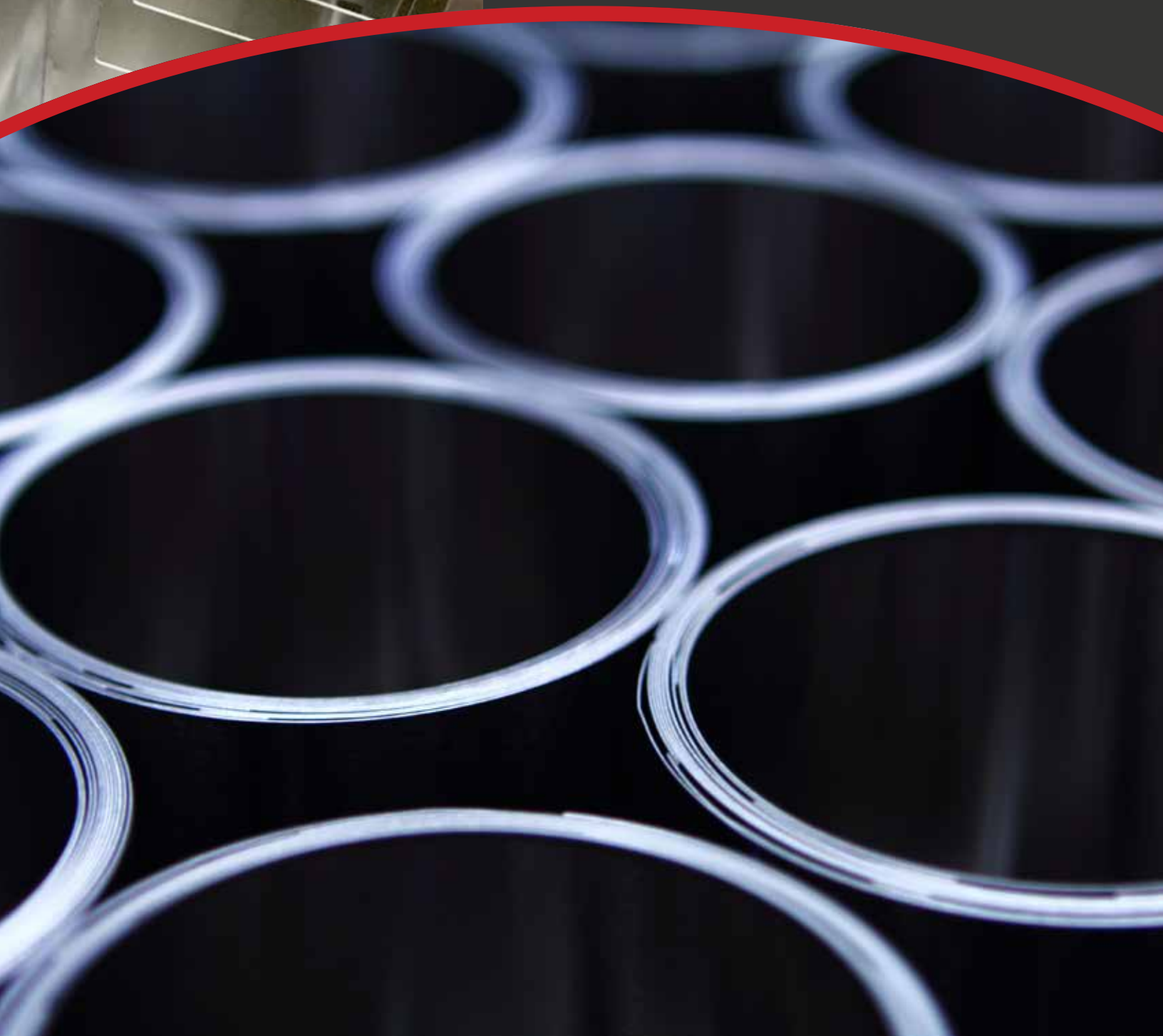


M μ Shield[®]

AS:9100 | ISO 9001:2015 Certified | ITAR Registered Company

High Permeability Magnetic Shielding per ASTM A753 Alloy Type 4



Available in coil, sheet, rod, billet, wire, and bar form, MuShield's High Permeability Magnetic Shielding is a soft magnetic alloy composed of 77-80% nickel, 15-17% iron, and 4.20% molybdenum, creating high permeability characteristics suitable for Medical, Aerospace, Defense, and Oil & Gas Exploration applications.

Useful Information For Designing Your Own Magnetic Shielding

MuShield's High Permeability material has an extremely high initial permeability with minimal hysteresis loss.

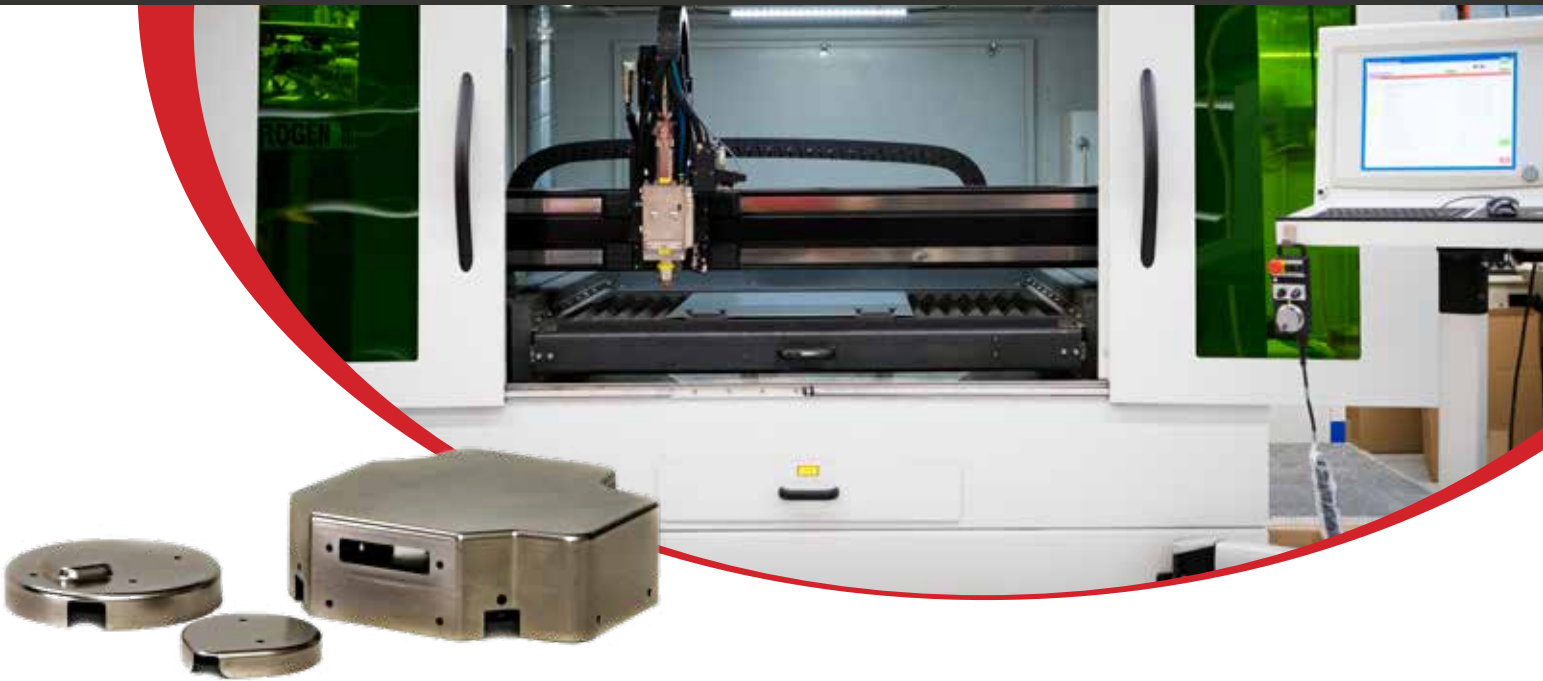
- The material can be easily cut, formed, hydroformed, rolled, spun, and deep drawn.
- MuShield's High Permeability material can be spot welded or TIG welded.
- To achieve the best shielding characteristics, components must be heat treated at 2050 °F or higher as described under heat treatment.
- Heat treatment is performed after all fabricating operations have been completed.

FORM	μ at B = 40 G	μ MAX	H ₀ from H=1 Oersted
Bar, Wire	50,000	350,000	0.02 max

DC hysteresis loss from:

H = 1 Oe, erg/cm ³ per cycle	16
Induction, gauss	8,000





AC Magnetic Properties, 60Hz

Minimum Limits

THICKNESS (in)	THICKNESS (mm)	μ @40G
0.025 ¹	0.635	35,000
0.014 ¹	0.356	55,000
0.006 ¹	0.152	65,000
0.002 ²	0.051	70,000

- 1. Ring laminations 1 1/2" (38.1mm) OD x 1" (25.4mm) ID specimens
- 2. Tape toroid specimen

MuShield Magnetic Shielding Material

Type analysis

Nickel	80%
Molybdenum	4.20%
Iron	Balance
Manganese	0.50%
Silicon	0.35%
Carbon	0.02%

Physical Properties

Specific Gravity	8.75	Electrical Resistivity		Curie temp.	860°F (460°C)
Density (in lbs/in3)	0.316	ohm-cir mil/ft	349	Melting point	2,650°F (1,454°C)
(in kg/m3)	8,747	microhm-mm	80	Specific heat:	
Thermal conductivity:		Temperature coefficient of electrical resistivity:		Btu/lb • °F	0.118
Btu-in/ft2/hr/°F	240	per °F from 0/930°F	0.0006	kJ/kg • K	0.494
W/m • K	34.6	per °C from -17.8/499°C	0.0011		



Mean Coefficient of Thermal Expansion

TEMPERATURE	°F	°C
	-103 to 77	-75 to 25
	-58 to 77	-50 to 25
	-11 to 77	-25 to 25
	77 to 122	25 to 50
	77 to 212	25 to 100
	77 to 392	25 to 200
	77 to 572	25 to 300
	77 to 752	25 to 400

COEFFICIENT	10 ⁻⁶ / °F	10 ⁻⁶ / °C
	6.00	10.80
	5.94	10.70
	5.78	10.40
	6.83	12.30
	6.89	12.40
	7.09	12.76
	7.22	13.00
	7.39	13.30



Extreme Heat for Extraordinary Results

- For maximum magnetic permeability, MuShield heat treats finished parts in an oxygen-free dry hydrogen atmosphere with a dew point below -40° F (-40° C) or vacuum for one to four hours at 2,050° F (1,121° C)-2,150° F (1,177° C).

Before placing finished parts in the furnace for heat treatment, all oil, grease, and other contaminants must be removed.

Individual parts must be separated by an inert insulation material such as magnesium or aluminum oxide during heat treatment.



Workability - Machine

- MuShield's High Permeability Magnetic Shield material will react similarly to 300 Series Stainless and other austenitic alloys when machined.
- It is suggested that bars with a Rockwell B 90 max hardness be used when machining.
- All drilling and machining should be done at slow to medium speeds and with water soluble coolants.
- Clean or heat treat all parts within 48 hours if water-soluble, or sulfur-bearing, cutting compounds are used during machining.
- High-speed steel or carbide tools are suggested for cutting operations.

Workability - Cold Forming

- Like machining, it is suggested that strip material with a Rockwell B 90 max hardness be used when blanking material.
- When forming, material should be in the cold rolled mill annealed condition.
- When drawing, material should be in the deep drawn mill annealed condition.



Corrosion Resistance

While you can nickel plate MuShield's High Permeability Magnetic Shielding materials for additional corrosion resistance, it is not required. The material's corrosion resistance is sufficient in most applications.

Mechanical Properties (Strip)

	Cold Rolled	As Hydrogen Annealed at 2050°F (1121 °C)	After Process Anneal at 1600° F (871° C)
Tensile strength, ksi	135	77	98
MPa	931	531	676
Yield point, ksi	--	21	38
MPa	--	145	262
Proportional limit, ksi	--	15	35
MPa	--	103	241
Elongation %	4	38	38
Rockwell B hardness	100	58	85

Mechanical Properties (Bar)

	As Cold Drawn	As Hydrogen Annealed at 2050°F (1121 °C)	After Process Anneal at 1600° F (871° C)
Tensile strength, ksi	97	79	90
MPa	669	545	620
Yield point, ksi	69	22	33
MPa	414	152	228
Proportional limit, ksi	19	19	28
MPa	131	131	193
Elongation %	37	64	57
Reduction of area, %	71	70	74
Modulus of elasticity in tension, 10 ³ ksi	33.7	33.3	31.4
10 ⁶ MPa	232	230	217
Rockwell B hardness	97	62	85
Izod impact, ft-lbs	120	85	85
J	163	115	115

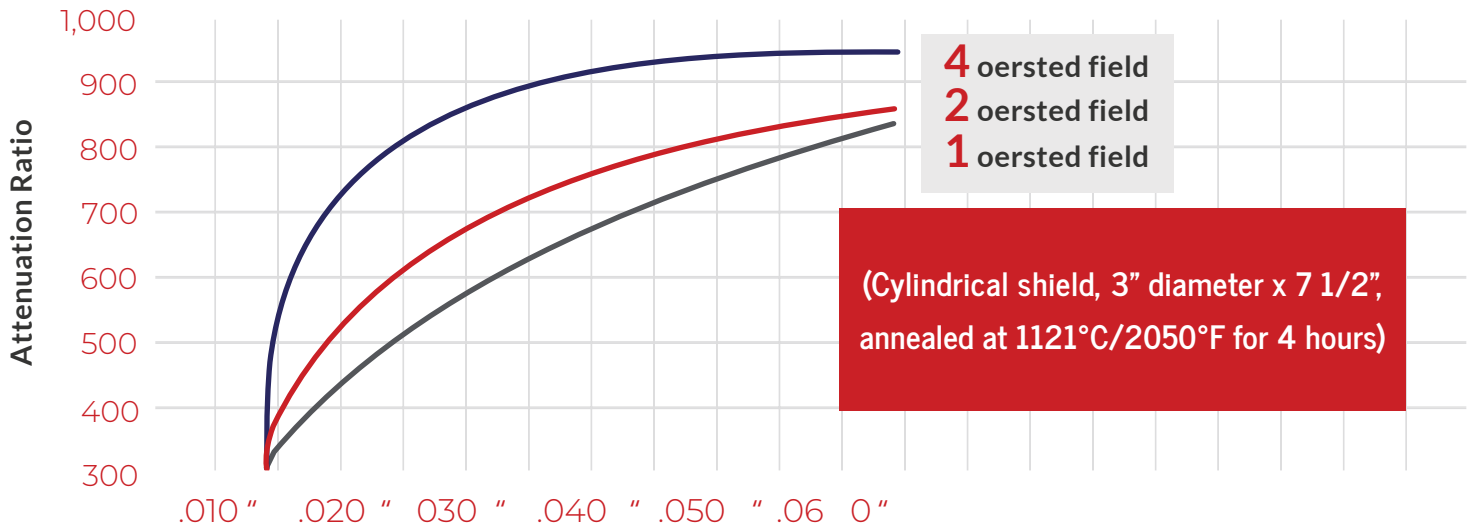
References for Machining

	OPERATION SPEED*		FEED		TOOL
	sf/m	m/s	i/r	mm/r	Materials
Turning	50	0.254	0.0007/ 0.002	0.018/ 0.051	M42
Drilling	35	0.18	0.001/ 0.004	0.025/ 0.102	M2
Milling	40	0.20	0.002/ 0.005	0.051/ 0.127	M2
Tapping	10/15	0.05/ 0.08	--	--	M1 or M2

* For carbide tools, double the sf/m

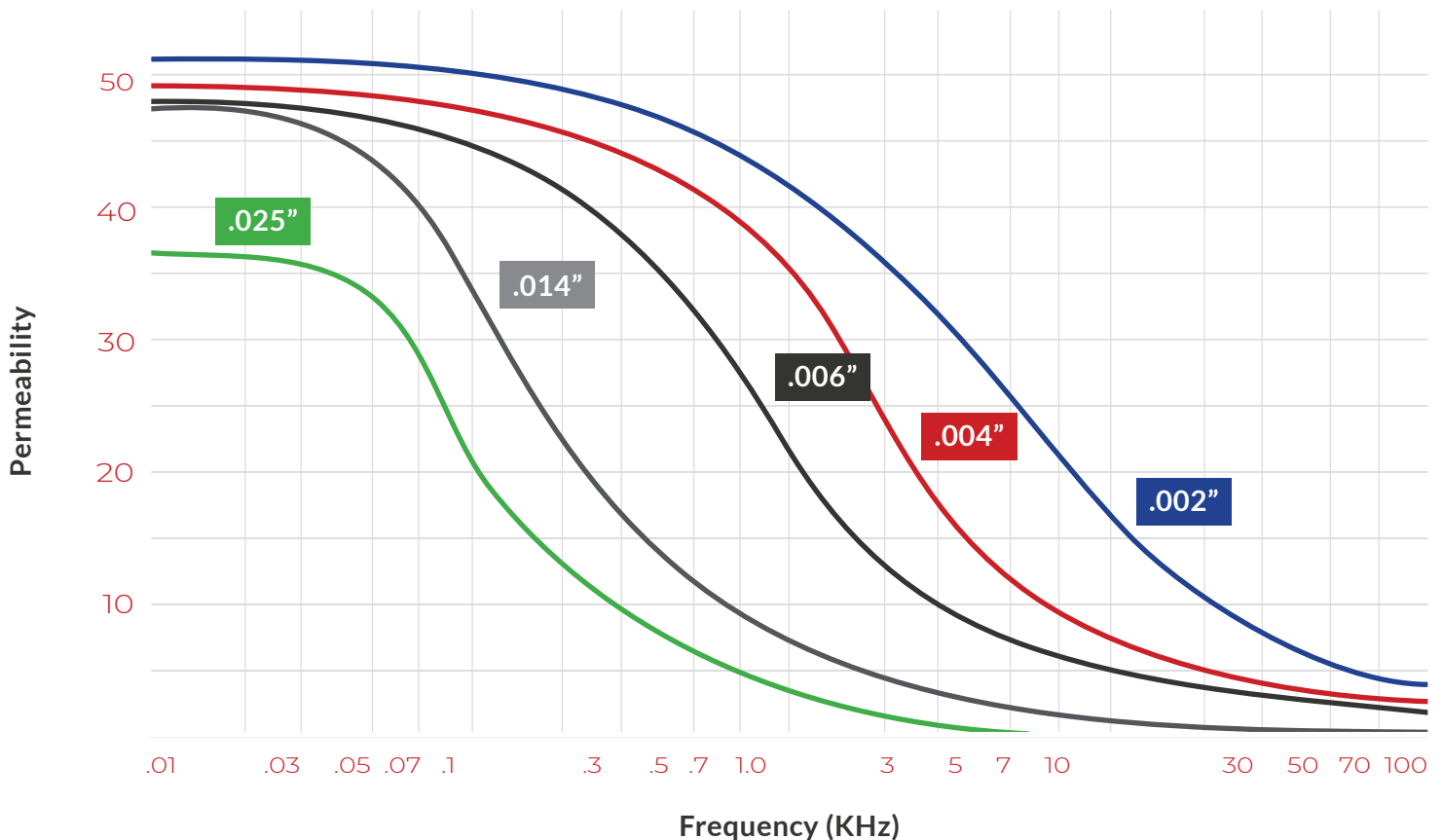
Shield Thickness vs. Attenuation Ratio at 60Hz

High Permeability MuShield Material



Typical Permeability vs. Frequency at B = 40 Gauss

High Permeability MuShield Material





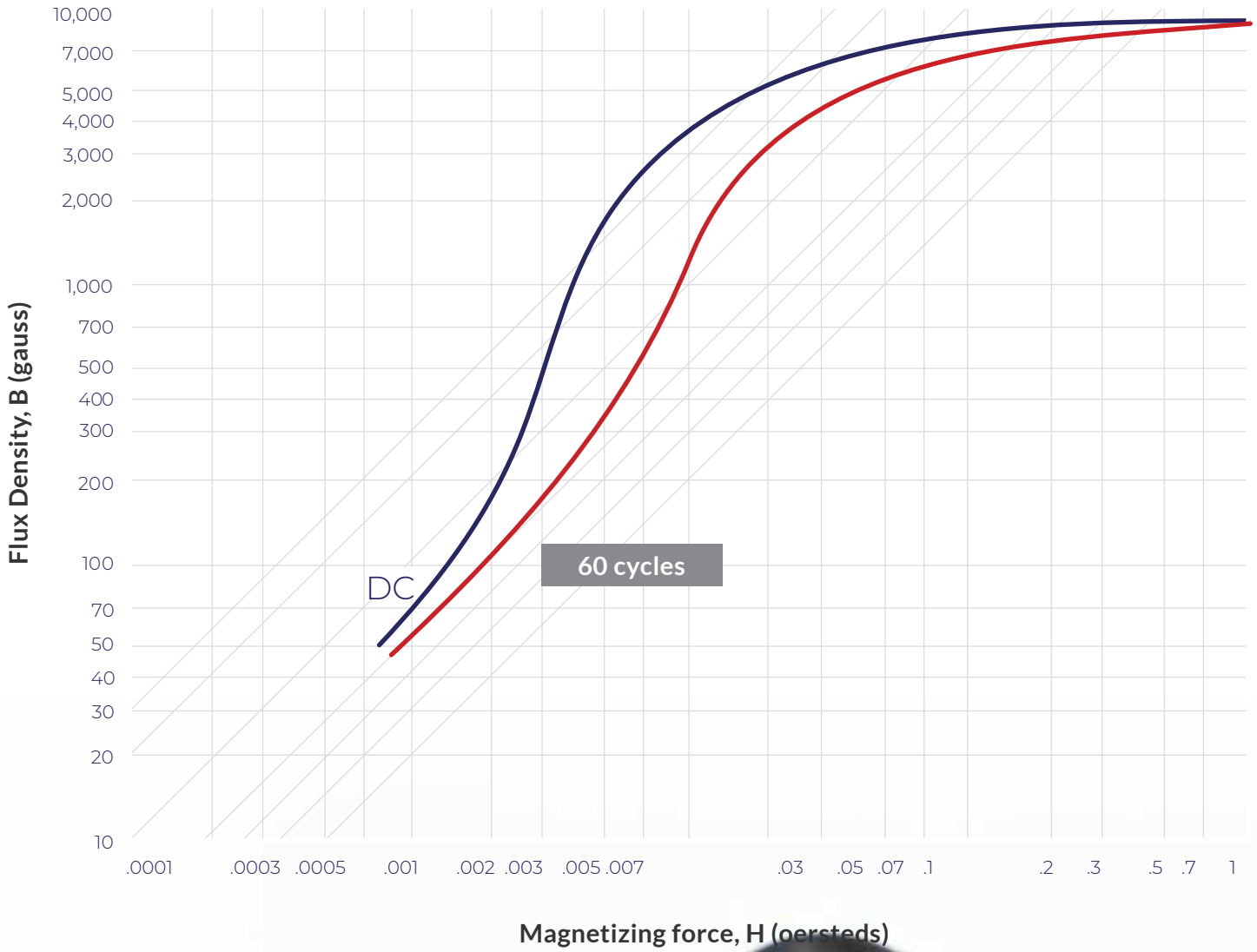
We Armor Your Assets



B/H Graph

Permeability, $B/H \times 10^3$

High Permeability MuShield Material



MATERIALS PER SPEC ASTM A753
Can be offered in the following forms

Sheets start at either 24" or 30" wide (based on availability) x 120" long. We have the capabilities to cut your custom blank size.

Sheet Thicknesses available

.010" .014" .020"
.025" .030" .040"
.050" .062" .125"

Custom thicknesses available upon request.

Coils start at either 12" or 15" wide (based on availability), can be slit to your custom width upon request and can be cut to whatever length you require.

Coil Thicknesses In Stock

.002"
.004"
.006"
.010"
.014"

Seamless Tubing (mumetal IAW ASTM A753 Alloy Type 3)

Diameters and lengths based on your custom needs.
Please contact sales for pricing.

Round Bar

Standard Diameters available

.250"
.500"
1.00"
1.50"
1.88"

Custom Diameters available upon request.
Please contact sales for pricing.

Flat Bar

Custom Dimensions available upon request.
Please contact sales for pricing.

Wire

Custom Diameters available upon request.
Please contact sales for pricing.

MUSHIELD'S MANUFACTURING CAPABILITIES

Conventional Sheet Metal Fabrication

2-Axis Laser Cutting for Flat Patterns

5-Axis Laser Cutting & Trimming

Hydroforming - Deep Draw

Hydrogen Annealing & Heat Treating

Vacuum Annealing & Heat Treating

TIG Welding

Spot Welding

Laser Welding

Metal Spinning

Stamping

Multi-Axis Machining

Wire EDM

Turret Punching

CONSULTING & ENGINEERING SERVICES

Consultation for Manufacturing Efficiencies - All Alloys

Magnetic Shielding Consultation

Special Process Development

QUALITY CAPABILITIES

ISO 9001 : 2015 Certified

AS9100D Certified

ITAR Registered

CMM and Vision System Inspection Equipment for Medical and Aerospace Applications

Magnetic Shield Testing

MATERIALS WE WORK WITH**MAGNETIC SHIELDING ALLOYS**

ASTM A753 Alloy Type 3 and 4 - aka mumetal
ASTM A753 Alloy Type 2 - aka Alloy 49
Cryoperm®
HiPerco® 50
High Saturation/Low Permeability Low Carbon
Steels and Silicon Iron

OTHER INDUSTRY ALLOYS

Aluminum and Aluminum Alloys
Brass
Copper
Hastelloy®
High Temperature Alloys
Inconel
Low Carbon Steel
Stainless Steel
Tantalum

From design consultation, to manufacturing,
final heat treatment and post production
testing or assistance - MuShield has your back.

info@mushield.com [603.666.4433]



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Boundless Capabilities Shielded Through Innovation.

For over 60 years, MuShield has been an industry leader in the fabrication of magnetic shields made from high permeability materials. We've long developed trust and working partnerships with our customers who come to us because they know we can analyze their issue and build a solution for their magnetic interference problems.

Manufacturing Capabilities

- Conventional Sheet Metal Fabrication
- 2-Axis Laser Cutting for Flat Patterns
- 5-Axis Laser Cutting & Trimming
- Hydroforming - Deep Draw
- Hydrogen Annealing & Heat Treating
- Vacuum Annealing & Heat Treating
- TIG Welding
- Spot Welding
- Laser Welding
- Metal Spinning
- Stamping
- Multi-Axis Machining
- Wire EDM
- Turret Punching

Consulting + Engineering Services

- Consultation for Manufacturing Efficiencies - All Alloys
- Magnetic Shielding Consultation
- Special Process Development

Quality Capabilities

- ISO 9001 : 2015 Certified
- AS9100D Certified
- ITAR Registered
- CMM and Vision System Inspection Equipment for Medical and Aerospace Applications
- Magnetic Shield Testing

For Orders and Pricing:
 Contact MuShield for more information
 [888.669.3549]