

# Technical Data Sheet - Samarium Cobalt Magnets, SmCo Magnets



## Samarium Cobalt Magnets, SmCo Magnets

Samarium Cobalt magnets (SmCo) is the sister Rare Earth Magnet to NdFeB. SmCo is sometimes called a Rare Earth Cobalt magnet. SmCo magnets exist in two alloy varieties. Sm<sub>1</sub>Co<sub>5</sub> (SmCo1:5) is the original SmCo alloy. Sm<sub>2</sub>Co<sub>17</sub> (SmCo2:17) is the more common used and stronger SmCo alloy with SmCo26 being the most popular variety. Sm<sub>1</sub>Co<sub>5</sub> contains mainly Sm and Co and contains no iron (Fe) so it has excellent corrosion resistance. Sm<sub>2</sub>Co<sub>17</sub> is mainly Sm and Co but also contains Cu, Hf &/or Zr, sometimes Pr, and Fe. The low free iron content in Sm<sub>2</sub>Co<sub>17</sub> means it is technically prone to a little surface corrosion when in water. Sm<sub>2</sub>Co<sub>17</sub> is regarded as having good to very good corrosion resistance (far superior to NdFeB) in most applications. A simple coating of NiCuNi will very likely solve any concern of corrosion risk. Samarium Cobalt magnets (SmCo) may be weaker than NdFeB magnets at room temperature but SmCo will often outperform NdFeB above +150 to +180 deg C (subject to the application and grade). SmCo magnets are ideal for aerospace, automotive, sensor, loudspeaker, motor and military applications. In mission critical applications they are an ideal first choice. SmCo magnets offer minimal change in magnetic output over a small temperature change (with far less variation than NdFeB or ferrite; only Alnico is better). The Low Temperature Coefficient (LTC) versions have less variation in magnetic output with temperature change (due to added Gd and Er). SmCo magnets performance over a massive range of temperatures (from near -273 deg C up to +350 deg C). The H versions Sm<sub>2</sub>Co<sub>17</sub> have higher Hci and operate up to +350°C rather than +300°C. For note, SmCo30 should perform very similarly to N30 at ambient temperature.

### Sm<sub>1</sub>Co<sub>5</sub> (1:5 alloy) Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m <sup>3</sup>	MGOe
SmCo16 (1:5)	0.81-0.85	8.1-8.5	620-660	7.8-8.3	1194-1830	15-23	110-127	14-16
SmCo18 (1:5)	0.85-0.90	8.5-9.0	660-700	8.3-8.8	1194-1830	15-23	127-143	16-18
SmCo20 (1:5)	0.90-0.94	9.0-9.4	680-725	8.5-9.1	1194-1830	15-23	150-167	19-21
SmCo22 (1:5)	0.92-0.96	9.2-9.6	710-750	8.9-9.4	1194-1830	15-23	160-175	20-22
SmCo24 (1:5)	0.96-1.00	9.6-10.0	730-770	9.2-9.7	1194-1830	15-23	175-190	22-24
SmCo18S (1:5)	0.85-0.90	8.5-9.0	660-700	8.3-8.8	1433-2000	18-25	135-151	17-19
SmCo20S (1:5)	0.90-0.94	9.0-9.4	680-725	8.5-9.1	1433-2000	18-25	143-160	18-20
SmCo22S (1:5)	0.92-0.96	9.2-9.6	710-750	8.9-9.4	1433-2000	18-25	160-175	20-22

### Low Temperature Coefficient Sm<sub>1</sub>Co<sub>5</sub> (1:5 alloy) Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m <sup>3</sup>	MGOe
SmCo10LTC (1:5)	0.59-0.63	5.9-6.3	460-493	5.8-6.2	1430-1830	18-23	68-80	8.5-10

Rev.Temp.Coef. of Induction (Br), α, %/°C :-

(+20 to +100°C) = -0.004, (+100 to +200°C) = -0.021, (+200 to +300°C) = -0.041.

### Sm<sub>2</sub>Co<sub>17</sub> (2:17 alloy) Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m <sup>3</sup>	MGOe
SmCo24L	0.95-1.02	9.5-10.2	557-716	7.0-9.0	636-955	8-12	175-191	22-24
SmCo26L	1.02-1.05	10.2-10.5	557-748	7.0-9.4	636-955	8-12	191-207	24-26
SmCo28L	1.03-1.08	10.3-10.8	557-765	7.0-9.9	636-955	8-12	207-220	26-28
SmCo30L	1.08-1.15	10.8-11.5	557-795	7.0-10.0	636-955	8-12	220-240	28-30
SmCo32L	1.10-1.15	11.0-11.5	557-810	7.0-10.2	636-955	8-12	230-255	29-32
SmCo26M	1.02-1.05	10.2-10.5	716-780	9.0-9.8	955-1273	12-16	191-207	24-26
SmCo28M	1.03-1.08	10.3-10.8	716-796	9.0-10.0	955-1273	12-16	207-220	26-28
SmCo30M	1.08-1.10	10.8-11.0	716-835	9.0-10.5	955-1273	12-16	220-240	28-30
SmCo32M	1.10-1.13	11.0-11.3	716-845	9.0-10.6	955-1273	12-16	230-255	29-32
SmCo22	0.93-0.97	9.3-9.7	676-740	8.5-9.3	>1433	>18	160-183	20-23
SmCo24	0.95-1.02	9.5-10.2	700-750	8.7-9.4	>1433	>18	175-191	22-24
SmCo26	1.02-1.05	10.2-10.5	750-780	9.4-9.8	>1434	>19	191-207	24-26
SmCo28	1.03-1.08	10.3-10.8	756-796	9.5-10.0	>1435	>20	207-220	26-28
SmCo30	1.08-1.10	10.8-11.0	788-835	9.9-10.5	>1436	>21	220-240	28-30
SmCo32	1.10-1.13	11.0-11.3	811-845	10.2-10.6	>1194	>15	230-255	29-32
SmCo24H	0.95-1.02	9.5-10.2	700-750	8.7-9.4	>1990	>25	175-191	22-24
SmCo26H	1.02-1.05	10.2-10.5	750-780	9.4-9.8	>1990	>25	191-207	24-26
SmCo28H	1.03-1.08	10.3-10.8	756-796	9.5-10.0	>1990	>25	207-220	26-28
SmCo30H	1.08-1.10	10.8-11.0	788-835	9.9-10.5	>1990	>25	220-240	28-30

### Low Temperature Coefficient Sm<sub>2</sub>Co<sub>17</sub> (2:17 alloy) Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m <sup>3</sup>	MGOe
SmCo22LTC	0.94-0.98	9.4-9.8	668-715	8.4-9.0	1194-1591	15-20	161-183	21-23

Rev.Temp.Coef. of Induction (Br), α, %/°C :-

(-50 to +20°C) = +0.005, (+20 to +100°C) = +0.012, (+100 to +200°C) = +0.006, (+200 to +300°C) = -0.025.

### Bonded Samarium Cobalt Magnets

These magnets are specially made to customer specified dimensions. There may be a tooling fee and also a magnetising coil fee (depends on magnetic pattern required). They are usually most cost efficient when ordered in high quantities (e.g. thousands). The binder limits the maximum operating temperature to +120°C as heat affects this first.

### Bonded Sm<sub>1</sub>Co<sub>5</sub> (1:5 alloy) Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m <sup>3</sup>	MGOe
SmCoB6	0.4	4.0	280	3.5	800	10	30-50	3.8-6.3
SmCoB10	0.5	5.0	320	4.0	800	10	50-65	6.3-8.2

### Bonded Sm<sub>2</sub>Co<sub>17</sub> (2:17 alloy) Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m <sup>3</sup>	MGOe
SmCoB10	0.6	6.0	360	4.5	800	10	65-80	8.2-10.0
SmCoB12	0.7	7.0	400	5.0	800	10	80-95	10.0-12.0

### Plastic Bonded SmCo Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m <sup>3</sup>	MGOe
SmCoP3	0.3-0.4	3.0-4.0	199-279	2.5-3.5	716-1194	9.0-15.0	20-28	2.5-3.5
SmCoP5	0.35-0.55	3.5-5.5	247-358	3.1-4.5	716-1194	9.0-15.0	32-52	4.0-6.5
SmCoP8	0.55-0.68	5.5-6.8	334-462	4.2-5.8	716-1194	9.0-15.0	48-64	6.0-8.0

### Additional Notes

SmCo magnets will outperform NdFeB magnets at temperatures above +150 to +180 degrees C. SmCo magnets can be used at cryogenic temperatures (i.e. towards absolute zero, -273 degrees C). The magnet shape, its environment, and the actual application affect how the NdFeB magnet will perform. Temperature is important as well as damp or wet conditions. When determining suitability, you should analyse the Intrinsic curve not the Normal curve. By keeping the intrinsic working point above the 'knee' and ideally at the BHmax working point maximum performance is possible. If you have any more questions, require technical assistance and would like a quotation, simply contact us. Although we have made every attempt to provide accurate information, we do reserve the right to change any of the information in this document without notice. We cannot accept any responsibility or liability for any errors or problems caused by using any of the information provided.

### Max Working Temperature (Please note - your application will affect the performance available)

Material	Maximum recommended
Sm1Co5 (1:5)	+250 degrees C
Sm2Co17 (2:17)	+250 (L) / +300 / +350 (H) degrees C
Bonded Sm1Co5 (1:5)	+120 degrees C (binder fails)
Bonded Sm2Co17 (2:17)	+120 degrees C (binder fails)
Plastic bonded SmCo	+120 degrees C (binder fails)

### Temperature coefficients (values given for 20-100 deg C)

Rev.Temp.Coef. of Induction (Br), α, %/°C	Rev.Temp.Coef. of Intrinsic Coercivity (Hci), β, %/°C
-0.050 (Sm1Co5)	-0.30 (Sm1Co5)
-0.045 (Sm1Co5 S)	-0.28 (Sm1Co5 S)
-0.035 (Sm2Co17)	-0.20 (Sm2Co17)
-0.050 (Bonded Sm1Co5)	-0.25 (Bonded Sm1Co5)
-0.030 (Bonded Sm2Co17)	-0.20 (Bonded Sm2Co17)
-0.040 (Plastic Bonded SmCo)	-0.20 (Plastic Bonded SmCo)

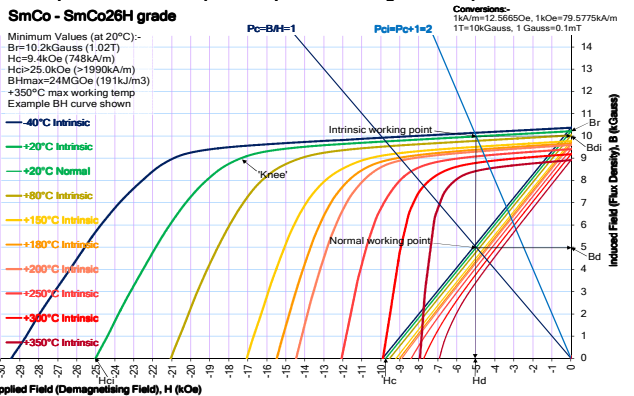
### Corrosion Resistance

Corrosion resistance:- SmCo(1:5) Excellent (has no iron); SmCo(2:17) Good to Very Good (has some free SmCo magnets can usually be used in humid applications without any need for a protective coating. In wet environments, coating of SmCo(2:17) in NiCuNi is recommended to avoid surface corrosion issue. NiCuNi plated SmCo is claimed by some to limit chipping and allows for soldering as well but is rarely do

### Physical Characteristics (excluding bonded variants)

Characteristic	Symbol	Unit	Value
Density Sm1Co5	D	g/cm <sup>3</sup>	8.2-8.4
Density Sm2Co17	D	g/cm <sup>3</sup>	8.2-8.5
Vickers Hardness Sm1Co5	Hv	D.P.N.	500-600
Vickers Hardness Sm2Co17	Hv	D.P.N.	450-500
Compression Strength Sm1Co5	C.S.	N/mm <sup>2</sup>	900-1000
Compression Strength Sm2Co17	C.S.	N/mm <sup>2</sup>	650-800
Coefficient of Thermal Expansion Sm1Co5	C//	10 <sup>-6</sup> /°C	6
Coefficient of Thermal Expansion Sm2Co17	C.L	10 <sup>-6</sup> /°C	13
	C//	10 <sup>-6</sup> /°C	8-10
	C.L	10 <sup>-6</sup> /°C	11
Electrical Resistivity Sm1Co5	ρ	μ Ω.cm	5-6
Electrical Resistivity Sm2Co17	ρ	μ Ω.cm	80-90
Electrical Conductivity Sm1Co5	σ	10 <sup>5</sup> S/m	16.6-20
Electrical Conductivity Sm2Co17	σ	10 <sup>5</sup> S/m	1.1-1.25
Thermal Conductivity Sm1Co5	k	kCal/(m.h.°C)	11
Thermal Conductivity Sm2Co17	k	kCal/(m.h.°C)	10
Specific Heat Capacity Sm1Co5	c	kCal/(kg.°C)	0.08
Specific Heat Capacity Sm2Co17	c	kCal/(kg.°C)	0.09
Tensile Strength Sm1Co5	σ <sub>UTS</sub> or σ <sub>T</sub>	kg/mm <sup>2</sup>	4.1
Tensile Strength Sm2Co17	σ <sub>UTS</sub> or σ <sub>T</sub>	kg/mm <sup>2</sup>	3.6
Young's Modulus Sm1Co5	λ / E	10 <sup>11</sup> N/m <sup>2</sup>	1.6
Young's Modulus Sm2Co17	λ / E	10 <sup>11</sup> N/m <sup>2</sup>	1.2
Flexural Strength Sm1Co5	σ	N/mm <sup>2</sup>	120
Flexural Strength Sm2Co17	σ	N/mm <sup>2</sup>	110
Compressive strength Sm1Co5	σ	N/mm <sup>2</sup>	650
Compressive strength Sm2Co17	σ	N/mm <sup>2</sup>	800
Rigidity	E.I	N/m <sup>2</sup>	150
Poisson's Ratio	ν		0.27
Curie Temperature Sm1Co5	Tc	°C	700-750
Curie Temperature Sm2Co17	Tc	°C	800-850

### Example of a BH curve (second quadrant demagnetisation)



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