Samarium Cobalt Magnets

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Introduction

Samarium cobalt (SmCo) magnets are the first commercially viable rare earth permanent magnet material since 1960s and considered to still be the premium

material for many high performance applications today. SmCo magnets have particularly high coercivities with simultaneous high saturation polarization and excellent temperature stability. Additionally, the corrosion resistance of SmCo magnets are significantly high, usually no coating necessary.

SmCo magnets can be divided to two categories sintered SmCo and bonded SmCo by processing technology. There are two generations of sintered SmCo magnets, the first is 1:5 SmCo ($SmCo_5$) and the second is 2:17 SmCo (Sm_2Co_{17}). Ductibility of $SmCo_5$ magnets is excellent. It is easy to be machined into disc, ring and complex shapes. Sm_2Co_{17} have a low temperature coefficient. The change of flux density can be lower than 2% per 100 °C.

SmCo magnets are widely used in servo motors, automotive applications (e.g. sensors...), high end sport cars, aviation. Sintered Samarium Cobalt magnets are still playing irreplaceable roles in high temperature applications which are not possible for sintered Neodymium magnet.

Samarium Cobalt (SmCo) Magnets

Features of samarium cobalt magnets

1. Typical magnetic properties of samarium cobalt magnets

There are differences in magnetic properties among different manufacturers. Following data are only for reference when designing and selecting materials, not as product acceptance standards.

	Grade	Residual magnetic flux density B_r		Intrinsic coercive force H_{cJ}		Coercive force H_{cB}		Maximum energy product $(BH)_{max}$		Work Temperature T_w	Average Temperature Coefficients of B_r
		T	kGs	kA/m	kOe	kA/m	kOe	kJ/m³	MGOe	℃	%/℃
Sm₂Co₁₇	YXG24H	0.95-1.02	9.5-10.2	692-764	8.7-9.6	≥1990	≥25.0	175-191	22-24	350	-0.025
	YXG26H	1.02-1.05	10.2-10.5	748-796	9.4-10.0	≥1990	≥25.0	191-207	24-26	350	-0.030
	YXG28H	1.03-1.08	10.3-10.8	756-812	9.5-10.2	≥1990	≥25.0	207-223	26-28	350	-0.035
	YXG30H	1.08-1.10	10.8-11.0	788-835	9.9-10.5	≥1990	≥25.0	223-239	28-30	350	-0.035
	YXG32H	1.10-1.13	11.0-11.3	812-860	10.2-10.8	≥1990	≥25.0	231-255	29-32	350	-0.035
	YXG33H	1.12-1.16	11.2-11.6	845-890	10.6-11.2	≥1990	≥25.0	239-263	30-33	350	-0.035
	YXG22	0.93-0.97	9.3-9.7	676-740	8.5-9.3	≥1433	≥18	160-183	20-23	300	-0.020
	YXG24	0.95-1.02	9.5-10.2	692-764	8.7-9.6	≥1433	≥18	175-191	22-24	300	-0.025
	YXG26	1.02-1.05	10.2-10.5	748-796	9.4-10.0	≥1433	≥18	191-207	24-26	300	-0.030
	YXG28	1.03-1.08	10.3-10.8	756-812	9.5-10.2	≥1433	≥18	207-223	26-28	300	-0.035
	YXG30	1.08-1.10	10.8-11.0	788-835	9.9-10.5	≥1433	≥18	223-239	28-30	300	-0.035
	YXG32	1.10-1.13	11.0-11.3	812-860	10.2-10.8	≥1433	≥18	231-255	29-32	300	-0.035
	YXG33	1.12-1.16	11.2-11.6	845-890	10.6-11.2	≥1433	≥18	239-263	30-33	300	-0.035
	YXG35	1.16-1.20	11.6-12.0	868-908	10.9-11.4	≥1433	≥18	255-278	32-35	300	-0.035
	YXG26M	1.02-1.05	10.2-10.5	676-780	8.5-9.8	955-1433	12-18	191-207	24-26	300	-0.035
	YXG28M	1.03-1.08	10.3-10.8	676-796	8.5-10.0	955-1433	12-18	207-220	26-28	300	-0.035

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YXG30M	1.08-1.10	10.8-11.0	676-835	8.5-10.5	955-1433	12-18	220-240	28-30	300	-0.035
YXG32M	1.10-1.13	11.0-11.3	676-852	8.5-10.7	955-1433	12-18	230-255	29-32	300	-0.035
YXG24L	0.95-1.02	9.5-10.2	541-716	6.8-9.0	636-955	8/12	175-191	22-24	250	-0.025
YXG26L	1.02-1.05	10.2-10.5	541-748	6.8-9.4	636-955	8/12	191-207	24-26	250	-0.035
YXG28L	1.03-1.08	10.3-10.8	541-764	6.8-9.6	636-955	8/12	207-220	26-28	250	-0.035
YXG30L	1.08-1.15	10.8-11.5	541-796	6.8-10.0	636-955	8/12	220-240	28-30	250	-0.035
YXG32L	1.10-1.15	11.0-11.5	541-812	6.8-10.2	636-955	8/12	230-255	29-32	250	-0.035
LTC18	0.84-0.89	8.4-8.9	629-668	7.9-8.4	≥1433	≥18	135-151	17-19	300	-0.001
LTC20	0.89-0.94	8.9-9.4	660-708	8.3-8.9	≥1433	≥18	151-167	19-21	300	-0.007
LTC22	0.94-0.98	9.4-9.8	692-740	8.7-9.3	≥1433	≥18	167-183	21-23	300	-0.010
HT400 (24)	0.99-1.04	9.9-10.4	740-788	9.3-9.9	≥1830	≥23	183-199	23-25	400	-0.035
HT400 (22)	0.94-0.99	9.4-9.9	700-748	8.8-9.4	≥1830	≥23	167-183	21-23	450	-0.035
HT400 (20)	0.89-0.94	8.9-9.4	660-708	8.3-8.9	≥1830	≥23	151-167	19-21	500	-0.035
YX16	0.81-0.85	8.1-8.5	620-660	7.8-8.3	1194-1830	15-23	110-127	14-16	250	-0.050
YX18	0.85-0.90	8.5-9.0	660-700	8.3-8.8	1194-1830	15-23	127-143	16-18	250	-0.050
YX20	0.90-0.94	9.0-9.4	676-725	8.5-9.1	1194-1830	15-23	150-167	19-21	250	-0.050
YX22	0.92-0.96	9.2-9.6	710-748	8.9-9.4	1194-1830	15-23	160-175	20-22	250	-0.050
YX24	0.96-1.00	9.6-10.0	730-770	9.2-9.7	1194-1830	15-23	175-190	22-24	250	-0.050
YX16s	0.79-0.84	7.9-8.4	620-660	7.8-8.3	≥1830	≥23	118-135	15-17	250	-0.035
YX18s	0.84-0.89	8.4-8.9	660-700	8.3-8.8	≥1830	≥23	135-151	17-19	250	-0.040
YX20s	0.89-0.93	8.9-9.3	684-732	8.6-9.2	≥1830	≥23	150-167	19-21	250	-0.045
YX22s	0.92-0.96	9.2-9.6	710-756	8.9-9.5	≥1830	≥23	167-183	21-23	250	-0.045
YX24s	0.96-1.00	9.6-10.0	740-788	9.3-9.9	≥1830	≥23	183-199	23-25	250	-0.045
LTC (YX10)	0.62-0.66	6.2-6.6	485-517	6.1-6.5	≥1830	≥23	75-88	9.5-11	300	20-100℃ +0.0125 100-200℃ +0.0087 200-300℃ +0.0007

SmCo₅

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Grade		Residual magnetic flux density B$_r$		Intrinsic coercive force H$_{cJ}$		Coercive force H$_{cB}$		Maximum energy product (BH)$_{max}$		Average Temperature Coefficients of B$_r$
		T	kGs	kA/m	kOe	%/°C	kOe	kJ/m^3	MGOe	%/°C
Bonded SmCo	SCZ-4T	380-420	3.8-4.2	200-280	2.5-3.5	640-1030	8.0-13.0	28-36	3.5-4.5	-0.030
	SCZ-5T	410-540	4.1-5.4	265-360	3.3-4.5	640-1200	8.0-15.0	36-44	4.5-5.5	-0.030
	SCZ-9	610-660	6.1-6.6	415-480	5.2-6.0	640-1200	8.0-15.0	68-75	8.5-9.5	-0.030
	SCZ-11	640-720	6.4-7.3	430-510	5.4-6.4	640-1200	8.0-15.0	76-88	9.5-11.0	-0.030

The above-mentioned data of magnetic properties and physical properties are given at room temperature (20°C).

The max working temperature of magnet is changeable due to length-diameter ratio, coating thickness and other environment factors.

Additional grades are available. Please contact us for information.

2. Other characteristic physical properties

Following data are only for reference when designing and selecting materials, not as product acceptance standards.

Item		Unit	SmCo$_5$	Sm$_2$Co$_{17}$
Recoil Permeability µ$_{rac}$	µ$_{rec}$	—	1.00-1.05	1.00~1.10
Curie Temperture T$_c$	T$_c$	°C	1000	1100
Density	D	g/cm^3	8.3	8.4
Vickers Hardness(HV)	Hv	MPa	450~500	550~600
Compressive Strength	δ$_c$	MPa	1000	800
Bending Strength	δ$_b$	MPa	150-180	130-150
Tensile Strength	δ$_t$	MPa	40	35
Electrical Resistivity	ρ	Ω·m	5~6x10^{-5}	8~9x10^{-5}
Coefficient of Thermal Expansion	α	10^{-6}/°C	C⊥: 12 C∥: 6	C⊥: 11 C∥: 6

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Precautions regarding safety and use

1. When a magnet is magnetized, strong attractive force or repulsive force arises between the magnet and other magnetic materials (magnet, yoke, rotor, stator, jig fixture, tool, etc.). A user's hand or finger may be sandwiched between the magnet and other magnetic materials during the handling or the assembling. Also, you may be injured by loss of balance of the body due to the attractive or repulsive force. Use appropriate jigs and take special care in handling the magnetized magnet. A magnetized magnet should be covered with a non-magnetic material such as wood or thick plastics and labeled as magnetized.
2. Sharp edge of a magnet may injure your finger. Protect fingers when needed.
3. When a magnet is magnetized in the winding coil, the magnet may fly out from the inside of the winding coil unexpectedly. It can be the cause of injury. Use a proper jig fixture and keep a magnet inside of the winding coil for safety.
4. When magnetized magnets are stacked, it is difficult to peel off, and chipping or a crack may occur. It is recommended to use spacers between the magnets. The stacked magnetized magnets are similar to one big magnet.
5. When a magnetized magnet is placed near the direct or alternating magnetic field, the demagnetization may occur.
6. A mechanical impact may be a cause of a fracture, a crack and a chipping of a magnet. Take special care during the handling of a magnetized magnet. Such a crack or a chipping may deteriorate the magnetic characteristic, the mechanical strength or the corrosion resistance. A broken piece of magnet may hurt your eyes or body.
7. Store magnets in the place without a mechanical impact. Keep the packaging materials of magnets to be dry. Keep the temperature above the dew point to prevent rust during the storage. Avoid water (rain, water used in the factory, etc.) to be splashed on the packaging material.

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