HIPERCO® 50A

Type analysis

Single figures are nominal except where noted.

Iron	Balance	**Cobalt**	48.5%	**Vanadium**	2.00 %
Niobium	0.01%	**Carbon**	0.001%		

Forms manufactured

Strip	**Plate**	**Bar**	**Billet**

Additional details available on page 5, Other Information.

Description

Hiperco 50A is an iron-cobalt vanadium soft magnetic alloy which exhibits the highest magnetic saturation (24 kilogauss) of commercially available soft magnetic alloys while maintaining low core loss as compared to electrical steel. This alloy is characterized by high purity. No intentional alloying additions are made for grain refinement and there are low tramp element concentrations which leads Hiperco 50A to have superior magnetic properties to other iron-cobalt soft magnetic alloys.

Hiperco 50A is used in motors and generators for achieving combination of maximum torque density and lowest losses. It helps to improve the motor power density, efficiency, and can reduce the size of the motor. This alloy works as a flux concentrator in electromagnetic pole pieces for different high flux applications such as medical radiology. This alloy is also used in actuator, specialty transformer, magnetic bearing applications offering high flux density and size reduction opportunity.

Key Properties:

- High magnetic saturation
- High purity
- Low core loss
- Low tramp element concentrations

Markets:

- Aerospace
- Automotive
- Consumer
- Industrial

Applications:

- Motors and generators
- Actuators
- Specialty transformers
- Electromagnetic pole pieces

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Physical properties

PROPERTY	At or From	English Units	Metric Units
SPECIFIC GRAVITY	68°F (20°C)	8.12	8.12
DENSITY	—	0.2930 lb/in^3	8.11 g/cm^3
MEAN COEFFICIENT OF THERMAL EXPANSION	77 to 392°F (25 to 200°C)	5.3 x 10^{-6} length/length/°F	9.59 x 10^{-6} length/length/°C
	77 to 752°F (25 to 400°C)	5.6 x 10^{-6} length/length/°F	10.1 x 10^{-6} length/length/°C
	77 to 1112°F (25 to 600°C)	5.8 x10^{-6} length/length/°F	10.5 x 10^{-6} length/length/°C
	77 to 1472°F (25 to 800°C)	6.3 x10^{-6} length/length/°F	11.3 x 10^{-6} length/length/°C
THERMAL CONDUCTIVITY		206.8 Btu in/hr/ft^2/°F	29.83 W/m/ length/length/°C
ELASTIC MODULUS	—	30.0 x 10^3 ksi	206.8 GPa
ELECTRICAL RESISTIVITY	70°F (21°C)	240.7 ohm-cir-mil/ft	40.1 x 10^{-8} ohm/m
CURIE TEMPERATURE[1]	—	1720°F	938°C

[1] Curie temperature is phase transition from magnetic to non-magnetic phase

Magnetic properties

AC CORE LOSS

CORE LOSS BY HEAT TREATMENT							
HEAT TREATMENT	0.014 IN (0.355 MM) SPECIFIC CORE LOSS (W/kg)			0.006 IN (0.1524 MM) SPECIFIC CORE LOSS (W/kg)			B (TESLA)
	60 Hz	400 Hz	1000 Hz	60 Hz	400 Hz	1000 Hz	
Standard magnetic anneal	0.94	12.7	55.6	0.75	7.8	28.2	1.0
	1.75	30.0	151	1.41	15.3	59.5	1.5
	2.73	56.8	313	2.18	24.4	98.3	2.0

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DC PROPERTIES

0.014 IN (0.355 MM) STRIP

HEAT TREATMENT	COERCIVITY (A/m) FROM 8 kA/m	DC RELATIVE PERMEABILITY μ_{MAX}	B (TESLA) A/m					
			400	*800*	*1600*	*4000*	*8000*	*16000*
Standard magnetic anneal	30	22000	2.12	2.19	2.23	2.27	2.28	2.30

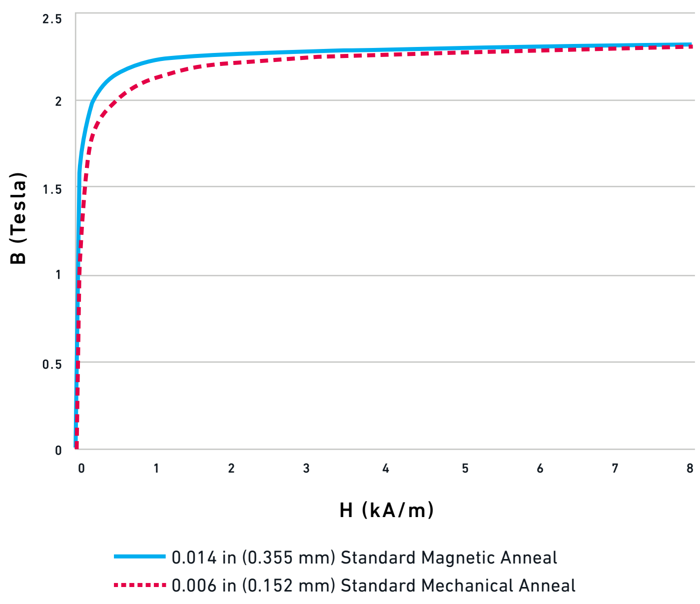
0.006 IN (0.1524 MM) STRIP

HEAT TREATMENT	COERCIVITY (A/m) FROM 8 kA/m	DC RELATIVE PERMEABILITY μ_{MAX}	B (TESLA) A/m					
			400	*800*	*1600*	*4000*	*8000*	*16000*
Standard magnetic anneal	30	21100	2.03	2.14	2.21	2.27	2.28	2.30

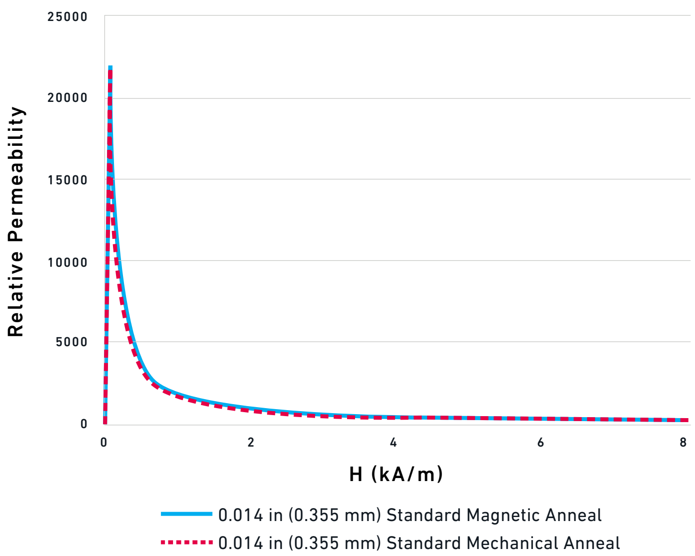
BULK MATERIAL (BAR)

HEAT TREATMENT	COERCIVITY (A/m) FROM 8 kA/m	DC RELATIVE PERMEABILITY μ_{MAX}	B (TESLA) A/m					
			400	*800*	*1600*	*4000*	*8000*	*16000*
Standard magnetic anneal	209	3350	1.49	1.80	2.00	2.18	2.25	2.30

DC B v H



DC RELATIVE PERMEABILITY



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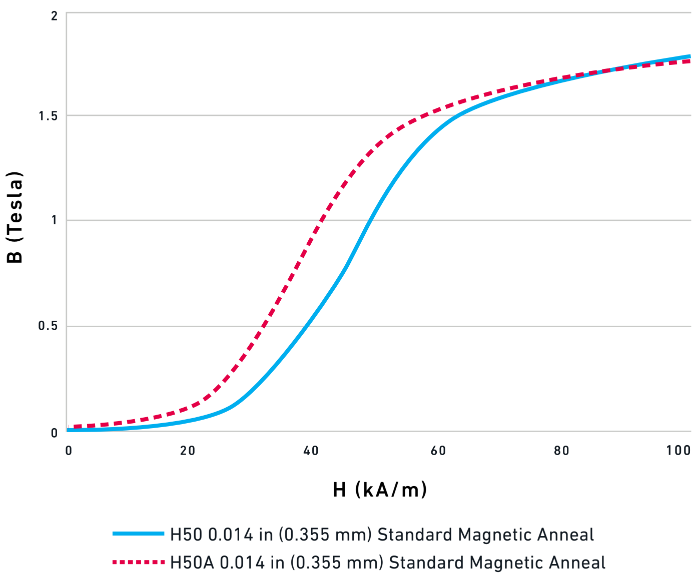
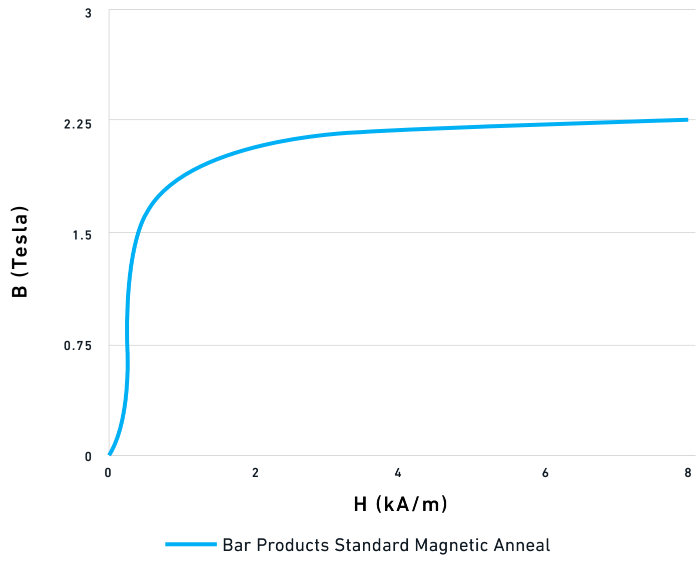
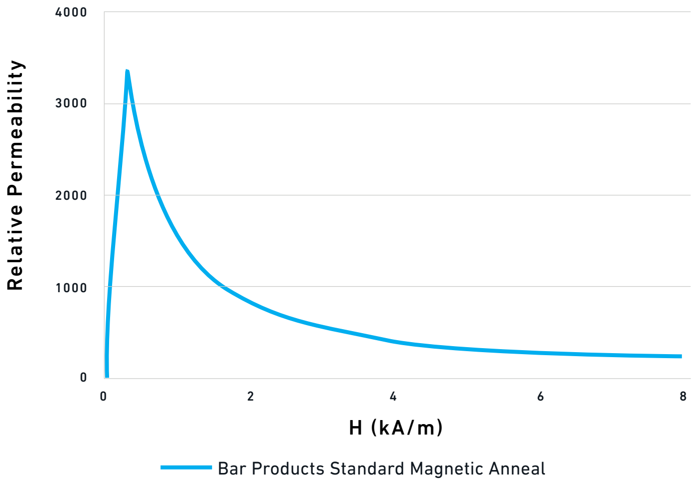
LOW FIELD DC B V H H50 VS H50A



BAR PRODUCT DC B V H



DC RELATIVE PERMEABILITY



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Typical mechanical properties

STRIP 0.014 IN (0.35 MM)					
HEAT TREATMENT	**0.2% YIELD STRENGTH**		**ULTIMATE TENSILE STRENGTH**		**ELONGATION IN 2 IN (50.8 MM)**
	ksi	**MPa**	**ksi**	**MPa**	**%**
Cold rolled unannealed	185	1276	195	1344	1
Standard magnetic anneal	30.8	202	72.2	498	6.7

Heat treatment

Standard treatment

It is important to avoid any contamination of the finished parts during heat treatment. All parts must be cleaned thoroughly to remove any surface contaminants prior to annealing.

A dry hydrogen atmosphere or high vacuum is recommended to minimize oxide contamination during annealing. When hydrogen is employed and the inside retort temperature is above 900°F (482°C), the entry dew point should be dryer than -60°F (-51°C) and the exit dew point should be dryer than about -40°F (-40°C).

Anneal parts at 1575/1600°F (857/871°C) for 4 hours in dry hydrogen or vacuum and cool at 250/400°F (139/222°C) per hour until 600°F (316°C) is reached, after which any cooling rate can be employed.

Lower temperature heat treating can be utilized to achieve higher strength in Hiperco 50A at the expense of magnetic properties. Contact a Carpenter Technology representative for more information.

Coatings

Inlac

Inlac coating is applied in a continuous process on coils of strip to create a mix of magnesium-based compounds on both sides of the strip surface. This surface layer acts as an inert barrier between laminations during heat treating and prevents adhesion. Additionally, during AC excitation, it provides improved electrical insulation between laminations reducing eddy current effects on core loss.

Oxide

Annealed laminations can be heat-treated in an oxygen bearing atmosphere in the range of 300-500°C (600-900°F) to grow a thin oxide layer on the surfaces. This coating serves to provide an enhanced level of electrical insulation between laminations, greatly reducing eddy current effects during AC excitation. Oxide heat treatment soak times are generally less than 5 hours and can be adjusted to refine coating thickness.

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Other information

Applicable specifications	ASTM A801 Alloy Type 1, MIL A 47182

Appendix

PHYSICAL PROPERTIES	ASTM STANDARD #
Density	B311-17
Coefficient of thermal expansion	E228
Thermal conductivity	ASTM E1225 - 13
Modulus of elasticity	ASTM A370 Section 14, E8-E8M
Electrical resistivity	B193
Curie temperature	A 894/A 894M-00
AC magnetic properties	A927/A927M
DC magnetic properties	A596/A596M
Mechanical properties	E8, A677 Section 9

For additional information, please contact your nearest sales office:
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