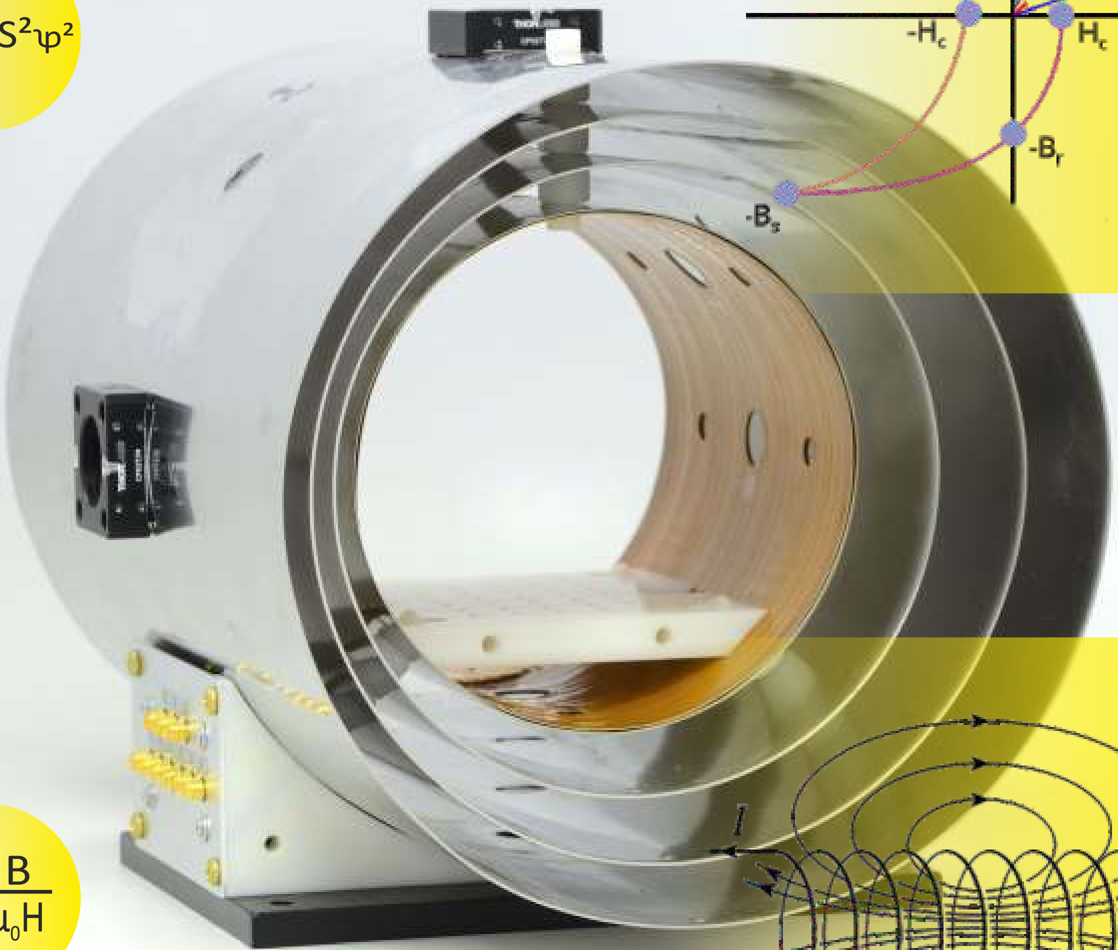
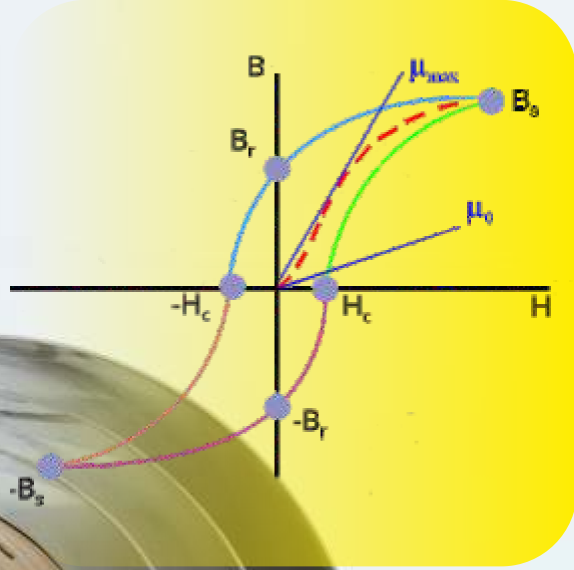
SOFT-MAGNETIC ALLOYS

$$B = \frac{\mu_0 I}{2\pi R}$$

$$W_A = I_A S^2 \psi^2$$

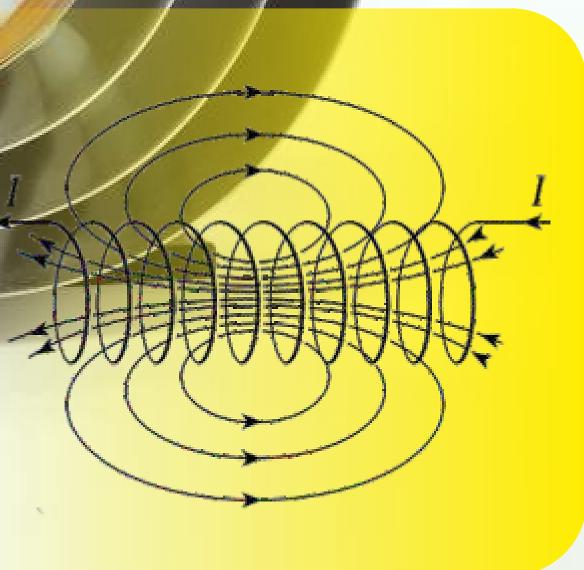




$$L = \frac{\mu_0 \mu n^2 A}{l}$$

$$\mu = \frac{B}{\mu_0 H}$$

$$\mu_r = \frac{\mu}{\mu_0}$$



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SOFT-MAGNETIC ALLOYS

Nickel-Iron Alloys

Magnetic materials are essential for numerous daily activities in our lives: from wind turbines for transformation of wind energy into electrical power and hard drives for information storage on our computers to simple decorative magnets with "to-do" list attached to refrigerator door.

They can be divided into magnetically "soft" materials, which can easily change their magnetization when external conditions require it and magnetically "hard" materials, which are very difficult to demagnetize even under the influence of external field.

Our delivery program covers soft-magnetic nickel-iron alloys and here we will try to give a brief outline of their basic properties and application areas.

Main characteristics of soft-magnetic alloys which determine high magnetic performance: permeability, coercivity, saturation induction, remanence, energy losses, electric resistivity.

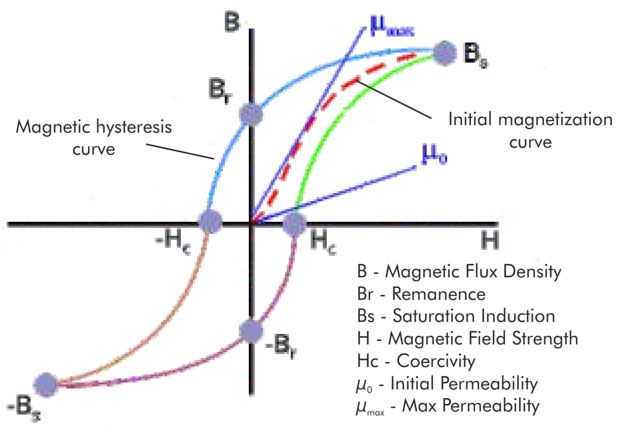


Figure 1. Hysteresis loop

- Permeability, μ (mH/m)

Is a measure of how readily the material responds to the applied magnetic field, or in other words, is a degree of magnetization that a material obtains in response to an applied magnetic field. The higher the permeability, the better the magnetic performance.

- Coercivity, Hc (A/m)

The coercivity is a measure of the degree of the ability of material to withstand an external magnetic field without becoming demagnetized. It therefore characterizes the loss vulnerability of soft magnetic materials for their common applications. The lower coercivity, the better the magnetic performance.

- Saturation induction, Bs (T)

Also known as saturation flux density, is a maximum intrinsic induction possible in material. High flux density allows the development of a strong magnetic field thus to design electromechanical devices that will function with greater force and efficiency.

- Remanence, Br (T)

The value of flux density remaining after the external field returns from the high level of saturation to zero bottom. The higher the value, the higher useable magnetic flux density.

- Energy losses

The energy losses can originate from two different sources:

1. Hysteresis loss – is the energy loss when the magnet material is going through a cycling state.

2. Eddy current loss – is caused when the lines of flux pass through the core inducing eddy current in it.

Hysteresis losses can be reduced by the reduction of the intrinsic coercivity, with a consequent reduction in the area contained within the hysteresis loop.

Eddy current losses can be reduced by decreasing the electrical conductivity of the material and by laminating the material, which has an influence on overall conductivity and is important because of skin effects at higher frequency.

Selecting the correct alloy and operating within it limits will prevent overheating that could result in damage.

- Electrical resistivity, R ($\mu\Omega$*m)

A measure of how easily electrical current can pass through an alloy. Selecting the right alloy and thickness for higher resistivity of the core makes the current low thus reducing eddy current losses (excessive eddy current losses may cause overheating). The lower eddy current losses, the lower wasted energy.

Specification:

Alloy		Magfield 36	Magfield 50	Magfield 75	Magfield 77	Magfield 80
Designation	DIN	Ni36	Ni48	NiFe16CuCr	NiFe16CuMo	NiFe15Mo
	W.N.	1.3910	1.3922	2.4501	2.4530	2.4545
	UNS	K93600	K94840	N14076	-	N14080
Nickel (Ni)		35.00-38.00	46.00-49.00	rest	rest	rest
Iron (Fe)		rest	rest	15.00-18.00	12.00-16.00	11.00-17.00
Chromium (Cr)		-	-	1.80-2.20	-	-
Molybdenum (Mo)		-	-	-	3.90-4.50	4.80-6.00
Copper (Cu)		-	-	4.80-5.20	4.80-6.00	-
Carbon (C)		≤ 0.30	≤ 0.30	≤ 0.30	≤ 0.30	≤ 0.30
Manganese (Mn)		≤ 0.60	≤ 0.60	≤ 0.60	≤ 0.60	≤ 0.60
Silicon (Si)		≤ 0.20	≤ 0.30	≤ 0.30	≤ 0.30	≤ 0.30
Density, g/cm³		8.10	8.20	8.60	8.60	8.75
Resistivity at 20°C, Ω mm²/m		0.75	0.45	0.55	0.55	0.56
Thermal conductivity, W/mK		10.50	15.00	17.00	17.00	17.00
Melting point, °C		1450	1425	1450	1450	1450
Curie point, °C		240	500	400	350	400
Saturation (B_s), T		1.20	1.50	0.75	0.60	0.70
Coercivity (H_c), A/m		≤ 10.00	≤ 11.20	≤ 1.40	≤ 1.00	≤ 1.20
Initial permeability ($\mu_{0.80}$), mH/m		≥ 6.00	≥ 3.30	≥ 31.30	≥ 62.50	≥ 50.00
Max permeability(μ_{max}), mH/m		≥ 25.00	≥ 50.00	≥ 225.00	≥ 275.00	≥ 225.00

*Note: DC values measured on rings with thickness 0.20 mm. Any other specification is subject to discussion and available upon request.

DELIVERY PROGRAM

STRIP

SHEET

SIZE & TOLERANCE RANGE

FORMS	THICKNESS, MM	WIDTH, MM	TOLERANCE, (TH), MM	TOLERANCE, (W), MM	CONDITION
STRIP / SHEET*	0,10 - 0,20	10,00 - 50,00	± 0,010	± 0,10	COLD-ROLLED, BRIGHT ANNEALED, THERMALLY TREATED, PICKLED
		50,00 - 90,00	± 0,015	± 0,20	
		90,00 - 400,00	± 0,020	± 0,30	
	0,20 - 0,50	10,00 - 50,00	± 0,020	± 0,20	
		50,00 - 90,00	± 0,020	± 0,30	
		90,00 - 400,00	± 0,030	± 0,40	
	0,50 - 1,00	10,00 - 50,00	± 0,030	± 0,20	
		50,00 - 90,00	± 0,030	± 0,30	
		90,00 - 400,00	± 0,040	± 0,50	
	1,00 - 1,80	10,00 - 50,00	± 0,040	± 0,30	
		50,00 - 90,00	± 0,040	± 0,40	
		90,00 - 400,00	± 0,050	± 0,60	
	1,80 - 2,50	10,00 - 50,00	± 0,050	± 0,30	
		50,00 - 90,00	± 0,050	± 0,40	
		90,00 - 400,00	± 0,060	± 0,60	

Note: other sizes and conditions is subject to special enquiry

TYPICAL APPLICATIONS

Magfield 36

Electronics, optical benches, clock motor parts, scientific instruments, components for automotive industry, OLED screens, as a passive component in bi-metal compound, pendulum, pole shoes, relays, etc.

Magfield 50/75

Relay, rotor and stator laminations, magnetic valves, shielding, gas safety, watches, sensors, transformers, transducers, memory cores, magnetic switches, chokes, etc.

Magfield 77

Cores of pulse transformers, magnetic amplifiers, relays, LF transducers, high metering accuracy (HMA) cores, laminations, shielding, etc.

Magfield 80

Memory cores, transformers, transducers, chokes, laminations, shielding, relay parts, stepping motors, toroidal strip wound cores, etc.

Induction / field strength curves of soft-magnetic alloys.

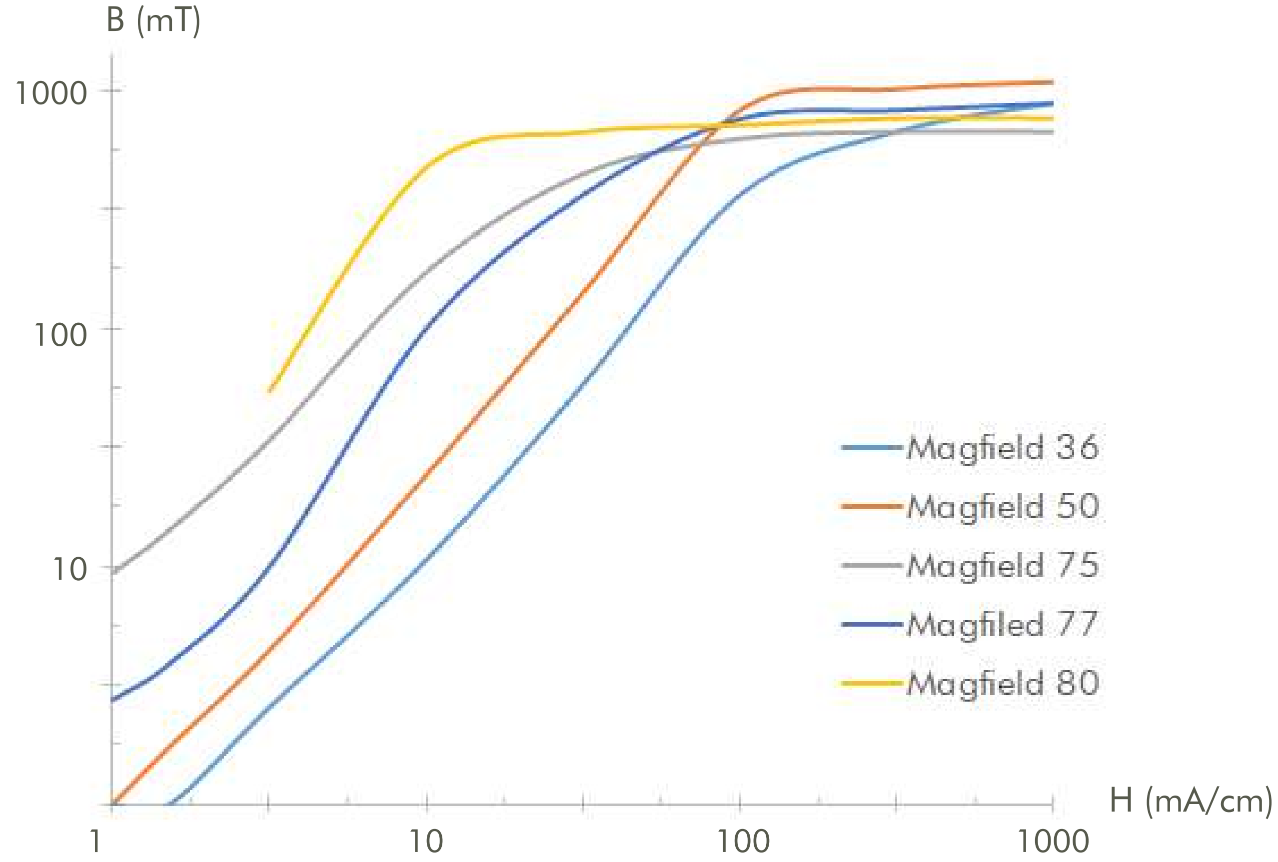


Figure 2. Typical induction/field strength curves measured at frequency 50 Hz using toroidal tape-wound cores of 0.20 mm strip thickness.

Magfield 36 (W.N.: 1.3910; UNS: K93600)

Description |

Iron-nickel soft-magnetic alloy with around of 36% nickel content.

Features |

Good permeability, low hysteresis losses at high frequencies, high resistivity, good ductility and toughness. Corrosion-resistant at room temperature in dry atmosphere.

Workability |

Can be easily cold, hot formed and machined. Workability is comparable to austenitic stainless steel.

Welding |

GTAW/GMAW/TIG/MIG: optimized welding filler is Alloy 36 (W.N.:1.3912); ERNiCr-3 (W.N.:2.4806). Before welding base material and welding filler should be cleaned by acetone. Brushing with a stainless steel wire brush immediately after welding results in heat tint removal and produces the desired surface condition without pickling.

Applications |

Electronics, optical benches, clock motor parts, scientific instruments, components for automotive industry, OLED screens, as a passive component in bi-metal compound, pendulum, pole shoes, relays, etc.

Magfield 50 (W.N.: 1.3922; UNS: K94840)

Description |

Iron-nickel soft-magnetic alloy with around of 48% nickel content.

Features |

Good permeability with low hysteresis losses, the highest possible saturation induction among nickel-iron soft-magnetic alloys, low coercive force. Corrosion resistance in a humid atmosphere is low.

Workability |

Can be easily cold, hot formed and machined. Workability is comparable to austenitic stainless steel.

Welding |

GTAW/GMAW/TIG/MIG: optimized welding filler is Alloy 48 (W.N.:1.3922); ERNiCr-3 (W.N.:2.4806). Before welding base material and welding filler should be cleaned by acetone. Brushing with a stainless steel wire brush immediately after welding results in heat tint removal and produces the desired surface condition without pickling.

Applications |

Relay, rotor and stator laminations, magnetic valves, shielding, gas safety, watches, sensors, transformers, transducers, memory cores, magnetic switches, chokes, etc.

Magfield 75 (W.N.: 2.4501; UNS: N14076)

Description |

Nickel-iron soft-magnetic alloy with around of 75% nickel content additionally alloyed by Cr and Cu.

Features |

High permeability, low coercive force. Corrosion resistance in a humid atmosphere is low.

Workability |

Can be easily cold, hot formed and machined. Workability is comparable to austenitic stainless steel.

Welding |

GTAW/GMAW/TIG/MIG: optimized welding filler is Alloy ERNiCr-3 (W.N.:2.4806), or any other nickel based welding alloy of similar content. Please check with us for advice of the best suitable alloy and welding process.

Applications |

Relay, rotor and stator laminations, magnetic valves, shielding, gas safety, watches, sensors, transformers, transducers, memory cores, magnetic switches, chokes, etc.

Magfield 77 (W.N.: 2.4530)

Description |

Nickel-iron soft-magnetic alloy with Ni content about 77%, additionally alloyed by 4% of Mo and 5.5% of Cu.

Features |

High permeability, good corrosion resistance in a humid atmosphere.

Workability |

Can be easily cold, hot formed and machined. Workability is comparable to austenitic stainless steel.

Welding |

GTAW/GMAW/TIG/MIG: optimized welding filler is Alloy ERNiCr-3 (W.N.:2.4806), ERNiCrMo-3 (W.N.: 2.4831) or any other nickel based welding alloy of similar content. Please check with us for advice of the best suitable alloy and welding process.

Applications |

Cores of pulse transformers, magnetic amplifiers, relays, LF transducers, high metering accuracy (HMA) cores, laminations, shielding, etc.

Magfield 80 (W.N.: 2.4545; UNS: N14080)

Description |

Nickel-iron soft-magnetic alloy with Ni content about 80%, additionally alloyed upto 6% of Mo.

Features |

High initial permeability, maximium permeability with minimum hysteresis losses. Good corrosion resistance in a humid atmosphere.

Workability |

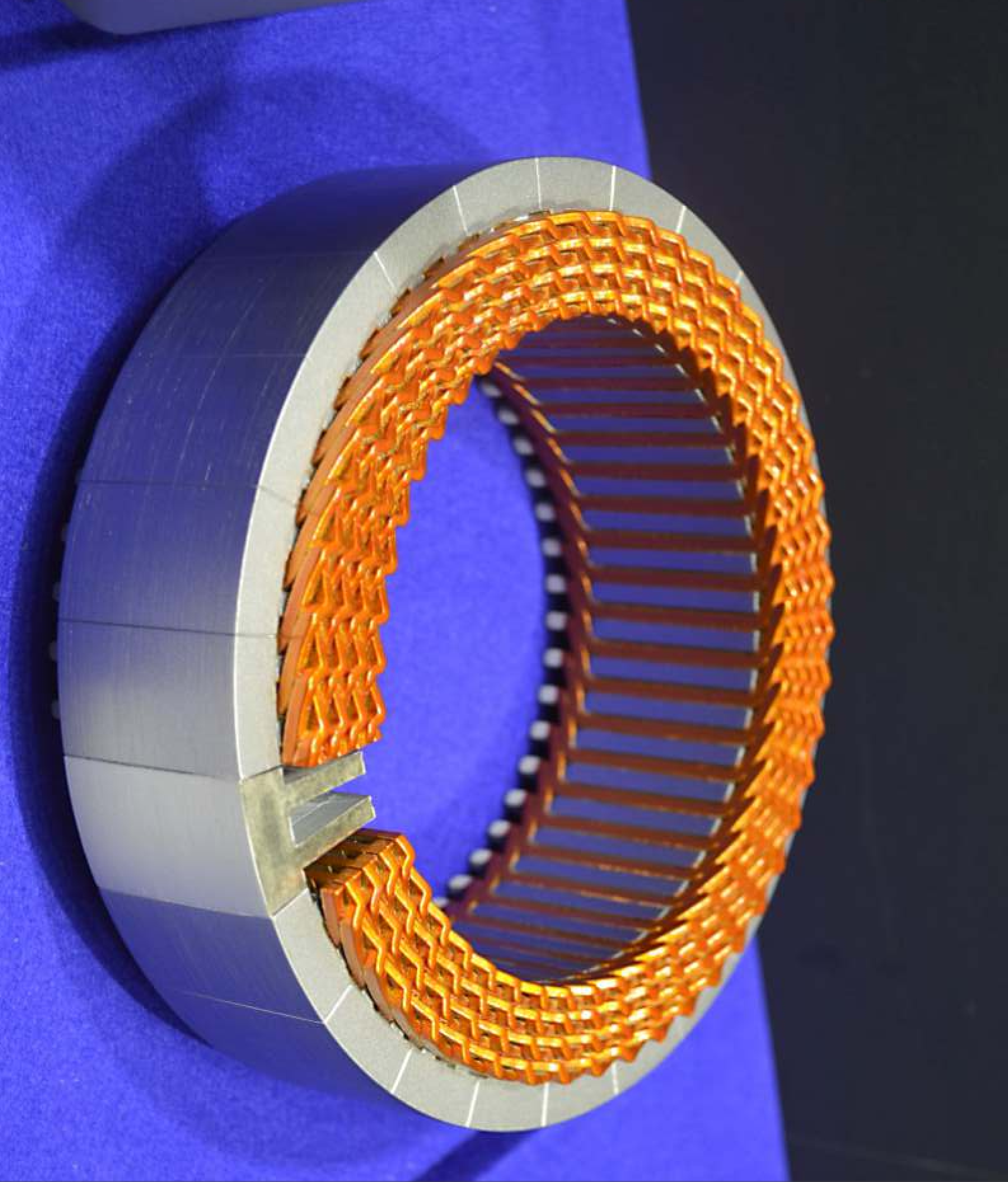
Can be easily cold, hot formed and machined. Workability is comparable to austenitic stainless steel.

Welding |

GTAW/GMAW/TIG/MIG: optimized welding filler is Alloy ERNiCr-3 (W.N.:2.4806), ERNiCrMo-3 (W.N.: 2.4831) or any other nickel based welding alloy of similar content. Please check with us for advice of the best suitable alloy and welding process.

Applications |

Memory cores, transformers, transducers, chokes, laminations, shielding, relay parts, stepping motors, toroidal strip wound cores, etc



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