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Samarium Cobalt Data Sheet

Samarium Cobalt (SmCo) Magnets

These magnets exist in two forms. Sm_1Co_5 (SmCo1:5) is the original SmCo and is the weaker variety.
Sm_2Co_{17} (SmCo2:17) is commonly used as it is stronger. SmCo26 is the most popular choice.
Sm_1Co_5 is made of mostly Sm and Co and has excellent corrosion resistance as it contains no iron (Fe).
Sm_2Co_{17} contains Sm, Co, Cu, Hf &/or Zr, sometimes Pr, and Fe (it is mainly Sm and Co).
In most applications Sm_2Co_{17} is regarded as having very good corrosion resistance (far better than NdFeB).
But the iron in Sm_2Co_{17} means a risk of some surface corrosion when in water - plating (e.g. Ni) fixes this.

This Low Temperature Coefficient (LTC) versions have less variation in magnetic output with temperature change (due to added Gd and Er).
The H versions Sm_2Co_{17} have higher Hci and operate up to +350°C rather than +300°C.

Sm_1Co_5 Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m³	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_1Co_5 Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m³	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_2Co_{17} Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m³	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_2Co_{17} Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m³	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_1Co_5 Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m³	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_2Co_{17} Typical Range of Values

Material	Br		Hc (Hcb)		Hci (Hcj)		BHmax	
	T	kG	kA/m	kOe	kA/m	kOe	kJ/m³	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/m³	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

Samarium Cobalt magnets start to outperform Neodymium magnets at temperatures above 150 degrees C.
Samarium Cobalt magnets can be used at cryogenic temperatures (i.e. towards absolute zero).
Samarium Cobalt magnets have better temperature coefficients than Neodymium so offer more stable fields over wider temperature ranges. (Alnico can be a better choice for a stable magnetic field over a wide temperature range due to it having the best temperature coefficients provided it does not demagnetise during operation due to its lower Hci).

Physical Characteristics (excluding bonded variants)

Characteristic	Symbol	Unit	Value
Density Sm1Co5	D	g/cm³	8.2-8.4
Density Sm2Co17	D	g/cm³	8.3-8.5
Vickers Hardness Sm1Co5	Hv	D.P.N.	500-600
Vickers Hardness Sm2Co17	Hv	D.P.N.	450-500
Compression Strength Sm1Co5	C.S.	N/mm²	900-1000
Compression Strength Sm2Co17	C.S.	N/mm²	650-800
Coefficient of Thermal Expansion Sm1Co5	C//	10^{-6}/°C	6
	C⊥	10^{-6}/°C	13
Coefficient of Thermal Expansion Sm2Co17	C//	10^{-6}/°C	8-10
	C⊥	10^{-6}/°C	11
Electrical Resistivity Sm1Co5	ρ	μΩ.cm	5-6
Electrical Resistivity Sm2Co17	ρ	μΩ.cm	80-90
Electrical Conductivity Sm1Co5	σ	10^6S/m	16.6-20
Electrical Conductivity Sm2Co17	σ	10^6S/m	1.11-1.25
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_{UTS} or S_U	kg/mm²	4.1
Tensile Strength Sm2Co17	σ_{UTS} or S_U	kg/mm²	3.6
Young's Modulus Sm1Co5	λ / E	10^{11}N/m²	1.6
Young's Modulus Sm2Co17	λ / E	10^{11}N/m²	1.2
Flexural Strength Sm1Co5	σ	N/mm²	120
Flexural Strength Sm2Co17	σ	N/mm²	110
Compressive strength Sm1Co5	σ	N/mm²	650
Compressive strength Sm2Co17	σ	N/mm²	800
Rigidity	E.I	N/m²	150
Poisson's Ratio	ν		0.27
Curie Temperature Sm1Co5	Tc	°C	700-750
Curie Temperature Sm2Co17	Tc	°C	800-850

Max Working Temperature
(Note - this varies with the magnetic working point!)

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

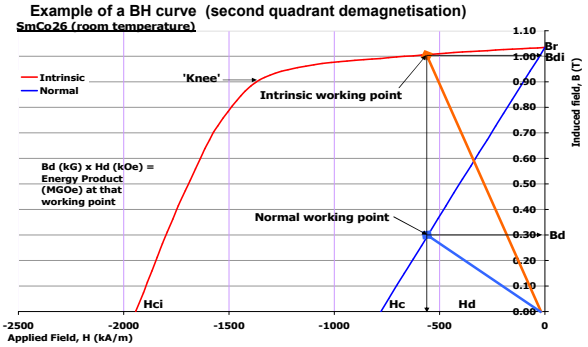
Corrosion Resistance

Corrosion resistance:- SmCo(1:5) Exellent (has no iron); SmCo(2:17) Good/Very Good (has some iron).
The magnets can be used in humid applications generally without the need for any coating.
In marine envrironments, it may be advisable to coat SmCo(2:17) to avoid surface corrosion issues.
They can be plated (for soldering, marine applications, less chipping, etc) but is rarely done e.g. NiCuNi.

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)

Example of a BH curve (second quadrant demagnetisation)



How the magnet is used affects the working point of the magnet (shape, magnetic circuit, temperature, etc). When determining suitability, use the Intrinsic curve during analysis (not the Normal curve).
To obtain maximum performance keep the intrinsic working point above the 'knee' and ideally above the BHmax working point. If in any doubt, please contact us for technical assistance.

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