Technical Datasheet

CarTech® Super Invar 32-5

Identification

UNS Number

• K93500

Type Analysis

Single figures are nominal except where noted.

Carbon	0.02 %	**Manganese**	0.40 %
Silicon	0.25 %	**Nickel**	32.00 %
Cobalt	5.50 %	**Iron**	Balance

General Information

Description

CarTech Super Invar 32-5, a magnetic, austenitic, solid solution alloy containing iron, nickel and cobalt, is designed to provide minimum thermal expansion at room temperatures.

This alloy also exhibits austenite stability to service temperatures at least -67°F (-55°C) and thermal expansion properties less than those of Carpenter Invar "36"® alloy (36% nickel-iron) when used in the -67/203°F (-55/95°C) temperature range.

Applications

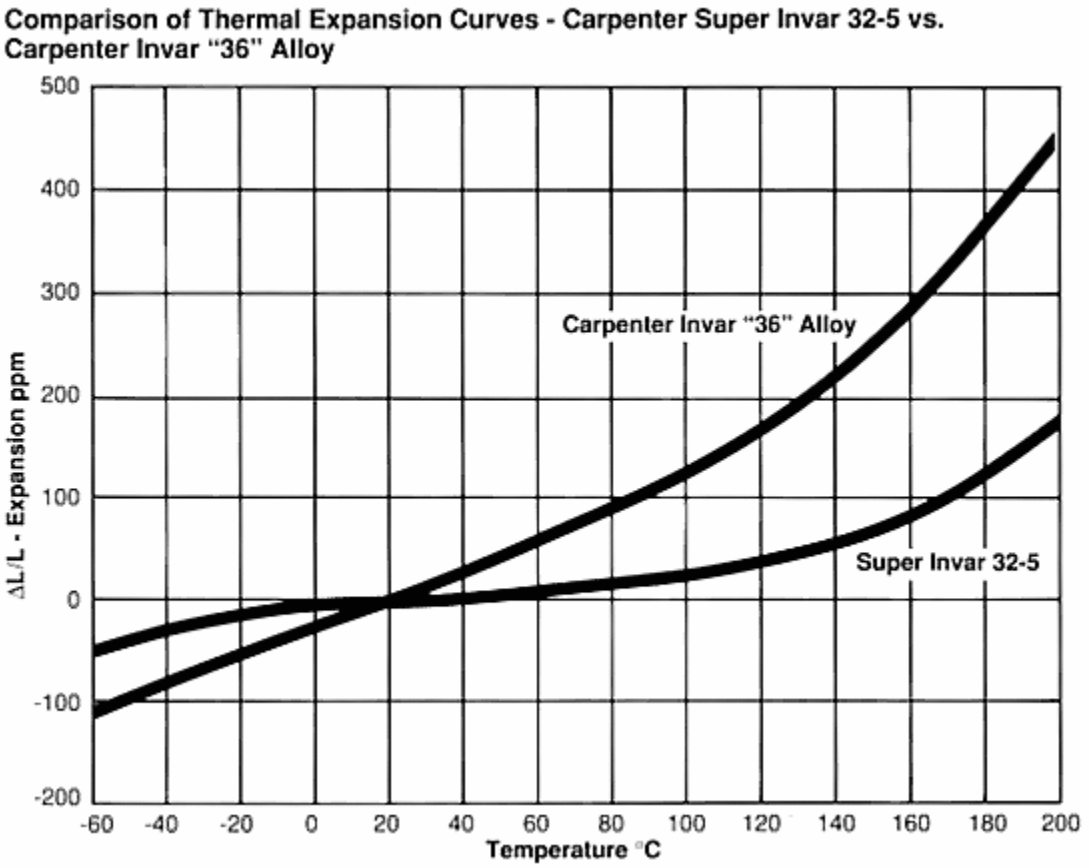
Applications for CarTech Super Invar 32-5 have included structural components for supports and substrates in optical and laser systems requiring precision measurements.

This alloy has also been used in wave guide tubes and other systems requiring metals in conjunction with low expansion glass/quartz assemblies.

Properties

Physical Properties

Specific Gravity	8.15	
Density	0.2940	lb/in³
Mean CTE (-67 to 203°F)	0.350	x 10 $^{-6}$ in/in/°F



Poisson's Ratio	0.230	
Modulus of Elasticity (E)	21.0	x 10 ³ ksi
Electrical Resistivity (73°F)	481.3	ohm-cir-mil/ft
Martensite Start	-112	°F

Typical Mechanical Properties

Typical Mechanical Properties - Carpenter Super Invar 32-5

0.2% Yield Strength		Ultimate Tensile Strength		% Elongation in 2" (50.8 mm)	Hardness Rockwell B	
ksi	MPa	ksi	MPa		Annealed	Cold Worked
40	276	70	483	40	75	90

Heat Treatment

Fabricating practices such as machining, forming, and deep drawing introduce stresses in this alloy which promote variation in thermal expansion behavior. Consequently, parts should be heat treated at or as close to finish size as possible.

Heat Treating for Lowest Thermal Expansion and Optimum Stability:
The recommended heat treating practice for lowest thermal expansion and optimum stability is to heat at 1550°F (843°C) for 1 hour, water quench, followed by a stress relieving operation at 600°F (316°C) for 1 hour, air cool and age at 200°F (93°C) for 24 hours, then air cool.

Because this alloy oxidizes readily at heat treating temperatures above about 1000°F (538°C), it is recommended parts be heat treated in a protective environment such as vacuum, hydrogen, dissociated ammonia, or inert gases.

Annealing

Heat to 1450°F (790°C) and hold at heat 30 minutes per inch of thickness, then air cool. Heating to temperatures above 1000°F (538°C) relieves the presence of cold work stresses. The higher the temperature, the lower the annealed hardness.

Workability

Forging

Suggested forging temperature is 2000/2150°F (1093/1177°C).

Heat rapidly and avoid soaking in the forging furnace. Long soaking time may result in a checked surface due to oxygen and sulfur contamination.

Cold Heading

This alloy may be swaged or cold upset.

Blanking and Forming

Super Invar 32-5 presents no unusual problems in blanking and forming. For best blanking, a hardness of Rb 90 is suggested. This hardness will allow mild bending and forming operations. When deep drawing operations are involved, a mill annealed strip of Rb 75 is usually desirable.

Machinability

Super Invar 32-5 machines similar to, but not as well as, Type 316 austenitic stainless steel. Its machinability rating is approximately 25% that of AISI B1112.

This alloy is somewhat difficult to machine because the machined chips are gummy and stringy. Work hardened bars can result in some improvement in machinability.

Tool geometries normally used for austenitic stainless steels are suitable for this alloy. All tools should be kept sharp with a fine finish, be as large as possible, and rigidly supported.

Recommended cutting fluids are 1 to 1 blend of a sulfachlorinated petroleum oil containing 8% to 10% fatty oil and a paraffin blending oil, or a water emulsifiable cutting fluid with polar and extreme pressure additives.

Parts should be degreased and cleaned as soon after machining as possible to remove any residual sulfur which can cause grain boundary embrittlement.

Following are typical feeds and speeds for Super Invar 32-5.

Turning - Single Point and Box Tools

Depth of Cut, in	Speed, fpm	Feed, ipr
.100 .020	30 20	.010 (Roughing) .002 (Finishing)

Turning - Cutoff and Form Tools

Speed, fpm	Feed, ipr				
	Tool Width				
	.125"	.250"	.500"	1.00"	2.00"
20	.001	.001	.0015	.001	.0007

Drilling

Speed, fpm	Feed, ipr							
	Drill Diameter, in							
	1/16	1/8	1/4	1/2	3/4	1	1-1/2	2
35	.001	.003	.004	.008	.010	.012	.015	.018

Tapping

Speed, fpm			
Threads/inch			
7 or less	8-15	16-24	Over 24
6	8	12	15

End Milling

Radial Depth of Cut, in.	Speed, fpm	Feed, in./tooth			
		Cutter Diameter - in.			
		3/8	1/2	3/4	1 to 2
.020 .060	65 50	.002 .002	.002 .003	.003 .004	.004 .005

Additional Machinability Notes

When using carbide tools, surface speed feet/minute can be increased between 2 to 3 times over the high speed suggestions. Feeds can be increased between 50 and 100%.

Figures used for all metal removal operations are average. On certain work, the nature of the part may require adjustment of speeds and feeds. Each job has to be developed for best production results with optimum tool life. Speeds or feeds should be increased or decreased in small steps.

Grinding and Polishing

A soft silicon carbide wheel which will wear without loading is recommended. For finish grinding, a satisfactory wheel roughness to start with is No. 80 grit.

Plating

Super Invar 32-5 can be chromium, cadmium, and nickel plated or zinc coated by the usual methods used for ferrous alloys.

Other Information

Applicable Specifications

- ASTM F1684

Forms Manufactured

- Bar-Flats
- Bar-Rounds
- Bar-Squares
- Billet
- Strip
- Wire

Technical Articles

- After 100 Years, the Uses for Invar Continue to Multiply
- Invar Alloy Resonator Support Structure Maintains Pinpoint Accuracy in Laser Technology
- Matching Glass and Metal Thermal Expansion Rates Key to Accuracy of World's Largest Telescope
- Selecting Controlled Expansion Alloys

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