

## Nilo 48 Invar 48 (UNS K94800)



Nilo 48 or Invar 48 offers stable coefficient of thermal expansion up to 840oF. Common material for glass to metal sealing. It is also used in electronic industries and transmission lines for LNG.

### Chemical Composition

Iron (Fe)	Rem %
Nickel (Ni)	48 %
Cobalt (Co)	-
Carbon (C)	0.05 %
Silicon (Si)	0.30 %
Sulfur (S)	0.025 %
Chromium (Cr)	0.025 %

### Physical Properties

Density	0.298 lb/cu in
Specific Gravity	8.25
Curie Temp	880 oF or 471oC
Melting Point	2600 oF or 1427oC
Electrical Resistivity	49 Micro-ohm-cm or 290 ohm-cir mil/ft
Thermal Conductivity	0.13 W/cm oC or 90 BTU-in/sq. ft-hr-
Specific Heat	0.12 Cal/g- oC
Thermal Expansion	5.0 ppm / oF (75oF to 842oF) or 9.0 ppm / oC (25oC to 450oC)

### Mechanical Properties

Tensile Strength	75 ksi or 545 MPa
Yield Strength	36 ksi or 248 Mpa
Elongation	30 % in 2 inches
Typical Hardness Ann.	80 Rockwell HRB
Modules of Elasticity	23 Mpsi or 159 kMPa

## Linear coefficient of thermal expansion

Temperature, oC	Linear CTE
30 to 100	9.4
30 to 150	9.4
30 to 200	9.4
30 to 250	9.3
30 to 300	8.8
30 to 325	--
30 to 350	9.0
30 to 375	--
30 to 400	8.2 to 9.2
30 to 425	8.9
30 to 450	9.0
30 to 475	9.3
30 to 500	9.4
30 to 525	--
30 to 550	9.6 to 10.3
30 to 600	10.4
30 to 700	11.3
30 to 800	12.1
30 to 900	13.0
30 to 1000	13.9

## Fabrication

Nilo alloys can be heat and cold processed, machined and produced by the process as followed for the austenitic stainless steel. Nilo alloys can be welded by employing Nickel Welding Electrode 141, INCO-WELD A, or INCOWELD B electrodes by following the metal arc method and Nickel Filler Metal 61 or INCONEL Filler Metal 82 for TIG, plasma, MIG, or pulsed arc welding. The MIG spray and submerged arc welding methods are not preferred for Nilo alloys. The welding of Nilo alloys is performed for the aerospace components. The **Nickel-Iron alloy wire** is offered in the annealed temper. The cutting, forming, welding and rough machining is performed on the annealed material subsequently age hardening and eventual machining. In the aging cycle, a nominal contraction takes place in Nilo alloy just like the other age hardening nickel alloys. The fabricated tool moving while heat processing is reduced and causes no issues while tool production or use.

A Nickel-Iron alloy can be immediately cold processed in the annealed condition and machined easily like annealed or annealed and age hardened temper. The large strength and toughness, age hardening Nilo alloy 365 is nominally sticky while machining than the tender, annealed Nilo alloy 48.

### Welding

Using **Ni** alloy for composite tooling at onetime is restricted by less welding components that cause sound weld metals more incline to cracking which are however overcome by Ni filler metals CF36 and CF42, filler wires with expansion rates similar to the main metals providing excellent crack free, vacuum rigid welds by submerged arc, gas metal arc and gas tungsten arc processes.

The improved composition of niobium and carbon produced for **Nickel-Iron alloy** welding proves to be better over previous manganese and titanium improved composition also called as Invar that is crack sensitive and possesses three times CTE of Ni filler CF36. Choosing an approximate filler metal that should be produced to meet the thermal expansion nature needed for the weld. The expert engineers at Heanjia alloys are continuously attempting on the production of new welds for Ni alloys. The produced quality is superior. 100% inert shielding gas is preferred. The care is taken to monitor the highest interpass temperature limit to 300oF or 150oC to prevent oxidation and undercutting.

The Gas metal arc welding GMAW parameters are shown in the below table:

Transfer Type	Wire Feed Speed		Voltage	Current
	in/min	m/min	Vol	Amp
Spray	300 - 400	7.6 - 10.2	29 – 33	
Short Circuit	500	12.7	25 – 27	
60 Pulses/Second	250	6.3	21 (background)	400 peak/150 average
120 Pulses/Second	320	8.1	21 (background)	400 peak/170 average

The weld beads on the pickled or unready plate causes the GMA cleaning task undercutting any oxide layer is produced. It is resolved by removing the oxide layer prior to welding. If the preparation is not viable, the SAW process is considered as the flux utilized with SAW permits welding without inner cutting. In case SAW is not viable, GMAW attachment value weldments can be prepared, free of undercutting by using the short circuiting factors are listed in the above table.

The plunged **Nickel-iron alloy** filler metals CF36 and CF42 provide wonderful SAW features. Use of INCOFLUX 6 is highly preferred to get the excellent results. SAW can be done by following the traditional factors as provided in the below table:

	Wire Feed Speed		Voltage	Current	Travel Speed	
	in/min	m/min	Vol	Amp	in/min	mm/min

Typical	370	9.4	31-34	230-260	8-12	203-305
High Deposition	650	16.5	32	320-360	8-15	203-381

The traditional processes provide the accumulation rate of about 10 lb (4.5 kg) per hour) and superior quality welding parts that are produced at the speed of 18 lb or 8.1 kg per hour.

## Available Forms

Wire, Strip, Foil, Plate, Sheet, Mesh