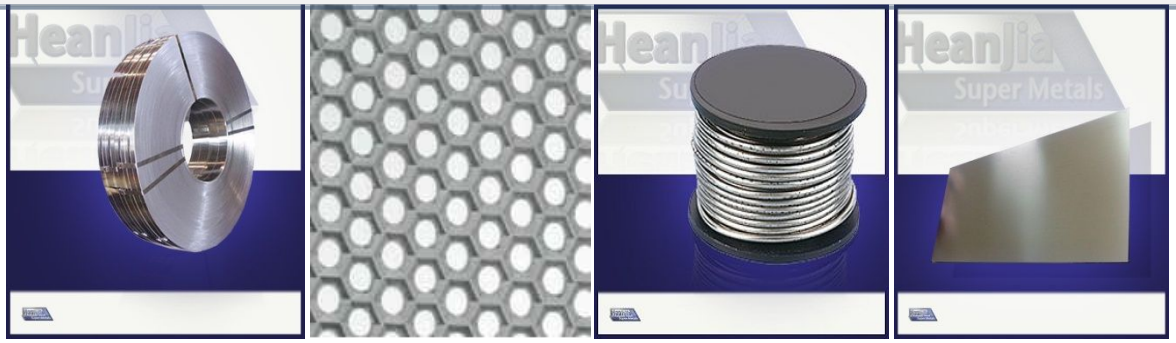
Permalloy, Carpenter HyMu 80, Hipernom



Permalloy or Carpenter HyMu 80 is a nickel-iron-molybdenum alloy providing great resistance to general corrosion and humidity. It has high magnetic permeability. It is basically a Nickel-Iron-Molybdenum alloy that provides high magnetic permeability with low hysteresis loss. It is commonly used in magnetic toroids, transformer cores, home theater systems and shielding applications.

Chemical Composition

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

Physical Properties

Specific Gravity	8.74
Density	0.3160 lb per inch3
Specific heat	0.118 BTU/lb/of
Thermal conductivity	240.1 BTU-in/hr/ft²/°F
Elastic modulus	31.4 x 10(3) ksi after process annealing up to 871oC
	33.7 x 10 (3) ksi after cold drawing
	33.3 x 10(3) ksi after hydrogen annealing at 1177oC
Electrical resistivity	349 ohm-cir-mil/ft at 70oF
Coefficient of electrical resistivity	6.00 x 10^{-4} Ohm/Ohm/°F at 0 to 930oF
Curie temperature	860oF
Melting point	2650oF
Coercivity	0.00800 to 0.0200 Oe
Permeability	200000
Residual induction	3500 G
Hysteresis Loss	1.80E-6 to 2.40E-6 J/cm³/cycle

Modulus of Elasticity

Subsequent Process Annealing up to 871°C, In Tension	31.4 x 10^3 ksi
Cold Drawn, In Tension	33.7 x 10^3 ksi
Hydrogen Annealed at 1177°C, In Tension	33.3 x 10^3 ksi

Shielding

Permalloy possesses high permeability and minimum coercive force, it is useful in the magnetic shielding operations. The annealed and deep drawn alloy can be formed into shields through bending, forging and spinning. Spot or tungsten inert gas welding methods are used including or excluding base metal filler rod.

The alloy shields are annealed up to 1900oF to obtain the suitable shielding properties after accomplishing the forging processes. Generally, high temperature yield strength and improved permeability are obtained.

In order to find the relative shielding competency of alloy HyMu 80, a specimen is assessed as an open ended cyinderical shield in a uniform magnetic field that is created by Helmholtz coil. When a pickup system is placed in coil, attenuation that is a ratio of finding no shield to that noticed when material is placed over the pickup having perpendicular axis on the field. It calculates the effect of shielding in the specific testing media and for provided specimen on the base of its thickness, length to diameter ratio and coil diameter.

Fabrication

Heat Processing

In the annealing process, to remove deformation and regaining alloy in a soft form, drawing, spinning, forging, bending, annealing up to 1450 to 1850oF is done for less than 60 minutes. As alloy contains high content of nickel, high permeability alloys immediately soak carbon, sulfur, oxygen and other elements from burnt gases in the furnace. This annealing should be done in the presence of detached ammonia, vacuum or inert gas and hydrogen conditions.

Hydrogen Annealing

To get utmost softness and suitable magnetic and electric features, the alloy is annealed in absence of oxygen with hydrogen at 1121oC to 1177oC for two to four hours. The furnace quenching up to 1100oF is done. From 1100oF to 700oF, quenching rate is between 350oF to 600oF per hour. Oil, grease, lacquer and pollutants should be eradicated prior to annealing. The component parts should be isolated through inert insulating powder like magnesium and aluminum oxide while hydrogen annealing.

Vacuum heat processing can be done. Normally, minor loss in magnetic features is noticed as compare to heat processing in arid hydrogen conditions.

Cold Processing

For high blanking features, Carpenter HyMu 80 alloy should be kept in the cold treated conditions. For high forging features, alloy strip should be processed in the cold rolled and annealed conditions. For excellent drawing features, the alloy should be annealed and deep drawn.

Welding Features

Carpenter alloy HyMu 80 is readily weldable by implementing the common processes for ferrous alloy. If a filler metal is needed, the same methods are used. The end annealed alloys can be tender or tough soldered. The soldering is not preferred before heat processing.

Mean coefficient of linear expansion

Temperature	in/in/°F
-103 oF to 77 oF	6 x 10 (-6) in/in/°F
-58 oF to 77 oF	5.94 x 10 (-6) in/in/°F
-11 oF to 77 of	5.78 x x 10 (-6) in/in/°F
77 of to 122 of	6.83 x 10 (-6) in/in/°F
77 of to 212 of	6.89 x 10 (-6) in/in/°F
77 of to 392 of	7.09 x 10 (-6) in/in/°F
77 of to 572 of	7.22 x 10 (-6) in/in/°F
77 of to 752 of	7.39 x 10 (-6) in/in/°F

Corrosion Resistance

It offers medium resistance to damped and atmospheric corrosive conditions.

Mean Critical temperature emissivity

-103 to 77°F	6.00 x 10^{-6} in/in/°F
-58 to 77°F	5.94 x 10^{-6} in/in/°F
-11 to 77°F	5.78 x 10^{-6} in/in/°F
77 to 122°F	6.83 x 10^{-6} in/in/°F
77 to 212°F	6.89 x 10^{-6} in/in/°F
77 to 392°F	7.09 x 10^{-6} in/in/°F
77 to 572°F	7.22 x 10^{-6} in/in/°F
77 to 752°F	7.39 x 10^{-6} in/in/°F

Available Forms

Wire, Strip, Sheet, Plate, Foil, Mesh