - 68	-	-
Ultimate tensile strength	Mechanical	MPa	3000 - 3500	psix10^3	435 - 507
Service temperature	Thermal	°C	-40 / 540	°F	-40 / 1004

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades
1,000 - 150,000	mm	3/64 - 6	"	See section International Standards: ISO 3290-1 / DIN 5401 / AFBMA

Corrosion Resistance

T15 balls show a corrosion resistance slightly better than M50 high speed tool steel.

ALUMINIUM ALLOYS BALLS SERIES 1XXX

Light balls featured by good corrosion and wear resistance, very good surface finishing. 1xxx series alloys are not heat treated. Balls can be provided in the passivated conditions.

Applications

Special bearings and valves, sealing elements (crushed balls), they are used in automotive industry (safety devices), aviation and aerospace industry, electronic industry, welding processes.

Chemical composition

Type	%Si	%Fe	%Mn	%Cr	%Cu	%Ti	%Al	%V	%Mg	%Zn	-
1050	0,25 max	0,40 max	0,05 max	0,05 max	0,05 max	0,05 max	99,50 min	0,05 max	0,05 max	0,07 max	-
1070	0,20 max	0,25 max	0,03 max	-	0,03 max	0,03 max	99,70 min	0,05 max	0,03 max	0,07 max	-
1100	% (Si+Fe) max 0,95	% (Si+Fe) max 0,95	0,05 max	0,10 max	0,05 - 0,20	0,03 max	99,00 min	0,05 max	0,05 max	0,10 max	-

International standards

Series	Description	Available heat treatments
1xxx	Commercially pure Al	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	2,71
Young's modulus	E	GPa	Mechanical	-	70
Specific heat	c	J/kg-K	Thermal	Room temp.	875
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	23,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	220,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	28
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,004

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV0.5	20-50	-	-
Ultimate tensile strength	Mechanical	MPa	65-165	psix10^3	10 - 23
Service temperature	Thermal	°C	-196 / 200	°F	-320,8 / 392

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 150,000	mm	3/64 - 6	"	G100-200-500-1000

Corrosion Resistance

1xxx series alloys provide better corrosion resistance thanks to their purity. Good resistance on almost all natural waters. All aluminium alloys are subjected to pitting corrosion in presence of chlorides.

ALUMINIUM ALLOYS BALLS SERIES 2XXX

Light balls feaature good corrosion and wear resistance, very good surface finishing. 2xxx series alloys allow to get better mechanical characteristics. Balls can be provided in the passivated condition.

Applications

Special bearings and valves, sealing elements (crushed balls), they are used in automotive industry (safety devices), aviation and aerospace industry, electronic industry, welding processes.

Chemical composition

Type	%Si	%Fe	%Mn	%Cr	%Cu	%Ti	%Al	%Mg	%Zn	-	-
2017	0,20-0,80	0,70 max	0,40-1,00	0,10 max	3,50-4,50	0,15 max	balance	0,40-0,80	0,25 max	-	-
2024	0,50 max	0,50 max	0,30-0,90	0,10 max	3,80-4,90	0,15 max	balance	1,20-1,80	0,25 max	-	-

International standards

Series	Description	Available heat treatments
2xxx	Al-Cu alloy	2017 A - 2017 W - 2017 T4 - 2024 T351 - 2024 T4

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	2,78
Young's modulus	E	GPa	Mechanical	-	73
Specific heat	c	J/kg-K	Thermal	Room temp.	795
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	22,9
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	136,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	43
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,004

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV	125-185	-	-
Ultimate tensile strength	Mechanical	MPa	400-500	psix10^3	58 - 72
Service temperature	Thermal	°C	-196 / 200	°F	-320,8 / 392

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
0,800 - 150,000	mm	1/32 - 6	"	G100-200-500-1000

Corrosion Resistance

2xxx series alloys are lower resistant than 1xxx series alloys due to the significant Cu content, that can generate galvanic reactions. They can be affected by corrosion under industrial and sea environments. All aluminium alloys are subjected to pitting corrosion in presence of chlorides.

ALUMINIUM ALLOYS BALLS SERIES 3XXX

Light balls characterized by good corrosion and wear resistance, very good surface finishing.
Series 3xxx alloys are not heat treated and show slightly better mechanical characteristics with respect to 1xxx series.
Balls can be provided in the passivated state.

Applications

Special bearings and valves, they are used in automotive industry (safety devices), electronic industry, welding processes.

Chemical composition

Type	%Si	%Fe	%Mn	%Cu	%Al	%Zn	-	-	-	-	-
3003	0,60 max	0,70 max	1,00-1,50	0,05-0,20	balance	0,10 max	-	-	-	-	-

International standards

Series	Description	Available heat treatments
3xxx	Al-Mn alloy	3003 T0

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	2,73
Young's modulus	E	GPa	Mechanical	-	69
Specific heat	c	J/kg-K	Thermal	Room temp.	893
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	23,5
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	178,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	37
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,004

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV	25 - 55	-	-
Ultimate tensile strength	Mechanical	MPa	130 - 170	psix10^3	19 - 24
Service temperature	Thermal	°C	-196 / 200	°F	-320,8 / 392

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 150,000	mm	3/64 - 6	"	G100-200-500-1000

Corrosion Resistance

Series 3xxx aluminium alloys show a corrosion resistance slightly worse to the series 1xxx.

They have a very good resistance to atmosheric corrosion and they are particularly resistant to pitting corrosion (except than in presence of chlorides).

ALUMINIUM ALLOYS BALLS SERIES 5XXX

Light balls featured by good corrosion and wear resistance, very good surface finishing. 5xxx series alloys feature a good workability.

Applications

Special bearings and valves, they are used in automotive industry (safety devices), aviation and aerospace industry, electronic industry, welding processes.

Chemical composition

Type	%Si	%Fe	%Mn	%Cr	%Cu	%Al	%Mg	%Zn	%Other(each)	%Other(total)
5050	0,40 max	0,70 max	0,10 max	0,10 max	0,20 max	balance	1,10-1,80	0,25 max	0,05 max	0,15 max
5056	0,30 max	0,40 max	0,05-0,20	0,05-0,20	0,10 max	balance	4,50-5,60	0,10 max	0,05 max	0,15 max

International standards

Series	Description	Available heat treatments
5xxx	Al-Mg alloy	5050 O - 5056 T2

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	2,68
Young's modulus	E	GPa	Mechanical	-	72
Specific heat	c	J/kg-K	Thermal	Room temp.	904
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	23,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	153,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	48
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,004

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV0.5	31-41 (Al 5050)	HV0.5	130-150 (Al 5056)
Ultimate tensile strength	Mechanical	MPa	120-160 (Al 5050) / 420-480 (Al 5056)	psix10^3	18-23 (Al 5050) / 61-69 (Al 5056)
Service temperature	Thermal	°C	-196 / 200	°F	-320,8 / 392

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 150,000	mm	3/64 - 6	"	G100-200-500-1000

Corrosion Resistance

Corrosion resistance similar to series 1xxx, better against chlorides and alkaline solutions. Good atmospheric corrosion resistance and against freshwater, seawater, organic acids, aldehydes. All aluminium alloys are subjected to pitting corrosion in presence of chlorides.

ALUMINIUM ALLOYS BALLS SERIES 6XXX

Light balls featured by good corrosion and wear resistance, very good surface finishing. 6xxx series alloys, thanks to Si and Mg addition, are heat treatable. They feature mechanical properties slightly lower than 2xxx and 7xxx series.

Applications

Special bearings and valves, they are used in automotive industry (safety devices), shipbuilding industry, aviation and aerospace industry, electronic industry, welding processes.

Chemical composition

Type	%Si	%Fe	%Mn	%Cr	%Cu	%Al	%Mg	%Zn	%Ti	-	-
6061	0,40-0,80	0,70 max	0,15 max	0,04-0,35	0,15-0,40	balance	0,80-1,20	0,25 max	0,15 max	-	-

International standards

Series	Description	Available heat treatments
6xxx	Al-Si-Mg alloy	6061 T6

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	2,70
Young's modulus	E	GPa	Mechanical	-	69
Specific heat	c	J/kg-K	Thermal	Room temp.	898
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	23,8
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	168,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	40
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,004

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV0.5	85 - 105	-	-
Ultimate tensile strength	Mechanical	MPa	280 - 340	psix10^3	41 - 49
Service temperature	Thermal	°C	-196 / 200	°F	-320,8 / 392

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 150,000	mm	3/64 - 6	"	G100-200-500-1000

Corrosion Resistance

Good corrosion resistance in atmosphere and water, even in marine environment. Corrosion resistance of 6xxx series alloy is usually slighlty lower than 1xxx and 5xxx series. Intergranular corrosion in aggressive environments due to the allowed copper content can be reduced by means of suitable heat treatments. They are subjected to pitting corrosion in presence of chlorides.

ALUMINIUM ALLOYS BALLS SERIES 7XXX

Light balls feature good corrosion and wear resistance, very good surface finishing. Series 7xxx alloys are heat treated and show the best mechanical properties between aluminium alloys. Balls can be provided in the passivated state.

Applications

Special bearings and valves, they are used in the aeronautic, aerospace, military fields and in welding processes.

Chemical composition

Type	%Si	%Fe	%Mn	%Cr	%Cu	%Ti	%Al	%Mg	%Zn	%Other(each)	%Other(total)
7A03	0,20 max	0,20 max	0,10 max	0,05 max	1,80-2,40	0,02-0,08	balance	1,20-1,60	6,00-6,70	0,05 max	0,10 max
7A09	0,50 max	0,50 max	0,15 max	0,16-0,30	1,20-2,00	0,10 max	balance	2,00-3,00	5,10-6,10	0,05 max	0,10 max

International standards

Series	Description	Available heat treatments
7xxx	Al-Zn alloy	T6

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	2,81
Young's modulus	E	GPa	Mechanical	-	71
Specific heat	c	J/kg-K	Thermal	Room temp.	888
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	23,9
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	156,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	45
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,004

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV	160-180	-	-
Ultimate tensile strength	Mechanical	MPa	450-550	psix10^3	66 - 79
Service temperature	Thermal	°C	-196 / 200	°F	-320,8 / 392

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 150,000	mm	3/64 - 6	"	G100-200-500-1000

Corrosion Resistance

Series 7xxx aluminium alloys show a corrosion resistance slighty better with respect to 2xxx series, but worse with respect to 1xxx and 3xxx series. They can subjected to pitting corrosion and stress corrosion cracking corrosion in aggressive environments.

BRASS BALLS

Brass balls show fairish mechanical performance, good corrosion resitance, excellent electrical properties. They generate low frictions.
Balls are provided in the passivated condition.

Applications

Special valves, industrial pumps and valves, electronic devices, safety switches, heating units, appliances, furniture rails.

They are used in the automotive, electronic and petrochemical industry.

Chemical composition

Type	%Cu	%Zn	%Pb	%Fe	-	-	-	-	-	-	-
C26000	68,50-71,50	balance	0,070 max	0,050 max	-	-	-	-	-	-	-
C27000	63,00-68,50	balance	0,090 max	0,070 max	-	-	-	-	-	-	-
C28000	59,00-63,00	balance	0,090 max	0,070 max	-	-	-	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
P-CuZn30	C26000	2.0265	CuZn30	CZ106	L70	H70	C2600
P-CuZn35	C27000	2.0335	CuZn36	CZ107	L63	H65	C2700
P-CuZn40	C28000	2.0360	CuZn40	CZ109	L60	H62	C2800

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,49
Young's modulus	E	GPa	Mechanical	-	110
Specific heat	c	J/kg-K	Thermal	Room temp.	375
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	20,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	118,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	63
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,05

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRB	75 - 95	-	-
Ultimate tensile strength	Mechanical	MPa	500 - 600	psix10^3	72 - 87
Service temperature	Thermal	°C	-196 / 500	°F	-320,8 / 932

www.rgpballs.com

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
0,400 - 180,000	mm	1/64 - 7	"	G100-200-500-1000-2000

Corrosion Resistance

Good corrosion resistance in drinking-water, brackish water, sea-water (except at high flow rate), salt atmospheres, petroleum products, alcohols.

Fairish resistance with respect to acids and alkali.

It does not resist in contact with hydroxides, cyanides, oxidizing acids.

As a general rule, corrosion resistance decreases as zinc content increases.

BRONZE ALUMINUM ALLOYS

Bronze Al alloys are characterized by good mechanical characteristics and hardness.
Balls are provided in the passivated condition.

Applications

Special pumps and valves, electronic industry, decorative applications.

Chemical composition

%Si	%Ni	%Cu	%Al	%Zn	%Pb	%Fe	-
0,10 max.	0,50 max.	balance	6,00 - 8,50	0,20 max.	0,02 max.	0,50 max.	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
CuAl8	C61000	2.0920	CuAl8	CA102	BrA7	QAl7	CuAl8

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,66
Young's modulus	E	GPa	Mechanical	-	119
Specific heat	c	J/kg-K	Thermal	Room temp.	376
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	13,9
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	69,1
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	115
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,05

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	27 - 32	-	-
Ultimate tensile strength	Mechanical	MPa	600 - 700	psix10^3	87 - 101
Service temperature	Thermal	°C	-196 / 400	°F	-320,8 / 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,500 - 180,000	mm	1/16 - 7	"	G50-100-200-500-1000-2000

Corrosion Resistance

Good corrosion resistance in hot concentrated caustic solutions and salt solutions, excellent in sea water environments.

Balls resist if they are plunged in acetic acid, dry ammonia, sodium carbonate, phosphates, bromide and chloride solutions (dry atmosphere).

BRONZE ALUMINUM NICKEL ALLOYS

Bronze Al Ni alloys, they feature excellent mechanical properties and abrasione and wear resistance. The addition of Ni increases the corrosion resistance without loss of other main properties of the alloy.
Balls are provided in the passivated condition.

Applications

Special pumps and valves for applications in the aerospace, automotive and marine fields.

Chemical composition

%Si	%Mn	%P	%Ni	%Cu	%Al	%Sn	%Zn	%Pb	%Fe
0,10 max.	0,30 max.	0,010 max.	3,50 - 5,50	balance	9,50 - 11,00	0,10 max.	0,50 max.	0,020 max.	3,50 - 5,50

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
P-CuAl10Ni5Fe5	C63000	2.0966	CuAl9Ni5Fe3	CA104	BrAZHN10-4-4	QAL 10-4-4	C6301

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	7,56
Young's modulus	E	GPa	Mechanical	-	120
Specific heat	c	J/kg-K	Thermal	Room temp.	398
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	16,3
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	51,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	207
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,03

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	29 - 34	-	-
Ultimate tensile strength	Mechanical	MPa	680 - 760	psix10^3	99 - 110
Service temperature	Thermal	°C	-196 / 400	°F	-320,8 / 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,500 - 180,000	mm	1/16 - 7	"	G50-100-200-500-1000-2000

Corrosion Resistance

Bronze Al Ni alloys are indicated for seawater applications. They feature good stress corrosion cracking and corrosion fatigue resistance. They are not affected by chloride pitting. They are attacked in enviroments containing hydrogen sulfide.

PHOSPHOR BRONZE ALLOYS

P-Bronze alloys provide good mechanical and electric performances, corrosion and wear resistance. Balls are produced in the passivated condition.

Applications

Special valves and pumps, check valves, special bearings, electric conductors.

Chemical composition

Type	%P	%Cu	%Sn	%Zn	%Pb	%Fe	-	-	-	-	-
CuSn5	0,030-0,350	balance	4,20-5,80	0,30 max	0,050 max	0,10 max	-	-	-	-	-
CuSn6	0,030-0,350	balance	5,00-7,00	0,30 max	0,050 max	0,10 max	-	-	-	-	-
CuSn8	0,030-0,350	balance	7,00-9,00	0,20 max	0,050 max	0,10 max	-	-	-	-	-

International standards

CEN	USA	GER	FRA	UK	RUS	CHN	JAP
CW451K	C51000	-	CuSn5Zn4	PB 102	-	QSn4-0.3	C5102
CW452K	C51900	2.1020	CuSn6p	PB 103	BrOF6,5-0,15	QSn6.5-0.1	C5191
CW453K	C52100	2.1030	CuSn9p	PB 104	-	QSn8-0.3	C5210

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,92
Young's modulus	E	GPa	Mechanical	-	116
Specific heat	c	J/kg-K	Thermal	Room temp.	380
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	18,2
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	65,8
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	115
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,20

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRB	75 - 105	HV10	135 - 276
Ultimate tensile strength	Mechanical	MPa	600 - 700	psix10^3	87 - 102
Service temperature	Thermal	°C	-196 / 400	°F	-320,8 / 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,500 - 180,000	mm	1/16 - 7	"	G100-200-500-1000-2000

Corrosion Resistance

Good in contact with water, steam, mineral oils, petrol. They do not resist against acids and alkalis. They are less corrosion resistant than Bronze Al.

COPPER BALLS

Nearly pure copper balls, they show good mechanical and corrosion resistance properties, excellent thermal and electric conductivity.
Small amounts of alloying elements as Cr, Zr, Ag, Cd, Mg, Sn allow to improve the mechanical properties.

Applications

Copper balls are used in galvanic applications and in the field of electronic industry.

Chemical composition

%Cu	%Other	-	-	-	-	-	-	-	-	-	-
99,900 min	0,010 max	-	-	-	-	-	-	-	-	-	-

International standards

EN	USA	GER	FRA	UK	RUS	CHN	JAP
CW004A	C11000	2.0065	Cu-a 1	C101	M0	T2	C 1100

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,91
Young's modulus	E	GPa	Mechanical	-	123
Specific heat	c	J/kg-K	Thermal	Room temp.	385
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	16,9
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	393,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	17
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,010

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV	40 - 120	-	-
Ultimate tensile strength	Mechanical	MPa	220 - 320	psix10^3	31 - 46
Service temperature	Thermal	°C	-196 / 260	°F	-320,8 / 500

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 60,000	mm	3/64 - 2.3/8	"	G100-200-500-1000

Corrosion Resistance

Good corrosion resistance in marine and industrial atmospheres, steam, alkali, neutral saline solutions.

They do not resist in contact with oxidizing acids, halogens, sulphides, ammonia, sea water.

COPPER BERYLLIUM ALLOY BALLS

Cu-Be age hardening alloy balls, they provide high mechanical features, excellent wear-resistance, very good electric conductivity.

Applications

Special bearings, low maintenance bearings, electric connectors, applications in aggressive environments.

Chemical composition

%Si	%Cu	%Al	%Be	%(Co+Ni)	%(Co+Ni+Fe)	-	-	-	-	-	-
0,20 max	balance	0,20 max	1,80-2,00	0,20 min	0,60 max	-	-	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
CuBe2	C17200	2.1247	CuBe1,9	CB101	BrB2	QBe2	C 1720

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,3
Young's modulus	E	GPa	Mechanical	-	127
Specific heat	c	J/kg-K	Thermal	Room temp.	400
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	13,5
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	105,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	80
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,0025

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	40 - 45	HV	390 - 450
Ultimate tensile strength	Mechanical	MPa	1200 - 1600	psix10^3	174 - 232
Service temperature	Thermal	°C	-196 / 260	°F	-320,8 / 500

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G50-100-200-500-1000

Corrosion Resistance

Cu-Be alloy is resisting to corrosive attacks in sea water, neutral salt solutions, petroleum products.

Fairish resistance to sodium hydroxide solutions, balls do not resist in ferric chloride, sulfides, organic and inorganic strong acids in oxidizing environment, ammonium hydroxide, ammonia steams, molten metals.

Absolutely not to put in contact with acetylene (explosive reaction).

HASTELLOY C4 ALLOY BALLS

Ni-Cr-Mo alloy with excellent ductility, high temperature resistance, pitting/crevice/stress corrosion cracking resistance.
Balls are provided in the passivated condition.

Applications

Special valves and pumps for the chemical industry.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	%Co	%Ti	%Fe	-
0,015 max	0,080 max	1,00 max	0,040 max	0,030 max	14,00-18,00	balance	14,00-17,00	2,00 max	0,70 max	3,00 max	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
NiMo16Cr16Ti	N06455	2.4610	NiMo16Cr16Ti	-	-	NS335	NW6455

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,64
Young's modulus	E	GPa	Mechanical	-	212
Specific heat	c	J/kg-K	Thermal	Room temp.	407
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	10,8
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	10,1
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	1245
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,0001

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV	350 - 480	-	-
Ultimate tensile strength	Mechanical	MPa	1300 - 1500	psix10^3	189 - 217
Service temperature	Thermal	°C	-196 / 400	°F	-320,8 / 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G50-100-200-500

Corrosion Resistance

Excellent corrosion resistance in contact with mineral acids, solvents, chlorine environments, acetic acid, formic acid, acetic anydride, sea water, oxidinzing atmospheres.

Good corrosion resistance in organic acid and chloride acids.

Fair resistance with respect to C276 alloy in strong reducing environments.

HASTELLOY C22 ALLOY BALLS

Fully austenitic NiCrMoW alloy with excellent corrosion resistance properties, both uniform and localized, even at higher temperatures, better than C276 and C4 alloys.
Balls are provided in the passivated conditions.

Applications

C22 balls are used in special valves and pumps for the chemical industry, mainly in multi-purposes devices where it is required an excellent corrosion resistance against aggressive and changing environments (both oxidizing and reducing environments).

Typical use in valves in contact with chlorine.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	%Co	%W	%V	%Fe
0,015 max	0,080 max	0,50 max	0,020 max	0,020 max	20,00-22,50	balance	12,50-14,50	2,50 max	2,50-3,50	0,35 max	2,00-6,00

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
NiCr21Mo14W	N06022	2.4602	NiCr21Mo14W	-	-	NS336	NW6022

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,69
Young's modulus	E	GPa	Mechanical	-	206
Specific heat	c	J/kg-K	Thermal	Room temp.	414
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	12,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	9,8
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	1140
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,0002

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV	250 - 480	-	-
Ultimate tensile strength	Mechanical	MPa	1400 - 1700	psix10^3	203 - 246
Service temperature	Thermal	°C	-196 / 400	°F	-320,8 / 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G50-100-200-500

Corrosion Resistance

Excellent corrosion resistance both in oxidizing and reducing environments, in contact with ferric and cuprum chlorides, hot contaminated organic and inorganic solutions, acetic, formic and nitric, sulphuric, hydrochloric acids, oxidizing acids, acetic angydride and sea water (both in stagnant and flowing conditions).

HASTELLOY C276 ALLOY BALLS

Ni based alloy balls, they show very good crevice, pitting and stress corrosion resistance, both on oxidating and reducing environments. Good wear resistance.
Balls are provided in the passivated condition.

Applications

Special pumps and valves, they are applied in the foodstuff, paper, chemical pharmaceutical, naval, petrol, textile industry.

Devices for waste treatment, pollution check, flue gas desulfurization, turbines.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	%Co	%W	%V	%Fe
0,010 max	0,080 max	1,00 max	0,040 max	0,030 max	14,50-16,50	balance	15,00-17,00	2,50 max	3,00-4,50	0,35 max	4,00-7,00

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
NiMo16Cr15W	N10276	2.4819	NiMo16Cr15W	NC17D	KHN65MV	NS334	NW0276

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,92
Young's modulus	E	GPa	Mechanical	-	195
Specific heat	c	J/kg-K	Thermal	Room temp.	424
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	11,1
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	11,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	1275
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,0002

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	32 - 48	-	-
Ultimate tensile strength	Mechanical	MPa	1140 - 1240	psix10^3	165 - 180
Service temperature	Thermal	°C	-196 / 400	°F	-320,8 / 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G50-100-200-500

Corrosion Resistance

Hastelloy C276 alloy is resisting against strong oxidizing agents like zinc, ammonium, iron and copper chlorides, acetic, formic, phosphoric, nitric, sulphuric, hydrofluoric, acids, hypochlorite, ferric and cupric salt solutions, acetic anhydride, sea water.

INCONEL 600 ALLOY BALLS

Age hardening Ni based alloy, they provide good mechanical features, corrosion resistance and high temperature oxidation resistance.
Balls are provided in the passivated conditions.

Applications

Special pumps and valves, automotive components, heat exchangers, turbines. They are applied in the foodstuff, aerospace, chemical, naval, nuclear, petrol industry.

Chemical composition

%C	%Si	%Mn	%S	%Cr	%Ni	%Cu	%Fe	-	-	-	-
0,15 max	0,50 max	1,00 max	0,015 max	14,00-17,00	72,00 min	0,50 max	6,00-10,00	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
-	N06600	2.4816	NC15FE	NA14	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,44
Young's modulus	E	GPa	Mechanical	-	210
Specific heat	c	J/kg-K	Thermal	Room temp.	437
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	11,9
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	14,9
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	1015
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,010

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	28 - 33	-	-
Ultimate tensile strength	Mechanical	MPa	725-1035	psix10^3	105-150
Service temperature	Thermal	°C	-196 / 1000	°F	-320,8 / 1832

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G50-100-200-500

Corrosion Resistance

Inconel 600 balls are used in environments too aggressive for stainless steel. Excellent corrosion resistance with respect to hot sulphuric acids, oxidizing acids and sea water.

Good resistance to chloride gases even at high temperature. They can suffer selective oxidation if they are alternatively subjected to oxiding and reducing conditions.

INCONEL 625 ALLOY BALLS

Ni based alloy with high corrosion resistance properties, even in very aggressive environments.
Balls are provided in the passivated condition.

Applications

Sea water applications, compressors, heat exchangers, turbines, special pumps and valves.

They are used in aviation, aerospace, chemical, naval, military, nuclear, petrol industry, high temperature applications.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Cu	%Mo	%Nb	%Co	%Al	%Ti	%Fe
0,100 max	0,50 max	0,50 max	0,015 max	0,015 max	20,00-23,00	58,00 min	0,50 max	8,00-10,00	3,15-4,15	1,00 max	0,40 max	0,40 max	5,00 max

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
-	N06625	2.4856	NC 22 D Nb	NA21	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,42
Young's modulus	E	GPa	Mechanical	-	207
Specific heat	c	J/kg-K	Thermal	Room temp.	420
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	13
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	9,9
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	1275
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,020

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	30 - 48	HV	300 - 480
Ultimate tensile strength	Mechanical	MPa	1000 - 1100	psix10^3	145 - 161
Service temperature	Thermal	°C	-196 / 1000	°F	-320,8 / 1832

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G50-100-200-500

Corrosion Resistance

Excellent resistance to crevice and pitting corrosion. Inconel 625 alloy resist in contact with chlorides, alkaline compounds, neutral salts, air.

Good corrosion resistance with respect to nitric, phosphoric, sulphuric, hydrochloric acid and alkali.

INCONEL 718 BALLS

High strength, corrosion-resistant material. Special nickel-chromium alloy, suitable for extreme applications.
Balls are provided in the passivated condition.

Applications

Gas turbine engines, aerospace and cryogenic applications.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Cu	%Mo	%Ti	%Nb	%Al	%Co	%Fe
0,020-0,080	0,35 max	0,35 max	0,015 max	0,015 max	17,00-21,00 max	50,00-55,00	0,30 max	2,80-3,30	0,60-1,20	4,70-5,50	0,30-0,70	1,00 max	5,00 max

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
-	N07718	2.4668	NC 19 Fe Nb	-	-	GH/4169	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,20
Young's modulus	E	GPa	Mechanical	-	204
Specific heat	c	J/kg-K	Thermal	Room temp.	435
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	13,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	11,3
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	1250
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,010

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	20 - 40	-	-
Ultimate tensile strength	Mechanical	MPa	1100 - 1300	psix10^3	160 - 188
Service temperature	Thermal	°C	-196 / 700	°F	-320,8 / 1292

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G50-100-200-500

Corrosion Resistance

Similar to other Ni-base alloys, they provide excellent pitting and interstitial corrosion resistance.

INCONEL X-750 ALLOY BALLS

Ni based alloy with excellent mechanical properties and corrosion resistance. Used both for elevated and low temperatures application. Balls are provided in the passivated condition.

Applications

Turbine gas components that work at high temperature, special pumps and valves, special moulding, check of pollution devices, heat treatments devices, heat exchangers, turbines. They are used in the aerospace, aviation industry, chemical, military and nuclear industry.

Chemical composition

%C	%Si	%Mn	%S	%Cr	%Ni	%Cu	%Ti	%Nb	%Al	%Fe	-
0,080 max	0,50 max	1,00 max	0,015 max	14,00-17,00	70,00 min	0,50 max	2,25-2,75	0,70-1,20	0,40-1,00	5,00-9,00	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
-	N07750	2.4669	NC 15Fe-T	HR 505	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,28
Young's modulus	E	GPa	Mechanical	-	211
Specific heat	c	J/kg-K	Thermal	Room temp.	440
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	12,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	12,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	1230
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,004

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	31 - 36	-	-
Ultimate tensile strength	Mechanical	MPa	1250 - 1350	psix10^3	181 - 196
Service temperature	Thermal	°C	-196 / 820	°F	-320,8 / 1508

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G50-100-200-500

Corrosion Resistance

Inconel 750 alloy is resisting against a wide variety of industrial corrosive oxidizing and reducing environments. Excellent resistance with respect to stress corrosion in chlorides environments.

INCOLOY 825 ALLOY BALLS

Austenitic NiCrFe alloy balls, they provide excellent corrosion resistance in aggressive environments, both general and localized.

Applications

Special valves for the chemical industry.

Chemical composition

%C	%Si	%Mn	%P	%S	%Cr	%Ni	%Mo	%Cu	%Ti	%Al	%Fe
0,050 max	0,50 max	1,00 max	0,020 max	0,030 max	19,50-23,50	38,00-46,00	2,50-3,50	1,50-3,00	0,60-1,20	0,20 max	22,00 min

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
-	N08825	2.4858	NC 21 FeDU	NA 16	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,14
Young's modulus	E	GPa	Mechanical	-	196
Specific heat	c	J/kg-K	Thermal	Room temp.	440
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	14,1
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	11,2
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	1130
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,005

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	25 - 30	-	-
Ultimate tensile strength	Mechanical	MPa	850 - 950	psix10^3	123 - 138
Service temperature	Thermal	°C	-196 / 540	°F	-320,8 / 1004

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G50-100-200-500

Corrosion Resistance

Excellent corrosion resistance in contact with oxidizing and reducing compounds, as chlorids, phosphoric, nitric, sulphuric acids, sodium and potassium hydroxide, hydrochloric acid, sea water.

MONEL 400 ALLOY BALLS

Ni-Cu based alloys with good mechanical characteristics and excellent corrosion resistance. Balls are provided in the passivated condition.

Applications

Special pumps and valves, flue gas desulfurization, heat exchangers.

They are used in the paper, chemical, pharmaceutical, naval, petrol and textile industry.

Chemical composition

%C	%Si	%Mn	%S	%Ni	%Cu	%Co	%Fe	-	-	-	-
0,30 max	0,50 max	2,00 max	0,024 max	63,00-70,00	28,00-34,00	1,00 max	2,50 max	-	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
-	N04400	2.4360	Nu 30	NA 13	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,82
Young's modulus	E	GPa	Mechanical	-	177
Specific heat	c	J/kg-K	Thermal	Room temp.	436
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	13,7
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	21,9
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	529
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,010

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	17 - 22	-	-
Ultimate tensile strength	Mechanical	MPa	670 - 770	psix10^3	97 - 112
Service temperature	Thermal	°C	-196 / 600	°F	-320,8 / 1112

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G50-100-200-500

Corrosion Resistance

Monel 400 is resisting in contact with sea water, steam even at high temperature, caustic salts and solutions.

Good corrosion resistance in sulphuric, hydrofluoric and hydrochlorine acids, organic acids, alkaline salts, calcium chloride.

It is not resisting against ferric chloride.

MONEL K 500 ALLOY BALLS

Ni-Cu precipitation hardening alloy, it presents higher hardness and load resistance with respect to Monel 400 alloy but same corrosion resistance. Balls are provided in the passivated state.

Applications

Special pumps and valves, they are used in paper, chemical, electronic, pharmaceutical, naval, petrol and textile industry.

Chemical composition

%C	%Si	%Mn	%S	%Ni	%Cu	%Ti	%Al	%Fe	-	-	-
0,25 max	0,50 max	1,50 max	0,010 max	63,00-70,00	27,00-33,00	0,35-0,85	2,30-3,15	2,00 max	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
-	N05500	2.4375	NU 30 AT	NA 18	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,42
Young's modulus	E	GPa	Mechanical	-	178
Specific heat	c	J/kg-K	Thermal	Room temp.	415
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	13,6
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	17,4
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	615
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,005

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRB	75 - 90 (standard)	HRC	24 - 34 (age hardening)
Ultimate tensile strength	Mechanical	MPa	920 - 1020	psix10^3	133 - 148
Service temperature	Thermal	°C	-196 / 650	°F	-320,8 / 1202

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G50-100-200-500

Corrosion Resistance

Good corrosion resistance in sulphuric, hydrofluoric and hydrochloride acid, and alkali solutions.

It resists in contact with neutral, basic and acid salts.

Excellent corrosion resistance in marine environment, even at high flow rate.

Fair resistance in contact with oxidizing salts and ferric chloride, nitric acid.

TITANIUM ALLOYS GRADE 1 - GRADE 2

Titanium balls provide low weight, good mechanical features, thermal properties and corrosion resistance. They are used even in aesthetic applications. Grade 1 and grade 2 belongs to the Commercially Pure Titanium Alloys family.

Applications

Titanium balls are used in aviation, aerospace, military, chemical, petrochemical industry, in the medical field, jewelry, calibration of measurement instruments, piercing purposes.

Chemical composition

Type	%C	%N	%Ti	%Fe	%O	%H	-	-	-
CP-Ti G1	0,080 max	0,030 max	balance	0,20 max	0,18 max	0,015 max	-	-	-
CP-Ti G2	0,080 max	0,030 max	balance	0,30 max	0,25 max	0,015 max	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
-	R50250	3.7025	T-35	2 TA 1	VT1-00	TA 1	Ti Class 1
-	R50400	3.7035	T-40	TA 2 to 5	VT1-L	TA 2	Ti Class 2

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	4,51
Young's modulus	E	GPa	Mechanical	-	103
Specific heat	c	J/kg-K	Thermal	Room temp.	518
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	8,6
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	21,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	560
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,0001

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	28 - 42	HV	285 - 415
Ultimate tensile strength	Mechanical	MPa	330 - 550	psix10^3	48 - 79
Service temperature	Thermal	°C	-196 / 400	°F	-320,8 / 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G100-200-500-1000

Corrosion Resistance

They resist in contact with salt water and marine atmosphere, oxidizing acids, chlorides (in presence of water). Good corrosion resistance in a wide variety of acids, alkali, and industrial atmospheres. Fairish resistance in sulphuric acid and sodium hydroxide. They do not resist in reducing acids, chlorides gases. CP-Ti 1 grade shows a slightly better corrosion resistance than CP-Ti 2 grade alloy.

TITANIUM ALLOYS GRADE 5 - GRADE 23

Titanium balls provide low weight, good mechanical features, thermal properties and corrosion resistance. They are used even in aesthetic applications. TiAl6V4 is the most common used Ti alloy all over the world. Grade 23 is manufactured with lower impurities content (TiAl6V4 ELI: Extra Low Interstitial). Balls are provided in the passivated condition.

Applications

Aviation, aerospace, military, chemical, petrochemical industry, in the medical field, jewelry, calibration of measurement instruments, piercing purposes.

Chemical composition

Type	%C	%N	%Ti	%Al	%V	%Fe	%O	%H	-	-	-
TiAl6V4	0,080 max	0,050 max	balance	5,50-6,75	3,50-4,50	0,30 max	0,20 max	0,015 max	-	-	-
TiAl6V4 ELI	0,080 max	0,050 max	balance	5,50-6,50	3,50-4,50	0,25 max	0,13 max	0,012 max	-	-	-

International standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
TiAl6V4	R56400	3.7164	TA6V	TA10-13; TA28	-	TiAl6V4	-
TiAl6V4 ELI	R56401	3.7165	T6V	TA11	-	TiAl6V4 ELI	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	4,45
Young's modulus	E	GPa	Mechanical	-	114
Specific heat	c	J/kg-K	Thermal	Room temp.	523
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	9,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	6,7
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	1780
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	1,0001

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	28 - 42	HV	285 - 415
Ultimate tensile strength	Mechanical	MPa	625 - 830	psix10^3	90 - 120
Service temperature	Thermal	°C	-196 / 400	°F	-320,8 / 752

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G100-200-500-1000

Corrosion Resistance

Balls are resisting in contact with salt water and marine atmosphere, oxidizing acids, chlorides (in presence of water). Good corrosion resistance in a wide variety of acids, alkali, and industrial atmospheres. Fairish resistance in sulphuric acid and sodium hydroxide. Balls are not resisting in reducing acids, chlorides gases. Grade 23 shows a corrosion resistance behaviour in sea water slightly better than grade 5 alloy.

TUNGSTEN CARBIDE (WC) TC K10 Co BINDER ALLOY BALLS

Tungsten carbide balls with small grain size, they provide higher hardness and wear resistance than TC K20 and TC K30 carbides. The impact resistance is much lower. Virgin powders always used.

Applications

Similar to TC K20 and TC K30 carbides, they are used when higher hardness and wear resistance are required.

Chemical composition

Type	%WC	%Co	-	-	-	-	-	-	-	-	-
TC K10	93,00-95,00	5,00-7,00	-	-	-	-	-	-	-	-	-

International standards

Type	ISO	USA	CHN	-	-	-	-
TC K10	K05-K10	C3	YG018	-	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	14,82
Young's modulus	E	GPa	Mechanical	-	650
Specific heat	c	J/kg-K	Thermal	Room temp.	220
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	5,2
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	80,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	200
Relative magnetic permeability	μ	-	Magnetic	Slighlty ferrom.	max 12

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Grain size	Physical	µm	~ 0,6	-	-
Hardness	Mechanical	HRA	92,5 - 94,0	HV	1945 - 2175
Ultimate compressive strength	Mechanical	MPa	5600 - 6000	psix10^3	813 - 870
Service temperature	Thermal	°C	-196 / 500	°F	-320,8 / 932

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
0,200 - 127,000	mm	1/64 - 5	"	G5-10-16-20-25-28-40-60-100

Corrosion Resistance

Similar to the corrosion resistance of TC K20 and TC K30 tungsten carbides.

TUNGSTEN CARBIDE (WC) K20 Co BINDER (ALLOY) BALLS

K20 WC balls are used in applications where extreme hardness and resistance to wear, abrasion, collision and deformation are required. Virgin powder is strictly used into this production.

Applications

Special and hydraulic precision valves, special bearings, couplers, flow meters, sprayers, recirculating balls, ball splines, tool machines, sliding rails, ballpoint pens, pin and tips for indicators, precision measurement instruments, medical instruments. They are used in naval, mining, petrol and coining industry.

Chemical composition

Type	%WC	%Co	-	-	-	-	-	-	-	-	-
WC20	93,00-95,00	5,00-7,00	-	-	-	-	-	-	-	-	-

International standards

Type	ISO	USA	CHN	-	-	-	-
WC20	K20	C1	YG6	-	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	14,95
Young's modulus	E	GPa	Mechanical	-	650
Specific heat	c	J/kg-K	Thermal	Room temp.	225
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	5,2
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	83,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	180
Relative magnetic permeability	μ	-	Magnetic	Slighlty ferrom.	max 12

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Grain size	Physical	µm	1,2 - 1,6	-	-
Hardness	Mechanical	HRA	90,0 - 91,5	HV	1550 - 1780
Ultimate compressive strength	Mechanical	MPa	4600 - 5800	psix10^3	797 - 841
Service temperature	Thermal	°C	-196 / 500	°F	-320,8 / 932

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
0,200 - 127,000	mm	1/64 - 5	"	G5-10-16-20-25-28-40-60-100

Corrosion Resistance

As a general rule Tungsten Carbides with Cobalt binder show good corrosion resistance into basic solution while they are not resisting into acid solutions.

TUNGSTEN CARBIDE (WC) K30 Co BINDER ALLOY BALLS

K30 tungsten carbide balls provide a binder percentage slightly higher than the standard balls (7-9%). They are available on demand. The mechanical properties and corrosion resistance are a little lower if compared to standard K20 balls. Virgin powder is strictly used into this kind of production.

Applications

Special and hydraulic precision valves, special bearings, couplers, flow meters, sprayers, recirculating balls, ball spindles, tooling machines, sliding rails, ballpoint pens, pin and tips for indicators, precision measurement instruments, medical instruments. They are used in naval, mining, petrol and coining industry.

Chemical composition

Type	%WC	%Co	-	-	-	-	-	-	-	-	-
WC30	91,00-93,00	7,00-9,00	-	-	-	-	-	-	-	-	-

International standards

Type	ISO	USA	CHN	-	-	-	-
WC30	K30	C2	YG8	-	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	14,70
Young's modulus	E	GPa	Mechanical	-	630
Specific heat	c	J/kg-K	Thermal	Room temp.	227
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	6,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	82,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	175
Relative magnetic permeability	μ	-	Magnetic	Slighlty ferrom.	max 12

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Grain size	Physical	μm	1,2 - 1,6	-	-
Hardness	Mechanical	HRA	89,5 - 91,0	HV	1480 - 1700
Ultimate compressive strength	Mechanical	MPa	5400 - 5700	psix10^3	784 - 826
Service temperature	Thermal	°C	-196 / 500	°F	-320,8 / 932

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
0,200 - 127,000	mm	1/64 - 5	"	G5-10-16-20-25-28-40-60-100

Corrosion Resistance

As a general rule Tungsten Carbides with Cobalt binder show good corrosion resistance into basic solution while they are not resisting into acid solutions.

TUNGSTEN CARBIDE (WC) YN6 Ni BINDER ALLOY BALLS

Tungsten Carbide with Ni binder (6%) balls, they show slightly worse mechanical characteristics but better corrosion reistance properties with respect to the Cobalt binder tungsten carbides. Virgin powder is always used.

Applications

Special bearings, pumps and valves, dispensers, nozzles/pumps for sprayers, ballpoint pens. They are used in mining and petrol industry.

Chemical composition

Type	%WC	%Ni	-	-	-	-	-	-	-	-	-
YN6	93,00-95,00	5,00-7,00	-	-	-	-	-	-	-	-	-

International standards

Type	ISO	USA	CHN	-	-	-	-
YN6	-	-	YN6	-	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	14,95
Young's modulus	E	GPa	Mechanical	-	620
Specific heat	c	J/kg-K	Thermal	Room temp.	212
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	5,9
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	92,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	185
Relative magnetic permeability	μ	-	Magnetic	Slighlty ferrom.	max 3,00

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Grain size	Physical	µm	~ 1,4	-	-
Hardness	Mechanical	HRA	89,0 - 91,0	HV	1400 - 1700
Ultimate compressive strength	Mechanical	MPa	4900 - 5200	psix10^3	711 - 754
Service temperature	Thermal	°C	-196 / 540	°F	-320,8 / 1004

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
0,200 - 127,000	mm	1/64 - 5	"	G5-10-16-20-25-28-40-60-100

Corrosion Resistance

Good corrosion resistance in basic and neutral solutions. For acid solutions they resist up to pH 4.

TUNGSTEN CARBIDE (WC) 9% Ni BINDER ALLOY BALLS

Tungsten Carbide with Ni binder balls (9%), they provide a better corrosion resistance and slightly worse mechanical properties than YN6 type balls. Virgin powders always used.

Applications

Special bearings, pumps and valves, dispensers, nozzles/pumps for sprayers, ballpoint pens. They are used in mining and petrol industry.

Chemical composition

Type	%WC	%Ni	-	-	-	-	-	-	-	-	-
YN9	90,00-92,00	8,00-10,00	-	-	-	-	-	-	-	-	-

International standards

Type	ISO	USA	CHN	-	-	-	-
YN9	-	-	YN9	-	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	14,7
Young's modulus	E	GPa	Mechanical	-	650
Specific heat	c	J/kg-K	Thermal	Room temp.	215
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	6,1
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	84,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	175
Relative magnetic permeability	μ	-	Magnetic	Slighlty ferrom.	max 3,00

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Grain size	Physical	µm	~ 1,4	-	-
Hardness	Mechanical	HRA	88,0 - 90,0	HV	1250 - 1550
Ultimate compressive strength	Mechanical	MPa	4700 - 5000	psix10^3	682 - 725
Service temperature	Thermal	°C	-196 / 540	°F	-320,8 / 1004

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
0,200 - 127,000	mm	1/64 - 5	"	G5-10-16-20-25-28-40-60-100

Corrosion Resistance

Good corrosion resistance in basic and neutral solutions. For acid solutions they resist up to pH 3.

TUNGSTEN CARBIDE (WC) 10% Ni BINDER ALLOY BALLS

Tungsten Carbide with Ni binder balls (10%), they provide a better corrosion resistance and slightly worse mechanical properties than YN9 type balls. Virgin powders always used.

Applications

Special bearings, pumps and valves, dispensers, nozzles/pumps for sprayers, ballpoint pens. They are used in mining and petrol industry.

Chemical composition

Type	%WC	%Ni	-	-	-	-	-	-	-	-	-
NK	89,00-91,00	9,00-11,00	-	-	-	-	-	-	-	-	-

International standards

Type	ISO	USA	CHN	UK	-	-	-
NK	-	-	-	NK	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	14,60
Young's modulus	E	GPa	Mechanical	-	660
Specific heat	c	J/kg-K	Thermal	Room temp.	216
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	6,2
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	81,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	170
Relative magnetic permeability	μ	-	Magnetic	Slighlty ferrom.	max 3,00

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Grain size	Physical	µm	~ 1,4	-	-
Hardness	Mechanical	HRA	87,5 - 89,5	HV	1200 - 1450
Ultimate compressive strength	Mechanical	MPa	4600 - 4900	psix10^3	668 - 710
Service temperature	Thermal	°C	-196 / 540	°F	-320,8 / 1004

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
0,200 - 127,000	mm	1/64 - 5	"	G5-10-16-20-25-28-40-60-100

Corrosion Resistance

Good corrosion resistance in basic and neutral solutions. For acid solutions they resist up to pH 2-3.

TUNGSTEN HEAVY ALLOYS WNiFe BALLS

High density tungsten alloy balls, they provide good mechanical properties, wear and corrosion resistance and good thermal stability.

Applications

Special bearings, pumps and valves, flowmeters, ball screws, measurement instruments. They are preferred when good hardness and wear resistance properties in not too aggressive environments are demanded.

Chemical composition / Density

Type	%W	%Ni	%Fe	Density g/cm3	Type	%W	%Ni	%Fe	Density g/cm3
85W-10.5Ni-4.5Fe	~ 85	~ 10,5	~ 4,5	~ 15,8 - 16,0	93W-4.9Ni-2.1Fe	~ 93	~ 4,9	~ 2,1	~ 17,5 - 17,6
90W-7Ni-3Fe	~ 90	~ 7	~ 3	~ 16,9 - 17,15	93W-4Ni-3Fe	~ 93	~ 4	~ 3	~ 17,5 - 17,6
90W-6Ni-4Fe	~ 90	~ 6	~ 4	~ 16,8 - 17,0	95W-3.5Ni-1.5Fe	~ 95	~ 3,5	~ 1,5	~ 17,9 - 18,1
91W-6Ni-3Fe	~ 91	~ 6	~ 3	~ 17,1 - 17,3	95W-3Ni-2Fe	~ 95	~ 3	~ 2	~ 17,9 - 18,1
92W-5Ni-3Fe	~ 92	~ 5	~ 3	~ 17,3 - 17,5	96W-3Ni-1Fe	~ 96	~ 3	~ 1	~ 18,2 - 18,3
92.5W-5Ni-2.5Fe	~ 92,5	~ 5	~ 2,5	~ 17,4 - 17,6	97W-2Ni-1Fe	~ 97	~ 2	~ 1	~ 18,4 - 18,6
93W-5Ni-2Fe	~ 93	~ 5	~ 2	~ 17,5 - 17,6	98W-1Ni-1Fe	~ 98	~ 1	~ 1	~ 18,5 - 18,7

Mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Young's modulus	E	GPa	Mechanical	-	328
Elongation at break	A	%	Mechanical	Room temp.	2 - 33 (98W...85W)
Specific heat	c	J/kg-K	Thermal	Room temp.	1500
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	5,6
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	95,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	124
Relative magnetic permeability	μ	-	Magnetic	Slighlty ferrom.	max 10

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	20 - 36	-	-
Ultimate tensile strength	Mechanical	MPa	550 - 980	psix10^3	80 - 142
Service temperature	Thermal	°C	-196 / 350	°F	-320,8 / 662

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 100,000	mm	3/64 - 4	"	G100-200-500-1000

Corrosion Resistance

WNiFe alloys provide good corrosion resistance properties, similar to that of series 300 austenitic stainless steels.

STELLITE® 3PM ALLOY BALLS

Co based alloy, usually STELLITE® trade name, that provide excellent wear resistance and high temperature resistance. Its microstructure is formed by a CoCr matrix and dispersed carbides. Balls are provided in the passivated condition. Virgin powders always used.

Applications

Special bearings, pumps and valves, slurry and homogeniser pumps, in all applications where high wear, corrosion and temperature resistance are demanded.

Chemical composition

%C	%Si	%Mn	%Cr	%Ni	%Co	%W	%Fe	-	-	-	-
2,00-2,60	1,00 max	1,00 max	30,00-33,00	3,00 max	42,40-56,00	12,00-14,00	3,00 max	-	-	-	-

International standards

STELLITE® is a trade name, from Deloro Stellite Holdings Corporation, St.Louis, U.S.A. Different alloys are indicated with alphanumeric symbols.

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,65
Young's modulus	E	GPa	Mechanical	-	235
Specific heat	c	J/kg-K	Thermal	Room temp.	460
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	11,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	14,8
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	3850
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	max 1,200

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	50 - 57	-	-
Ultimate tensile strength	Mechanical	MPa	450 - 550	psix10^3	65 - 80
Service temperature	Thermal	°C	0 - 1000	°F	32 / 1832

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
9,500 - 75,000	mm	3/8 - 3	"	G25-40-60-100

Corrosion Resistance

Good corrosion resistance in contact with oxidizing agents (except with reducing acids), nitric, phosphoric and formic acid in not extreme concentration and temperature conditions, sulphuric acid at room temperature.

STELLITE® 20 ALLOY BALLS

Co based alloy, usually STELLITE® trade name, that provide excellent wear resistance and high temperature resistance. Its microstructure is formed by a CoCr matrix and dispersed carbides. Balls are provided in the passivated condition. Virgin powders always used.

Applications

Special bearings, pumps and valves, slurry and homogeniser pumps, in all applications where high wear, corrosion and temperature resistance are demanded.

Chemical composition

%C	%Si	%Mn	%Cr	%Ni	%Mo	%Co	%W	%B	%Fe	-	-
1,90-2,95	1,50 max	1,00 max	31,00-35,50	3,00 max	1,00 max	balance	16,50-19,50	0,30 max	3,00 max	-	-

International standards

STELLITE® is a trade name, from Deloro Stellite Holdings Corporation, St.Louis, U.S.A. Different alloys are indicated with alphanumeric symbols.

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,80
Young's modulus	E	GPa	Mechanical	-	230
Specific heat	c	J/kg-K	Thermal	Room temp.	450
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	10,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	14,5
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	3800
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	max 1,200

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	54 - 61	-	-
Ultimate tensile strength	Mechanical	MPa	500 - 600	psix10^3	72 - 87
Service temperature	Thermal	°C	0 - 1000	°F	32 / 1832

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
9,500 - 75,000	mm	3/8 - 3	"	G25-50-100

Corrosion Resistance

Good corrosion resistance in contact with oxidizing agents (except with reducing acids), nitric, phosphoric and formic acid in not extreme concentration and temperature conditions, sulphuric acid at room temperature.

STELLITE® 20PMH ALLOY BALLS

Co based alloy, usually STELLITE® trade name, that provide excellent wear resistance and high temperature resistance. Its microstructure is formed by a CoCr matrix and dispersed carbides. Balls are provided in the passivated condition. Virgin powders always used.

Applications

Special bearings, pumps and valves, slurry and homogeniser pumps, in all applications where high wear, corrosion and temperature resistance are demanded.

Chemical composition

%C	%Mn	%Cr	%Ni	%Mo	%Co	%W	%Sn	%Fe	-	-	-
2,80-3,00	0,20-0,40	33,00-36,00	2,50 max	0,50 max	35,10-40,50	17,00-19,00	1,00 max	2,50 max	-	-	-

International standards

STELLITE® is a trade name, from Deloro Stellite Holdings Corporation, St.Louis, U.S.A. Different alloys are indicated with alphanumeric symbols.

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	8,60
Young's modulus	E	GPa	Mechanical	-	240
Specific heat	c	J/kg-K	Thermal	Room temp.	440
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	12,7
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	15,2
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	3750
Relative magnetic permeability	μ	-	Magnetic	Paramagnetic	max 1,200

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRC	56 - 63	-	-
Ultimate tensile strength	Mechanical	MPa	550 - 650	psix10^3	80 - 94
Service temperature	Thermal	°C	0 - 1000	°F	32 / 1832

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
9,500 - 75,000	mm	3/8 - 3	"	G25-40-60-100

Corrosion Resistance

Good corrosion resistance in contact with oxidizing agents (except with reducing acids), nitric, phosphoric and formic acid in not extreme concentration and temperature conditions, sulphuric acid at room temperature.

TANTALUM BALLS

High density bio-compatible pure tantalum precision balls, they show good mechanical characteristics at elevated temperatures and toughness.

Applications

Special pumps and valves, electronic components, flowmeters, viscometers, capacitors, ball point pen.
They are used in the chemical and nuclear field and mainly as a orthopedic marker and target ball.

Chemical composition

Type	%C	%Si	%Ni	%Mo	%N	%Ti	%Nb	%Ta	%W	%Fe	%O	%H
R05200	0,010 max	0,005 max	0,010 max	0,020 max	0,010 max	0,010 max	0,100 max	balance	0,050 max	0,010 max	0,015 max	0,0015 max
R05400	0,010 max	0,005 max	0,010 max	0,020 max	0,010 max	0,010 max	0,100 max	balance	0,050 max	0,010 max	0,030 max	0,0015 max

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	16,63
Young's modulus	E	GPa	Mechanical	-	185
Specific heat	c	J/kg-K	Thermal	Room temp.	146
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	6,5
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	55,9
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	130
Relative magnetic permeability	μ	-	agnetic	Paramagnetic	1,0001

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV	120 - 300	HRC	20 - 30
Ultimate tensile strength	Mechanical	MPa	175 - 1100	psix10^3	25 - 159
Service temperature	Thermal	°C	-196 / 300	°F	-320,8 / 572

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade (ISO 3290)
0,203 - 3,175	mm	1/125 - 1/8	"	G50-100-200

Corrosion Resistance

Excellent corrosion resistance at room temperature, it is not resisting only to strong acids (hydroifluoric and sulphuric acids).

It is resisting to the most salt solutions and organic chemicals, hydrochloric, formic acids, cold ammonia, bromine .

It is not resisting against strong alkaline solutions (sodium hydroxide) and fluorine.

ABS BALLS

Thermoplastic resin balls obtained by the polimerization of butadiene rubber with acrylonitrile and styrene (usually 50% styrene and acrylonitrile/butadiene in different percentages). They feature good dimensional stability, hardness, stiffness and resistance to collision and wear, high toughness even at low temperatures. It is a recyclable material.

Applications

Special pumps and valves, automotive field, electronic devices components, toys.

Technical name	Commercial name	Abbreviation	Molecular formula
Acrylonitrile Butadiene Styrene	ABS	ABS	(C8H8C4H6C3H3N)n

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,03
Young's modulus	E	MPa	Mechanical	-	2350
Friction coefficient	μ	-	Mechanical	Room temp.	0,30
Water absorption	Aw	%	Physical	24 h	0,28
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	78,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,18
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	80 - 90	-	-
Compressive yield strength	Mechanical	MPa	30 - 70	psix10^3	4 - 10
Service temperature	Thermal	°C	-30 / 80	°F	-22 / 176

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Good corrosion resistance in contact with water, salt water, diluted acids, alkalis, inorganic salts, saturated hydrocarbons, petrol, mineral oils, animal and vegetal greases. They are not resisting to strong acids, aliphatic aromatic and chlorinated hydrocarbons, aldehydes, ketones, esters.

ACRYLIC (PMMA) BALLS

Amorphous thermoplastics balls, provide good hardness, transparency, abrasion and outdoor resistance. Fair mechanical properties, shock resistance and corrosion resistance.

Applications

Acrylic balls are used in check valves, visual flow equipment, laboratory applications, contact juggling. They could be considered as cheaper choice than polycarbonate and lighter than glass.

Technical name	Commercial name	Abbreviation	Molecular formula
Polymethyl-methacrylate	Acrylic, Plexiglass	PMMA	(C5O2H8)n

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,18
Young's modulus	E	MPa	Mechanical	-	2870
Friction coefficient	μ	-	Mechanical	Room temp.	0,45
Water absorption	Aw	%	Physical	24 h	0,30
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	68
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,18
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	84 - 87	-	-
Compressive yield strength	Mechanical	MPa	80 - 120	psix10^3	11 - 17
Service temperature	Thermal	°C	-40 / 90	°F	-40 / 194

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Good resistance against aqueous solutions, diluted inorganic acids, aliphatic hydrocarbons, ammonia, alkalis, greases and oils, balls are not resisting against aromatic hydrocarbons, halogens, ketones, esters, ethyl and methyl alcohols.

DELRIN® - POM BALLS

Very light homopolimeric thermoplastic resin balls, they provide good mechanical characteristics, corrosion resistance, wear and abrasion resistance. They are even good electric insulators and auto lubricant materials.

Applications

Spray agitators, light safety valves, low load bearings. Special pumps and valves, sliding rails for furniture, fluids flow check devices, medical instruments. They are used in foodstuff, chemical, electronic, pharmaceutical industry.

Technical name	Commercial name	Abbreviation	Molecular formula
Polyoxymethylene	Delrin®	POM	(~CH2OH)

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,37
Young's modulus	E	MPa	Mechanical	-	2800
Friction coefficient	μ	-	Mechanical	Room temp.	0,28
Water absorption	Aw	%	Physical	24 h	0,3
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	93
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,27
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	80 - 90	-	-
Compressive yield strength	Mechanical	MPa	30 - 120	psix10^3	4 - 17
Service temperature	Thermal	°C	-40 / 85	°F	-40 / 185

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,000 - 160,000	mm	3/64 - 6.5/16	"	0 - I - II - III - IV

Corrosion Resistance

Delrin is resisting in contact with basic, neutral and average acid compounds, sea water, petroleum products, mineral oils and greases, inorganic salt solutions, aliphatic, aromatic and chlorine hydrocarbons, low gradation alcools, ether. It's not resisting in contact with strong acids (hydrochloric, phosphoric, nitric and sulphuric), mineral acids, chlorides, alkalis.

HYTREL® - TPEE BALLS

Thermoplastic polyester elastomer balls, they provide both rubber and plastic properties. Excellent flexibility properites, wear and corrosion resistance. Very large service temperature range. Good radiation resistance.

Applications

Special pumps and valves, diaphragm pumps.

Technical name	Commercial name	Abbreviation	Molecular formula
Polyester elastomer	Hytrel®	TPEE	(-A-B-)n

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,16
Young's modulus	E	MPa	Mechanical	-	56
Friction coefficient	μ	-	Mechanical	Room temp.	0,31
Water absorption	Aw	%	Physical	24 h	0,70
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	190
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,19
Volume resistivity	ρ	Ω*m	Electric	-	> 10^10
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	35 - 45	-	-
Compressive yield strength	Mechanical	MPa	7 - 17	psix10^3	1 - 3
Service temperature	Thermal	°C	-40 / 120	°F	-40 / 248

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Excellent corrosion resistance in contact with petroleum products and mineral oils, good to alcohols and ketones, fair with aromatic hydrocarbons and into not aggressive acid environment. They are not resisting in contact with strong acids, even if diluted.

NYLON 6/NYLON 6.6 (PA 6/PA 6.6) BALLS

Semicrystalline thermoplastic Nylon 6/Nylon 6.6 polymer balls, they provide low weight, high corrosion, wear and abrasion resistance. They are auto lubricant and with good ductility, toughness and electric insulating properties. Useful even for high temperature applications.

Applications

Special valves, low load bearings, flow meters, switches, handgrips, medical and industrial applications.

Technical name	Commercial name	Abbreviation	Molecular formula
Polyamide	Nylon 6 / Nylon 6.6	PA 6/PA 6.6	-OC-(CH2)4-CO-NH-(CH2)6-NH-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,11
Young's modulus	E	MPa	Mechanical	-	2500
Friction coefficient	μ	-	Mechanical	Room Temp.	0,25
Water absorption	Aw	%	Physical	24 h	2,10
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	87,5
Thermal conductivity	λ	W/(m·K)	Thermal	Room Temp.	0,25
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	75 - 85	-	-
Compressive yield strength	Mechanical	MPa	86 - 103	psix10^3	12,4 - 15
Service temperature	Thermal	°C	-30 /80	°F	-22 / 176

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 160,000	mm	1/16 - 6.5/16	"	0 - I - II - III - IV

Corrosion Resistance

Nylon balls are insolvable into diluted mineral acids and in most organic acids. They are resisting to alkalis, petroleum products, greases, inorganic salt solutions, low gradation alcohols, motor oil, transmission fluids, methanol, ketones, esters. They do not resist to strong acids and basis.

PEEK BALLS

High performance semi-crystalline thermoplastic balls, they provide high mechanical properties, dimensional stability and excellent wear and abrasion, corrosion, high temperature and gamma radiation resistance. The high temperature resistance decreases considerably in case the material is charged by heavy loads. Unstable to UV radiations.

Applications

Special bearings, pumps and valves, components for chemical, electronic and mechanical industry when high mechanical characteristics and corrosion resistance properties are demanded.

Technical name	Commercial name	Abbreviation
Polyetheretherketone	PEEK	PEEK

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,29
Young's modulus	E	MPa	Mechanical	-	3750
Friction coefficient	μ	-	Mechanical	Room temp.	0,29
Water absorption	Aw	%	Physical	24 h	0,48
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	55
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,28
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	82 - 88	-	-
Compressive yield strength	Mechanical	MPa	120 - 250	psix10^3	17 - 36
Service temperature	Thermal	°C	-50 / 250	°F	-58 / 482

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

PEEK balls are resisting in contact with most solvents (organic compounds, salts, oils), hot waters and high temparature steams. They are not resisting against strong acids (concentrated nitric acids, sulphuric acids), halogens and some aromatic hydrocarbons.

POLYCARBONATE (PC) BALLS

Polycarbonate amorphous thermoplastic balls, they provide good hardness, impact resistance, dimensional stability. Fair resistance to corrosion, wear and weathering. Suitable into a wide range of temperatures.

Applications

Special applications when a high impact resistance is demanded, musical instruments, medical and decorative applications.

Technical name	Commercial name	Abbreviation	Molecular formula
Polycarbonate	Lexan	PC	C15H16O2

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,20
Young's modulus	E	MPa	Mechanical	-	2250
Friction coefficient	μ	-	Mechanical	Room temp.	0,34
Water absorption	Aw	%	Physical	24 h	0,20
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	67
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,21
Volume resistivity	ρ	Ω*m	Electric	-	> 10^14
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	80 - 90	-	-
Compressive yield strength	Mechanical	MPa	60 - 110	psix10^3	8 - 16
Service temperature	Thermal	°C	-40 / 120	°F	-40 / 248

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Good corrosion resistance in contact with diluted acids, alcohols and mineral/vegetal oils, they are not resisting against strong acids and bases, esters, organic solvents, aromatic, aliphatic and halogenated hydrocarbons, ketones, oils and greases, oxidizing agents.

POLYKETONE (PK) BALLS

Semi-crystalline engineering thermoplastic material balls, they feature good mechanical properties, excellent wear and abrasion resistance, good corrosion resistance and resistance to high temperatures, high elasticity and good dimensional stability. This material is not stable to UV radiation.

Applications

Special bearings and pumps, they are used in the automotive and aerospace fields, and in chemical, electronic and petroleum industry.

Technical name	Commercial name	Abbreviation
Polyketone	Polyketone	PK

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,24
Young's modulus	E	MPa	Mechanical	-	1500
Friction coefficient	μ	-	Mechanical	Room temp.	0,27
Water absorption	Aw	%	Physical	24 h	0,50
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	110
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,30
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	75 - 85	-	-
Compressive yield strength	Mechanical	MPa	80 - 110	psix10^3	11 - 16
Service temperature	Thermal	°C	-40 / 120	°F	-40 / 248

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Good corrosion resistance in contact with aliphatic hydrocarbons, lubricants, oils, greases, petroleum products, saline solutions. Polyketone balls are attacked by strong acids and basis.

HIGH DENSITY POLYETHYLENE (HDPE) BALLS

Very light thermoplastic material balls, they are available in three versions (high/low density and ultra high molecular weight). High density polyethylene presents best mechanical characteristics. They provide good wear and abrasion resistance. Excellent corrosion resistance and resistance to radiations, they are electric insulators.

Applications

Anti evaporation and anti smell devices, they are useful for floating applications. Used in electronic, pharmaceutical and medical industry.

Technical name	Commercial name	Abbreviation	Molecular formula
High Density Polyethylene	High Density Polyethylene	HDPE	(C2H4)n

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	0,97
Young's modulus	E	MPa	Mechanical	-	950
Friction coefficient	μ	-	Mechanical	Room temp.	0,30
Water absorption	Aw	%	Physical	24 h	0,10
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	126
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,46
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	60 - 73	-	-
Compressive yield strength	Mechanical	MPa	20 - 32	psix10^3	2,9 - 4,6
Service temperature	Thermal	°C	-30 / 70	°F	-22 / 158

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Excellent corrosion resistance in contact with acids, alcohols, basis, esters, petrol, greases and oils. Fairish resistance to aliphatic and aromatic hydrocarbons, mineral oils, oxidizing agents. They are not resisting in contact with halogenated hydrocarbons.

LOW DENSITY POLYETHYLENE (LDPE) BALLS

Very light thermoplastic material balls, they are available in three versions (high/low density and ultra high molecular weight). They provide good wear and abrasion resistance. Excellent corrosion resistance and resistance to radiations, they are electric insulators.

Applications

Anti evaporation and anti smell devices, they are useful for floating applications. Used in electronic, pharmaceutical and medical industry.

Technical name	Commercial name	Abbreviation	Molecular formula
Low Density Polyethylene	Low Density Polyethylene	LDPE	(C2H4)n

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	0,92
Young's modulus	E	MPa	Mechanical	-	290
Friction coefficient	μ	-	Mechanical	Room temp.	0,40
Water absorption	Aw	%	Physical	24 h	0,10
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	160
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,33
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	40 - 55	-	-
Compressive yield strength	Mechanical	MPa	9 - 20	psix10^3	1,4 - 2,9
Service temperature	Thermal	°C	-30 / 70	°F	-22 / 158

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Excellent corrosion resistance in contact with acids, alcohols, basis, esters, petrol, greases and oils. Fairish resistance to aliphatic and aromatic hydrocarbons, mineral oils, oxidizing agents. They are not resisting in contact with halogenated hydrocarbons.

ULTRA HIGH MOLECULAR WEIGHT POLYETHYLENE (UHMWPE) BALLS

Very light thermoplastic material balls, they are available in three versions (high/low density and ultra high molecular weight). Ultra high molecular weight polyethylene presents very good wear resistance. They provide good wear and abrasion resistance. Excellent corrosion resistance and resistance to radiations, they are electric insulators.

Applications

Anti evaporation and anti smell devices, they are useful for floating applications. Used in valves in electronic, pharmaceutical and medical industry.

Technical name	Commercial name	Abbreviation	Molecular formula
Ultra High Molecular Weight Polyethylene	Ultra High Molecular Weight Polyethylene	UHMWPE	(C2H4)n

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	0,94
Young's modulus	E	MPa	Mechanical	-	790
Friction coefficient	μ	-	Mechanical	Room temp.	0,20
Water absorption	Aw	%	Physical	24 h	0,01
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	191,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,41
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	60 - 68	-	-
Compressive yield strength	Mechanical	MPa	20 - 28	psix10^3	2,9 - 4,1
Service temperature	Thermal	°C	-100 / 80	°F	-148 / 176

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
6,350 - 100,000	mm	1/4 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Excellent corrosion resistance in contact with acids, alcohols, basis, esters, petrol, greases and oils. Fairish resistance to aliphatic and aromatic hydrocarbons, mineral oils, oxidizing agents. They are not resisting in contact with halogenated hydrocarbons.

POLYPROPYLENE (PP) BALLS

Polypropylene balls are featured by a low weight, good mechanical characteristics and corrosion, fatigue and collisions resistance. They are resisting to heat and they are excellent electric insulators. They are floating into water. Additives can be added to avoid degradation phenomena causing to a long exposure at sun light (UV radiation absorption). It is a recyclable material.

Applications

Low load bearings, special valves, check valves, floating valves, fluid level indicators, carburetors, flow meters, chemical, medical and laboratory devices, blood transfusion kits.

Technical name	Commercial name	Abbreviation	Molecular formula
Poly(propene)	Polypropylene	PP	(C3H6)n

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	0,87
Young's modulus	E	MPa	Mechanical	-	1285
Friction coefficient	μ	-	Mechanical	Room temp.	0,30
Water absorption	Aw	%	Physical	24 h	0,01
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	135,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,19
Volume resistivity	ρ	Ω*m	Electric	-	> 10^14
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	70 - 80	-	-
Compressive yield strength	Mechanical	MPa	40 - 50	psix10^3	5,8 - 7,3
Service temperature	Thermal	°C	-30 / 110	°F	-22 / 230

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 160,000	mm	1/16 - 6.5/16	"	0 - I - II - III - IV

Corrosion Resistance

Polypropylene balls are resisting into not concentrated acids, alkalis, alcohols, oils, greases and most inorganic compounds. Fair resistance in aromatic hydrocarbons, they are not resistant in contact with halogens. They provide corrosive phenomena even in presence of concentrated acids and oxidizing agents at high temperature.

POLYSTYRENE (PS) BALLS

Amorphous light vinyl polymer balls, they provide good hardness and stiffness. Brittle material with fair corrosion resistance and no UV radiation resistant.

Applications

They are used as floating elements on not acqueous liquids, different applications in the electronic, pharmaceutical and medical field, and as decorative elements.

Technical name	Commercial name	Abbreviation	Molecular formula
Polystyrene	Polystyrene	PS	(C8H8)n

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,05
Young's modulus	E	MPa	Mechanical	-	3200
Friction coefficient	μ	-	Mechanical	Room temp.	0,40
Water absorption	Aw	%	Physical	24 h	0,15
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	90
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,12
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	78 - 82	-	-
Compressive yield strength	Mechanical	MPa	50 - 90	psix10^3	7 - 13
Service temperature	Thermal	°C	-10 / 90	°F	14 / 194

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Good corrosion resistance in contact with diluted acids, basis, acqueous solutions, detergents. Fair against oxidizing agents, oils and greases. Poor resistance in contact with aromatic hydrocarbons, aldehydes, halogens, esters, ethers, ketones.

POLYURETHANE (TPU) BALLS

Thermoplastic elastomer balls with characteristics similar to rubber, they provide much better wear and abrasion resistance. Properties are strongly influenced by the starting polymeric formulation.

Applications

Special bearings, safety valves, they are frequently used in foodstuff industry. Screen cleaning (balls with a metal core and polyurethane coating).

Technical name	Commercial name	Abbreviation	Molecular formula
-	Polyurethane	PUR / PU	-NH-(CO)-O-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,14
Young's modulus	E	MPa	Mechanical	-	360
Friction coefficient	μ	-	Mechanical	Room temp.	0,24
Water absorption	Aw	%	Physical	24 h	0,3
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	150
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,03
Volume resistivity	ρ	Ω*m	Electric	-	> 10^14
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore A	80 - 100	-	-
Compressive yield strength	Mechanical	MPa	70 - 140	psix10^3	10,1 - 20,3
Service temperature	Thermal	°C	-40 / 80	°F	-76 / 176

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Polyurethane provides good corrosion resistance in diluted acids and alkali, mineral oils and greases, petroleum products. Balls are not resisting into strong acids and basis. Poor resistance in contact with hot water, hot and wet air, steam, aromatic hydrocarbons, organic polar solvents.

Notes

Property	Description
Polyether Urethane	On demand it is possible to supply Polyether Urethane balls, a plastic material similar to Polyurethane with improved mechanical properties.

PVC BALLS

Thermoplastic amorphous polymer balls, they provide good hardness and stiffness, dimensional stability, radiation resistance and fair corrosion resistance, and can be supplied in a very bright surface aspect. PVC becomes flexible when plasticisers are added enlarging their service temperature range. Moderate impact resistance.

Applications

Galvanic and petrolchemical valves, seal valves, processing plants valves.

Technical name	Commercial name	Abbreviation	Molecular formula
Polyvinyl chloride	PVC	PVC	CH2=CHCl

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,38
Young's modulus	E	MPa	Mechanical	-	3250
Friction coefficient	μ	-	Mechanical	Room temp.	0,50
Water absorption	Aw	%	Physical	24 h	0,15
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	75
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,19
Volume resistivity	ρ	Ω*m	Electric	-	> 10^14
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	80 - 84	-	-
Compressive yield strength	Mechanical	MPa	55 - 90	psix10^3	8 - 13
Service temperature	Thermal	°C	-15 / 70	°F	5 / 158

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Good corrosion resistance in contact with diluted acids, alkalis, inorganic compounds, greases and mineral oils. They can suffer stress corrosion cracking in contact with solvents. Poor resistance with aromatic and halogenated hydrocarbons, ketones, cyclic ethers, aldehydes.

PVDF BALLS

Semi-crystalline thermoplastic fluoropolymer balls, they provide excellent corrosion, aging and UV radiation resistance. Plastic with a lower density, better mechanical properties and abrasion resistance, lower resistance to high temperatures than Teflon material.

Applications

Special pumps and valves, heat exchangers, lithium batteries. They are used into the electronic and petrolchemical industry. They are useful for applications into aggressive environments when balls are even subjected to wear or collisions.

Technical name	Commercial name	Abbreviation	Molecular formula
Polyvinylidenefluoride	PVDF	PVDF	(C2H2F2)n

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,77
Young's modulus	E	MPa	Mechanical	-	1900
Friction coefficient	μ	-	Mechanical	Room temp.	0,32
Water absorption	Aw	%	Physical	24 h	0,04
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	130,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,17
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	70 - 85	-	-
Compressive yield strength	Mechanical	MPa	50 - 70	psix10^3	7 - 10
Service temperature	Thermal	°C	-40 / 130	°F	-40 / 266

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 60,000	mm	1/16 | 2-1/4	"	0 - I - II - III - IV

Corrosion Resistance

Excellent corrosion resistance in contact with inorganic acids and salts, organic acids, alcohols, ethers, aliphatic and aromatic hydrocarbons, halogens except fluorines, oxidizing environments. They are not suitable against nearly pure strong acids and basis, liquid alcaline metals, strong polar solvents.

PHENOLIC RESIN BALLS

Synthetic thermoset resin balls, they provide good dimensional stability, hardness and heat/corrosion resistance.

Applications

Special pumps and valves, computer industry (mouse), game balls (billiard, bowling and table-based balls).

Technical name	Commercial name	Abbreviation
Phenolic resin	Phenolic resin	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,70 *
Young's modulus	E	MPa	Mechanical	-	3000
Friction coefficient	μ	-	Mechanical	Room temp.	0,25
Water absorption	Aw	%	Physical	24 h	0,35
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	95
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,25
Volume resistivity	ρ	Ω*m	Electric	-	> 10^9
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	85 - 90	-	-
Compressive yield strength	Mechanical	MPa	35 - 55	psix10^3	5 - 8
Service temperature	Thermal	°C	-40 / 200	°F	-40 / 392

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
12,700 - 100,000	mm	1/2 - 4	"	III - IV

Corrosion Resistance

Good corrosion resistance in contact with weak acids and basis, hydrocarbons, petroleum products, alcohols, glycols, mineral oils and greases. They are not resistant to strong acids and bases, oxidizing agents, phenols, hard lyes.

Notes

Property	Description
Density *	For big diameters balls with a lower density (about 1,3 g/cm3) and a precision grade GIV could be available.
Thermoset resin balls (density 1,2-1,7 g/cm3)	Balls typically used for aesthetic applications, they are available in different styles and with highly polished or matt surface finishing.

TEFLON (PTFE) BALLS

Low weight fluorinated semicrystalline polymer balls, they provide exceptional corrosion resistance and are used into high temperature applications. Mechanical and wear resistance properties are lower than other plastic materials. Good electric insulators, they are auto lubricant. Teflon properties change if they are exposed to electromagnetic radiations.

Applications

Ball bearings, special valves (very aggressive environments), measurement and medical instruments, appliances. They are used into foodstuff, paper, chemical, electronic, pharmaceutical industry.

Technical name	Commercial name	Abbreviation	Molecular formula
Polytetrafluoroethylene	Teflon	PTFE	(CF2-CF2)n

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	2,16
Young's modulus	E	MPa	Mechanical	-	670
Friction coefficient	μ	-	Mechanical	Room temp.	0,12
Water absorption	Aw	%	Physical	24 h	0,02
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	145,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,23
Volume resistivity	ρ	Ω*m	Electric	-	> 10^16
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	50 - 65	-	-
Compressive yield strength	Mechanical	MPa	7 - 30	psix10^3	1 - 4
Service temperature	Thermal	°C	-269 / 250	°F	-436 / 482

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 160,000	mm	1/16 - 6.5/16	"	0 - I - II - III - IV

Corrosion Resistance

Teflon balls provide exceptional corrosion resistance properties, they are resisting even in contact with industrial acids or caustic substances. They suffer corrosive phenomena only against molten alkaline metals and fluorides at elevated temperatures.

TORLON BALLS

Amorphous thermoplastic material balls, they provide excellent mechanical and stiffness/thoughness features (the best ones among plastics), very good thermal stability and creep resistance, they are suitable for high temperature applications. Torlon 4301 has better friction and wear resistance properties. They are electric insulators.

Applications

Special bearings (when it is demanded lubrication absence, high temperature and wear resistance), automotive components (transmission). They are used in aviation/aerospace and electronic industry. Applications even in naval industry and angling.

Technical name	Commercial name	Abbreviation
Polyamide-polyimide	Torlon 4301	PAI + graphite + PTFE
Polyamide-polyimide	Torlon 4203L	PAI

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,42
Young's modulus	E	MPa	Mechanical	4203L / 4301	4135 / 6800
Friction coefficient	μ	-	Mechanical	Room temp.	0,21
Water absorption	Aw	%	Physical	24 h	0,34
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	28
Thermal conductivity	λ	W/(m·K)	Thermal	Room t. 4203L / 4301	0,26 / 0,54
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	80 - 85	-	-
Compressive yield strength	Mechanical	MPa	150 - 220	psix10^3	22 - 32
Service temperature	Thermal	°C	-196 / 200	°F	-320,8 / 392

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Torlon is resisting in contact with aliphatic, aromatic, chlorine and fluorine hydrocarbons, most acids compounds at moderate temperatures, automotive and aviation lubricants. Fair resistance to saturated steam, strong basis, high temperature acids.

VESPEL® BALLS

Super engineering polyimide thermoplastic resin balls, they provide excellent mechanical and toughness features, dimensional stability, wear, friction, corrosion and radiation resistance. High maximum service temperature between plastic materials.

Applications

Special bearings and check valves when high temperatures and strong wear is expected.

Technical name	Commercial name	Notes
Polyimide	Vespel®	Vespel® : Registered trademark of DuPont

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,43
Young's modulus	E	MPa	Mechanical	-	2760
Friction coefficient	μ	-	Mechanical	Room temp.	0,29
Water absorption	Aw	%	Physical	24 h	0,24
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	54
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,35
Volume resistivity	ρ	Ω*m	Electric	-	> 10^14
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore D	80 - 85	-	-
Compressive yield strength	Mechanical	MPa	80 - 250	psix10^3	12 - 36
Service temperature	Thermal	°C	-196 / 250	°F	-320,8 / 482

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 4	"	0 - I - II - III - IV

Corrosion Resistance

Good corrosion resistance in contact with oil, industrial fluids ans solvents even at elevated temperatures, they are less resistant in contact with alkali, concentrated nitric and sulphuric acids, chloroforms and dichloromethanes.

MACHINED ROD END PLASTIC BALLS

Plastic balls individually machined from rod end only, they do not contain air bubbles (void free). Balls are tumble polished.

Applications

Similar to the corresponding injection molded balls they are used when void free balls are required. The absence of air bubbles slightly increases the density and the mechanical properties of the balls.

Technical name	Commercial name	Abbreviation	Molecular formula
Acrylonitrile Butadiene	ABS	ABS	(C8H8C4H6C3H3N)n
Polymethyl-methacrylate	Acrylic, Plexiglass	PMMA	(C5O2H8)n
Polyoxymethylene	Delrin	POM	(~CH2OH)
Polyamide	Nylon 6.6	PA 66	-OC-(CH2)4-CO-NH-(CH2)6-NH-
Polyetheretherketone	PEEK	PEEK	-
Polycarbonate	Lexan	PC	C15H16O2
Polyethylene	Polyethylene	PE	(C2H4)n
Poly(propene)	Polypropylene	PP	(C3H6)n
Polystyrene	Polystyrene	PS	(C8H8)n
-	Polyurethane	TPU	-NH-(CO)-O-
Polyvinyl chloride	PVC	PVC	CH2=CHCl
Polyvinylidenefluoride	PVDF	PVDF	(C2H2F2)n
Polytetrafluoroethylene	Teflon	PTFE	(CF2-CF2)n
Polyamide-polyimide	Torlon 4203	PAI	-

Technical data

Property	Symbol	U.o.M.	ABS	PMMA	POM	PA 66	PEEK	PC	PE
Density	δ	g/cm3	1,07	1,22	1,43	1,15	1,32	1,24	0,95
Young's modulus	E	MPa	2500	3050	3000	2400	3750	2400	800
Yield strength	σy	MPa	35-55	40-65	50-70	45-58	130-220	70-100	17-27
Friction coefficient	μ	-	0,10	0,14	0,09	0,08	0,10	0,10	0,12
Water absorption	Aw	%	0,18	0,20	0,20	2,50	0,08	0,22	0,013
Coefficient of linear thermal expansion	α	10^-6/°C	90,0	85,0	120,0	85,0	80,0	65,0	180,0
Thermal conductivity	λ	W/(m·K)	0,21	0,21	0,29	0,23	0,30	0,25	0,38
Volume resistivity	ρ	Ω*m	> 10^13	> 10^13	> 10^13	> 10^12	> 10^13	> 10^14	> 10^15
Hardness	-	Shore D	75-85	75-85	75-85	80-83	80-85	75-85	57-67
Service temperatures (min/max)	-	°C	-30/80	-40/90	-40/85	-30/80	-50/250	-40/120	-50/80

www.rgpballs.com

Technical data

Property	Symbol	U.o.M.	PP	PS	TPU	PVC	PVDF	PTFE	PAI
Density	δ	g/cm3	0,91	1,09	1,15	1,42	1,80	2,18	1,45
Young's modulus	E	MPa	1400	3350	400	3400	2100	700	4400
Yield strength	σy	MPa	27-37	35-60	50-100	40-60	40-55	10-30	140-200
Friction coefficient	μ	-	0,10	0,09	0,08	0,09	0,10	0,09	0,07
Water absorption	Aw	%	0,10	0,15	0,20	0,15	0,03	0,010	0,24
Coefficient of linear thermal expansion	α	10^-6/°C	160,0	110,0	170,0	90,0	155,0	175,0	50,0
Thermal conductivity	λ	W/(m·K)	0,22	0,20	0,20	0,23	0,20	0,23	0,28
Volume resistivity	ρ	Ω*m	> 10^14	> 10^14	> 10^14	> 10^14	> 10^13	> 10^17	> 10^13
Hardness	-	Shore D	70-80	75-85	30-60	75-85	65-75	50-65	75-85
Service temperatures (min/max)	-	°C	-30/110	-10/90	-40/80	-15/70	-40/130	-269/200	-196/250

Range

Diameters (min/max)	Tolerances	Roundness	U.o.M.	Precision grade
1,000 - 3,000	±0,040	≤ 0,06	mm	II
3,001 - 6,000	±0,048	≤ 0,06	mm	II
6,001 - 10,000	±0,058	≤ 0,06	mm	III
10,001 - 18,000	±0,070	≤ 0,06	mm	III
18,001 - 30,000	±0,084	≤ 0,06	mm	III
30,001 - 50,000	±0,100	≤ 0,10	mm	III
50,001 - 80,000	±0,120	≤ 0,14	mm	III
80,001 -120,000	±0,140	≤ 0,18	mm	IV
120,001 -160,000	±0,170	≤ 0,18	mm	IV

"GF" GLASS FILLED PLASTIC BALLS

"GF" plastic balls filled with fiber glass (from 20% to 30%), they provide best mechanical, dimensional and heat resisting properties than the corresponding standard balls.

Applications

Similar to the applications of the correspinding solid balls, mainly when higher mechanical properties are required.

Technical name	Commercial name	Abbreviation	Molecular formula
Polyoxymethylene	Delrin	POM	(~CH2OH)
Polyamide	Nylon 6.6	PA 66	-OC-(CH2)4-CO-NH-(CH2)6-NH-
Polycarbonate	Lexan	PC	C15H16O2
Poly(propene)	Polypropylene	PP	(C3H6)n
Polyphthalamide	Polyphthalamide	PPA	-
Polyphenylene Sulfide	Polyphenylene Sulfide	PPS	(C6H6)-S n
Epoxy Resin	Epoxy Resin	-	-
Phenolic Resin	Frac balls	-	-
Polytetrafluoroethylene	Teflon	PTFE	(CF2-CF2)n
Polyamide-polyimide	Torlon	PAI	-

Technical data

Property	Symbol	U.o.M.	POM	PA 66	PC	PP	PPA 1	PPA 2
% Fiber glass	-	%	25	30	20	30	30	35
Density	δ	g/cm3	1,60	1,38	1,35	1,10	1,70	1,47
Young's modulus	E	MPa	6450	4600	5670	4000	13100	12100
Friction coefficient	μ	-	0,35	0,24	0,16	0,30	0,28	0,25
Water absorption	Aw	%	0,24	2,04	0,16	0,08	0,15	0,40
Coefficient of linear thermal expansion	α	10^-6/°C	79,0	111,0	28,2	65,0	65,1	48,0
Thermal conductivity	λ	W/(m·K)	0,34	0,30	0,23	0,26	0,33	0,31
Volume resistivity	ρ	Ω*m	> 10^12	> 10^13	> 10^13	> 10^12	> 10^13	> 10^13
Hardness	-	Shore D	80-90	77-85	82-92	75-85	80-90	80-90
Compressive yield strength	-	MPa	104-124	130-170	110-125	60-100	235-285	310-360
Service temperature (min/max)	-	°C	-20/160	-10/110	-20/130	-10/120	-30/150	-20/140

www.rgpballs.com

Technical data

Property	Symbol	U.o.M.	PPS	Epox. Res.	Phen. Res.	PTFE	PAI
% Fiber glass	-	%	30	10	30	25	30
Density	δ	g/cm3	1,58	1,85	1,77	2,24	1,60
Young's modulus	E	MPa	13100	18000	6500	800	7460
Friction coefficient	μ	-	0,11	0,15	0,30	0,12	0,20
Water absorption	Aw	%	0,02	0,10	0,05	0,017	0,30
Coefficient of linear thermal expansion	α	10^-6/°C	20,8	12,0	85,0	158,0	30,4
Thermal conductivity	λ	W/(m·K)	0,33	0,29	0,32	0,46	0,36
Volume resistivity	ρ	Ω*m	> 10^14	> 10^13	> 10^9	> 10^13	> 10^12
Hardness	-	Shore D	80-90	80-90	90-95	65-75	85-95
Compressive yield strength	-	MPa	120-180	180-220	250-350	19-29	160-260
Service temperature (min/max)	-	°C	-30/220	-30/130	-40/200	-196/230	-100/260

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 14	"	0 - I - II - III - IV

COMPOSITES PLASTIC BALLS

Type	Materials	Description / Applications
PTFE filled PA6.6	PA6.6 + PTFE	Nylon PA6.6 balls with a small addition of PTFE (2%), they feature a lower friction coefficient ad better wear resistance in comparison to the standard Nylon balls.
MoS2 filled PA6.6	PA6.6 + MoS2	Nylon PA6.6 balls with a small addition of MoS2, they feature better mechanical properties and dimensional stability in comparison to the standard Nylon balls.
Metal detector PEEK	PEEK + detectable filler	PEEK balls with a detectable filler inside, they are typically used in the foodstuff field.
BaSO4 filled PP	PP + BaSO4	Polypropylene balls with addition of BaSO4, they feature better mechanical characteristics and a lower friction coefficient in comparison to the standard Polypropylene balls.

Technical data

Property	Symbol	U.o.M.	PA6.6+PTFE	PA6.6+MoS2	PEEK+D.F.	PP+BaSO4
% Filler element	-	%	2	1	2	25
Density	δ	g/cm3	1,16	1,15	1,44	1,12
Young's modulus	E	MPa	2800	3600	4400	1750
Friction coefficient	μ	-	0,20	0,22	0,27	0,20
Water absorption	Aw	%	1,80	2,30	0,02	0,01
Coefficient of linear thermal expansion	α	10^-6/°C	99,0	80,0	54,1	168,8
Thermal conductivity	λ	W/(m·K)	0,25	0,29	1,43	0,24
Volume resistivity	ρ	Ω*m	> 10^14	> 10^12	> 10^12	> 10^14
Hardness	-	Shore D	70-80	80-90	90-100	75-85
Compressive yield strength	-	MPa	80-100	90-120	145-285	45-55
Service temperature (min/max)	-	°C	-40/90	-20/80	-60/260	-30/120

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,500 - 100,000	mm	1/16 - 14	"	0 - I - II - III - IV

GRADES AND SURFACE FINISHING OF PLASTIC BALLS

PRECISION GRADES

GRADE	TOLERANCE ON DIAMETER (µm)	TOLERANCE ON DIAMETER (in)	TOLERANCE ON SPHERICITY (µm)	TOLERANCE ON SPHERICITY (in)
GR. 0	±10	±0,0004	5 max	0,0002 max
GR. I	±25	±0,0010	12 max	0,0005 max
GR. II	±50	±0,0020	25 max	0,0010 max
GR. III	± 127	±0,0050	60 max	0,0024 max
GR. IV	± 500	±0,0197	600 max	0,0236 max
GR. V	± 1000	±0,0394	-	-

SURFACE FINISH

Precision grade	Type of surface
GRADE 0	SUPER LAPPED FINISHING
GRADE I	LAPPED FINISHING
GRADE II / III	GRINDED FINISHING
GRADE IV	FLASHED FINISHING
GRADE V	BALL BLANKS

GRAMS NET WEIGHTS PER 100 PCS FROM 1,000 MM TO 10,000 MM

DIAMETER		GRAMS NET WEIGHTS PER 100 BALLS			
mm	inch	Delrin (POM)	Nylon 6.6 (PA)	Polypropylene (PP)	Polyurethane (PUR)
1	-	0,07	0,06	0,05	0,06
1,191	3/64	0,12	0,10	0,08	0,10
1,5	-	0,25	0,20	0,15	0,20
1,588	1/16	0,29	0,23	0,18	0,24
2,000	-	0,59	0,46	0,36	0,48
2,381	3/32	0,99	0,78	0,62	0,81
2,500	-	1,15	0,91	0,71	0,93
2,778	7/64	1,57	1,25	0,98	1,28
3,000	-	1,98	1,57	1,23	1,61
3,175	1/8	2,35	1,86	1,46	1,91
3,500	-	3,14	2,49	1,95	2,56
3,969	5/32	4,58	3,63	2,85	3,73
4,000	-	4,69	3,72	2,92	3,82
4,500	-	6,68	5,30	4,15	5,44
4,763	3/16	7,92	6,28	4,92	6,45
5,000	-	9,16	7,26	5,69	7,46
5,500	-	12,2	9,67	7,58	9,93
5,556	7/32	12,6	9,97	7,81	10,2
6,000	-	15,8	12,6	9,84	12,9
6,350	1/4	18,8	14,9	11,7	15,3
6,500	-	20,1	16,0	12,5	16,4
7,000	-	25,1	19,9	15,6	20,5

www.rgpballs.com

DIAMETER		GRAMS NET WEIGHTS PER 100 BALLS			
mm	inch	Delrin (POM)	Nylon 6.6 (PA)	Polypropylene (PP)	Polyurethane (PUR)
7,144	9/32	26,7	21,2	16,6	21,8
7,500	-	30,9	24,5	19,2	25,2
7,938	5/16	36,7	29,1	22,8	29,9
8,000	-	37,5	29,8	23,3	30,6
8,500	-	45,0	35,7	28,0	36,7
8,731	11/32	48,8	38,7	30,3	39,7
9,000	-	53,4	42,4	33,2	43,5
9,500	-	62,8	49,8	39,1	51,2
9,525	3/8	63,3	50,2	39,4	51,6
10,000	-	73,3	58,1	45,6	59,7

GRAMS NET WEIGHTS PER 100 PCS FROM 10,319 MM TO 25,400 MM

DIAMETER		GRAMS NET WEIGHTS PER 100 BALLS			
mm	inch	Delrin (POM)	Nylon 6.6 (PA)	Polypropylene (PP)	Polyurethane (PUR)
10,319	13/32	80,5	63,9	50,0	65,6
11,000	-	97,6	77,4	60,6	79,4
11,113	7/16	101	79,8	62,5	81,9
11,906	15/32	124	98,1	76,9	101
12,000	-	127	100	78,7	103
12,700	1/2	150	119	93,3	122
13,000	-	161	128	100	131
13,494	17/32	180	143	112	147
14,000	-	201	159	125	164
14,288	9/16	214	170	133	174
15,000	-	247	196	154	201
15,081	19/32	251	199	156	205
15,875	5/8	293	233	182	239
16,000	-	300	238	187	244
16,669	21/32	339	269	211	276
17,000	-	360	286	224	293
17,463	11/16	390	309	243	318
18,000	-	428	339	266	348
18,256	23/32	446	354	277	363
19,000	-	503	399	312	409
19,050	3/4	507	402	315	413
19,844	25/32	573	454	356	466

www.rgpballs.com

DIAMETER		GRAMS NET WEIGHTS PER 100 BALLS			
mm	inch	Delrin (POM)	Nylon 6.6 (PA)	Polypropylene (PP)	Polyurethane (PUR)
20,000	-	586	465	364	478
20,638	13/16	644	511	400	525
21,000	-	679	538	422	553
21,431	27/32	722	572	448	588
22,000	-	781	619	485	636
22,225	7/8	805	638	500	655
23,000	-	892	707	554	726
23,019	29/32	894	709	556	728
23,813	15/16	990	785	615	806
24,000	-	1013	803	630	825
24,606	31/32	1092	866	679	889
25,000	-	1145	908	712	933
25,400	1	1201	952	746	978

KG NET WEIGHTS PER 10 PCS FROM 30,000 MM TO 101,600 MM

DIAMETER		KG NET WEIGHTS PER 10 BALLS			
mm	inch	Delrin (POM)	Nylon 6.6 (PA)	Polypropylene (PP)	Polyurethane (PUR)
30,000	-	0,20	0,16	0,12	0,16
31,750	1.1/4	0,23	0,19	0,15	0,19
35,000	-	0,31	0,25	0,20	0,26
38,100	1.1/2	0,41	0,32	0,25	0,33
40,000	-	0,47	0,37	0,29	0,38
44,450	1.3/4	0,64	0,51	0,40	0,52
45,000	-	0,67	0,53	0,42	0,54
50,000	-	0,92	0,73	0,57	0,75
50,800	2	0,96	0,76	0,60	0,78
55,000	-	1,22	0,97	0,76	0,99
57,150	2.1/4	1,37	1,08	0,85	1,11
60,000	-	1,58	1,26	0,98	1,29
63,500	2.1/2	1,88	1,49	1,17	1,53
65,000	-	2,01	1,60	1,25	1,64
69,850	2.3/4	2,50	1,98	1,55	2,03
70,000	-	2,51	1,99	1,56	2,05
75,000	-	3,09	2,45	1,92	2,52
76,200	3	3,24	2,57	2,02	2,64
80,000	-	3,75	2,98	2,33	3,06
82,550	3.1/4	4,12	3,27	2,56	3,36
85,000	-	4,50	3,57	2,80	3,67
88,900	3.1/2	5,15	4,08	3,20	4,19

www.rgpballs.com

DIAMETER		KG NET WEIGHTS PER 10 BALLS			
mm	inch	Delrin (POM)	Nylon 6.6 (PA)	Polypropylene (PP)	Polyurethane (PUR)
90,000	-	5,34	4,24	3,32	4,35
95,000	-	6,28	4,98	3,91	5,12
95,250	3.3/4	6,33	5,02	3,94	5,16
100,000	-	7,33	5,81	4,56	5,97
101,600	4	7,69	6,10	4,78	6,26

PLASTIC MATERIALS PROPERTIES

DENSITY

MATERIAL	DENSITY (g/cm3)	MATERIAL	DENSITY (g/cm3)
PMMA	1,18	LDPE / HDPE	0,92 / 0,97
AURUM	1,42	PP	0,87
POM	1,40	PS	1,05
TPE	1,20	PUR	1,14
PC	1,20	PVC	1,38
PA6.6	1,14	PHENOLIC RESIN	1,40
PBT	1,30	PTFE	2,16
PEEK	1,29	TORLON	1,42

COMPRESSIVE YIELD STRENGTH

MATERIAL	STRENGTH MPa	MATERIAL	STRENGTH MPa
PMMA	80 - 120	LDPE / HDPE	9 - 32
AURUM	70 - 230	PP	40 - 50
POM	30 - 90	PS	50 - 90
TPE	10 - 60	PUR	70 - 140
PC	60 - 110	PVC	55 - 90
PA6.6	86 - 103	PHENOLIC RESIN	35 - 55
PBT	75 - 135	PTFE	7 - 30
PEEK	200 - 300	TORLON	150 - 220

www.rgpballs.com

WORKING TEMPERATURES

MATERIAL	MINIMUM TEMPERATURE	MAXIMUM TEMPERATURE	MATERIAL	MINIMUM TEMPERATURE	MAXIMUM TEMPERATURE
PMMA	-40	90	LDPE / HDPE	-30	70
AURUM	-196	235	PP	-60	120
POM	-40	85	PS	-10	90
TPE	-40	180	PUR	-40	80
PC	-40	120	PVC	-15	70
PA6.6	-30	80	PHENOLIC RESIN	-40	200
PBT	-30	120	PTFE	-269	250
PEEK	-50	250	TORLON	-196	200

ALUMINUM OXIDE (Al2O3) BALLS

Polycrystalline structure light weight oxide balls, they provide good mechanical characteristics, corrosion, abrasion and heat resistance. They are auto lubricant and good electric insulators. Natural colour white/ivory.

Applications

Special bearings, check valves, pumps and valves that operate in aggressive environments, petroleum pumps, flow meters, measurement instruments, medical devices.

Commercial name	Other name	Formula	Oxide %
Aluminum Trioxide	Alumina	Al2O3	99,00 - 99,99

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	3,90
Young's modulus	E	GPa	Mechanical	-	365
Friction coefficient	μ	-	Mechanical	Room temp.	0,2
Specific heat	c	J/kg-K	Thermal	Room temp.	795
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	7,8
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	31,0
Volume resistivity	ρ	Ω*m	Electric	-	> 10^14
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV	1250 - 1700	-	-
Ultimate compressive strength	Mechanical	MPa	2100 - 2600	psix10^3	304 - 377
Service temperature	Thermal	°C	-100 / 1600	°F	-148 / 2912

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
0,300 - 100,000	mm	1/64 - 4	"	G10-16-20-25-28-40-60-100

Corrosion Resistance

Excellent corrosion resistance in water, salt solutions, acids, they are resistant even into aggressive environments excepted hydrofluoric, hydrochloric acids, hot sulphuric acid and strong alkaline solutions.

ZTA CERAMIC BALLS

Aluminium Oxide with about 20% content of Zirconium Oxide balls, they feature better mechanical properties, wear and compression resistance and thermal shocks resistance in comparison to nearly pure Aluminium Oxide balls.

Applications

Ball bearings, special pumps and valves mainly when both high corrosion resistance and high heat resistance are required. Medical field applications. They are used even as grinding and machining media.

Commercial name	Other name	Formula	Aluminum Oxide %
Zirconia toughened alumina	ZTA	Al2O3 + ZrO2 + Y2O3	~ 80

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	4,18
Young's modulus	E	GPa	Mechanical	-	338
Friction coefficient	μ	-	Mechanical	Room temp.	0,52
Specific heat	c	J/kg-K	Thermal	Room temp.	680
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	8,2
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	25,0
Volume resistivity	ρ	Ω*m	Electric	-	> 10^11
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRA	89,5 - 91,5	-	-
Ultimate compressive strength	Mechanical	MPa	2500 - 2800	psix10^3	363 - 406
Service temperature	Thermal	°C	-80 / 1500	°F	-112 / 2732

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
0,400 - 50,000	mm	1/64 - 2	"	G10-16-20-25-28-40-60-100

Corrosion Resistance

Good corrosion resistance in almost all diluted and concentrated solutions (both acid and basic, for example nitric acid, sulphuric acid and caustic soda) except against hydrofluoric acid and phosphoric acid. The chemical compatibility is similar to Aluminum Oxide ceramic. ZTA balls can be used even in contact with halogens and melted metals.

ZIRCONIUM OXIDE (ZrO2) BALLS

Refractory ceramic material balls, they provide excellent corrosion, wear and heat resistance. They improve their hardness when they are subjected to collisions. Yttrium doped Zirconia Oxide, they provide the best properties between ceramic materials in grinding and milling applications.

Applications

Special bearings, pumps and valves that operate in aggressive environments, check valves, flow meters, measurement instruments. They are used in the medical field (very pure material). Grinding and milling applications.

Commercial name	Other name	Formula	Oxides %
Zirconium Dioxide	Zirconia	ZrO2 + Y2O3	95% ZrO2 / 5% Y2O3

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	6
Young's modulus	E	GPa	Mechanical	-	210
Friction coefficient	μ	-	Mechanical	Room temp.	0,2
Specific heat	c	J/kg-K	Thermal	Room temp.	450
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	10,5
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	3,5
Volume resistivity	ρ	Ω*m	Electric	-	> 10^11
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HRA	87 - 91	-	-
Ultimate compressive strength	Mechanical	MPa	1750 - 2500	psix10^3	254 - 362
Service temperature	Thermal	°C	0 / 1350	°F	32 / 2462

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
0,300 - 101,600	mm	1/64 - 4	"	G10-16-20-25-28-40-60-100

Corrosion Resistance

Zirconia balls are chemically inert in molten metals, caustic and organic solvents and most acids substances. They are not resisting against hydrochloric acid and strong alkaline solutions.

SILICON NITRIDE (Si3N4) BALLS

Light weight ceramic material balls, they provide very good mechanical/thoughness properties and corrosion resistance. They are auto lubricant materials and good electric insulators. They have excellent resistance to thermal shocks. Balls are manufactured according to ASTM F 2094 Class II standards.

Applications

Special bearings, high-speed bearings, under vacuum pumps, compressors, centrifugal pumps, shafts/mandril, recirculating balls, flow meters, measurement instruments. They are used in aerospace and military industry.

Commercial name	Other name	Formula	Nitride %
Silicon Nitride	Nierite	Si3N4	90,0 - 95,0

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	3,26
Young's modulus	E	GPa	Mechanical	-	300
Friction coefficient	μ	-	Mechanical	Room temp.	0,1
Specific heat	c	J/kg-K	Thermal	Room temp.	740
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	3,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	23,0
Volume resistivity	ρ	Ω*m	Electric	-	> 10^13
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV	1400 - 1600	-	-
Ultimate compressive strength	Mechanical	MPa	2300 - 4000	psix10^3	334 - 580
Service temperature	Thermal	°C	0 / 1200	°F	32 / 2192

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades
0,4000 - 200,000	mm	1/64 - 8	"	See section International Standards ISO 3290-2

Corrosion Resistance

Excellent corrosion resistance in all almost corrosive environments, apart from acids (except sulphuric acid) and basic solutions at high concentrations.

SILICON CARBIDE (SiC) BALLS

Ceramic balls with good mechanical and stiffness properties, good corrosion and wear resistance. They are electric conductors and suitable for high temperature applications.

Applications

Special bearings and pumps, electric switches and sensors, medical instruments. They are used in automotive, aviation and aerospace, naval, petroleum, chemical and electronic industry.

Commercial name	Other name	Formula	Carbide %
Silicon Carbide	Carborundum	SiC	99,9

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	3,15
Young's modulus	E	GPa	Mechanical	-	405
Friction coefficient	μ	-	Mechanical	Room temp.	0,6
Specific heat	c	J/kg-K	Thermal	Room temp.	695
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	3,7
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	144,0
Volume resistivity	ρ	Ω*m	Electric	-	> 10^4
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV	2200 - 2800	-	-
Ultimate compressive strength	Mechanical	MPa	1700 - 2275	psix10^3	246 - 330
Service temperature	Thermal	°C	0 / 1500	°F	32 / 2732

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
1,000 - 50,000	mm	3/64 - 2	"	G10-16-20-25-28-40-60-100

Corrosion Resistance

Good corrosion resistance in diluted and concentrated acids, fairish in alkalis and halogens, they are resisting in contact with hydrofluoric and sulphuric acids and sodium hydroxide, fair resistance in nitric and hydrochloric acids. They are not resisting in contact with molten metals.

RUBY BALLS

Monocrystalline aluminum oxide based ceramics balls, the typical red colour of ruby is due to small amounts of impurities. They provide excellent hardness, corrosion resistance and high temperatures resistance properties, good wear resistance and dimensional stability. They are auto lubricant and easy polishing materials.

Applications

Special bearings, pumps and valves (chemical pumps, check valves), measurement instruments, pen tips, optical and probing applications, flow meters.

Commercial name	Other name	Formula	Oxide %
Monocrystalline Aluminum Trioxide	Ruby	Al2O3 (+Cr2O3/Si2O3)	98,0-99,99

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	3,98
Young's modulus	E	GPa	Mechanical	-	420
Friction coefficient	μ	-	Mechanical	Room temp.	0,15
Specific heat	c	J/kg-K	Thermal	Room temp.	750
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	5,8
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	39,0
Volume resistivity	ρ	Ω*m	Electric	-	> 10^14
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV	1570 - 2170	-	-
Ultimate compressive strength	Mechanical	MPa	2030 - 2130	psix10^3	294 - 309
Service temperature	Thermal	°C	-196 / 1750	°F	-320,8 / 3250

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades
0,127 - 14,986	mm	0.005 - 0.590	"	G3-5-6-10-25

Corrosion Resistance

Good corrosion resistance in contact with acids (even strong acids), alkalis and halogens, even at high temperatures.

SAPPHIRE BALLS

High purity monocrystalline aluminum oxide balls, they are transparent and provide high hardness, wear, temperature and corrosion resistance.

Applications

Special bearings, chemical, medical ans check valves, flowmeters, pens and styli tips, measurement instruments, bar code readers, fiber optical connectors.

Commercial name	Other name	Formula	Oxide %
Monocrystalline Aluminum Trioxide	Sapphire	Al2O3	99,90-99,99

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	3,98
Young's modulus	E	GPa	Mechanical	-	415
Friction coefficient	μ	-	Mechanical	Room temp.	0,15
Specific heat	c	J/kg-K	Thermal	Room temp.	750
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	6,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	40,0
Volume resistivity	ρ	Ω*m	Electric	-	> 10^14
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	HV	1600 - 2300	-	-
Ultimate compressive strength	Mechanical	MPa	2000 - 2100	psix10^3	290 - 304
Service temperature	Thermal	°C	-196 / 1800	°F	-320,8 / 3272

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades
0,200 - 20,000	mm	1/128 - 25/32	"	G3-5-6-10-25

Corrosion Resistance

Sapphire balls provide excellent corrosion resistance both in acid and basic environments, even in severe conditions., better than ruby balls. They are attacked only by melt substanbces containing Li, B, F, Na and K elements.

SODA LIME GLASS BALLS

Light weight glass balls, they are chemically inert and they allow to get excellent surface finishing.

Applications

Special bearings and valves, plastic bearings, low-cost check valves, metering pumps, flow meters, measurement instruments, agitators, optic fiber devices, ink cartridges, closures for bottle, shot blasting, grinding. They are used even into art and decoration fields.

Chemical composition

%SiO2	%Na2O	%CaO	%MgO	%Al2O3	%Li2O	%K2O	%TiO2	%Fe2O3	% PbO	-	-
63,00-81,00	9,00-15,00	7,00-14,00	6,00 max	2,00 max	2,00 max	1,50 max	0,80 max	0,80 max	0,010 max	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	2,50
Young's modulus	E	GPa	Mechanical	-	70
Refractive index	n	-	Optic	-	1,518
Softening temperature	-	°C/°F	Thermal	Room temp./P.atm.	726 / 1340
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	9,4
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	1,00
Volume resistivity	ρ	Ω*m	Electric	-	> 10^14
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Knoop	465 - 585	Mohs	6
Ultimate compressive strength	Mechanical	MPa	900 - 1100	psix10^3	131 - 159
Service temperature	Thermal	°C	0 / 200	°F	32 / 392

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades
1,000 - 100,000	mm	3/64 - 4	"	G50-100-200-500-1000-2000

Corrosion Resistance

Basically inert material, soda lime balls resist even to strong alkaline solutions.

BOROSILICATE GLASS BALLS

Glass balls with high chemical and thermal stability. They are electric insulators and they are resisting even at strong external strengths and pressure variations.

Applications

Special valves, safety valves, metering pumps. They are used in the pharmaceutical field and photographic devices.

Chemical composition

%SiO2	%Na2O	%CaO	%Al2O3	%B2O3	%K2O	%BaO	-	-	-	-	-
65,00-85,00	3,00-9,00	2,50 max	1,00-5,00	8,00-15,00	2,00 max	1,00 max	-	-	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	2,23
Young's modulus	E	GPa	Mechanical	-	64
Refractive index	n	-	Optic	-	1,471
Softening temperature	-	°C/°F	Thermal	Room temp./P.atm.	821 / 1510
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	3,30
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	1,15
Volume resistivity	ρ	Ω*m	Electric	-	> 10^15
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Knoop	420 - 520	Mohs	6
Ultimate compressive strength	Mechanical	MPa	1900 - 2100	psix10^3	275 - 305
Service temperature	Thermal	°C	0 / 200	°F	32 / 392

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades
1,000 - 100,000	mm	3/64 - 4	"	G10-25-50-100-200-500-1000-2000

Corrosion Resistance

Borosilicate balls have excellent corrosion resistance into water, most acid compounds, salt solutions, organic solvents and halogens. They are useful to resist in strong oxidizing environments. Fairish resistance to alkaline solutions, they do not resist to strong alkaline solutions, hydrofluoric acid and hot concentrated phosphoric acid.

BLACK GLASS BALLS

High dimensional stability, these balls are resistant to corrosion and to chemical absorption.

Applications

Medical and chemical flowmeters, aircraft slips, turn indicators. Variety of functions, most common use into precision instruments.

Chemical composition

%SiO2	%Na2O	%CaO	%Al2O3	%B2O3	%K2O	%BaO	%MnO2	-	-	-	-
65,00-75,00	9,50-15,50	3,00-5,00	1,00 max	1,00-3,00	2,00-3,00	3,00-4,00	5,00-7,00	-	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	2,57
Young's modulus	E	GPa	Mechanical	-	66
Refractive index	n	-	Optic	-	1,520
Softening temperature	-	°C/°F	Thermal	Room temp./P.atm.	650 / 1202
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	7,2
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,76
Volume resistivity	ρ	Ω*m	Electric	-	> 10^14
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Knoop	468 - 530	Mohs	6
Ultimate compressive strength	Mechanical	MPa	750 - 950	psix10^3	109 - 138
Service temperature	Thermal	°C	0 / 300	°F	32 / 572

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades
1,000 - 100,000	mm	3/64 - 4	"	G25-50-100-200-500-1000-2000

Corrosion Resistance

Good corrosion resistance in contact with most acid and basic compounds.

QUARTZ (SiO2) BALLS

Pure amorphous silicone dioxide (fused silica) transparent balls, they feature elevated hardness, heat resistance, excellent optical properties (high trasmittance both in UV and IR wavelengths).

Applications

They are mainly used in optical devices and anti-reflective coatings.

Chemical composition (%)

%Si02	% Other	-	-	-	-	-	-	-	-	-	-
99,99	0,01	-	-	-	-	-	-	-	-	-	-

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	2,20
Young's modulus	E	GPa	Mechanical	-	73
Refractive index	n	-	Optic	-	1,459
Softening temperature	-	°C/°F	Thermal	Room temp./P.atm.	1650 / 3002
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	0,5
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	1,42
Volume resistivity	ρ	Ω*m	Electric	-	> 10^15
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Knoop	500 - 700	Mohs	7
Ultimate compressive strength	Mechanical	MPa	1050 - 1150	psix10^3	152 - 166
Service temperature	Thermal	°C	0 / 1000	°F	32 / 1832

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision grades (ISO 3290 / AFBMA)
0,300 - 10,000	mm	1/64 - 25/64	"	G10-25

Corrosion Resistance

Fused silica balls are insoluble in water, they resist against strong acids (chloridric, nitric, sulphuric) except hydrofluoric acid. They are not resisting against alkaline solutions (they are attacked by sodium hydroxide, potassium hydroxide, sodium carbonate).

PRECISION GRADES OF GLASS BALLS

Material	Minimum diameter	Maximum diameter	Units	Precision grade	Tolerance on diameter	Units	Roundness	Units
BSG/QUA	1,000	3,500	mm	G10	+/- 2,5	µm	0,25 max	µm
BSG/QUA	3,501	10,000	mm	G10	+/- 5	µm	0,30 max	µm
BSG	10,001	12,700	mm	G10	+/- 5	µm	0,30 max	µm
BSG/BLG/QUA	1,000	3,500	mm	G25	+/- 2,5	µm	0,63 max	µm
BLG	3,501	12,700	mm	G25	+/- 2,5	µm	0,63 max	µm
BSG/QUA	3,501	10,000	mm	G25	+/- 10	µm	0,50 max	µm
BSG	10,001	12,700	mm	G25	+/- 10	µm	0,50 max	µm
SLG/BSG/BLG	1,000	100,000	mm	G50	+/- 10	µm	10 max	µm
SLG/BSG/BLG	1,000	100,000	mm	G100	+/- 20	µm	20 max	µm
SLG/BSG/BLG	1,000	100,000	mm	G200	+/- 30	µm	30 max	µm
SLG/BSG/BLG	1,000	100,000	mm	G500	+/- 100	µm	100 max	µm
SLG/BSG/BLG	1,000	100,000	mm	G1000	+/- 500	µm	-	-
SLG/BSG/BLG	1,000	100,000	mm	G2000	+/- 1000	µm	-	-

Legend of materials

SLG	Sodalime Glass
BSG	Borosilicate Glass
BLG	Black Glass
QUA	Quartz

NBR RUBBER BALLS

Acrylonitrile and butadiene unsatured copolymers balls, they provide good wear/abrasion, heat and compression resistance. Excellent contact compatibility with plastics. Poor resistance to aging. They allow to get closer tolerances despite of the soft components. The natural color of the balls is black.

Applications

Safety pumps and valves (as sealing element), hydraulic and pneumatic applications.

Technical name	Commercial name	Abbreviation
Acrylonitrile Butadiene	Buna-N, Nitrile	NBR

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,20 / 1,40
Young's modulus	E	MPa	Mechanical	-	3,5
Elongation at break	A	%	Mechanical	Room temp.	max 700
Compression set	-	%	Mechanical	Room temp.	25
Friction coefficient	μ	-	Mechanical	Room temp.	0,90
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	170
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,25
Electric resistivity	ρ	Ohm.mm2/m	Electric	-	> 10^15
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore A	75 - 90	-	-
Ultimate tensile strength	Mechanical	MPa	15 - 20	psix10^3	2,15 - 2,90
Service temperature	Thermal	°C	-15 / 100	°F	5 / 212

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,000 - 152,400	mm	3/64 | 6	"	III

Corrosion Resistance

NBR balls are resistant in contact with hydraulic fluids, lubricant oils, transmission fluids, not polar petroleum products, aliphatic hydrocarbons, mineral greases, most diluted acids, basis and salt solutions at room temperature. They are resisting even into air and water environments. They are not resisting against aromatic and chlorinated hydrocarbons, polar solvents, ozone, ketones, esters, aldehydes.

EPDM RUBBER BALLS

Terpolymer EPDM balls provide good resistance against heat, aging, atmospheric agents, UV radiations and good behaviour at low temperatures. They are available even with peroxide crosslinking agent.

Applications

They are used in several industrial applications, as sealing or floating units. They are even used in environment devices, mainly when balls are bleak.

Technical name	Commercial name	Abbreviation
Ethylene-Propylene-Diene Monomer	Buna-EP	EPDM

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,20
Young's modulus	E	MPa	Mechanical	-	8
Elongation at break	A	%	Mechanical	Room temp.	max 600
Compression set	-	%	Mechanical	Room temp.	35
Friction coefficient	μ	-	Mechanical	Room temp.	0,50
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	165
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,15
Electric resistivity	ρ	Ohm.mm2/m	Electric	-	> 10^21
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore A	75 - 90	-	-
Ultimate tensile strength	Mechanical	MPa	11 - 15	psix10^3	1,60 - 2,18
Service temperature	Thermal	°C	-30 / 130	°F	-22 / 266

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,000 - 152,400	mm	3/64 | 6	"	III

Corrosion Resistance

EPDM rubber is resistant to water, steam, ozone, alkali, alcools, ketones, esters, glycols, salt solutions and oxidizing substances, mild acids, detergents and several organic and inorganic bases. Balls are not resisting in contact with petrol, diesel oil, greases, mineral oils and aliphatic, aromatic and chlorinated hydrocarbons.

VITON RUBBER BALLS

Fluorocarbon elastomer balls, they provide excellent corrosion, aging and high temperature resistance. They are mainly used as sealings and are not flammable.

Applications

Check valves, safety valves and special pumps (sealing elements), for high temperature and aggressive environment applications.

Technical name	Commercial name	Abbreviation
Fluorocarbon (Fluoroelastomer)	Viton	FPM, FKM

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,84
Young's modulus	E	MPa	Mechanical	-	12
Elongation at break	A	%	Mechanical	Room temp.	max 500
Compression set	-	%	Mechanical	Room temp.	26
Friction coefficient	μ	-	Mechanical	Room temp.	0,70
Coefficient of linear thermal	α	10^-6/°C	Thermal	(ΔT=0-100°C)	125,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,16
Volume resistivity	ρ	Ω*m	Electric	-	> 10^8
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore A	70 - 90	-	-
Ultimate tensile strength	Mechanical	MPa	7 - 21	psix10^3	1,00 - 3,00
Service temperature	Thermal	°C	-18 / 200	°F	0 / 392

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,000 - 152,400	mm	3/64 | 6	"	III

Corrosion Resistance

Viton balls are resistant into water, steam, oxygen, ozone, mineral/silicon/vegetable/animal oils and greases, diesel oil, hydraulic fluids, aliphatic, aromatic and chlorinated hydrocarbons, methanol fuel. They are not resisting against polar solvents, glycols, ammonia gases, amines and alkalis, hot steam, organic acids with low molecular weight.

POLYURETHANE RUBBER BALLS

High performances polyurethane elastomer balls, they are featured by excellent mechanical properties, high wear, laceration and collision resistance, joined with a good elastic behaviour. Good radiation and weather resistance.

Applications

Special bearings, pneumatic pumps, applications where good elastic properties correlated to high toughness are required.

Technical name	Commercial name	Abbreviation
-	Polyurethane rubber	PUR

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,15
Young's modulus	E	MPa	Mechanical	-	100
Elongation at break	A	%	Mechanical	Room temp.	max 750
Compression set	-	%	Mechanical	Room temp.	11
Friction coefficient	μ	-	Mechanical	Room temp.	0,80
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	180,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,25
Volume resistivity	ρ	Ω*m	Electric	-	> 10^8
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore A	50 - 95*	-	-
Ultimate tensile strength	Mechanical	MPa	8 - 45	psix10^3	1,16 - 6,53
Service temperature	Thermal	°C	-20 / 80	°F	-20 / 176

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,000 - 152,400	mm	3/64 | 6	"	III

Corrosion Resistance

Good corrosion resistance in contact with nitrogen, oxygen, ozonemineral oils and greases, aliphatic hydrocarbons, diesel oil. They are attacked by hot water and steam, acids, alkalis.

Property	Description
Hardness*	Available hardness: 50-60/65-75/70-80/80-90/85-95 Shore A

SANTOPRENE BALLS

Vulcanized thermoplastic elastomer polyolefinic material balls, they combine the quality of rubbers (flexibility and durability) with easiness on workability of thermoplastic materials.

Applications

Check valves, diaphragm pumps, automotive field, they are used even as floating elements.

Technical name	Commercial name	Abbreviation
Santoprene	Santoprene	TPV

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	0,96
Young's modulus	E	MPa	Mechanical	-	0,6
Elongation at break	A	%	Mechanical	Room temp.	max 620
Compression set	-	%	Mechanical	Room temp.	25
Friction coefficient	μ	-	Mechanical	Room temp.	0,80
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	91
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,20
Electric resistivity	ρ	Ohm.mm2/m	Electric	-	> 10^14
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore A	60 - 90	-	-
Ultimate tensile strength	Mechanical	MPa	6 - 20	psix10^3	0,87 - 2,90
Service temperature	Thermal	°C	-40 / 130	°F	-40 / 266

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
3,000 - 115,000	mm	1/8 | 4.1/2	"	III

Corrosion Resistance

Good corrosion resistance in contact with acid and basic solutions (except strong acids), little attack in presence of alcohols, ketones, esthers, eters, phenols, glycols, acqueous solutions; fair resistance with aromatic hydrocarbons and petroleum products.

SILICONE BALLS

Silicone rubber balls, they can be used in a wide range of temperatures with high elastic properties. They are resisting to weather and radiation and they can be insulating or conducting according to the manufacturing processing. They do not provide good mechanical and wear features.

Applications

Silicone rubber balls are used in applications where good elastic properties are required both at low and high temperatures. They are used in the foodstuff, automotive, medical fields and are excellent sealing elements.

Technical name	Commercial name	Abbreviation
Polysiloxane / Polydimethylsiloxane	Silicone	MQ / VMQ / PMVQ / PDMS

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,20
Young's modulus	E	MPa	Mechanical	-	7
Elongation at break	A	%	Mechanical	Room temp.	max 400
Compression set	-	%	Mechanical	Room temp.	40
Friction coefficient	μ	-	Mechanical	Room temp.	1,00
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	230,0
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,17
Electric resistivity	ρ	Ohm.mm2/m	Electric	-	10^4 < ρ < 10^15
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore A	25 - 90*	-	-
Ultimate tensile strength	Mechanical	MPa	8 - 12	psix10^3	1,16 - 1,74
Service temperature	Thermal	°C	-65 / 180	°F	-85 / 356

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
1,000 - 150,000	mm	3/64 | 5.3/4	"	III

Corrosion Resistance

Good corrosion resistance in contct with water (even hot water), oxygen, ozone, hydraulic fluids, animal and vegetal oils and greases, diluted acids. They are not resisting in contact with strong acids and basis, mineral oils and greases, alkalis, aromatic hydrocarbons, ketones, petroleum products, polar solvents.

Property	Description
Hardness*	Available hardness: 25-35/35-45/45-55/55-65/65-75/75-85/80-90 Shore A

NATURAL RUBBER (NR) BALLS

Elastomer polymer balls, the raw material is obtained directly from the rubber tree (Hevea Brasiliensis). They provide good mechanical properties and abrasion, friction, compression and low temperatures resistance. Fair resistance to UV radiation. The addition of stirene-butadiene copolymer allows to obtain a rubber (NR/SBR) with improved mechanical properties.

Applications

They are excellent sealing elements (strong bonding to metal parts), then they are often used in different types of pumps and valves. NR balls are even used in the toys field and for manufacture golf balls.

Technical name	Commercial name	Abbreviation
Polyisoprene	Latex	NR

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,32
Young's modulus	E	MPa	Mechanical	-	5
Elongation at break	A	%	Mechanical	Room temp.	max 700
Compression set	-	%	Mechanical	70° 22h	20
Friction coefficient	μ	-	Mechanical	Room temp.	0,85
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	180
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,14
Electric resistivity	ρ	Ohm.mm2/m	Electric	-	> 10^19
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore A	40 - 80*	-	-
Ultimate tensile strength	Mechanical	MPa	10 - 25	psix10^3	1,45 - 3,63
Service temperature	Thermal	°C	-50 / 80	°F	-58 / 176

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
2,000 - 152,400	mm	3/32 | 6	"	III

Corrosion Resistance

Good corrosion resistance in contact with water, diluted acids and basis, alcohols. Fair in contact with ketones. The behaviour of balls is not suitable in contact with steam, oils, petrol and aromatic hydrocarbons, oxygen and ozone.

Property	Description
Hardness*	Available hardness: 40-50/50-65/65-75/70-80 Shore A

NEOPRENE ® (CR) BALLS

Polychloroprene elastomer balls, they feature good mechanical characteristics, collision and abrasion resistance. They have an excellent resistance to weathering, UV radiation and auto extinguish properties. Very good adhesion to metals.
Neoprene® is a registered trademark of DuPont Company.

Applications

Industrial field in pumps and valves as sealing elements, they are used even as decorative elements and in sports applications. Excellent behaviour in external environments.

Technical name	Commercial name	Abbreviation
Polychloroprene	Neoprene®	CR

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,36
Young's modulus	E	MPa	Mechanical	-	2,5
Elongation at break	A	%	Mechanical	Room temp.	max 600
Compression set	-	%	Mechanical	Room temp.	28
Friction coefficient	μ	-	Mechanical	Room temp.	0,65
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	139
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,19
Electric resistivity	ρ	Ohm.mm2/m	Electric	-	> 10^17
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore A	60 - 80	-	-
Ultimate tensile strength	Mechanical	MPa	10 - 25	psix10^3	0,73 - 2,90
Service temperature	Thermal	°C	-30 / 100	°F	-22 / 212

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
2,000 - 152,400	mm	3/32 | 6	"	III

Corrosion Resistance

Neoprene® balls feature an excellent resistance against sea and fresh water, diluted acids and basis, refrigerant fluids, ammonia, ozone, alkali. Fair resistance against mineral oils, aliphatic hydrocarbons and steam. Poor resistance against strong acids and basis, aromatic hydrocarbons, polar solvents, ketones.

EPM RUBBER BALLS

Saturated ethylene propylene rubber balls obtained by means of reticulation with organic peroxides, they feature good abrasion, weathering, aging and heat resistance. They are good electrical insulators. Lower UV resistance than EPDM rubber.

Applications

Special pumps and valves as sealing elements, automotive field, outdoor applications.

Technical name	Commercial name	Abbreviation
Ethylene-Propylene Monomer	Buna-EP	EPM

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,15
Young's modulus	E	MPa	Mechanical	-	7
Elongation at break	A	%	Mechanical	Room temp.	max 600
Compression set	-	%	Mechanical	Room temp.	40
Friction coefficient	μ	-	Mechanical	Room temp.	0,55
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	180
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,30
Electric resistivity	ρ	Ohm.mm2/m	Electric	-	> 10^17
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore A	60 - 80	-	-
Ultimate tensile strength	Mechanical	MPa	10 - 20	psix10^3	1,45 - 2,90
Service temperature	Thermal	°C	-30 / 130	°F	-22 / 266

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
4,750 - 150,000	mm	3/16 | 5.3/4	"	III

Corrosion Resistance

Good corrosion resistance against water, ozone, steam, alkali, alcohols, ketones, esters, glicols, hydraulic fluids, polar solvents, diluted acids. They are not suitable in contact with aromatic and chlorinated hydrocarbons, petroleum products.

SBR RUBBER BALLS

Styrene butadiene copolymer balls, they feature good mechanical properties, excellent abrasion, wear and permanent defomation resistance. They are not suitable in outdoor applications and they feature even low aging resistance.

Applications

Special pumps and valves as sealing elements, mixing devices, automotive field.

Technical name	Commercial name	Abbreviation
Styrene-butadiene	Buna-S	SBR

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	Values
Density	δ	g/cm3	Physical	Room temp.	1,23
Young's modulus	E	MPa	Mechanical	-	6
Elongation at break	A	%	Mechanical	Room temp.	max 700
Compression set	-	%	Mechanical	Room temp.	25
Friction coefficient	μ	-	Mechanical	Room temp.	0,82
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	180
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	0,17
Electric resistivity	ρ	Ohm.mm2/m	Electric	-	> 10^19
Relative magnetic permeability	μ	-	Magnetic	Diamagnetic	<~1

Technical data

Property	Type	U.o.M.	Values	U.o.M.	Values
Hardness	Mechanical	Shore A	50 - 95	-	-
Ultimate tensile strength	Mechanical	MPa	5 - 20	psix10^3	0,73 - 2,90
Service temperature	Thermal	°C	-50 / 90	°F	-58 / 194

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade
4,750 - 150,000	mm	3/16 | 5.3/4	"	III

Corrosion Resistance

Good resistance against water, fair in contact with alcohols, ketones, glycols, brake fluids, diluted acids and basis. They are not suitable in contact with oils and fat, aliphatic and aromatic hydrocarbons, petroleum products, esters, ethers, oxygen, ozone, strong acids and basis.

MOLDED RUBBER BALLS

Unground balls, they are manufactured by molded processing and they provide a seamline. They are useful for applications when tolerances are not important.

Applications

Anti-blinding and screen-cleaning devices, grinding & polishing machines.

Technical name	Commercial name	Abbreviation
Ethylene-Propylene-Diene Monomer	Buna-EP	EPDM
Polyisoprene	Latex	NR
Acrylonitrile Butadiene	Buna-N, Nitrile	NBR
Polychloroprene	Neoprene®	CR
Polysiloxane / Polydimethylsiloxane	Silicone	MQ / VMQ / PMVQ / PDMS
Fluorocarbon (Fluoroelastomer)	Viton	HK, FKM, FFKM

Technical data

Property	Symbol	U.o.M.	EPDM	NR	NBR	CR	Silicone	Viton
Density	δ	g/cm3	1,20	1,41	1,20	1,24	1,26	1,84
Young's modulus	E	MPa	8	4	3,5	4	7	12
Ultimate tensile strength	Rm	MPa	11-15	5-15	15-20	5-20	8-12	7-21
Elongation at break (maximum)	A	%	600	700	700	600	400	500
Compression set	-	%	35	20	25	28	40	26
Friction coefficient	μ	-	0,50	0,85	0,90	0,65	1,00	0,70
Coefficient of linear thermal expansion	α	10^-6/°C	165,0	180,0	170,0	139,0	230,0	125,0
Thermal conductivity	λ	W/(m·K)	0,15	0,14	0,25	0,19	0,17	0,16
Electric resistivity	ρ	Ohm.mm2/m	> 10^21	> 10^19	> 10^15	> 10^17	> 10^14	> 10^8(Vol.)
Hardness	-	Shore A	60-90	50-65	80-90	50-90	65-75	65-75
Service temperature (min/max)	-	°C	-20/130	-50/80	-15/100	-30/100	-65/180	-18/200

Range

Minimum diameter	Maximum diameter	U.o.M.	Tolerance on diameter	U.o.M.	Roundness	U.o.M.
2,000	10,000	mm	± 0,300	mm	0,300 max	mm
10,001	20,000	mm	± 0,500	mm	0,500 max	mm
20,001	40,000	mm	± 0,750	mm	0,750 max	mm
40,001	60,000	mm	± 1,000	mm	1,000 max	mm
60,001	80,000	mm	± 2,000	mm	2,000 max	mm
80,001	150,000	mm	± 3,000	mm	3,000 max	mm

PRECISION GROUND RUBBER BALLS TOLERANCES (GRADE III)

Minimum diameter	Maximum diameter	U.o.M.	Tolerance on diameter	U.o.M.	Roundness	U.o.M.
1,000	2,000	mm	+/- 0,050	mm	0,050 max	mm
2,001	10,000	mm	+/- 0,075	mm	0,075 max	mm
10,001	20,000	mm	+/- 0,125	mm	0,125 max	mm
20,001	40,000	mm	+/-0,200	mm	0,200 max	mm
40,001	60,000	mm	+/-0,300	mm	0,300 max	mm
60,001	80,000	mm	+/- 1,000	mm	1,000 max	mm
80,001	100,000	mm	+/- 1,500	mm	1,500 max	mm
100,001	150,000	mm	+/- 2,000	mm	2,000 max	mm

GRINDING / POLISHING BALLS DATA

Balls in different qualities of materials, sold in kilos, they are useful for applications where precision is not important. The big variety of manufactured materials allows to satisfy all inquiries and needs.

Applications

Grinding of different compounds (concrete, food, etc...), ball mill, tumble and vibro finishing, polishing, shot peening, filtering systems. They are often used as filler or cover elements in electrical, idraulic or thermal applications.

Chemical composition

Steel	%C	%Si	%Mn	%P	%S	%Cr	%Ni	%N	%Mo	%Ti
AISI 52100	0,95-1,10	0,35 max	0,20-0,50	0,025 max	0,025 max	1,30-1,60	-	-	-	-
AISI 1010/1015	0,08-0,18	0,10-0,35	0,30-0,60	0,040 max	0,050 max	-	-	-	-	-
AISI 1085	0,80-0,93	0,10-0,35	0,70-1,00	0,040 max	0,050 max	-	-	-	-	-
AISI 304/304L	0,080 / 0,030 max	0,75 max	2,00 max	0,045 max	0,030 max	18,00-20,00	8,00-10,50	0,100 max	-	-
AISI 316/316L	0,080 / 0,030 max	1,00 max	2,00 max	0,045 max	0,030 max	16,00-18,00	10,00-14,00	-	2,00-3,00	-
AISI 316Ti	0,080 max	0,75 max	2,00 max	0,045 max	0,030 max	16,00-18,00	10,00-14,00	0,100 max	2,00-3,00	5x%C-0,70
AISI 420(A-B-C)	0,16-0,50	1,00 max	1,50 max	0,040 max	0,030 max	12,00-14,50	-	-	-	-
AISI 440C	0,95-1,20	1,00 max	1,00 max	0,040 max	0,030 max	16,00-18,00	-	-	0,75 max	-

Metal alloys	%Si	%Fe	%Mn	%Cr	%Cu	%Ti	%Al	%V	%Mg	%Zn	%P
Al series 1XXX	0,25 max	0,40 max	0,05 max	0,10 max	0,20 max	0,05 max	99,00 min	0,05 max	0,05 max	0,10 max	-
Al 6061 alloy	0,40-0,80	0,70 max	0,15 max	0,04-0,35	0,15-0,40	0,15 max	balance	-	0,80-1,20	0,25 max	-
Copper anode	-	-	-	-	99,90 min	-	-	-	-	-	0,10 max

Hard metal	%WC	%Co	-	-	-	-	-	-	-	-
TCK 20/TCK 30	90,00-95,00	5,00-10,00	-	-	-	-	-	-	-	-

Ceramics	%Al2O3	%SiO2	%ZrO2	%Y2O3	%CeO2	%Si3N4	%SiC	%Fe2O3	%Na2O	%TiO2	%CaO	%MgO
Al2O3 92%	91,00-93,00	4,00-6,00	-	-	-	-	-	-	-	-	-	-
ZrO2 stab. Y2O3	-	-	94,00-96,00	4,00-6,00	-	-	-	-	-	-	-	-
ZrSiO4	7,00-11,00	32,00-36,00	51,00-53,00	-	-	-	-	-	-	-	-	-
Si3N4	2,00-4,00	-	-	4,00-6,00	-	90,00-94,00	-	-	-	-	-	-
SiC	-	-	-	-	-	-	99,90 min	-	-	-	-	-
C167®BASF	19,00-26,00	64,00-75,00	-	-	-	-	-	1,50 max	1,00 max	1,50 max	0,50 max	0,50 max

www.rgpballs.com

Glass	%SiO2	%Na2O	%CaO	%MgO	%Al2O3	%Li2O	%K2O	%TiO2	%Fe2O3	%PbO	%B2O3	%BaO
Sodalime glass	63,00-81,00	9,00-15,00	7,00-14,00	6,00 max	2,00 max	2,00 max	1,50 max	0,80 max	0,80 max	0,010 max	-	-
Reflective glass	65,00-79,00	5,00-14,00	4,00-13,00	-	1,50 max	-	0,50 max	-	5,00-,15,00	-	-	-
Borosilicate glass	65,00-85,00	3,00-9,00	2,50 max	-	1,00-5,00	-	2,00 max	-	-	-	8,00-15,00	1,00 max

Technical characteristics / Availability

Steel/Alloys	Diameters (min/max) mm	Precision Grade	Tolerances mm	Density g/cm3	Hardness	Units	Ultimate compressive strength MPa	Service temperatures (min/max) °C
AISI 52100	0,5 - 76,2	1000/2000	±0,05/±0,10	7,80	60 - 66	HRC	2500 - 2600	-60 / 150
AISI 1010/1015	0,5 - 50	1000/2000	±0,05/±0,10	7,82	55 - 65	HRC	1500 - 2000	-40 / 500
AISI 1085	0,5 - 50	1000/2000	±0,05/±0,10	7,85	59 - 66	HRC	2000 - 2500	-40 / 500
AISI 304/304L	0,5 - 50	1000/2000	±0,05/±0,10	7,95	25 - 39	HRC	150 - 300	-196 / 700
AISI 316/316L	0,5 - 50	1000/2000	±0,05/±0,10	7,95	25 - 39	HRC	150 - 300	-196 / 600
AISI 316Ti	0,5 - 50	1000/2000	±0,05/±0,10	7,95	15 - 35	HRC	150 - 300	-196 / 600
AISI 420(A-B-C)	0,5 - 50	1000/2000	±0,05/±0,10	7,74	48 - 60	HRC	1100 - 1400	0 / 400
AISI 440C	0,5 - 50	1000/2000	±0,05/±0,10	7,70	57 - 65	HRC	1200 - 1500	0 / 400
Al series 1XXX	1 - 50	1000/2000	±0,10/±0,20	2,71	20 - 50	HV0.5	100 - 250	-196 / 200
Al 6061 alloy	1 - 50	1000/2000	±0,10/±0,20	2,70	85 - 105	HV	400 - 600	-196 / 200
Copper anode	25 / 40 / 50	3000	±3,00	8,91	40 - 120	HV	200 - 700	-196 / 260
TCK 20/TCK 30	0,5 - 50	1000/2000	±0,05/±0,10	14,85	87,5 - 91,5	HRA	5400 - 5800	-196 / 500

Technical characteristics / Availability

Ceramics/Glass	Diameters (min/max) mm	Precision Grade	Tolerances mm	Density g/cm3	Hardness	Units	Ultimate compressive strength MPa	Service temperatures (min/max) °C
Al2O3 92%	1 - 60	1000/2000/3000	±0,5/±1,0/±3,0	3,60	1250 - 1700	HV	1900 - 2400	-100 / 1600
ZrO2 stab. Y2O3	0,9 - 50	1000/2000/3000	±0,5/±1,0/±3,0	6,00	87 - 91	HRA	1750 - 2500	0 / 1350
ZrSiO4	0,6 - 20	1000/2000/3000	±0,5/±1,0/±3,0	4,05	1200 - 1500	HV	1500 - 2000	0 / 1500
Si3N4	1 - 50	1000/2000/3000	±0,5/±1,0/±3,0	3,26	1400 - 1600	HV	2300 - 4000	0 / 1200
SiC	1 - 50	1000/2000/3000	±0,5/±1,0/±3,0	3,15	2200 - 2800	HV	1700 - 2275	0 / 1500
C167®BASF	3,175 - 50,8	2000	±1,5	2,20	950 - 1550	HV	2500 - 2900	0 / 980
Sodalime glass	0,50 - 50	1000/2000	±0,50/±1,00	2,50	465 - 585	Knoop	900 - 1100	0 / 200
Reflective glass	0,040 - 0,850	1000/2000	±0,05/±0,10	2,55	640 - 740	Knoop	1100 - 1300	0 / 200
Borosilicate glass	0,50 - 50	1000/2000	±0,50/±1,00	2,23	420 - 520	Knoop	1900 - 2100	0 / 200

SATELLITES/BICONES

Special products manufactured for surface bright polishing and tumbling purposes. They are available in two different shapes: REAL SATELLITE or BICONE.
REAL SATELLITE: Presence of an equatorial ring and a spherical cap.
BICONE: The equatorial ring is absent or slightly prominent, conical cap with a flat/spherical/beveled tip.

Applications

Surface bright polishing and tumbling purposes.

Chemical composition

Type	%C	%Si	%Mn	%P	%S	%Cr	%Ni	%N	%Mo
52100	0,95-1,10	0,35 max	0,20-0,50	0,025 max	0,025 max	1,30-1,60	-	-	-
201	0,15 max	1,00 max	5,50-7,50	0,060 max	0,030 max	16,00-18,00	3,50-5,50	0,250 max	-
304/304L	0,080/0,030 max	0,75 max	2,00 max	0,045 max	0,030 max	18,00-20,00	8,00-10,50	0,100 max	-
316/316L	0,080/0,030 max	1,00 max	2,00 max	0,045 max	0,030 max	16,00-18,00	10,00-14,00	-	2,00-3,00
420C	0,43-0,50	1,00 max	1,00 max	0,040 max	0,030 max	12,50-14,50	-	-	-
440C	0,95-1,20	1,00 max	1,00 max	0,040 max	0,030 max	16,00-18,00	0,75 max	-	0,75 max
1015	0,12-0,18	0,10-0,35	0,30-0,60	0,040 max	0,050 max	-	-	-	-
1085	0,80-0,93	0,10-0,35	0,70-1,00	0,040 max	0,050 max	-	-	-	-

International Standards

ITA	USA	GER	FRA	UK	RUS	CHN	JAP
100Cr6	52100	1.3505	100C6	534A99	9Ch1	GCr15	SUJ2
-	201	1.4372	Z12CMN17-07Az	201 S 01	14Ch18N4G4L	1Cr17Mn6Ni5N	SUS 201
X5CrNi18-10	304	1.4301	Z7CN18-09	304S15	08KH18N10	0Cr18Ni9	SUS304
X2CrNi18-9	304L	1.4307	Z3CN18-10	304S11	04KH18N10	00Cr19Ni10	SUS304L
X5CrNiMo1712	316	1.4401	Z6CND17.11	316S16	08KH16N11M3	0Cr17Ni12Mo2	SUS316
X2CrNiMo1712	316L	1.4404	Z3CND17-11-02	316S11	03KH17N14M2	0Cr18Ni12Mo2Ti	SUS316L
X46Cr13	420C	1.4034	Z 34 C 14	-	40 Kh 13	4Cr13	-
X 105CrMo17	440C	1.4125	Z100CD17	-	95X18	9Cr18Mo	SUS440C
C15	1015	1.1141	XC12	080M15	15	15	S15C
C90	1085	1.1269	XC90	C85S	85 (A)	82B	SWRH87B

www.rgpballs.com

Range

Ball Diameter	U.o.M.	Ring diameter					U.o.M.	Precision grade
2,000	mm	3,000	4,000	-	-	-	mm	G1000 (± 1 mm)
3,000	mm	4,000	5,000	6,000	-	-	mm	G1000 (± 1 mm)
3,500	mm	5,500	-	-	-	-	mm	G1000 (± 1 mm)
4,000	mm	5,000	6,000	7,000	-	-	mm	G1000 (± 1 mm)
4,500	mm	5,500	7,000	-	-	-	mm	G1000 (± 1 mm)
5,000	mm	5,000	6,000	7,000	8,000	-	mm	G1000 (± 1 mm)
6,000	mm	6,000	7,000	8,000	9,000	-	mm	G1000 (± 1 mm)
7,000	mm	7,000	8,000	9,000	10,000	11,000	mm	G1000 (± 1 mm)
8,000	mm	8,000	9,000	10,000	11,000	12,000	mm	G1000 (± 1 mm)
9,000	mm	9,000	10,000	11,000	12,000	13,000	mm	G1000 (± 1 mm)
10,000	mm	10,000	11,000	12,000	13,000	14,000	mm	G1000 (± 1 mm)

Notes

Property	Description
Ball cones shape	If a specific ball cone shape is needed, please clearly indicate it in the order.

STAINLESS STEEL/METALLIC ALLOY HOLLOW BALLS

Hollow balls manufactured in different materials, they allow to get a remarkable weigth saving and keep the properties of the correspondent solid balls (mechanical properties, corrosion resistance, magnetism). Balls are hand made (welding plus polishing), this is the reason when precision grade is not high.

Applications

Special valves, ball transfer units, conveyor belts, magnetic devices, floating devices, calibration instruments, ornamental applications (internal and external decor), cosmetic rollon.

Chemical composition

Type	%C	%Si	%Mn	%P	%S	%Cr	%Ni	%N	%Mo
Carbon steel	0,08-0,93	0,10-0,35	0,30-1,00	0,040 max	0,050 max	-	-	-	-
AISI 201	0,15 max	1,00 max	5,50-7,50	0,060 max	0,030 max	16,00-18,00	3,50-5,50	0,250 max	-
AISI 304/304L	0,080/0,030 max	0,75 max	2,00 max	0,045 max	0,030 max	18,00-20,00	8,00-10,50	0,100 max	-
AISI 316/316L	0,080/0,030 max	1,00 max	2,00 max	0,045 max	0,030 max	16,00-18,00	10,00-14,00	-	2,00-3,00
AISI 420C	0,43-0,50	1,00 max	1,00 max	0,040 max	0,030 max	12,50-14,50	-	-	-
AISI 440A	0,60-0,75	1,00 max	1,00 max	0,040 max	0,030 max	16,00-18,00	-	-	0,75 max
AISI 440C	0,95-1,10	0,80 max	0,80 max	0,035 max	0,030 max	16,00-18,00	0,60 max	-	0,40-0,70

Chemical composition

Type	%Si	%Mn	%Cu	%Al	%Zn	%Pb	%Fe	%C	%N	%Ti	%O	%H	%Other
Al 3003 alloy	0,60 max	1,00-1,50	0,05-0,20	balance	0,100 max	-	0,70 max	-	-	-	-	-	-
Brass	-	-	68,50-71,50	-	balance	0,070 max	0,050 max	-	-	-	-	-	-
Copper	-	-	99,900 min	-	-	-	-	-	-	-	-	-	0,010 max
CP-Ti G1	-	-	-	-	-	-	0,20 max	0,080 max	0,030 max	balance	0,18 max	0,015 max	-
CP-Ti G2	-	-	-	-	-	-	0,30 max	0,080 max	0,030 max	balance	0,25 max	0,015 max	-

www.rgpballs.com

Technical data / Range

Type	Diameters (min/max)	Thicknesses	U.o.M.	Surface aspect	Precision grades	Service temperature (min/max)	Units
Carbon steel	25 - 1000	1,5/2,0/2,5	mm	Bright, smooth	G1000 (± 1,5 mm)	-40 / 500	°C
AISI 201	19 - 600	0,8/1,0/1,5/2,0/3,0	mm	Bright, smooth	-	-196 / 700	°C
AISI 304/304L	4 - 15	0,6/0,8/1,0	mm	Bright, smooth	G500 (± 0,5 mm)	-196 / 700	°C
AISI 304/304L	15,001 - 100	0,4/0,6/0,8/1,0/1,5/2,0/3,0/4,0/5,0	mm	Bright, smooth	G1000 (± 1,5 mm)	-196 / 700	°C
AISI 304/304L	100,001 - 200	0,4/0,6/0,8/1,0/1,5/2,0/3,0/4,0/5,0	mm	Bright, smooth	G2000 (± 3 mm)	-196 / 700	°C
AISI 304/304L	200,001 - 400	0,4/0,6/0,8/1,0/1,5/2,0/3,0/4,0/5,0	mm	Bright, smooth	G3000 (± 5 mm)	-196 / 700	°C
AISI 304/304L	400,001 - 1200	0,8/1,0/1,5/2,0/3,0	mm	Bright, smooth	-	-196 / 700	°C
AISI 316/316L	6 - 15	0,6/0,8/1,0	mm	Bright, smooth	G500 (± 0,5 mm)	-196 / 600	°C
AISI 316/316L	15,001 - 100	0,4/0,6/0,8/1,0/1,5/2,0/3,0/4,0/5,0	mm	Bright, smooth	G1000 (± 1,5 mm)	-196 / 600	°C
AISI 316/316L	100,001 - 200	0,4/0,6/0,8/1,0/1,5/2,0/3,0/4,0/5,0	mm	Bright, smooth	G2000 (± 3 mm)	-196 / 600	°C
AISI 316/316L	200,001 - 400	0,4/0,6/0,8/1,0/1,5/2,0/3,0/4,0/5,0	mm	Bright, smooth	G3000 (± 5 mm)	-196 / 600	°C
AISI 420C/440A/440C	15 - 50	0,4/0,6/0,8/1,0/1,5/2,0/3,0/4,0/5,0	mm	Bright polished	G500 (± 0,5 mm)	0 / 400	°C
AISI 420C/440A/440C	50,001 - 200	0,4/0,6/0,8/1,0/1,5/2,0/3,0/4,0/5,0	mm	Bright polished	G1000 (± 1 mm)	0 / 400	°C
AISI 420C/440A/440C	200,001 - 400	0,4/0,6/0,8/1,0/1,5/2,0/3,0/4,0/5,0	mm	Bright polished	G2000 (± 1,5 mm)	0 / 400	°C
Al 3003 Alloy	6 - 50	2,0/2,5/3,0	mm	Bright, smooth	G1000 (± 0,05 mm)	-196 / 200	°C
Al 3003 Alloy	50,001 - 100	2,0/2,5/3,0	mm	Bright, smooth	G2000 (± 0,1 mm)	-196 / 200	°C
Al 3003 Alloy	100,001 - 500	2,0/2,5/3,0	mm	Bright, smooth	G3000 (± 5 mm)	-196 / 200	°C
Brass	200 - 1000	1,0/1,5/2,0	mm	Bright, smooth	-	-196 / 500	°C
Copper	200 - 1000	1,0/1,5/2,0	mm	Bright, smooth	-	-196 / 260	°C
CP-Ti Grade 1 / Grade 2	80,001 - 150	0,5 6,0	mm	Bright, smooth	G1000 (± 0,05 mm)	-196 / 400	°C
CP-Ti Grade 1 / Grade 2	80,001 - 150	0,5 6,0	mm	Bright, smooth	G1000 (± 0,05 mm)	-196 / 400	°C

www.rgpballs.com

Type	Diameters (min/max)	Thicknesses	U.o.M.	Surface aspect	Precision grades	Service temperature (min/max)	Units
CP-Ti Grade 1 / Grade 2	150,001 - 200	0,6 8,0	mm	Bright, smooth	G2000 (± 0,1 mm)	-196 / 400	°C

HOLLOW PLASTIC BALLS

Hollow balls in plastic materials, they are very light and show good corrosion resistance properties. They can feature an equatorial seamline.

Applications

Hollow plastic balls are used as floating elements, they help to strongly reduce evaporation of liquids and emission of unwished steam. They are frequently used even as decorative elements and cosmetic rollon.

Technical name	Commercial name	Abbreviation	Molecular formula
Polymethyl-methacrylate	Acrylic, Plexiglass	PMMA	(C5O2H8)n
High Density Polyethylene	High Density Polyethylene	HDPE	(C2H4)n
Low Density Polyethylene	Low Density Polyethylene	LDPE	(C2H4)n
Poly(propene)	Polypropylene	PP	(C3H6)n
Polystyrene	Polystyrene	PS	(C8H8)n
Polytetrafluoroethylene	Teflon	PTFE	(CF2-CF2)n
Polyvinylidene fluoride	Kynar, Hylar, Sygef	PVDF	(C2H2F2)n

Technical data / Available diameters

Type	Aspect	Diameters (min/max)	U.o.M.	Max service Temp.	U.o.M.	Notes
PMMA	Clear	17,468 - 160	mm	90 / 194	°C / °F	Decorative applications, they can be supplied with equatorial loop.
HDPE	Natural/Colored/Black (UV stabilized)	6,35 - 150	mm	80 / 176	°C / °F	Recomanded for outdoor applications and in contact with hydrocarbons.
LDPE	Natural/Colored	6,35 - 150	mm	80 / 176	°C / °F	Outdoor and decorative applications
PP	Natural/Colored	6,35 - 150	mm	110 / 230	°C / °F	Good corrosion resistance and high temperature resistance
PS	Clear/Clear colored/Opaque colored	50 - 580	mm	90 / 194	°C / °F	Decorative applications, they can be supplied with equatorial loop.
PTFE	Natural color	20 - 100	mm	250 / 482	°C / °F	Excellent corrosion resistance, recommended for high temperature applications.
PVDF	Natural color	8,5 - 150	mm	140 / 284	°C / °F	Recommended for high temperature applications, very good corrosion resistance

www.rgpballs.com

Tolerances on the diameter

Minimum diameter	Maximum diameter	U.o.M.	Balls withou seamline (grade III)	U.o.M.	Balls with seamline (grade IV)	U.o.M.
6,35	25,4	mm	± 0,25	mm	± 1	mm
25,401	50,8	mm	± 0,5	mm	± 1,5	mm
50,801	101,6	mm	± 1	mm	± 2	mm
101,601	160	mm	Balls not available	-	± 3	mm
160,001	580	mm	Balls not available	-	-	-

STEEL CORE RUBBER BALLS

Rubber balls with a steel core inside, they allow to join the rubber properties with the high density typical of metals. Balls are available in different colors.

Applications

They are usually used in the foodstuff field (valves for wine pumps).

Notes

Property	Description
Core Material	AISI 52100 chrome steel, stainless steel
Standard cover material	EPDM, Natural, NBR, Silicon, Viton rubber
Cover material on demand	EPM, Neoprene, Polyurethane, SBR rubber
Available standards for cover material	ACS, FDA, NSF, WRAS

Range

Ball diameters	U.o.M.	Ball diameters	U.o.M.	Tolerances mm
35,000 - 260,000	mm	1-7/16 | 10-1/4	"	± 1

Notes

Property	Description
Big balls	For diameters higher than 160 mm two welded hollow steel hemispheres are used.

FLOATING RUBBER BALLS

Rubber balls with a hollow nylon core inside, that allows to reduce the specific weight favouring the floating in most liquids. Particular specific weights required by the customer can be obtained with appropriate core diameters.

Applications

Check valves, effluent pumps, floating lines (pipes, air filtering systems, siphons).

Notes

Property	Description
Standard materials	EPDM, Natural and NBR rubber
Materials on demand	EPM, Neoprene, Polyurethane, SBR, Silicone, Viton rubber
Available standards for cover material	ACS, FDA, NSF, WRAS

Range

Ball diameters	U.o.M.	Ball diameters	U.o.M.	Tolerances mm
60,000 - 190,000	mm	2-3/8 | 7-15/32	"	± 1 up to 130 mm / ± 2 for bigger diameters

MAGNETIC BALLS

Rare earth alloys balls (NdFeB and SmCo), barium and strontium ferrite balls, aluminium-nickel-cobalt balls, they show exceptional magnetic properties. These material are usually not suitable in application where balls are mechanically stressed.

Applications

Microphones, motors, sensors, aeronautical and military industry, medical and acoustic devices, notice board magnets, jewellry.

Chemical composition

Type	%Ni	%Cu	%Al	%Dy	%Ti	%Co	%Nb	%B	%Fe	%Nd	%Sm	%Fe2O3	%BaO/SrO
NdFeB	-	0,2-0,4	0,2-0,4	0,8-1,2	-	-	0,5-1,0	1,0-1,2	64,2-68,5	29,0-32,0	-	-	-
SmCo	-	-	-	-	-	62,0-64,0	-	0,1 max	-	-	35,0-37,0	-	-
Ferrite	-	-	-	-	-	-	-	-	-	-	-	85,0-95,0	5,0-10,0
AlNiCo	13,0-26,0	2,0-6,0	6,0-13,0	-	9,0 max	42,0 max	3,0 max	-	30,0-40,0	-	-	-	-

Alloys name

NdFeB	SmCo	Ferrite	AlNiCo
Neodymium Iron Boron	Samarium Cobalt	Ferrite	Aluminium Nickel Cobalt

Physical / mechanical / thermal / electric / magnetic properties

Property	Symbol	U.o.M.	Type	Notes	NdFeB	SmCo	Ferrite	AlNiCo
Density	δ	g/cm3	Physical	Room temp.	7,55	8,30	4,95	7,20
Young's modulus	E	GPa	Mechanical	-	156	138	165	150
Specific heat	c	J/kg-K	Thermal	Room temp.	502	356	700	502
Coefficient of linear thermal expansion	α	10^-6/°C	Thermal	(ΔT=0-100°C)	7,9	10,5	12,9	11,7
Thermal conductivity	λ	W/(m·K)	Thermal	Room temp.	8,9	12,0	3,2	60,0
Electric resistivity	ρ	Ω*m*10^-9	Electric	-	1475	625	> 10^5	580
Magnetic field density energy	(BH)max	kJ/m3	Magnetic	-	290-420	150-280	20-40	15-110
Coercitivity	HcJ	kA/m	Magnetic	-	820-2900	600-2000	150-350	50-130

Technical data

Property	Type	U.o.M. 1	U.o.M. 2	NdFeB	SmCo	Ferrite	AlNiCo
Hardness	Mechanical	HV	-	520 - 620	500-600	400-700	520 - 700
Ultimate tensile strength	Mechanical	MPa	psix10^3	83 / 12	37 / 5	42 / 6	60 / 9
Service temperature (max)	Thermal	°C	°F	150 / 302	300 / 572	250 / 482	450 / 842

www.rgpballs.com

Range

Diameters (min/max)	U.o.M.	Diameters (min/max)	U.o.M.	Precision Grade (ISO 3290)
3,000 - 26,000	mm	1/8" - 1	"	G1000 ± 50 µm

Corrosion Resistance

Excellent corrosion resistance for AlNiCo alloys, good for SmCo and ferrite alloys, poor for NdFeB alloys (this is the reason NdFeB alloys are often covered with a protective layer).

COATED BALLS

Type of coating	Color of balls	Description of the surface treatment
Silver Plating	Bright white	Electrolytic treatment, improving corrosion resistance and surface finish. It is used even in the electrical and optical fields. It is protected by a passivation.
Burnishing	Black	Allowing to get bright black balls, with better corrosion resistance and surface finish.
Chrome Plating	Silver (even glazed or sanded)	Improving surface finish and increasing the corrosion resistance. The surface can be bright or matte finish.
Gold Plating	Bright yellow	Electrilytic treatment mainly used in the electronic field and for decorative applications.
Phosphating	Grey(light,dark)/Black	Surface conversion processing based on zinc and manganese oxides, providing better corrosion and wear resistance, lubricant properties increase, allows deposition of other substances if required (oils, polymers, rubber, wax).
Kolsterizing®	-	Surface carbon diffusion treatment, copyright of the Bodycote Company. Allowing to increase the surface hardness without any change on dimensional, finishing and corrosion resistance properties of balls.
Nickel Plating	Silver grey (even glazed or sanded)	Galvanic processing allowing to get harder balls, with higher corrosion and wear resistance. It is used even for decorative applications.
Nitriding	Grey	Surface hardening termochemical treatment, provided by a diffusion of nitrogen on the surface. Wear and abrasion resistance of balls are higly increased.
Brass Plating	Bright yellow	Electrolytic treatment used mainly for decorative applications. It makes easier the adherence of rubber on the surface of the metals.
Chrome Passivation	Nor colored/Dark Yellow	Surface treatment allowing to increase the natural corrosion resistance of stainless steel by strengthening the oxide layer. With different compositions it can be applied even to brass, bronze, Al Ni, Ti, stellite, alloys.
Copper Plating	Pink/Red	It is used mainly to increase the electric conductivity of balls.
Tin Plating	Silver white (bright/dark)	Electrolytic treatment allowing to improve corrosion resistance and electric conductivity of balls. It is used in electronic and foodstuff industry.
White Zinc Plating	Silver iridescent	Electrolysis process used to increase corrosion resistance, it is particularly suitable even for decorative applications. They can be subjected even to Chromiting (iridescent color).
Yellow Zinc Plating	Silver yellow	Standard Zinc Plating processing allowing to get a good corrosion resistance (better than white zinc plating).
Black Zinc Plating	Black	Protective/decorative zinc plating process, it allows to obtain a bright and homogeneous surface finishing.
Sealing Zinc Plating	Grey/Blue	Sealing compound zinc plating processing increasing corrosion resistance the corrosion resistace.

www.rgpballs.com

Type of coating	Material	Minimum diameter	U.o.M.	Thickness (min/max)	U.o.M.	Hardness	U.o.M.
Silver Plating	CS-SS-Al-Cu-BRA	0,500	mm	0,5 - 15	µm	50-200	HV
Burnish	CS-SS-BS	3,000	mm	~ 0,1	µm	-	-
Chrome Plating	CS-SS-Al-Cu-BRA	3,000	mm	5 - 20	µm	65-68	HRC
Gold Plating	CS-SS-BS-Cu-BRA	3,000	mm	0,1 - 30	µm	50-250	HV
Phosphating	CS	2,500	mm	5 - 8	µm	-	-
Kolsterizing®	SS	0,300	mm	22 - 33	µm	66-72	HRC
Nickel Plating	CS-Al-Cu	2,500	mm	5 - 30	µm	140-550	HV
Nitriding	SS - 400 series	0,500	mm	5 - 50	µm	56 - 68	HRC
Brass Plating	CS-SS-BS-Al-Cu-BRA	3,000	mm	0,1 - 6	µm	750-850	HV
Chrome Passivation	SS-Al-BRA-BRO-Ni-ST-Ti	3,000	mm	0,3 - 0,5	µm	-	-
Copper Plating	CS-SS-Al-Cu-BRA	3,000	mm	0,1 - 30	µm	40-60	HV
Tin Plating	CS-SS-Al-Cu-BRA	3,000	mm	1 - 30	µm	20-40	HV
White Zinc Plating	CS-BS-Cu	4,000	mm	1 - 15	µm	-	-
Yellow Zinc Plating	CS-BS-Cu	3,000	mm	3 - 15	µm	-	-
Black Zinc Plating	CS-SS-BS-Cu	3,000	mm	6 - 12	µm	-	-
Sealing Zinc Plating	CS-BS-Cu	3,000	mm	1 - 25	µm	-	-

Material legend

CS	Low/High carbon steel
SS	Stainless steel
BS	Bearing steel
Al	Aluminum and its alloys
Cu	Copper and its alloys
BRA	Brass and its alloys
BRO	Bronze and its alloys
Ni	Base Ni alloys
ST	Stellite®
Ti	Base Ti alloys

Notes

Large diameter of balls	Coatings on balls of big diameters must be specifically evaluated.
Different materials	Coatings on different types of materials must be specifically eveluated.

SPECIAL BALLS

Family	Type	Property	Description
Austenitic stainless steel	AISI 201/304/316	Hemispherical balls	Hemispherical balls available on demand between 19,000 and 300,000 mm (thickness 0,3-8 mm). They are particularly used for decorative applications.
Plastic	POM	Antistatic plastic	Delrin balls can be specifically manufactured with antistatic properties. These balls dot not accumulate electrostatic charges on the surface (they can cause unwished attraction of the pieces during the use).
Plastic	POM	UV resistance	Delrin balls manufactured with particular additives that considerably increase UV radiation resistance than the standard acetal resin. Trade name Delrin® 527UV NC010.
Plastic	PA6.6 2% PTFE filled	Self lubricating plastic	Nylon PA6.6 balls with a small addition of PTFE (2%), they feature a low friction coefficient and improved wear resistance in comparison to the unfilled nylon.
Plastic	All	Thermoset balls	Typically used for aesthetic applications, available styles include clear, fluorescent, glowing, marbleised, opaque, pearlescent, sparkle coloured and transparent coloured with glitter embedded inside. Highly polished or matt finish available. They are easy to drill, machine and tap.
Metals / Hardmetals / Plastic / Glasses	AISI 52100 / WC / Stellite / HDPE / PP / Glass	Ball blanks	Ball blanks available on demand in several type of materials, they are used in application where the dimensional precision is not demanded. There are available even the seat blanks for special oil well pump applications (tungsten carbide and stellite).

www.rgpballs.com

Titanium Carbide TiC-28

Ceramics Titanium Carbide balls, they feature excellent hardness and wear resistance. They are suitable for high temperature applications and they are electrical conductors.

Chemical composition TiC-28 balls

% Ni/Co	% TiC	% TaC	% WC-Co
13-14	27,5-28,5	0,8-1,8	balance

Physical / mechanical properties TiC-28 balls

Property	Type	Units	Value
Density	Physical	g/cm3	9,10
Hardness	Mechanical	HRA	89,0-90,5
T.R.S.	Mechanical	MPa	1.517

COLORED BALLS

Family	Type	Colors on demand
Plastics	All the types except PTFE	All "RAL" table colors
Plastics	Phenolic Resin	Black (Density 1,40 g/cm3-It exhibits improved impact strength and resistance to flexural fatigue for demanding automotive, electrical and appliance applications).
Glasses	All	Black, red, blue, yellow, green, orange, brown
Rubbers	All	Red (other colors must be evaluated), the natural color is black

ISO 3290-1 INTERNATIONAL STANDARD

ISO 3290-1:2014 STANDARD (STEEL BALLS)

Precision grade	Variation of ball diameter (VDws)(µm) (a)	Deviation from spherical form (tDw)(µm) (a)	Surface roughness (Ra)(µm) (a)	Variation of ball lot diameter (VDwL)(µm)	Gauge interval (IG)	Description of preferred gauge	Subgauge interval	Description of subgauges (SG)
3	0.08	0.08	0.010	0.13	0.5	-5/-0.5,0,+0.5/+5	0.1	-0.2,-0.1,0,0.1,0.2
5	0.13	0.13	0.014	0.25	1	-5/-1,0,+1/+5	0.2	-0.4,-0.2,0,0.2,0.4
10	0.25	0.25	0.020	0.5	1	-9/-1,0,+1/+9	0.2	-0.4,-0.2,0,0.2,0.4
16	0.4	0.4	0.025	0.8	2	-10/-2,0,+2/+10	0.4	-0.8,-0.4,0,0.4,0.8
20	0.5	0.5	0.032	1	2	-10/-2,0,+2/+10	0.4	-0.8,-0.4,0,0.4,0.8
24	0.6	0.6	0.040	1.2	2	-12/-2,0,+2/+12	0.4	-0.8,-0.4,0,0.4,0.8
28	0.7	0.7	0.050	1.4	2	-12/-2,0,+2/+12	0.4	-0.8,-0.4,0,0.4,0.8
40	1	1	0.060	2	4	-16/-4,0,+4/+16	0.8	-1.6,-0.8,0,0.8,1.6
60	1.5	1.5	0.080	3	6	-18/-6,0,+6/+18	1.2	-2.4,-1.2,0,1.2,2.4
100	2.5	2.5	0.100	5	10	-40/-10,0,10/40	2.0	-4,-2,0,2,4
200	5	5	0.150	10	15	-60/-15,0,15/60	3.0	-6,-3,0,3,6

Notes

(a) The values do not take into account surface defects; hence, measurement shall be taken outside such defects.

VALVE GRADES

PRECISION GRADE	VARIATION OF BALL DIAMETER (µm)	DEVIATION FROM SPHERICAL FORM (µm)	VARIATION OF BALL LOT DIAMETER (µm)	SURFACE ROUGHNESS (µm)
48V	1,2	1,2	25	0,08
100V	2,5	2,5	50	0,125
200V	5	5	75	0,200
500V	13	13	125	-

www.rgpballs.com

TERM	SYMBOL	DEFINITION
Surface faultiness	-	Element, irregularity or set of elements and irregularities of the actual surface, unintentionally or accidentaly during production, storage or surface usage. These types of elements or irregularities considerably differ from elements related to surface roughness and they should not been considered in the measurement of the surface roughness
Nominal ball diameter	Dw	Diameter value which is used for the general identification of a ball size
Single ball diameter	Dws	Distance between two parallel planes tangential to the actual surface of a ball.
Mean ball diameter	Dwm	Arithmetical mean of the largest and the smallest of the single diameters of a ball.
Variation of ball diameter	VDws	Difference between the largest and the smallest of the single diameters of a ball.
Deviation from spherical form	tDw	Greatest radial distance, in any equatorial plane, between the smallest circumscribed sphere and the greatest inscribed sphere, with their centres common to the least square sphere centre.
Ball lot	-	Defines quantity of balls manufactured under conditions presumed uniform and which is considered as an entity
Mean diameter of ball lot	DwmL	Arithmetical mean of the mean diameters of the largest ball and the smallest ball in a ball lot.
Variation of ball lot diameter	VDwL	Difference between the mean diameters of the largest ball and the smallest ball in a ball lot.
Ball grade	G	Specific combination of dimensional, form, surface roughness and sorting tolerances for balls. Ball grade is identified by the letter G and a number.
Ball gauge	S	Amount by which the mean diameter of a ball lot should differ from the nominal ball diameter, this amount being one of an established series. Each ball gauge is a whole multiple of the ball gauge interval established for the ball grade in question. A ball gauge, in combination with the ball grade and nominal diameter, should be considered as the most exact ball size specification to be used by a customer for ordering purposes.
Deviation of a ball lot from ball gauge	ΔS	Difference between the mean diameter of a ball lot and the sum of the nominal ball diameter and the ball gauge: ΔS=DwmL-(Dw+S).
Ball subgauge:	-	Amount of an established series of amounts, which is the nearest to the actual deviation from the ball gauge of a ball lot. Each ball subgauge is a whole multiple of the ball subgauge interval established for the ball grade in question. The ball subgauge, in combination with the nominal ball diameter and the ball gauge, is used by ball manufacturers to denote the mean diameter of a ball lot and should not be used by customers of ordering purposes.
Hardness	-	Measure of resistance to penetration as determined by specific methods
Surface roughness	Ra	Surface irregularities with relatively small spacings, which usually include irregularities resulting from the method of manufacture being used and/or other influences. These irregularities are considered within the limits that are conventionally defined, e.g., whitin the limits of the sampling length.
Waviness	-	Surface irregularities of random of periodical deviation from the ideal spherical form. It is recommended that waviness be evaluated as velocity amplitude. In practice, the waviness components are separated from the real surface by a waviness analyser (filters).

ISO 3290-2 INTERNATIONAL STANDARD

ISO 3290-2:2014 STANDARD (CERAMIC BALLS: SILICON NITRIDE)

Precision grade	Variation of ball diameter (VDws)(µm) (a)	Deviation from spherical form (tDw)(µm) (a)	Surface roughness (Ra)(µm) (a)	Variation of ball lot diameter (VDwL)(µm)	Gauge interval (IG)	Description of preferred gauge	Subgauge interval	Description of subgauges (SG)
3	0.08	0.08	0.010	0.13	0.5	-5/-0.5,0,+0.5/+5	0.1	-0.2,-0.1,0,0.1,0.2
5	0.13	0.13	0.014	0.25	1	-5/-1,0,+1/+5	0.2	-0.4,-0.2,0,0.2,0.4
10	0.25	0.25	0.020	0.5	1	-9/-1,0,+1/+9	0.2	-0.4,-0.2,0,0.2,0.4
16	0.4	0.4	0.025	0.8	2	-10/-2,0,+2/+10	0.4	-0.8,-0.4,0,0.4,0.8
20	0.5	0.5	0.032	1	2	-10/-2,0,+2/+10	0.4	-0.8,-0.4,0,0.4,0.8
24	0.6	0.6	0.040	1.2	2	-12/-2,0,+2/+12	0.4	-0.8,-0.4,0,0.4,0.8
28	0.7	0.7	0.050	1.4	2	-12/-2,0,+2/+12	0.4	-0.8,-0.4,0,0.4,0.8
40	1	1	0.060	2	4	-16/-4,0,+4/+16	0.8	-1.6,-0.8,0,0.8,1.6
60	1.5	1.5	0.080	3	6	-18/-6,0,+6/+18	1.2	-2.4,-1.2,0,1.2,2.4
100	2.5	2.5	0.100	5	10	-40/-10,0,10/40	2.0	-4,-2,0,2,4

Notes

(a) The values do not take into account surface defects; hence, measurement shall be taken outside such defects.

www.rgpballs.com

TERM	SYMBOL	DEFINITION
Surface faultiness	-	Element, irregularity or set of elements and irregularities of the actual surface, unintentionally or accidentaly during production, storage or surface usage. These types of elements or irregularities considerably differ from elements related to surface roughness and they should not been considered in the measurement of the surface roughness
Nominal ball diameter	Dw	Diameter value which is used for the general identification of a ball size
Single ball diameter	Dws	Distance between two parallel planes tangential to the actual surface of a ball.
Mean ball diameter	Dwm	Arithmetical mean of the largest and the smallest of the single diameters of a ball.
Variation of ball diameter	VDws	Difference between the largest and the smallest of the single diameters of a ball.
Deviation from spherical form	tDw	Greatest radial distance, in any equatorial plane, between the smallest circumscribed sphere and the greatest inscribed sphere, with their centres common to the least square sphere centre.
Ball lot	-	Defines quantity of balls manufactured under conditions presumed uniform and which is considered as an entity
Mean diameter of ball lot	DwmL	Arithmetical mean of the mean diameters of the largest ball and the smallest ball in a ball lot.
Variation of ball lot diameter	VDwL	Difference between the mean diameters of the largest ball and the smallest ball in a ball lot.
Ball grade	G	Specific combination of dimensional, form, surface roughness and sorting tolerances for balls. Ball grade is identified by the letter G and a number.
Ball gauge	S	Amount by which the mean diameter of a ball lot should differ from the nominal ball diameter, this amount being one of an established series. Each ball gauge is a whole multiple of the ball gauge interval established for the ball grade in question. A ball gauge, in combination with the ball grade and nominal diameter, should be considered as the most exact ball size specification to be used by a customer for ordering purposes.
Deviation of a ball lot from ball gauge	ΔS	Difference between the mean diameter of a ball lot and the sum of the nominal ball diameter and the ball gauge: ΔS=DwmL-(Dw+S).
Ball subgauge:	-	Amount of an established series of amounts, which is the nearest to the actual deviation from the ball gauge of a ball lot. Each ball subgauge is a whole multiple of the ball subgauge interval established for the ball grade in question. The ball subgauge, in combination with the nominal ball diameter and the ball gauge, is used by ball manufacturers to denote the mean diameter of a ball lot and should not be used by customers of ordering purposes.
Hardness	-	Measure of resistance to penetration as determined by specific methods
Surface roughness	Ra	Surface irregularities with relatively small spacings, which usually include irregularities resulting from the method of manufacture being used and/or other influences. These irregularities are considered within the limits that are conventionally defined, e.g., whitin the limits of the sampling length.
Waviness	-	Surface irregularities of random of periodical deviation from the ideal spherical form. It is recommended that waviness be evaluated as velocity amplitude. In practice, the waviness components are separated from the real surface by a waviness analyser (filters).

DIN 5401 INTERNATIONAL STANDARDS

DIN 5401 : 2002-08 (GERMAN STANDARDS)

GRADE	Class	Nominal diameter Dw (mm)		Limit deviations (µm) (5)	Ball diameter variation	Roundness error	Surface roughness (6)	Lot diameter variation (5)	Subgauge interval	Subgauges (µm) (7)		
		From	To		VDws Max. (µm)	tDws Max. (µm)	Ra Max. (µm)	VDwL/A Max. (µm)	IG, ST (µm)			
G3	-	-	12,7	± 5,32	0,08	0,08	0,010	0,13 (L)	0,5	from -5 to -0,5	0	from +0,5 to +5
G5	I	-	12,7	± 5,63	0,13	0,13	0,014	0,25 (L)	1	from -5 to -1	0	from +1 to +5
G10	II	-	25,4	± 9,75	0,25	0,25	0,020	0,50 (L)	1	from -9 to -1	0	from +1 to +9
G16 (1)	II	-	25,4	± 11,4	0,40	0,40	0,025	0,80 (L)	2	from -10 to -2	0	from +2 to +10
G20 (1)	III	-	38,1	± 11,5	0,50	0,50	0,032	1,0 (L)	2	from -10 to -2	0	from +2 to +10
G28 (1)	III	-	50,8	± 13,7	0,70	0,70	0,050	1,4 (L)	2	from -12 to -2	0	from +2 to +12
G40	III	-	100	± 19,0	1,0	1,0	0,060	2,0 (L)	4	from -16 to -4	0	from +4 to +16
G80 (2)	III	-	100	± 14,0	2,0	2,0	0,10	4,0 (A)	4	from -12 to -4	0	from +4 to +12
G100	III	-	150	± 47,5	2,5	2,5	0,10	5,0 (L)	10	from -40 to -10	0	from 10 to +40
G200	IV	-	150	± 72,5	5,0	5,0	0,15	10 (L)	10	from -60 to -10	0	from +10 to +60
G300 (1)	IV	-	25,4	± 70,0	10	10	0,20	20 (A)	20	from -60 to -20	0	from +20 to +60
G300 (3)	IV	25,4	50,8	± 105	15	15	0,20	30 (A)	30	from -90 to -30	0	from +30 to +90
G300	IV	50,8	75	± 140	20	20	0,20	40 (A)	40	from -120 to -40	0	0 from +40 to +120
G500 (4)	V	-	25,4	± 75,0	25	25	-	50 (A)	50	-50	0	+50
G500	V	25,4	50,8	± 112,5	25	25	-	75 (A)	75	-75	0	+75
G500	V	50,8	75	± 150	25	25	-	100 (A)	100	-100	0	+100
G500	V	75	100	± 187,5	32	32	-	125 (A)	125	-125	0	+125
G500	V	100	125	± 225	38	38	-	150 (A)	150	-150	0	+150
G500	V	125	150	± 262,5	44	44	-	175 (A)	175	-175	0	+175
G600 (4)	VI	all	all	± 200	-	-	-	400 (A)	-	-	0	-
G700 (4)	VI	all	all	± 1000	-	-	-	2000 (A)	-	-	0	-

www.rgpballs.com

Notes

(1) In some cases and subject to agreement, half teh gauge interval values may be used for grades G16, G20, G28 and G300.

(2) Not specified in ISO 3290.

(3) Not specified in ISO 3290.

(4) Not specified in ISO 3290.

(5) Values relate to the mean diameter of a ball, Dwm.

(6) See DIN EN ISO 4288. For smaller ball sizes (not covered ib this standard), values are subject to agreement.

(7) Graded in intervals equal to IG.

A.F.B.M.A. INTERNATIONAL STANDARDS

A.F.B.M.A. STANDARDS (U.S.A.)

AFBMA GRADES	Variation of ball diameter /ROUNDNESS		LOT DIAMETER VARIATION		BASIC DIAMETER TOLERANCE		MAXIMUM INCREMENTS		SURFACE ROUGHNESS	
	INCHES	µm	INCHES	µm	INCHES	µm	INCHES	µm	INCHES	µm
3	0.000003	0,0762	0.000005	0,127	± 0.00003	0,762	0.000010	0,254	0.0000005	0,0127
5	0.000005	0,127	0.000010	0,254	± 0.00005	1,27	0.000010	0,254	0.0000008	0,02032
10	0.000010	0,254	0.000020	0,508	± 0.00010	2,54	0.000010	0,254	0.000001	0,0254
15	0.000015	0,381	0.000030	0,762	± 0.00010	2,54	0.000010	0,254	0.000001	0,0254
16	0.000016	0,4064	0.000032	0,8128	± 0.00010	2,54	0.000010	0,254	0.000001	0,0254
24	0.000024	0,6096	0.000048	1,2192	± 0.00010	2,54	0.000010	0,254	0.000002	0,0508
25	0.000025	0,635	0.000050	1,27	± 0.00010	2,54	0.000010	0,254	0.000002	0,0508
48	0.000048	1,2192	0.000096	2,4384	± 0.00020	5,08	0.000050	1,27	0.000003	0,0762
50	0.000050	1,27	0.000100	2,54	± 0.00030	7,62	0.000050	1,27	0.000003	0,0762
100	0.000100	2,54	0.000200	5,08	± 0.00050	12,70	0.000100	2,54	0.000005	0,127
200	0.000200	5,08	0.000400	10,20	± 0.00100	25,40	0.000200	5,08	0.000008	0,2032
300	0.000300	7,62	0.000400	15,24	± 0.00100	25,40	0.000300	7,62	-	-
500	0.000500	12,70	0.001000	25,40	± 0.00200	50,80	0.000500	12,70	-	-
1000	0.001000	25,40	0.002000	50,80	± 0.00500	127,0	0.001000	25,40	-	-
2000	0.002000	50,80	0.004000	101,60	± 0.00500	127,0	0.002000	50,80	-	-
3000	0.003000	76,20	0.006000	152,40	± 0.00500	127,0	0.003000	76,20	-	-

APPROXIMATE EQUIVALENT GRADES BETWEEN ISO 3290, AFBMA, DIN AND OLD "RGP" GRADES

ISO 3290

Grade AAAA	Grade AAA	Grade AA	Grade A	Grade B	Grade C	Ø (mm)
Grade 5	Grade 10	Grade 16	Grade 28	Grade 40	Grade 100	Ø ≤ 3
Grade 10	Grade 16	Grade 28	Grade 40	Grade 100	Grade 100	3 < Ø ≤ 6
Grade 10	Grade 16	Grade 28	Grade 40	Grade 100	Grade 200	6 < Ø ≤ 10
Grade 16	Grade 20	Grade 28	Grade 40	Grade 100	Grade 200	10 < Ø ≤ 20
-	Grade 28	Grade 40	Grade 100	Grade 200	-	20 < Ø ≤ 30
-	Grade 40	Grade 40	Grade 100	Grade 200	-	30 < Ø ≤ 50
-	Grade 40	Grade 100	Grade 100	Grade 200	-	Ø > 50

AFBMA

Grade AAAA	Grade AAA	Grade AA	Grade A	Grade B	Grade C	Ø (mm)
Grade 5	Grade 10	Grade 16	Grade 24	Grade 48	Grade 100	Ø ≤ 3
Grade 10	Grade 16	Grade 24	Grade 48	Grade 100	Grade 100	3 < Ø ≤ 6
Grade 10	Grade 16	Grade 24	Grade 48	Grade 100	Grade 200	6 < Ø ≤ 10
Grade 16	Grade 16	Grade 24	Grade 48	Grade 100	Grade 200	10 < Ø ≤ 20
-	Grade 24	Grade 48	Grade 100	Grade 200	Grade 300	20 < Ø ≤ 30
-	Grade 48	Grade 48	Grade 100	Grade 200	Grade 300	30 < Ø ≤ 50
-	Grade 48	Grade 100	Grade 100	Grade 200	Grade 300	Ø > 50

DIN

Grade AAAA	Grade AAA	Grade AA	Grade A	Grade B	Grade C	Ø (mm)
-	Class I	Class II	Class III	Class IV	-	Ø ≤ 3
-	Class I	Class II	Class III	Class IV	-	3 < Ø ≤ 6
Class I	Class II	Class III	Class IV	-	-	6 < Ø ≤ 10
Class I	Class II	Class III	Class IV	-	-	10 < Ø ≤ 20
Class II	Class II	Class III	Class IV	-	-	20 < Ø ≤ 30
-	-	Class III	Class IV	-	-	30 < Ø ≤ 50
-	-	Class III	Class IV	-	-	Ø > 50

INTERNATIONAL STANDARDS

STEELS

Type	Regulatory body	Designation	Year	Title
Stainless steels	AMS	5524	2014	Steel, Corrosion and Heat-Resistant, Sheet, Strip and Plate 18Cr - 13Ni - 2.5Mo (SAE 30316) Solution Heat Treated
Stainless steels	AMS	5630	2013	Steel, Corrosion-Resistant, Bars, Wire, and Forgings 17Cr - 0.52Mo (0.95 - 1.20C) (440C)
Stainless steels	AMS	5880	2013	Steel, Corrosion-Resistant, Bars, Wire, and Forgings 17Cr 0.52Mo (0.95 1.20C) (SAE 51440C) for Bearing Applications
Stainless steels	AMS	QQ-S-763	2015	Steel, Corrosion Resistant, Bars, Wire, Shapes, and Forgings
Stainless steels	ASTM	A262	2015	Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
Stainless steels	ASTM	A276	2015	Standard Specification for Stainless Steel Bars and Shapes
Stainless steels	ASTM	A493	2009	Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging
Stainless steels	ASTM	A580	2015	Standard Specification for Stainless Steel Wire
Stainless steels	ASTM	A756	2009	Standard Specification for Stainless Anti-Friction Bearing Steel
Nonferrous steels	ASTM	E55	2011	Standard Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition
Bearing steels	ASTM	A295	2014	Standard Specification for High-Carbon Anti-Friction Bearing Steel
Bearing steels	ISO	15243	2004	Rolling bearings — Damage and failures — Terms, characteristics and causes
Bearing steels	ISO	683-17	2014	Heat-treated steels, alloy steels and free-cutting steels — Part 17: Ball and roller bearing steels
Tool steels	ASTM	A681	2008	Standard Specification for Tool Steels Alloy

www.rgpballs.com

OTHER PRODUCTS

Type	Regulatory body	Designation	Year	Title
Balls for bearings	ASTM	F2215	2008	Standard Specification for Balls, Bearings, Ferrous and Nonferrous for Use in Bearings, Valves, and Bearing Applications
Ceramics	ASTM	F2094	2014	Standard Specification for Silicon Nitride Bearing Balls
Grinding/polishing	AMS	2431-5B	2011	Peening Media Hardened Steel Peening Balls
Rollers	DIN	5402-1	2014	Rolling bearings – Parts of rolling bearings – Part 1: Cylindrical rollers
Rollers	DIN	5402-3	2012	Rolling bearings – Parts of rolling bearings – Part 3: Needle rollers
Rollers	ISO	3096	1996	Rolling bearings - Needle rollers - Dimensions and tolerances
Rollers	ISO	12297	2012	Rolling bearings. Steel cylindrical rollers. Dimensions and tolerances

GRADES AND TOLERANCES

Type	Regulatory body	Designation	Year	Title
Precision grade	ISO	3290-1	2014	Rolling bearings - Balls - Part 1: Steel balls
Precision grade	ISO	3290-2	2014	Rolling bearings - Balls - Part 2: Ceramic balls
Precision grade	DIN	5401	2002	Rolling bearings - Balls for rolling bearings and general industrial use
Precision grade	ANSI-AFBMA	Std. 10	1989	Metal balls
Cylindricity	ISO	12180-2	2011	Geometrical product specifications (GPS) - Cylindricity - Part 2: Specification operators
Roundness	ISO	12181-2	2011	Geometrical product specifications (GPS) - Roundness - Part 2: Specification operators
Roughness	ISO	1302	2002	Geometrical Product Specifications (GPS) — Indication of surface texture in technical product documentation
Rubber tolerances	ISO	3302-1	2014	Rubber - Tolerances for products - Part 1: Dimensional tolerances

www.rgpballs.com

OTHER STANDARDS

Type	Regulatory body	Designation	Year	Title
Hardness	ISO	6507-1	2005	Metallic materials - Vickers hardness test - Part 1: Test method
Hardness	ISO	6508-1	2015	Metallic materials - Rockwell hardness test - Part 1: Test method
Microstructure	ASTM	E112	2013	Standard Test Methods for Determining Average Grain Size
Passivation	ASTM	A380	2013	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
Passivation	ASTM	A967	2013	Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts
Passivation	ASTM	G 82	1998	Standard Guide for Development and Use of a Galvanic Series for Predicting Galvanic Corrosion Performance

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 0,200 MM TO 4,7625 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
0,200000	-	0,007874	0,000003	30.606.720	1.000.000
0,300000	-	0,011811	0,000011	9.068.658	1.000.000
0,396875	1/64	0,015625	0,000026	3.916.928	1.000.000
0,500000	-	0,019685	0,000051	1.958.830	1.000.000
0,793750	1/32	0,031250	0,00021	489.616	600.000
1,000000	-	0,039370	0,00041	244.854	600.000
1,190625	3/64	0,046875	0,00073	145.071	600.000
1,500000	-	0,059055	0,00138	72.549	600.000
1,587500	1/16	0,062500	0,00164	61.202	600.000
2,000000	-	0,078740	0,00326	30.607	300.000

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
2,381250	3/32	0,093750	0,00560	18.134	200.000
2,500000	-	0,098425	0,00638	15.671	150.000
2,778125	7/64	0,109375	0,00825	11.420	120.000
3,000000	-	0,118110	0,01103	9.069	90.000
3,175000	1/8	0,125000	0,01301	7.650	80.000
3,500000	-	0,137795	0,01762	5.711	60.000
3,968750	5/32	0,156525	0,02553	3.917	40.000
4,000000	-	0,157480	0,02630	3.826	40.000
4,500000	-	0,177165	0,03745	2.687	30.000
4,762500	3/16	0,187500	0,04412	2.267	25.000

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 5,000 MM TO 11,509375 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
5,000000	-	0,196850	0,05138	1.959	20.000
5,500000	-	0,216535	0,06838	1.472	15.000
5,556250	7/32	0,218750	0,07028	1.427	15.000
6,000000	-	0,236220	0,08878	1.134	11.000
6,350000	1/4	0,250000	0,1021	956	10.000
6,500000	-	0,255906	0,1129	892	8.000
7,000000	-	0,275591	0,1409	714	7.000
7,143750	9/32	0,281250	0,1498	672	7.000
7,500000	-	0,295276	0,1734	580	6.000
7,937500	5/16	0,312500	0,2056	490	5.000
8,000000	-	0,314961	0,2104	478	5.000
8,500000	-	0,334646	0,2524	399	4.000
8,731250	11/32	0,343750	0,2658	368	3.500
9,000000	-	0,354331	0,2996	336	3.500
9,525000	3/8	0,375000	0,3554	283	3.000
10,000000	-	0,393701	0,4110	245	2.500
10,318750	13/32	0,406250	0,4434	223	2.500
11,000000	-	0,433071	0,5471	184	1.800
11,112500	7/16	0,437500	0,5641	178	1.800
11,509375	29/64	0,453125	0,6227	161	1.500

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 11,90625 MM TO 20,000 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
11,906250	15/32	0,468750	0,6931	145	1.500
12,000000	-	0,472441	0,7102	142	1.250
12,303125	31/64	0,484375	0,7606	131	1.250
12,700000	1/2	0,500000	0,8420	120	1.250
13,000000	-	0,511811	0,9030	111	1.000
13,493750	17/32	0,531250	1,010	99,7	1.000
14,000000	-	0,551181	1,128	89,2	900
14,287500	9/16	0,562500	1,202	84,0	800
15,000000	-	0,590551	1,387	72,5	700
15,081250	19/32	0,593750	1,413	71,4	700
MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
15,875000	5/8	0,625000	1,649	61,2	600
16,000000	-	0,629921	1,684	59,8	600
16,668750	21/32	0,656250	1,906	52,9	500
17,000000	-	0,669291	2,019	49,8	500
17,462500	11/16	0,687500	2,187	46,0	450
18,000000	-	0,708661	2,397	42,0	400
18,256250	23/32	0,718750	2,501	40,2	400
19,050000	3/4	0,750000	2,842	35,4	400
19,843750	25/32	0,781250	3,239	31,3	300
20,000000	-	0,787402	3,288	30,6	300

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 20,6375 MM TO 32,000 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
20,637500	13/16	0,812500	3,618	27,9	300
21,000000	-	0,826772	3,808	26,4	250
21,431250	27/32	0,843750	4,065	24,9	250
22,000000	-	0,866142	4,377	23,0	200
22,225000	7/8	0,875000	4,512	22,3	200
23,000000	-	0,905512	5,001	20,1	200
23,018750	29/32	0,906250	5,015	20,1	200
23,812500	15/16	0,937500	5,550	18,1	150
24,000000	-	0,944882	5,682	17,7	150
24,606250	31/32	0,968750	6,121	16,4	150
MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
25,000000	-	0,984252	6,422	15,7	150
25,400000	1	1,000000	6,736	14,9	150
26,000000	-	1,023622	7,224	13,9	120
26,987500	1.1/16	1,062500	8,080	12,5	120
28,000000	-	1,102362	9,023	11,2	100
28.575000	1.1/8	1,125000	9,551	10,5	100
30,000000	-	1,181102	11,10	9,1	80
30,162500	1.3/16	1,187500	11,28	8,9	80
31,750000	1.1/4	1,250000	13,19	7,7	80
32,000000	-	1,259843	13,47	7,5	70

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 33,3375 MM TO 52,3875 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
33,337500	1.5/16	1,312500	15,21	6,6	70
34,000000	-	1,338583	16,16	6,2	60
34,925000	1.3/8	1,375000	17,51	5,8	50
35,000000	-	1,377953	17,62	5,7	50
36,000000	-	1,417323	19,18	5,3	50
36,512500	1.7/16	1,437500	20,01	5,0	50
38,000000	-	1,496063	22,55	4,5	50
38,100000	1.1/2	1,500000	22,73	4,4	40
39,687500	1.9/16	1,562500	25,72	3,9	40
40,000000	-	1,574803	26,31	3,8	40
MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
41,275000	1.5/8	1,625000	28,96	3,5	40
42,862500	1.11/16	1,687500	32,45	3,1	25
44,450000	1.3/4	1,750000	36,10	2,8	25
45,000000	-	1,771654	37,45	2,7	25
46,037500	1.13/16	1,812500	40,27	2,5	25
47,625000	1.7/8	1,875000	44,61	2,3	20
49,212500	1.15/16	1,937500	48,98	2,1	20
50,000000	-	1,968504	51,38	2,0	20
50,800000	2	2,000000	53,88	1,9	20
52,387500	2.1/16	2,062500	58,72	1,7	15

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 53,975 MM TO 92,075 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
53,975000	2.1/8	2,125000	64,63	1,6	15
55,000000	-	2,165354	68,38	1,5	15
57,150000	2.1/4	2,250000	76,92	1,3	10
60,000000	-	2,362205	88,78	1,1	10
60,325000	2.3/8	2,375000	89,42	1,1	10
63,500000	2.1/2	2,500000	105,2	0,96	10
66,675000	2.5/8	2,625000	122,0	0,83	5
69,850000	2.3/4	2,750000	140,4	0,72	5
70,000000	-	2,755906	141,0	0,71	5
73,025000	2.7/8	2,875000	160,6	0,63	5
MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
75,000000	-	2,952756	173,4	0,58	5
76,200000	3	3,000000	181,9	0,55	4
79,375000	3.1/8	3,125000	205,7	0,49	4
80,000000	-	3,149606	210,4	0,48	4
82,550000	3.1/4	3,250000	231,6	0,44	4
85,000000	-	3,346457	252,4	0,40	4
85,725000	3.3/8	3,375000	258,7	0,39	4
88,900000	3.1/2	3,500000	288,8	0,35	1
90,000000	-	3,543307	299,6	0,34	1
92,075000	3.5/8	3,625000	311,1	0,31	1

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 95,000 MM TO 300,000 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
95,000000	-	3,740157	352,4	0,29	1
95,250000	3.3/4	3,750000	355,8	0,28	1
98,425000	3.7/8	3,875000	392,5	0,26	1
100,000000	-	3,937001	411,0	0,24	1
101,600000	4	4,000000	431,1	0,23	1
107,950000	4.1/4	4,250000	517,1	0,19	1
110,000000	-	4,330709	547,1	0,18	1
114,300000	4.1/2	4,500000	613,9	0,16	1
120,000000	-	4,724409	710,3	0,14	1
120,650000	4.3/4	4,750000	717,3	0,14	1
MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
127,000000	5	5,000000	841,9	0,12	1
133,350000	5.1/4	5,250000	974,6	0,10	1
139,700000	5.1/2	5,500000	1121	0,090	1
146,050000	5.3/4	5,750000	1281	0,079	1
150,000000	-	5,905512	1390	0,073	1
152,400000	6	6,000000	1455	0,069	1
177,800000	7	7,000000	2296	0,044	1
200,000000	-	7,874016	3290	0,031	1
250,000000	-	9,842520	6420	0,016	1
300,000000	-	11,811024	11027	0,009	1

NUMBER OF BALLS PER LITRE FROM 0,798 MM TO 12,700 MM

MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)	MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)
0,797350	1/32	0,031250	2.444.163	2,800000	-	0,110236	55.681
1,000000	-	0,039370	1.222.310	3,000000	-	0,118110	45.271
1,190625	3/64	0,046875	724.196	3,175000	1/8	0,125000	38.190
1,500000	-	0,059055	362.166	3,500000	-	0,137795	28.509
1,587500	1/16	0,062500	305.520	3,968750	5/32	0,156250	19,553
1,984375	5/64	0,078125	156.426	4,000000	-	0,157480	19,099
2,000000	-	0,078740	152.789	4,500000	-	0,177165	13,414
2,381250	3/32	0,093750	90.525	4,762500	3/16	0,187500	11.316
2,500000	-	0,098425	78.228	5,000000	-	0,196850	9.778
2,778125	7/64	0,109375	57.007	5,500000	-	0,216535	7.347

MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)	MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)
5,556250	7/32	0,218750	7.126	8,731250	11/32	0,343750	1.836
6,000000	-	0,236220	5.659	9,000000	-	0,354331	1.677
6,350000	1/4	0,250000	4.774	9,525000	3/8	0,375000	1.414
6,500000	-	0,255906	4.451	10,000000	-	0,393701	1.222
7,000000	-	0,275591	3.564	10,318750	13/32	0,406250	1.113
7,143750	9/32	0,281250	3.353	11,000000	-	0,433071	918
7,500000	-	0,295276	2.897	11,112500	7/16	0,437500	891
7,937500	5/16	0,312500	2.444	11,906250	15/32	0,468750	724
8,000000	-	0,314961	2.387	12,000000	-	0,472441	707
8,500000	-	0,334646	1.990	12,700000	1/2	0,500000	597

NUMBER OF BALLS PER LITRE FROM 13,000 MM TO 35,000 MM

MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)	MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)
13,000000	-	0,511811	556	17,462500	11/16	0,687500	230
13,493750	17/32	0,531250	497	18,000000	-	0,708661	210
14,000000	-	0,551181	445	18,256250	23/32	0,718750	201
14,287500	9/16	0,562500	419	19,050000	3/4	0,750000	177
15,000000	-	0,590551	362	19,843750	25/32	0,781250	156
15,081250	19/32	0,593750	356	20,000000	-	0,787402	153
15,875000	5/8	0,625000	306	20,637500	13/16	0,812500	139
16,000000	-	0,629921	298	21,000000	-	0,826772	132
16,668750	21/32	0,656250	264	21,431250	27/32	0,843750	124
17,000000	-	0,669291	249	22,000000	-	0,866142	115

MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)	MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)
22,225000	7/8	0,875000	111	28,000000	-	1,102362	56
23,000000	-	0,905512	100	28,575000	1.1/8	1,125000	52
23,018750	29/32	0,906250	100	30,000000	-	1,181102	45
23,812500	15/16	0,937500	91	30,162500	1.3/16	1,187500	45
24,000000	-	0,944882	88	31,750000	1.1/4	1,250000	38
24,606250	31/32	0,968750	82	32,000000	-	1,259843	37
25,000000	-	0,984252	78	33,337500	1.5/16	1,312500	33
25,400000	1	1,000000	75	34,000000	-	1,338583	31
26,000000	-	1,023622	70	34,925000	1.3/8	1,375000	29
26,987500	1.1/16	1,062500	62	35,000000	-	1,377953	29

NUMBER OF BALLS PER LITRE FROM 36,000 MM TO 100,000 MM

MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)	MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)
36,000000	-	1,417323	26	46,037500	1.13/16	1,812500	13
36,512500	1.7/16	1,437500	25	47,625000	1.7/8	1,875000	11
38,000000	-	1,496063	22	49,212500	1.15/16	1,937500	10
38,100000	1.1/2	1,500000	22	50,000000	-	1,968504	10
39,687500	1.9/16	1,562500	20	50,800000	2	2,000000	9,3
40,000000	-	1,574803	19	52,387500	2.1/16	2,062500	8,5
41,275000	1.5/8	1,625000	17	53,975000	2.1/8	2,125000	7,8
42,862500	1.11/16	1,687500	16	55,000000	-	2,165354	7,3
44,450000	1.3/4	1,750000	14	57,150000	2.1/4	2,250000	6,5
45,000000	-	1,771654	13	60,000000	-	2,362205	5,7

MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)	MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)
60,325000	2.3/8	2,375000	5,6	82,550000	3.1/4	3,250000	2,2
63,500000	2.1/2	2,500000	4,8	85,000000	-	3,346457	2,0
66,675000	2.5/8	2,625000	4,1	85,725000	3.3/8	3,375000	1,9
69,850000	2.3/4	2,750000	3,6	88,900000	3.1/2	3,500000	1,7
70,000000	-	2,755906	3,6	90,000000	-	3,543307	1,7
73,025000	2.7/8	2,875000	3,1	92,075000	3.5/8	3,625000	1,6
75,000000	-	2,952756	2,9	95,000000	-	3,740157	1,4
76,200000	3	3,000000	2,8	95,250000	3.3/4	3,750000	1,4
79,375000	3.1/8	3,125000	2,4	98,425000	3.7/8	3,875000	1,3
80,000000	-	3,149606	2,4	100,000000	-	3,937001	1,2

TABLE CONVERSION OF SIXTY-FOURTH INCHES TO MM

Inches "	Decimal inches	Millimeters mm	Inches "	Decimal inches	Millimeters mm
1/64	0,015625	0,397	33/64	0,515625	13,097
3/64	0,046875	1,191	35/64	0,546875	13,891
5/64	0,078125	1,984	37/64	0,578125	14,684
7/64	0,109375	2,778	39/64	0,609375	15,478
9/64	0,140625	3,572	41/64	0,640625	16,272
11/64	0,171875	4,366	43/64	0,671875	17,066
13/64	0,203125	5,159	45/64	0,703125	17,859
15/64	0,234375	5,953	47/64	0,734375	18,653
17/64	0,265625	6,747	49/64	0,765625	19,447
19/64	0,296875	7,541	51/64	0,796875	20,241
21/64	0,328125	8,334	53/64	0,828125	21,034
23/64	0,359375	9,128	55/64	0,859375	21,828
25/64	0,390625	9,922	57/64	0,890625	22,622
27/64	0,421875	10,716	59/64	0,921875	23,416
29/64	0,453125	11,509	61/64	0,953125	24,209
31/64	0,484375	12,303	63/64	0,984375	25,003

WEIGHT 100 BALLS/QUANTITY PER KG SIXTY-FOURTH INCHES

Inches "	Weight 100 ball AISI 52100 kg	Quantity per kg (AISI 52100)	Inches "	Weight 100 ball AISI 52100 kg	Quantity per kg (AISI 52100)
1/64	0,000026	3.916.928	33/64	0,9175	109
3/64	0,00073	145.071	35/64	1,095	91
5/64	0,00319	31.335	37/64	1,293	77
7/64	0,00825	11.420	39/64	1,514	66
9/64	0,01861	5.373	41/64	1,760	57
11/64	0,03398	2.943	43/64	2,030	49
13/64	0,05609	1.783	45/64	2,326	43
15/64	0,08616	1.161	47/64	2,651	38
17/64	0,1254	797	49/64	3,004	33
19/64	0,1751	571	51/64	3,387	30
21/64	0,2364	423	53/64	3,801	26
23/64	0,3106	322	55/64	4,248	24
25/64	0,3989	251	57/64	4,728	21
27/64	0,5025	199	59/64	5,243	19
29/64	0,6227	161	61/64	5,795	17
31/64	0,7606	131	63/64	6,384	16

SPS “DV” pressed metal sheet type with fixing holes

ISO 3290-1 INTERNATIONAL STANDARD

ISO 3290-1:2014 STANDARD (STEEL BALLS)

Precision grade	Variation of ball diameter (VDws)(µm) (a)	Deviation from spherical form (tDw)(µm) (a)	Surface roughness (Ra)(µm) (a)	Variation of ball lot diameter (VDwL)(µm)	Gauge interval (IG)	Description of preferred gauge	Subgauge interval	Description of subgauges (SG)
3	0.08	0.08	0.010	0.13	0.5	-5/-0.5,0,+0.5/+5	0.1	-0.2,-0.1,0,0.1,0.2
5	0.13	0.13	0.014	0.25	1	-5/-1,0,+1/+5	0.2	-0.4,-0.2,0,0.2,0.4
10	0.25	0.25	0.020	0.5	1	-9/-1,0,+1/+9	0.2	-0.4,-0.2,0,0.2,0.4
16	0.4	0.4	0.025	0.8	2	-10/-2,0,+2/+10	0.4	-0.8,-0.4,0,0.4,0.8
20	0.5	0.5	0.032	1	2	-10/-2,0,+2/+10	0.4	-0.8,-0.4,0,0.4,0.8
24	0.6	0.6	0.040	1.2	2	-12/-2,0,+2/+12	0.4	-0.8,-0.4,0,0.4,0.8
28	0.7	0.7	0.050	1.4	2	-12/-2,0,+2/+12	0.4	-0.8,-0.4,0,0.4,0.8
40	1	1	0.060	2	4	-16/-4,0,+4/+16	0.8	-1.6,-0.8,0,0.8,1.6
60	1.5	1.5	0.080	3	6	-18/-6,0,+6/+18	1.2	-2.4,-1.2,0,1.2,2.4
100	2.5	2.5	0.100	5	10	-40/-10,0,10/40	2.0	-4,-2,0,2,4
200	5	5	0.150	10	15	-60/-15,0,15/60	3.0	-6,-3,0,3,6

Notes

(a) The values do not take into account surface defects; hence, measurement shall be taken outside such defects.

VALVE GRADES

PRECISION GRADE	VARIATION OF BALL DIAMETER (µm)	DEVIATION FROM SPHERICAL FORM (µm)	VARIATION OF BALL LOT DIAMETER (µm)	SURFACE ROUGHNESS (µm)
48V	1,2	1,2	25	0,08
100V	2,5	2,5	50	0,125
200V	5	5	75	0,200
500V	13	13	125	-

www.rgpballs.com

TERM	SYMBOL	DEFINITION
Surface faultiness	-	Element, irregularity or set of elements and irregularities of the actual surface, unintentionally or accidentaly during production, storage or surface usage. These types of elements or irregularities considerably differ from elements related to surface roughness and they should not been considered in the measurement of the surface roughness
Nominal ball diameter	Dw	Diameter value which is used for the general identification of a ball size
Single ball diameter	Dws	Distance between two parallel planes tangential to the actual surface of a ball.
Mean ball diameter	Dwm	Arithmetical mean of the largest and the smallest of the single diameters of a ball.
Variation of ball diameter	VDws	Difference between the largest and the smallest of the single diameters of a ball.
Deviation from spherical form	tDw	Greatest radial distance, in any equatorial plane, between the smallest circumscribed sphere and the greatest inscribed sphere, with their centres common to the least square sphere centre.
Ball lot	-	Defines quantity of balls manufactured under conditions presumed uniform and which is considered as an entity
Mean diameter of ball lot	DwmL	Arithmetical mean of the mean diameters of the largest ball and the smallest ball in a ball lot.
Variation of ball lot diameter	VDwL	Difference between the mean diameters of the largest ball and the smallest ball in a ball lot.
Ball grade	G	Specific combination of dimensional, form, surface roughness and sorting tolerances for balls. Ball grade is identified by the letter G and a number.
Ball gauge	S	Amount by which the mean diameter of a ball lot should differ from the nominal ball diameter, this amount being one of an established series. Each ball gauge is a whole multiple of the ball gauge interval established for the ball grade in question. A ball gauge, in combination with the ball grade and nominal diameter, should be considered as the most exact ball size specification to be used by a customer for ordering purposes.
Deviation of a ball lot from ball gauge	ΔS	Difference between the mean diameter of a ball lot and the sum of the nominal ball diameter and the ball gauge: ΔS=DwmL-(Dw+S).
Ball subgauge:	-	Amount of an established series of amounts, which is the nearest to the actual deviation from the ball gauge of a ball lot. Each ball subgauge is a whole multiple of the ball subgauge interval established for the ball grade in question. The ball subgauge, in combination with the nominal ball diameter and the ball gauge, is used by ball manufacturers to denote the mean diameter of a ball lot and should not be used by customers of ordering purposes.
Hardness	-	Measure of resistance to penetration as determined by specific methods
Surface roughness	Ra	Surface irregularities with relatively small spacings, which usually include irregularities resulting from the method of manufacture being used and/or other influences. These irregularities are considered within the limits that are conventionally defined, e.g., whitin the limits of the sampling length.
Waviness	-	Surface irregularities of random of periodical deviation from the ideal spherical form. It is recommended that waviness be evaluated as velocity amplitude. In practice, the waviness components are separated from the real surface by a waviness analyser (filters).

ISO 3290-2 INTERNATIONAL STANDARD

ISO 3290-2:2014 STANDARD (CERAMIC BALLS: SILICON NITRIDE)

Precision grade	Variation of ball diameter (VDws)(µm) (a)	Deviation from spherical form (tDw)(µm) (a)	Surface roughness (Ra)(µm) (a)	Variation of ball lot diameter (VDwL)(µm)	Gauge interval (IG)	Description of preferred gauge	Subgauge interval	Description of subgauges (SG)
3	0.08	0.08	0.010	0.13	0.5	-5/-0.5,0,+0.5/+5	0.1	-0.2,-0.1,0,0.1,0.2
5	0.13	0.13	0.014	0.25	1	-5/-1,0,+1/+5	0.2	-0.4,-0.2,0,0.2,0.4
10	0.25	0.25	0.020	0.5	1	-9/-1,0,+1/+9	0.2	-0.4,-0.2,0,0.2,0.4
16	0.4	0.4	0.025	0.8	2	-10/-2,0,+2/+10	0.4	-0.8,-0.4,0,0.4,0.8
20	0.5	0.5	0.032	1	2	-10/-2,0,+2/+10	0.4	-0.8,-0.4,0,0.4,0.8
24	0.6	0.6	0.040	1.2	2	-12/-2,0,+2/+12	0.4	-0.8,-0.4,0,0.4,0.8
28	0.7	0.7	0.050	1.4	2	-12/-2,0,+2/+12	0.4	-0.8,-0.4,0,0.4,0.8
40	1	1	0.060	2	4	-16/-4,0,+4/+16	0.8	-1.6,-0.8,0,0.8,1.6
60	1.5	1.5	0.080	3	6	-18/-6,0,+6/+18	1.2	-2.4,-1.2,0,1.2,2.4
100	2.5	2.5	0.100	5	10	-40/-10,0,10/40	2.0	-4,-2,0,2,4

Notes

(a) The values do not take into account surface defects; hence, measurement shall be taken outside such defects.

www.rgpballs.com

TERM	SYMBOL	DEFINITION
Surface faultiness	-	Element, irregularity or set of elements and irregularities of the actual surface, unintentionally or accidentaly during production, storage or surface usage. These types of elements or irregularities considerably differ from elements related to surface roughness and they should not been considered in the measurement of the surface roughness
Nominal ball diameter	Dw	Diameter value which is used for the general identification of a ball size
Single ball diameter	Dws	Distance between two parallel planes tangential to the actual surface of a ball.
Mean ball diameter	Dwm	Arithmetical mean of the largest and the smallest of the single diameters of a ball.
Variation of ball diameter	VDws	Difference between the largest and the smallest of the single diameters of a ball.
Deviation from spherical form	tDw	Greatest radial distance, in any equatorial plane, between the smallest circumscribed sphere and the greatest inscribed sphere, with their centres common to the least square sphere centre.
Ball lot	-	Defines quantity of balls manufactured under conditions presumed uniform and which is considered as an entity
Mean diameter of ball lot	DwmL	Arithmetical mean of the mean diameters of the largest ball and the smallest ball in a ball lot.
Variation of ball lot diameter	VDwL	Difference between the mean diameters of the largest ball and the smallest ball in a ball lot.
Ball grade	G	Specific combination of dimensional, form, surface roughness and sorting tolerances for balls. Ball grade is identified by the letter G and a number.
Ball gauge	S	Amount by which the mean diameter of a ball lot should differ from the nominal ball diameter, this amount being one of an established series. Each ball gauge is a whole multiple of the ball gauge interval established for the ball grade in question. A ball gauge, in combination with the ball grade and nominal diameter, should be considered as the most exact ball size specification to be used by a customer for ordering purposes.
Deviation of a ball lot from ball gauge	ΔS	Difference between the mean diameter of a ball lot and the sum of the nominal ball diameter and the ball gauge: ΔS=DwmL-(Dw+S).
Ball subgauge:	-	Amount of an established series of amounts, which is the nearest to the actual deviation from the ball gauge of a ball lot. Each ball subgauge is a whole multiple of the ball subgauge interval established for the ball grade in question. The ball subgauge, in combination with the nominal ball diameter and the ball gauge, is used by ball manufacturers to denote the mean diameter of a ball lot and should not be used by customers of ordering purposes.
Hardness	-	Measure of resistance to penetration as determined by specific methods
Surface roughness	Ra	Surface irregularities with relatively small spacings, which usually include irregularities resulting from the method of manufacture being used and/or other influences. These irregularities are considered within the limits that are conventionally defined, e.g., whitin the limits of the sampling length.
Waviness	-	Surface irregularities of random of periodical deviation from the ideal spherical form. It is recommended that waviness be evaluated as velocity amplitude. In practice, the waviness components are separated from the real surface by a waviness analyser (filters).

DIN 5401 INTERNATIONAL STANDARDS

DIN 5401 : 2002-08 (GERMAN STANDARDS)

GRADE	Class	Nominal diameter Dw (mm)		Limit deviations (µm) (5)	Ball diameter variation	Roundness error	Surface roughness (6)	Lot diameter variation (5)	Subgauge interval	Subgauges (µm) (7)		
		From	To		VDws Max. (µm)	tDws Max. (µm)	Ra Max. (µm)	VDwL/A Max. (µm)	IG, ST (µm)			
G3	-	-	12,7	± 5,32	0,08	0,08	0,010	0,13 (L)	0,5	from -5 to -0,5	0	from +0,5 to +5
G5	I	-	12,7	± 5,63	0,13	0,13	0,014	0,25 (L)	1	from -5 to -1	0	from +1 to +5
G10	II	-	25,4	± 9,75	0,25	0,25	0,020	0,50 (L)	1	from -9 to -1	0	from +1 to +9
G16 (1)	II	-	25,4	± 11,4	0,40	0,40	0,025	0,80 (L)	2	from -10 to -2	0	from +2 to +10
G20 (1)	III	-	38,1	± 11,5	0,50	0,50	0,032	1,0 (L)	2	from -10 to -2	0	from +2 to +10
G28 (1)	III	-	50,8	± 13,7	0,70	0,70	0,050	1,4 (L)	2	from -12 to -2	0	from +2 to +12
G40	III	-	100	± 19,0	1,0	1,0	0,060	2,0 (L)	4	from -16 to -4	0	from +4 to +16
G80 (2)	III	-	100	± 14,0	2,0	2,0	0,10	4,0 (A)	4	from -12 to -4	0	from +4 to +12
G100	III	-	150	± 47,5	2,5	2,5	0,10	5,0 (L)	10	from -40 to -10	0	from 10 to +40
G200	IV	-	150	± 72,5	5,0	5,0	0,15	10 (L)	10	from -60 to -10	0	from +10 to +60
G300 (1)	IV	-	25,4	± 70,0	10	10	0,20	20 (A)	20	from -60 to -20	0	from +20 to +60
G300 (3)	IV	25,4	50,8	± 105	15	15	0,20	30 (A)	30	from -90 to -30	0	from +30 to +90
G300	IV	50,8	75	± 140	20	20	0,20	40 (A)	40	from -120 to -40	0	0 from +40 to +120
G500 (4)	V	-	25,4	± 75,0	25	25	-	50 (A)	50	-50	0	+50
G500	V	25,4	50,8	± 112,5	25	25	-	75 (A)	75	-75	0	+75
G500	V	50,8	75	± 150	25	25	-	100 (A)	100	-100	0	+100
G500	V	75	100	± 187,5	32	32	-	125 (A)	125	-125	0	+125
G500	V	100	125	± 225	38	38	-	150 (A)	150	-150	0	+150
G500	V	125	150	± 262,5	44	44	-	175 (A)	175	-175	0	+175
G600 (4)	VI	all	all	± 200	-	-	-	400 (A)	-	-	0	-
G700 (4)	VI	all	all	± 1000	-	-	-	2000 (A)	-	-	0	-

www.rgpballs.com

Notes

(1) In some cases and subject to agreement, half teh gauge interval values may be used for grades G16, G20, G28 and G300.

(2) Not specified in ISO 3290.

(3) Not specified in ISO 3290.

(4) Not specified in ISO 3290.

(5) Values relate to the mean diameter of a ball, Dwm.

(6) See DIN EN ISO 4288. For smaller ball sizes (not covered ib this standard), values are subject to agreement.

(7) Graded in intervals equal to IG.

A.F.B.M.A. INTERNATIONAL STANDARDS

A.F.B.M.A. STANDARDS (U.S.A.)

AFBMA GRADES	Variation of ball diameter /ROUNDNESS		LOT DIAMETER VARIATION		BASIC DIAMETER TOLERANCE		MAXIMUM INCREMENTS		SURFACE ROUGHNESS	
	INCHES	µm	INCHES	µm	INCHES	µm	INCHES	µm	INCHES	µm
3	0.000003	0,0762	0.000005	0,127	± 0.00003	0,762	0.000010	0,254	0.0000005	0,0127
5	0.000005	0,127	0.000010	0,254	± 0.00005	1,27	0.000010	0,254	0.0000008	0,02032
10	0.000010	0,254	0.000020	0,508	± 0.00010	2,54	0.000010	0,254	0.000001	0,0254
15	0.000015	0,381	0.000030	0,762	± 0.00010	2,54	0.000010	0,254	0.000001	0,0254
16	0.000016	0,4064	0.000032	0,8128	± 0.00010	2,54	0.000010	0,254	0.000001	0,0254
24	0.000024	0,6096	0.000048	1,2192	± 0.00010	2,54	0.000010	0,254	0.000002	0,0508
25	0.000025	0,635	0.000050	1,27	± 0.00010	2,54	0.000010	0,254	0.000002	0,0508
48	0.000048	1,2192	0.000096	2,4384	± 0.00020	5,08	0.000050	1,27	0.000003	0,0762
50	0.000050	1,27	0.000100	2,54	± 0.00030	7,62	0.000050	1,27	0.000003	0,0762
100	0.000100	2,54	0.000200	5,08	± 0.00050	12,70	0.000100	2,54	0.000005	0,127
200	0.000200	5,08	0.000400	10,20	± 0.00100	25,40	0.000200	5,08	0.000008	0,2032
300	0.000300	7,62	0.000400	15,24	± 0.00100	25,40	0.000300	7,62	-	-
500	0.000500	12,70	0.001000	25,40	± 0.00200	50,80	0.000500	12,70	-	-
1000	0.001000	25,40	0.002000	50,80	± 0.00500	127,0	0.001000	25,40	-	-
2000	0.002000	50,80	0.004000	101,60	± 0.00500	127,0	0.002000	50,80	-	-
3000	0.003000	76,20	0.006000	152,40	± 0.00500	127,0	0.003000	76,20	-	-

APPROXIMATE EQUIVALENT GRADES BETWEEN ISO 3290, AFBMA, DIN AND OLD "RGP" GRADES

ISO 3290

Grade AAAA	Grade AAA	Grade AA	Grade A	Grade B	Grade C	Ø (mm)
Grade 5	Grade 10	Grade 16	Grade 28	Grade 40	Grade 100	Ø ≤ 3
Grade 10	Grade 16	Grade 28	Grade 40	Grade 100	Grade 100	3 < Ø ≤ 6
Grade 10	Grade 16	Grade 28	Grade 40	Grade 100	Grade 200	6 < Ø ≤ 10
Grade 16	Grade 20	Grade 28	Grade 40	Grade 100	Grade 200	10 < Ø ≤ 20
-	Grade 28	Grade 40	Grade 100	Grade 200	-	20 < Ø ≤ 30
-	Grade 40	Grade 40	Grade 100	Grade 200	-	30 < Ø ≤ 50
-	Grade 40	Grade 100	Grade 100	Grade 200	-	Ø > 50

AFBMA

Grade AAAA	Grade AAA	Grade AA	Grade A	Grade B	Grade C	Ø (mm)
Grade 5	Grade 10	Grade 16	Grade 24	Grade 48	Grade 100	Ø ≤ 3
Grade 10	Grade 16	Grade 24	Grade 48	Grade 100	Grade 100	3 < Ø ≤ 6
Grade 10	Grade 16	Grade 24	Grade 48	Grade 100	Grade 200	6 < Ø ≤ 10
Grade 16	Grade 16	Grade 24	Grade 48	Grade 100	Grade 200	10 < Ø ≤ 20
-	Grade 24	Grade 48	Grade 100	Grade 200	Grade 300	20 < Ø ≤ 30
-	Grade 48	Grade 48	Grade 100	Grade 200	Grade 300	30 < Ø ≤ 50
-	Grade 48	Grade 100	Grade 100	Grade 200	Grade 300	Ø > 50

DIN

Grade AAAA	Grade AAA	Grade AA	Grade A	Grade B	Grade C	Ø (mm)
-	Class I	Class II	Class III	Class IV	-	Ø ≤ 3
-	Class I	Class II	Class III	Class IV	-	3 < Ø ≤ 6
Class I	Class II	Class III	Class IV	-	-	6 < Ø ≤ 10
Class I	Class II	Class III	Class IV	-	-	10 < Ø ≤ 20
Class II	Class II	Class III	Class IV	-	-	20 < Ø ≤ 30
-	-	Class III	Class IV	-	-	30 < Ø ≤ 50
-	-	Class III	Class IV	-	-	Ø > 50

INTERNATIONAL STANDARDS

STEELS

Type	Regulatory body	Designation	Year	Title
Stainless steels	AMS	5524	2014	Steel, Corrosion and Heat-Resistant, Sheet, Strip and Plate 18Cr - 13Ni - 2.5Mo (SAE 30316) Solution Heat Treated
Stainless steels	AMS	5630	2013	Steel, Corrosion-Resistant, Bars, Wire, and Forgings 17Cr - 0.52Mo (0.95 - 1.20C) (440C)
Stainless steels	AMS	5880	2013	Steel, Corrosion-Resistant, Bars, Wire, and Forgings 17Cr 0.52Mo (0.95 1.20C) (SAE 51440C) for Bearing Applications
Stainless steels	AMS	QQ-S-763	2015	Steel, Corrosion Resistant, Bars, Wire, Shapes, and Forgings
Stainless steels	ASTM	A262	2015	Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
Stainless steels	ASTM	A276	2015	Standard Specification for Stainless Steel Bars and Shapes
Stainless steels	ASTM	A493	2009	Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging
Stainless steels	ASTM	A580	2015	Standard Specification for Stainless Steel Wire
Stainless steels	ASTM	A756	2009	Standard Specification for Stainless Anti-Friction Bearing Steel
Nonferrous steels	ASTM	E55	2011	Standard Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition
Bearing steels	ASTM	A295	2014	Standard Specification for High-Carbon Anti-Friction Bearing Steel
Bearing steels	ISO	15243	2004	Rolling bearings — Damage and failures — Terms, characteristics and causes
Bearing steels	ISO	683-17	2014	Heat-treated steels, alloy steels and free-cutting steels — Part 17: Ball and roller bearing steels
Tool steels	ASTM	A681	2008	Standard Specification for Tool Steels Alloy

www.rgpballs.com

OTHER PRODUCTS

Type	Regulatory body	Designation	Year	Title
Balls for bearings	ASTM	F2215	2008	Standard Specification for Balls, Bearings, Ferrous and Nonferrous for Use in Bearings, Valves, and Bearing Applications
Ceramics	ASTM	F2094	2014	Standard Specification for Silicon Nitride Bearing Balls
Grinding/polishing	AMS	2431-5B	2011	Peening Media Hardened Steel Peening Balls
Rollers	DIN	5402-1	2014	Rolling bearings – Parts of rolling bearings – Part 1: Cylindrical rollers
Rollers	DIN	5402-3	2012	Rolling bearings – Parts of rolling bearings – Part 3: Needle rollers
Rollers	ISO	3096	1996	Rolling bearings - Needle rollers - Dimensions and tolerances
Rollers	ISO	12297	2012	Rolling bearings. Steel cylindrical rollers. Dimensions and tolerances

GRADES AND TOLERANCES

Type	Regulatory body	Designation	Year	Title
Precision grade	ISO	3290-1	2014	Rolling bearings - Balls - Part 1: Steel balls
Precision grade	ISO	3290-2	2014	Rolling bearings - Balls - Part 2: Ceramic balls
Precision grade	DIN	5401	2002	Rolling bearings - Balls for rolling bearings and general industrial use
Precision grade	ANSI-AFBMA	Std. 10	1989	Metal balls
Cylindricity	ISO	12180-2	2011	Geometrical product specifications (GPS) - Cylindricity - Part 2: Specification operators
Roundness	ISO	12181-2	2011	Geometrical product specifications (GPS) - Roundness - Part 2: Specification operators
Roughness	ISO	1302	2002	Geometrical Product Specifications (GPS) — Indication of surface texture in technical product documentation
Rubber tolerances	ISO	3302-1	2014	Rubber - Tolerances for products - Part 1: Dimensional tolerances

www.rgpballs.com

OTHER STANDARDS

Type	Regulatory body	Designation	Year	Title
Hardness	ISO	6507-1	2005	Metallic materials - Vickers hardness test - Part 1: Test method
Hardness	ISO	6508-1	2015	Metallic materials - Rockwell hardness test - Part 1: Test method
Microstructure	ASTM	E112	2013	Standard Test Methods for Determining Average Grain Size
Passivation	ASTM	A380	2013	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
Passivation	ASTM	A967	2013	Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts
Passivation	ASTM	G 82	1998	Standard Guide for Development and Use of a Galvanic Series for Predicting Galvanic Corrosion Performance

ISO 3290-1 INTERNATIONAL STANDARD

ISO 3290-1:2014 STANDARD (STEEL BALLS)

Precision grade	Variation of ball diameter (VDws)(µm) (a)	Deviation from spherical form (tDw)(µm) (a)	Surface roughness (Ra)(µm) (a)	Variation of ball lot diameter (VDwL)(µm)	Gauge interval (IG)	Description of preferred gauge	Subgauge interval	Description of subgauges (SG)
3	0.08	0.08	0.010	0.13	0.5	-5/-0.5,0,+0.5/+5	0.1	-0.2,-0.1,0,0.1,0.2
5	0.13	0.13	0.014	0.25	1	-5/-1,0,+1/+5	0.2	-0.4,-0.2,0,0.2,0.4
10	0.25	0.25	0.020	0.5	1	-9/-1,0,+1/+9	0.2	-0.4,-0.2,0,0.2,0.4
16	0.4	0.4	0.025	0.8	2	-10/-2,0,+2/+10	0.4	-0.8,-0.4,0,0.4,0.8
20	0.5	0.5	0.032	1	2	-10/-2,0,+2/+10	0.4	-0.8,-0.4,0,0.4,0.8
24	0.6	0.6	0.040	1.2	2	-12/-2,0,+2/+12	0.4	-0.8,-0.4,0,0.4,0.8
28	0.7	0.7	0.050	1.4	2	-12/-2,0,+2/+12	0.4	-0.8,-0.4,0,0.4,0.8
40	1	1	0.060	2	4	-16/-4,0,+4/+16	0.8	-1.6,-0.8,0,0.8,1.6
60	1.5	1.5	0.080	3	6	-18/-6,0,+6/+18	1.2	-2.4,-1.2,0,1.2,2.4
100	2.5	2.5	0.100	5	10	-40/-10,0,10/40	2.0	-4,-2,0,2,4
200	5	5	0.150	10	15	-60/-15,0,15/60	3.0	-6,-3,0,3,6

Notes

(a) The values do not take into account surface defects; hence, measurement shall be taken outside such defects.

VALVE GRADES

PRECISION GRADE	VARIATION OF BALL DIAMETER (µm)	DEVIATION FROM SPHERICAL FORM (µm)	VARIATION OF BALL LOT DIAMETER (µm)	SURFACE ROUGHNESS (µm)
48V	1,2	1,2	25	0,08
100V	2,5	2,5	50	0,125
200V	5	5	75	0,200
500V	13	13	125	-

www.rgpballs.com

TERM	SYMBOL	DEFINITION
Surface faultiness	-	Element, irregularity or set of elements and irregularities of the actual surface, unintentionally or accidentaly during production, storage or surface usage. These types of elements or irregularities considerably differ from elements related to surface roughness and they should not been considered in the measurement of the surface roughness
Nominal ball diameter	Dw	Diameter value which is used for the general identification of a ball size
Single ball diameter	Dws	Distance between two parallel planes tangential to the actual surface of a ball.
Mean ball diameter	Dwm	Arithmetical mean of the largest and the smallest of the single diameters of a ball.
Variation of ball diameter	VDws	Difference between the largest and the smallest of the single diameters of a ball.
Deviation from spherical form	tDw	Greatest radial distance, in any equatorial plane, between the smallest circumscribed sphere and the greatest inscribed sphere, with their centres common to the least square sphere centre.
Ball lot	-	Defines quantity of balls manufactured under conditions presumed uniform and which is considered as an entity
Mean diameter of ball lot	DwmL	Arithmetical mean of the mean diameters of the largest ball and the smallest ball in a ball lot.
Variation of ball lot diameter	VDwL	Difference between the mean diameters of the largest ball and the smallest ball in a ball lot.
Ball grade	G	Specific combination of dimensional, form, surface roughness and sorting tolerances for balls. Ball grade is identified by the letter G and a number.
Ball gauge	S	Amount by which the mean diameter of a ball lot should differ from the nominal ball diameter, this amount being one of an established series. Each ball gauge is a whole multiple of the ball gauge interval established for the ball grade in question. A ball gauge, in combination with the ball grade and nominal diameter, should be considered as the most exact ball size specification to be used by a customer for ordering purposes.
Deviation of a ball lot from ball gauge	ΔS	Difference between the mean diameter of a ball lot and the sum of the nominal ball diameter and the ball gauge: ΔS=DwmL-(Dw+S).
Ball subgauge:	-	Amount of an established series of amounts, which is the nearest to the actual deviation from the ball gauge of a ball lot. Each ball subgauge is a whole multiple of the ball subgauge interval established for the ball grade in question. The ball subgauge, in combination with the nominal ball diameter and the ball gauge, is used by ball manufacturers to denote the mean diameter of a ball lot and should not be used by customers of ordering purposes.
Hardness	-	Measure of resistance to penetration as determined by specific methods
Surface roughness	Ra	Surface irregularities with relatively small spacings, which usually include irregularities resulting from the method of manufacture being used and/or other influences. These irregularities are considered within the limits that are conventionally defined, e.g., whitin the limits of the sampling length.
Waviness	-	Surface irregularities of random of periodical deviation from the ideal spherical form. It is recommended that waviness be evaluated as velocity amplitude. In practice, the waviness components are separated from the real surface by a waviness analyser (filters).

ISO 3290-2 INTERNATIONAL STANDARD

ISO 3290-2:2014 STANDARD (CERAMIC BALLS: SILICON NITRIDE)

Precision grade	Variation of ball diameter (VDws)(µm) (a)	Deviation from spherical form (tDw)(µm) (a)	Surface roughness (Ra)(µm) (a)	Variation of ball lot diameter (VDwL)(µm)	Gauge interval (IG)	Description of preferred gauge	Subgauge interval	Description of subgauges (SG)
3	0.08	0.08	0.010	0.13	0.5	-5/-0.5,0,+0.5/+5	0.1	-0.2,-0.1,0,0.1,0.2
5	0.13	0.13	0.014	0.25	1	-5/-1,0,+1/+5	0.2	-0.4,-0.2,0,0.2,0.4
10	0.25	0.25	0.020	0.5	1	-9/-1,0,+1/+9	0.2	-0.4,-0.2,0,0.2,0.4
16	0.4	0.4	0.025	0.8	2	-10/-2,0,+2/+10	0.4	-0.8,-0.4,0,0.4,0.8
20	0.5	0.5	0.032	1	2	-10/-2,0,+2/+10	0.4	-0.8,-0.4,0,0.4,0.8
24	0.6	0.6	0.040	1.2	2	-12/-2,0,+2/+12	0.4	-0.8,-0.4,0,0.4,0.8
28	0.7	0.7	0.050	1.4	2	-12/-2,0,+2/+12	0.4	-0.8,-0.4,0,0.4,0.8
40	1	1	0.060	2	4	-16/-4,0,+4/+16	0.8	-1.6,-0.8,0,0.8,1.6
60	1.5	1.5	0.080	3	6	-18/-6,0,+6/+18	1.2	-2.4,-1.2,0,1.2,2.4
100	2.5	2.5	0.100	5	10	-40/-10,0,10/40	2.0	-4,-2,0,2,4

Notes

(a) The values do not take into account surface defects; hence, measurement shall be taken outside such defects.

www.rgpballs.com

TERMS, SYMBOLS AND DEFINITIONS

TERM	SYMBOL	DEFINITION
Surface faultiness	-	Element, irregularity or set of elements and irregularities of the actual surface, unintentionally or accidentaly during production, storage or surface usage. These types of elements or irregularities considerably differ from elements related to surface roughness and they should not been considered in the measurement of the surface roughness
Nominal ball diameter	Dw	Diameter value which is used for the general identification of a ball size
Single ball diameter	Dws	Distance between two parallel planes tangential to the actual surface of a ball.
Mean ball diameter	Dwm	Arithmetical mean of the largest and the smallest of the single diameters of a ball.
Variation of ball diameter	VDws	Difference between the largest and the smallest of the single diameters of a ball.
Deviation from spherical form	tDw	Greatest radial distance, in any equatorial plane, between the smallest circumscribed sphere and the greatest inscribed sphere, with their centres common to the least square sphere centre.
Ball lot	-	Defines quantity of balls manufactured under conditions presumed uniform and which is considered as an entity
Mean diameter of ball lot	DwmL	Arithmetical mean of the mean diameters of the largest ball and the smallest ball in a ball lot.
Variation of ball lot diameter	VDwL	Difference between the mean diameters of the largest ball and the smallest ball in a ball lot.
Ball grade	G	Specific combination of dimensional, form, surface roughness and sorting tolerances for balls. Ball grade is identified by the letter G and a number.
Ball gauge	S	Amount by which the mean diameter of a ball lot should differ from the nominal ball diameter, this amount being one of an established series. Each ball gauge is a whole multiple of the ball gauge interval established for the ball grade in question. A ball gauge, in combination with the ball grade and nominal diameter, should be considered as the most exact ball size specification to be used by a customer for ordering purposes.
Deviation of a ball lot from ball gauge	ΔS	Difference between the mean diameter of a ball lot and the sum of the nominal ball diameter and the ball gauge: ΔS=DwmL-(Dw+S).
Ball subgauge:	-	Amount of an established series of amounts, which is the nearest to the actual deviation from the ball gauge of a ball lot. Each ball subgauge is a whole multiple of the ball subgauge interval established for the ball grade in question. The ball subgauge, in combination with the nominal ball diameter and the ball gauge, is used by ball manufacturers to denote the mean diameter of a ball lot and should not be used by customers of ordering purposes.
Hardness	-	Measure of resistance to penetration as determined by specific methods
Surface roughness	Ra	Surface irregularities with relatively small spacings, which usually include irregularities resulting from the method of manufacture being used and/or other influences. These irregularities are considered within the limits that are conventionally defined, e.g., whitin the limits of the sampling length.
Waviness	-	Surface irregularities of random of periodical deviation from the ideal spherical form. It is recommended that waviness be evaluated as velocity amplitude. In practice, the waviness components are separated from the real surface by a waviness analyser (filters).

DIN 5401 INTERNATIONAL STANDARDS

DIN 5401 : 2002-08 (GERMAN STANDARDS)

GRADE	Class	Nominal diameter Dw (mm)		Limit deviations (µm) (5)	Ball diameter variation	Roundness error	Surface roughness (6)	Lot diameter variation (5)	Subgauge interval	Subgauges (µm) (7)		
		From	To		VDws Max. (µm)	tDws Max. (µm)	Ra Max. (µm)	VDwL/A Max. (µm)	IG, ST (µm)			
G3	-	-	12,7	± 5,32	0,08	0,08	0,010	0,13 (L)	0,5	from -5 to -0,5	0	from +0,5 to +5
G5	I	-	12,7	± 5,63	0,13	0,13	0,014	0,25 (L)	1	from -5 to -1	0	from +1 to +5
G10	II	-	25,4	± 9,75	0,25	0,25	0,020	0,50 (L)	1	from -9 to -1	0	from +1 to +9
G16 (1)	II	-	25,4	± 11,4	0,40	0,40	0,025	0,80 (L)	2	from -10 to -2	0	from +2 to +10
G20 (1)	III	-	38,1	± 11,5	0,50	0,50	0,032	1,0 (L)	2	from -10 to -2	0	from +2 to +10
G28 (1)	III	-	50,8	± 13,7	0,70	0,70	0,050	1,4 (L)	2	from -12 to -2	0	from +2 to +12
G40	III	-	100	± 19,0	1,0	1,0	0,060	2,0 (L)	4	from -16 to -4	0	from +4 to +16
G80 (2)	III	-	100	± 14,0	2,0	2,0	0,10	4,0 (A)	4	from -12 to -4	0	from +4 to +12
G100	III	-	150	± 47,5	2,5	2,5	0,10	5,0 (L)	10	from -40 to -10	0	from 10 to +40
G200	IV	-	150	± 72,5	5,0	5,0	0,15	10 (L)	10	from -60 to -10	0	from +10 to +60
G300 (1)	IV	-	25,4	± 70,0	10	10	0,20	20 (A)	20	from -60 to -20	0	from +20 to +60
G300 (3)	IV	25,4	50,8	± 105	15	15	0,20	30 (A)	30	from -90 to -30	0	from +30 to +90
G300	IV	50,8	75	± 140	20	20	0,20	40 (A)	40	from -120 to -40	0	0 from +40 to +120
G500 (4)	V	-	25,4	± 75,0	25	25	-	50 (A)	50	-50	0	+50
G500	V	25,4	50,8	± 112,5	25	25	-	75 (A)	75	-75	0	+75
G500	V	50,8	75	± 150	25	25	-	100 (A)	100	-100	0	+100
G500	V	75	100	± 187,5	32	32	-	125 (A)	125	-125	0	+125
G500	V	100	125	± 225	38	38	-	150 (A)	150	-150	0	+150
G500	V	125	150	± 262,5	44	44	-	175 (A)	175	-175	0	+175
G600 (4)	VI	all	all	± 200	-	-	-	400 (A)	-	-	0	-
G700 (4)	VI	all	all	± 1000	-	-	-	2000 (A)	-	-	0	-

www.rgpballs.com

Notes

(1) In some cases and subject to agreement, half teh gauge interval values may be used for grades G16, G20, G28 and G300.

(2) Not specified in ISO 3290.

(3) Not specified in ISO 3290.

(4) Not specified in ISO 3290.

(5) Values relate to the mean diameter of a ball, Dwm.

(6) See DIN EN ISO 4288. For smaller ball sizes (not covered ib this standard), values are subject to agreement.

(7) Graded in intervals equal to IG.

A.F.B.M.A. INTERNATIONAL STANDARDS

A.F.B.M.A. STANDARDS (U.S.A.)

AFBMA GRADES	Variation of ball diameter /ROUNDNESS		LOT DIAMETER VARIATION		BASIC DIAMETER TOLERANCE		MAXIMUM INCREMENTS		SURFACE ROUGHNESS	
	INCHES	µm	INCHES	µm	INCHES	µm	INCHES	µm	INCHES	µm
3	0.000003	0,0762	0.000005	0,127	± 0.00003	0,762	0.000010	0,254	0.0000005	0,0127
5	0.000005	0,127	0.000010	0,254	± 0.00005	1,27	0.000010	0,254	0.0000008	0,02032
10	0.000010	0,254	0.000020	0,508	± 0.00010	2,54	0.000010	0,254	0.000001	0,0254
15	0.000015	0,381	0.000030	0,762	± 0.00010	2,54	0.000010	0,254	0.000001	0,0254
16	0.000016	0,4064	0.000032	0,8128	± 0.00010	2,54	0.000010	0,254	0.000001	0,0254
24	0.000024	0,6096	0.000048	1,2192	± 0.00010	2,54	0.000010	0,254	0.000002	0,0508
25	0.000025	0,635	0.000050	1,27	± 0.00010	2,54	0.000010	0,254	0.000002	0,0508
48	0.000048	1,2192	0.000096	2,4384	± 0.00020	5,08	0.000050	1,27	0.000003	0,0762
50	0.000050	1,27	0.000100	2,54	± 0.00030	7,62	0.000050	1,27	0.000003	0,0762
100	0.000100	2,54	0.000200	5,08	± 0.00050	12,70	0.000100	2,54	0.000005	0,127
200	0.000200	5,08	0.000400	10,20	± 0.00100	25,40	0.000200	5,08	0.000008	0,2032
300	0.000300	7,62	0.000400	15,24	± 0.00100	25,40	0.000300	7,62	-	-
500	0.000500	12,70	0.001000	25,40	± 0.00200	50,80	0.000500	12,70	-	-
1000	0.001000	25,40	0.002000	50,80	± 0.00500	127,0	0.001000	25,40	-	-
2000	0.002000	50,80	0.004000	101,60	± 0.00500	127,0	0.002000	50,80	-	-
3000	0.003000	76,20	0.006000	152,40	± 0.00500	127,0	0.003000	76,20	-	-

APPROXIMATE EQUIVALENT GRADES BETWEEN ISO 3290, AFBMA, DIN AND OLD "RGP" GRADES

ISO 3290

Grade AAAA	Grade AAA	Grade AA	Grade A	Grade B	Grade C	Ø (mm)
Grade 5	Grade 10	Grade 16	Grade 28	Grade 40	Grade 100	Ø ≤ 3
Grade 10	Grade 16	Grade 28	Grade 40	Grade 100	Grade 100	3 < Ø ≤ 6
Grade 10	Grade 16	Grade 28	Grade 40	Grade 100	Grade 200	6 < Ø ≤ 10
Grade 16	Grade 20	Grade 28	Grade 40	Grade 100	Grade 200	10 < Ø ≤ 20
-	Grade 28	Grade 40	Grade 100	Grade 200	-	20 < Ø ≤ 30
-	Grade 40	Grade 40	Grade 100	Grade 200	-	30 < Ø ≤ 50
-	Grade 40	Grade 100	Grade 100	Grade 200	-	Ø > 50

AFBMA

Grade AAAA	Grade AAA	Grade AA	Grade A	Grade B	Grade C	Ø (mm)
Grade 5	Grade 10	Grade 16	Grade 24	Grade 48	Grade 100	Ø ≤ 3
Grade 10	Grade 16	Grade 24	Grade 48	Grade 100	Grade 100	3 < Ø ≤ 6
Grade 10	Grade 16	Grade 24	Grade 48	Grade 100	Grade 200	6 < Ø ≤ 10
Grade 16	Grade 16	Grade 24	Grade 48	Grade 100	Grade 200	10 < Ø ≤ 20
-	Grade 24	Grade 48	Grade 100	Grade 200	Grade 300	20 < Ø ≤ 30
-	Grade 48	Grade 48	Grade 100	Grade 200	Grade 300	30 < Ø ≤ 50
-	Grade 48	Grade 100	Grade 100	Grade 200	Grade 300	Ø > 50

DIN

Grade AAAA	Grade AAA	Grade AA	Grade A	Grade B	Grade C	Ø (mm)
-	Class I	Class II	Class III	Class IV	-	Ø ≤ 3
-	Class I	Class II	Class III	Class IV	-	3 < Ø ≤ 6
Class I	Class II	Class III	Class IV	-	-	6 < Ø ≤ 10
Class I	Class II	Class III	Class IV	-	-	10 < Ø ≤ 20
Class II	Class II	Class III	Class IV	-	-	20 < Ø ≤ 30
-	-	Class III	Class IV	-	-	30 < Ø ≤ 50
-	-	Class III	Class IV	-	-	Ø > 50

INTERNATIONAL STANDARDS

STEELS

Type	Regulatory body	Designation	Year	Title
Stainless steels	AMS	5524	2014	Steel, Corrosion and Heat-Resistant, Sheet, Strip and Plate 18Cr - 13Ni - 2.5Mo (SAE 30316) Solution Heat Treated
Stainless steels	AMS	5630	2013	Steel, Corrosion-Resistant, Bars, Wire, and Forgings 17Cr - 0.52Mo (0.95 - 1.20C) (440C)
Stainless steels	AMS	5880	2013	Steel, Corrosion-Resistant, Bars, Wire, and Forgings 17Cr 0.52Mo (0.95 1.20C) (SAE 51440C) for Bearing Applications
Stainless steels	AMS	QQ-S-763	2015	Steel, Corrosion Resistant, Bars, Wire, Shapes, and Forgings
Stainless steels	ASTM	A262	2015	Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
Stainless steels	ASTM	A276	2015	Standard Specification for Stainless Steel Bars and Shapes
Stainless steels	ASTM	A493	2009	Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging
Stainless steels	ASTM	A580	2015	Standard Specification for Stainless Steel Wire
Stainless steels	ASTM	A756	2009	Standard Specification for Stainless Anti-Friction Bearing Steel
Nonferrous steels	ASTM	E55	2011	Standard Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition
Bearing steels	ASTM	A295	2014	Standard Specification for High-Carbon Anti-Friction Bearing Steel
Bearing steels	ISO	15243	2004	Rolling bearings — Damage and failures — Terms, characteristics and causes
Bearing steels	ISO	683-17	2014	Heat-treated steels, alloy steels and free-cutting steels — Part 17: Ball and roller bearing steels
Tool steels	ASTM	A681	2008	Standard Specification for Tool Steels Alloy

www.rgpballs.com

OTHER PRODUCTS

Type	Regulatory body	Designation	Year	Title
Balls for bearings	ASTM	F2215	2008	Standard Specification for Balls, Bearings, Ferrous and Nonferrous for Use in Bearings, Valves, and Bearing Applications
Ceramics	ASTM	F2094	2014	Standard Specification for Silicon Nitride Bearing Balls
Grinding/polishing	AMS	2431-5B	2011	Peening Media Hardened Steel Peening Balls
Rollers	DIN	5402-1	2014	Rolling bearings – Parts of rolling bearings – Part 1: Cylindrical rollers
Rollers	DIN	5402-3	2012	Rolling bearings – Parts of rolling bearings – Part 3: Needle rollers
Rollers	ISO	3096	1996	Rolling bearings - Needle rollers - Dimensions and tolerances
Rollers	ISO	12297	2012	Rolling bearings. Steel cylindrical rollers. Dimensions and tolerances

GRADES AND TOLERANCES

Type	Regulatory body	Designation	Year	Title
Precision grade	ISO	3290-1	2014	Rolling bearings - Balls - Part 1: Steel balls
Precision grade	ISO	3290-2	2014	Rolling bearings - Balls - Part 2: Ceramic balls
Precision grade	DIN	5401	2002	Rolling bearings - Balls for rolling bearings and general industrial use
Precision grade	ANSI-AFBMA	Std. 10	1989	Metal balls
Cylindricity	ISO	12180-2	2011	Geometrical product specifications (GPS) - Cylindricity - Part 2: Specification operators
Roundness	ISO	12181-2	2011	Geometrical product specifications (GPS) - Roundness - Part 2: Specification operators
Roughness	ISO	1302	2002	Geometrical Product Specifications (GPS) — Indication of surface texture in technical product documentation
Rubber tolerances	ISO	3302-1	2014	Rubber - Tolerances for products - Part 1: Dimensional tolerances

www.rgpballs.com

OTHER STANDARDS

Type	Regulatory body	Designation	Year	Title
Hardness	ISO	6507-1	2005	Metallic materials - Vickers hardness test - Part 1: Test method
Hardness	ISO	6508-1	2015	Metallic materials - Rockwell hardness test - Part 1: Test method
Microstructure	ASTM	E112	2013	Standard Test Methods for Determining Average Grain Size
Passivation	ASTM	A380	2013	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
Passivation	ASTM	A967	2013	Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts
Passivation	ASTM	G 82	1998	Standard Guide for Development and Use of a Galvanic Series for Predicting Galvanic Corrosion Performance

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 0,200 MM TO 4,7625 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
0,200000	-	0,007874	0,000003	30.606.720	1.000.000
0,300000	-	0,011811	0,000011	9.068.658	1.000.000
0,396875	1/64	0,015625	0,000026	3.916.928	1.000.000
0,500000	-	0,019685	0,000051	1.958.830	1.000.000
0,793750	1/32	0,031250	0,00021	489.616	600.000
1,000000	-	0,039370	0,00041	244.854	600.000
1,190625	3/64	0,046875	0,00073	145.071	600.000
1,500000	-	0,059055	0,00138	72.549	600.000
1,587500	1/16	0,062500	0,00164	61.202	600.000
2,000000	-	0,078740	0,00326	30.607	300.000

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
2,381250	3/32	0,093750	0,00560	18.134	200.000
2,500000	-	0,098425	0,00638	15.671	150.000
2,778125	7/64	0,109375	0,00825	11.420	120.000
3,000000	-	0,118110	0,01103	9.069	90.000
3,175000	1/8	0,125000	0,01301	7.650	80.000
3,500000	-	0,137795	0,01762	5.711	60.000
3,968750	5/32	0,156525	0,02553	3.917	40.000
4,000000	-	0,157480	0,02630	3.826	40.000
4,500000	-	0,177165	0,03745	2.687	30.000
4,762500	3/16	0,187500	0,04412	2.267	25.000

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 5,000 MM TO 11,509375 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
5,000000	-	0,196850	0,05138	1.959	20.000
5,500000	-	0,216535	0,06838	1.472	15.000
5,556250	7/32	0,218750	0,07028	1.427	15.000
6,000000	-	0,236220	0,08878	1.134	11.000
6,350000	1/4	0,250000	0,1021	956	10.000
6,500000	-	0,255906	0,1129	892	8.000
7,000000	-	0,275591	0,1409	714	7.000
7,143750	9/32	0,281250	0,1498	672	7.000
7,500000	-	0,295276	0,1734	580	6.000
7,937500	5/16	0,312500	0,2056	490	5.000
MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
8,000000	-	0,314961	0,2104	478	5.000
8,500000	-	0,334646	0,2524	399	4.000
8,731250	11/32	0,343750	0,2658	368	3.500
9,000000	-	0,354331	0,2996	336	3.500
9,525000	3/8	0,375000	0,3554	283	3.000
10,000000	-	0,393701	0,4110	245	2.500
10,318750	13/32	0,406250	0,4434	223	2.500
11,000000	-	0,433071	0,5471	184	1.800
11,112500	7/16	0,437500	0,5641	178	1.800
11,509375	29/64	0,453125	0,6227	161	1.500

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 11,90625 MM TO 20,000 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
11,906250	15/32	0,468750	0,6931	145	1.500
12,000000	-	0,472441	0,7102	142	1.250
12,303125	31/64	0,484375	0,7606	131	1.250
12,700000	1/2	0,500000	0,8420	120	1.250
13,000000	-	0,511811	0,9030	111	1.000
13,493750	17/32	0,531250	1,010	99,7	1.000
14,000000	-	0,551181	1,128	89,2	900
14,287500	9/16	0,562500	1,202	84,0	800
15,000000	-	0,590551	1,387	72,5	700
15,081250	19/32	0,593750	1,413	71,4	700
MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
15,875000	5/8	0,625000	1,649	61,2	600
16,000000	-	0,629921	1,684	59,8	600
16,668750	21/32	0,656250	1,906	52,9	500
17,000000	-	0,669291	2,019	49,8	500
17,462500	11/16	0,687500	2,187	46,0	450
18,000000	-	0,708661	2,397	42,0	400
18,256250	23/32	0,718750	2,501	40,2	400
19,050000	3/4	0,750000	2,842	35,4	400
19,843750	25/32	0,781250	3,239	31,3	300
20,000000	-	0,787402	3,288	30,6	300

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 20,6375 MM TO 32,000 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
20,637500	13/16	0,812500	3,618	27,9	300
21,000000	-	0,826772	3,808	26,4	250
21,431250	27/32	0,843750	4,065	24,9	250
22,000000	-	0,866142	4,377	23,0	200
22,225000	7/8	0,875000	4,512	22,3	200
23,000000	-	0,905512	5,001	20,1	200
23,018750	29/32	0,906250	5,015	20,1	200
23,812500	15/16	0,937500	5,550	18,1	150
24,000000	-	0,944882	5,682	17,7	150
24,606250	31/32	0,968750	6,121	16,4	150
MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
25,000000	-	0,984252	6,422	15,7	150
25,400000	1	1,000000	6,736	14,9	150
26,000000	-	1,023622	7,224	13,9	120
26,987500	1.1/16	1,062500	8,080	12,5	120
28,000000	-	1,102362	9,023	11,2	100
28.575000	1.1/8	1,125000	9,551	10,5	100
30,000000	-	1,181102	11,10	9,1	80
30,162500	1.3/16	1,187500	11,28	8,9	80
31,750000	1.1/4	1,250000	13,19	7,7	80
32,000000	-	1,259843	13,47	7,5	70

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 33,3375 MM TO 52,3875 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
33,337500	1.5/16	1,312500	15,21	6,6	70
34,000000	-	1,338583	16,16	6,2	60
34,925000	1.3/8	1,375000	17,51	5,8	50
35,000000	-	1,377953	17,62	5,7	50
36,000000	-	1,417323	19,18	5,3	50
36,512500	1.7/16	1,437500	20,01	5,0	50
38,000000	-	1,496063	22,55	4,5	50
38,100000	1.1/2	1,500000	22,73	4,4	40
39,687500	1.9/16	1,562500	25,72	3,9	40
40,000000	-	1,574803	26,31	3,8	40
MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
41,275000	1.5/8	1,625000	28,96	3,5	40
42,862500	1.11/16	1,687500	32,45	3,1	25
44,450000	1.3/4	1,750000	36,10	2,8	25
45,000000	-	1,771654	37,45	2,7	25
46,037500	1.13/16	1,812500	40,27	2,5	25
47,625000	1.7/8	1,875000	44,61	2,3	20
49,212500	1.15/16	1,937500	48,98	2,1	20
50,000000	-	1,968504	51,38	2,0	20
50,800000	2	2,000000	53,88	1,9	20
52,387500	2.1/16	2,062500	58,72	1,7	15

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 53,975 MM TO 92,075 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
53,975000	2.1/8	2,125000	64,63	1,6	15
55,000000	-	2,165354	68,38	1,5	15
57,150000	2.1/4	2,250000	76,92	1,3	10
60,000000	-	2,362205	88,78	1,1	10
60,325000	2.3/8	2,375000	89,42	1,1	10
63,500000	2.1/2	2,500000	105,2	0,96	10
66,675000	2.5/8	2,625000	122,0	0,83	5
69,850000	2.3/4	2,750000	140,4	0,72	5
70,000000	-	2,755906	141,0	0,71	5
73,025000	2.7/8	2,875000	160,6	0,63	5
MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
75,000000	-	2,952756	173,4	0,58	5
76,200000	3	3,000000	181,9	0,55	4
79,375000	3.1/8	3,125000	205,7	0,49	4
80,000000	-	3,149606	210,4	0,48	4
82,550000	3.1/4	3,250000	231,6	0,44	4
85,000000	-	3,346457	252,4	0,40	4
85,725000	3.3/8	3,375000	258,7	0,39	4
88,900000	3.1/2	3,500000	288,8	0,35	1
90,000000	-	3,543307	299,6	0,34	1
92,075000	3.5/8	3,625000	311,1	0,31	1

DIAMETERS AND PACKAGING FOR AISI 52100 BALLS FROM 95,000 MM TO 300,000 MM

MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
95,000000	-	3,740157	352,4	0,29	1
95,250000	3.3/4	3,750000	355,8	0,28	1
98,425000	3.7/8	3,875000	392,5	0,26	1
100,000000	-	3,937001	411,0	0,24	1
101,600000	4	4,000000	431,1	0,23	1
107,950000	4.1/4	4,250000	517,1	0,19	1
110,000000	-	4,330709	547,1	0,18	1
114,300000	4.1/2	4,500000	613,9	0,16	1
120,000000	-	4,724409	710,3	0,14	1
120,650000	4.3/4	4,750000	717,3	0,14	1
MM	INCHES	DECIMAL INCHES	WEIGHT 100 BALLS (KG)	N° OF BALLS PER KG	N° OF BALLS PER BOX
127,000000	5	5,000000	841,9	0,12	1
133,350000	5.1/4	5,250000	974,6	0,10	1
139,700000	5.1/2	5,500000	1121	0,090	1
146,050000	5.3/4	5,750000	1281	0,079	1
150,000000	-	5,905512	1390	0,073	1
152,400000	6	6,000000	1455	0,069	1
177,800000	7	7,000000	2296	0,044	1
200,000000	-	7,874016	3290	0,031	1
250,000000	-	9,842520	6420	0,016	1
300,000000	-	11,811024	11027	0,009	1

NUMBER OF BALLS PER LITRE FROM 0,798 MM TO 12,700 MM

MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)	MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)
0,797350	1/32	0,031250	2.444.163	2,800000	-	0,110236	55.681
1,000000	-	0,039370	1.222.310	3,000000	-	0,118110	45.271
1,190625	3/64	0,046875	724.196	3,175000	1/8	0,125000	38.190
1,500000	-	0,059055	362.166	3,500000	-	0,137795	28.509
1,587500	1/16	0,062500	305.520	3,968750	5/32	0,156250	19,553
1,984375	5/64	0,078125	156.426	4,000000	-	0,157480	19,099
2,000000	-	0,078740	152.789	4,500000	-	0,177165	13,414
2,381250	3/32	0,093750	90.525	4,762500	3/16	0,187500	11.316
2,500000	-	0,098425	78.228	5,000000	-	0,196850	9.778
2,778125	7/64	0,109375	57.007	5,500000	-	0,216535	7.347
MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)	MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)
5,556250	7/32	0,218750	7.126	8,731250	11/32	0,343750	1.836
6,000000	-	0,236220	5.659	9,000000	-	0,354331	1.677
6,350000	1/4	0,250000	4.774	9,525000	3/8	0,375000	1.414
6,500000	-	0,255906	4.451	10,000000	-	0,393701	1.222
7,000000	-	0,275591	3.564	10,318750	13/32	0,406250	1.113
7,143750	9/32	0,281250	3.353	11,000000	-	0,433071	918
7,500000	-	0,295276	2.897	11,112500	7/16	0,437500	891
7,937500	5/16	0,312500	2.444	11,906250	15/32	0,468750	724
8,000000	-	0,314961	2.387	12,000000	-	0,472441	707
8,500000	-	0,334646	1.990	12,700000	1/2	0,500000	597

NUMBER OF BALLS PER LITRE FROM 13,000 MM TO 35,000 MM

MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)	MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)
13,000000	-	0,511811	556	17,462500	11/16	0,687500	230
13,493750	17/32	0,531250	497	18,000000	-	0,708661	210
14,000000	-	0,551181	445	18,256250	23/32	0,718750	201
14,287500	9/16	0,562500	419	19,050000	3/4	0,750000	177
15,000000	-	0,590551	362	19,843750	25/32	0,781250	156
15,081250	19/32	0,593750	356	20,000000	-	0,787402	153
15,875000	5/8	0,625000	306	20,637500	13/16	0,812500	139
16,000000	-	0,629921	298	21,000000	-	0,826772	132
16,668750	21/32	0,656250	264	21,431250	27/32	0,843750	124
17,000000	-	0,669291	249	22,000000	-	0,866142	115

MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)	MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)
22,225000	7/8	0,875000	111	28,000000	-	1,102362	56
23,000000	-	0,905512	100	28,575000	1.1/8	1,125000	52
23,018750	29/32	0,906250	100	30,000000	-	1,181102	45
23,812500	15/16	0,937500	91	30,162500	1.3/16	1,187500	45
24,000000	-	0,944882	88	31,750000	1.1/4	1,250000	38
24,606250	31/32	0,968750	82	32,000000	-	1,259843	37
25,000000	-	0,984252	78	33,337500	1.5/16	1,312500	33
25,400000	1	1,000000	75	34,000000	-	1,338583	31
26,000000	-	1,023622	70	34,925000	1.3/8	1,375000	29
26,987500	1.1/16	1,062500	62	35,000000	-	1,377953	29

NUMBER OF BALLS PER LITRE FROM 36,000 MM TO 100,000 MM

MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)	MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)
36,000000	-	1,417323	26	46,037500	1.13/16	1,812500	13
36,512500	1.7/16	1,437500	25	47,625000	1.7/8	1,875000	11
38,000000	-	1,496063	22	49,212500	1.15/16	1,937500	10
38,100000	1.1/2	1,500000	22	50,000000	-	1,968504	10
39,687500	1.9/16	1,562500	20	50,800000	2	2,000000	9,3
40,000000	-	1,574803	19	52,387500	2.1/16	2,062500	8,5
41,275000	1.5/8	1,625000	17	53,975000	2.1/8	2,125000	7,8
42,862500	1.11/16	1,687500	16	55,000000	-	2,165354	7,3
44,450000	1.3/4	1,750000	14	57,150000	2.1/4	2,250000	6,5
45,000000	-	1,771654	13	60,000000	-	2,362205	5,7

MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)	MM	INCHES	DECIMAL INCHES	BALLS PER LITRE (PCS)
60,325000	2.3/8	2,375000	5,6	82,550000	3.1/4	3,250000	2,2
63,500000	2.1/2	2,500000	4,8	85,000000	-	3,346457	2,0
66,675000	2.5/8	2,625000	4,1	85,725000	3.3/8	3,375000	1,9
69,850000	2.3/4	2,750000	3,6	88,900000	3.1/2	3,500000	1,7
70,000000	-	2,755906	3,6	90,000000	-	3,543307	1,7
73,025000	2.7/8	2,875000	3,1	92,075000	3.5/8	3,625000	1,6
75,000000	-	2,952756	2,9	95,000000	-	3,740157	1,4
76,200000	3	3,000000	2,8	95,250000	3.3/4	3,750000	1,4
79,375000	3.1/8	3,125000	2,4	98,425000	3.7/8	3,875000	1,3
80,000000	-	3,149606	2,4	100,000000	-	3,937001	1,2

TABLE CONVERSION OF SIXTY-FOURTH INCHES TO MM

Inches "	Decimal inches	Millimeters mm	Inches "	Decimal inches	Millimeters mm
1/64	0,015625	0,397	33/64	0,515625	13,097
3/64	0,046875	1,191	35/64	0,546875	13,891
5/64	0,078125	1,984	37/64	0,578125	14,684
7/64	0,109375	2,778	39/64	0,609375	15,478
9/64	0,140625	3,572	41/64	0,640625	16,272
11/64	0,171875	4,366	43/64	0,671875	17,066
13/64	0,203125	5,159	45/64	0,703125	17,859
15/64	0,234375	5,953	47/64	0,734375	18,653
17/64	0,265625	6,747	49/64	0,765625	19,447
19/64	0,296875	7,541	51/64	0,796875	20,241
21/64	0,328125	8,334	53/64	0,828125	21,034
23/64	0,359375	9,128	55/64	0,859375	21,828
25/64	0,390625	9,922	57/64	0,890625	22,622
27/64	0,421875	10,716	59/64	0,921875	23,416
29/64	0,453125	11,509	61/64	0,953125	24,209
31/64	0,484375	12,303	63/64	0,984375	25,003

WEIGHT 100 BALLS/QUANTITY PER KG SIXTY-FOURTH INCHES

Inches "	Weight 100 ball AISI 52100 kg	Quantity per kg (AISI 52100)	Inches "	Weight 100 ball AISI 52100 kg	Quantity per kg (AISI 52100)
1/64	0,000026	3.916.928	33/64	0,9175	109
3/64	0,00073	145.071	35/64	1,095	91
5/64	0,00319	31.335	37/64	1,293	77
7/64	0,00825	11.420	39/64	1,514	66
9/64	0,01861	5.373	41/64	1,760	57
11/64	0,03398	2.943	43/64	2,030	49
13/64	0,05609	1.783	45/64	2,326	43
15/64	0,08616	1.161	47/64	2,651	38
17/64	0,1254	797	49/64	3,004	33
19/64	0,1751	571	51/64	3,387	30
21/64	0,2364	423	53/64	3,801	26
23/64	0,3106	322	55/64	4,248	24
25/64	0,3989	251	57/64	4,728	21
27/64	0,5025	199	59/64	5,243	19
29/64	0,6227	161	61/64	5,795	17
31/64	0,7606	131	63/64	6,384	16