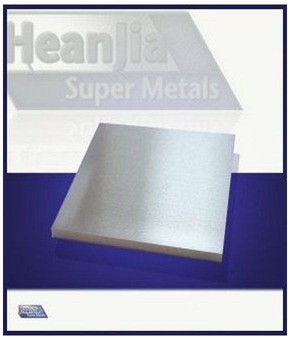
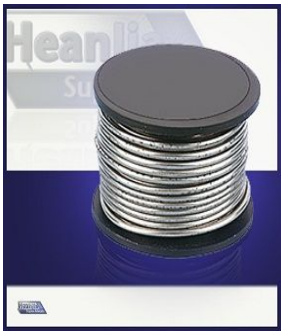
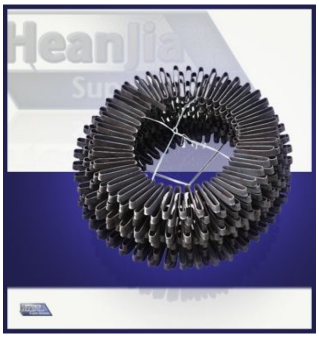
Mumetal Magnetic Shielding



Mu metal is a soft ferromagnetic alloy that has extremely high initial and maximum magnetic permeability. It is used in electric transformer, storage disks, magnetic phonographs, resonance devices and superconducting circuits.

Mumetal alloy generally attributes relative permeability about 80,000 to 100,000 than the normal steel alloy. It is also called as soft magnetic alloy and offers low magnetic anisotropy and magnetostriction providing low corceivity to saturate the low magnetic fields. It provides nominal hysteresis loses when the alloy is employed in the AC magnetic circuits. Various high permeability **Nickel-Iron alloys** are comprising of equivalent magnetic features, the benefit of using Mumetal is that is has more ductile features and provides good performance making it to be easily forged in the thin sheets that are used for magnetic shielding.

Chemical Composition

Carbon (C)	0.02 %
Manganese (Mn)	0.50 %
Silicon (Si)	0.35 %
Nickel (Ni)	80 %
Molybdenum (Mo)	4.20 %
Iron (Fe)	Rem %

Physical Properties

Specific Gravity	8.74
Density	0.316 lb/inch3
	8747 kg/meter3
Thermal conductivity	240 Btu-in/ft^2/hr/°F
	34.6 W/m· K
Electrical resistivity	349 ohm-cir mil/ft or 580 microhm-mm

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Temperature coefficient of electrical resistivity	0.0006 per oF from 0 to 930oF
	0.0011 per °C from -17.8 to 499°C
Curie temperature	860 oF to 460 oC
Melting point	2650 oF or 1454oC
Specific heat	0.118 Btu/lb · °F or 0.494 kJ/kg · K

Coefficient of thermal expansion

Temperature		Coefficient of thermal expansion	
oF	oC	10^{-6} /°F	10^{-6} /°C
-103 oF to 77 oF	-75 oC to 25 oC	6 x 10^{-6} /°F	10.80 x 10^{-6} /°C
-58 oF to 77 oF	-50 oC to 25 oC	5.94 x 10^{-6} /°F	10.70 x 10^{-6} /°C
-11 oF to 77 oF	-25 oC to 25 oC	5.78 x 10^{-6} /°F	10.40 x 10^{-6} /°C
77 oF to 122 oF	25 oC to 50 oC	6.83 x 10^{-6} /°F	12.30 x 10^{-6} /°C
77 oF to 212 oF	25 oC to 100 oC	6.89 x 10^{-6} /°F	12.40 x 10^{-6} /°C
77 oF to 392 oF	25 oC to 200 oC	7.09 x 10^{-6} /°F	12.76 x 10^{-6} /°C
77 oF to 572 oF	25 oC to 300 oC	7.22 x 10^{-6} /°F	13 x 10^{-6} /°C
77 oF to 752 oF	25 oC to 400 oC	7.39 x 10^{-6} /°F	13.30 x 10^{-6} /°C

Mechanical Properties

Hardness	120 Hv
Tensile strength	530 Mpa
Yield strength	160 Mpa
Elongation	45 %
Permeability	350000 to 500000
Saturation induction	0.76
Coercive force	0.6 A/m
DC hysteresis loss from H = 1 Oe, erg/cm^3 per cycle	16
Induction	7300 gauss
Residual induction	3500 gauss

Processing

Mumetal needs heat processing after getting converted in the final form such as annealing in the magnetic region in the presence of hydrogen that increases the magnetic permeability by 40 times. The annealing changes the crystal form, arranging the grain and eradicating the impurities like carbon and others that inhibit the free movement of the magnetic domains. The deformation or mechanical stress applied after the annealing cause disturbance of grain arrangement in the alloy decreasing the permeability of affected region that can be recovered by recurring the hydrogen annealing of **Mumetal alloy**.

The large permeability of Mumetal offers a nominal reluctance way for magnetic flux making it widely usable in the magnetic shields. The magnetic shield comprised with large permeability, material such as **Nickel-Iron alloy Mumetal** performs not by inhibiting the magnetic fields though offering the way for magnetic field lines surrounding the shielding region. Therefore the suitable shape for shielding material is the closed vessel covering the shielded region. The influence of the Mumetal shielding reduces with the permeability of Mumetal that reduces at the low field strength and due to equilibrium at the large field strength. Therefore the mumetal shields are made of many inclusions inside each other that every one that gradually decreases the magnetic field inside it. Because **Mumetal alloy** balances at the poor magnetic fields, the external layer in these multilayer shields is comprised of normal steel.

The large saturation value of magnetic fields decreases to the nominal level that can be shielded adequately by the internal Mumetal layers. The magnetic field more than 100 khz can be shielded via Faraday shields. The superconducting materials can also eject the magnetic fields with the Mesissner effect that need the cryogenic temperatures.

Annealing

Mumetal stress annealed alloy is offered in various forms though the most shields are forged in gauges and inches. Mumetal foil is completely annealed. It is employed where large attenuation is required. It is manufactured in the fully annealed form best for using in the shielding applications like cover, door, wall or flat surface. It is completely annealed in the specific configuration in the quality controlled conditions that provide grains structure, an essential mechanical feature for quality shielding. Mumetal alloy is also introduced in the wire, strip, sheet, plate and tube forms.

Applications

The primary use of Mumetal alloy is in shielding equipment from magnetic field. It is used in electric power transformers that are comprised of Mumetal shells to avoid them get influenced by the neighbor circuits. The hard disks that have Mumetal backside to the magnets are discovered in the drive to avoid the magnetic field from the disk.

The magnetic resonance imaging system also uses **Nickel-Iron Mumetal wire** as well as it is used in the magnetometer, photomultiplier tubes and vacuum chambers for assessments with nominal energy electrons such as photoelectron spectroscopy.

Available Forms

Wire, Strip, Foil, Plate, Sheet, Mesh