

# DATA SHEET

## INVAR 42 FOR COMPOSITE TOOLING

### APPLICATION

Re-Steel produces Invar 42 in accordance to the **Boeing D33028-2** and **ASTM-F30 specifications**. The constraints of these specifications limit the Sulfur and Phosphorus content of the material for increased weldability. This material has been specifically manufactured for composite tooling when low Coefficient of Thermal Expansion (CTE) is required.

### CHEMISTRY – Typical Percent by Weight

Carbon	C	0.02%
Manganese	Mn	0.35%
Silicon	Si	0.20%
Nickel	Ni	42.00%
Iron	Fe	BAL.
Sulphur	S	0.002%
Phosphorus	P	0.002%

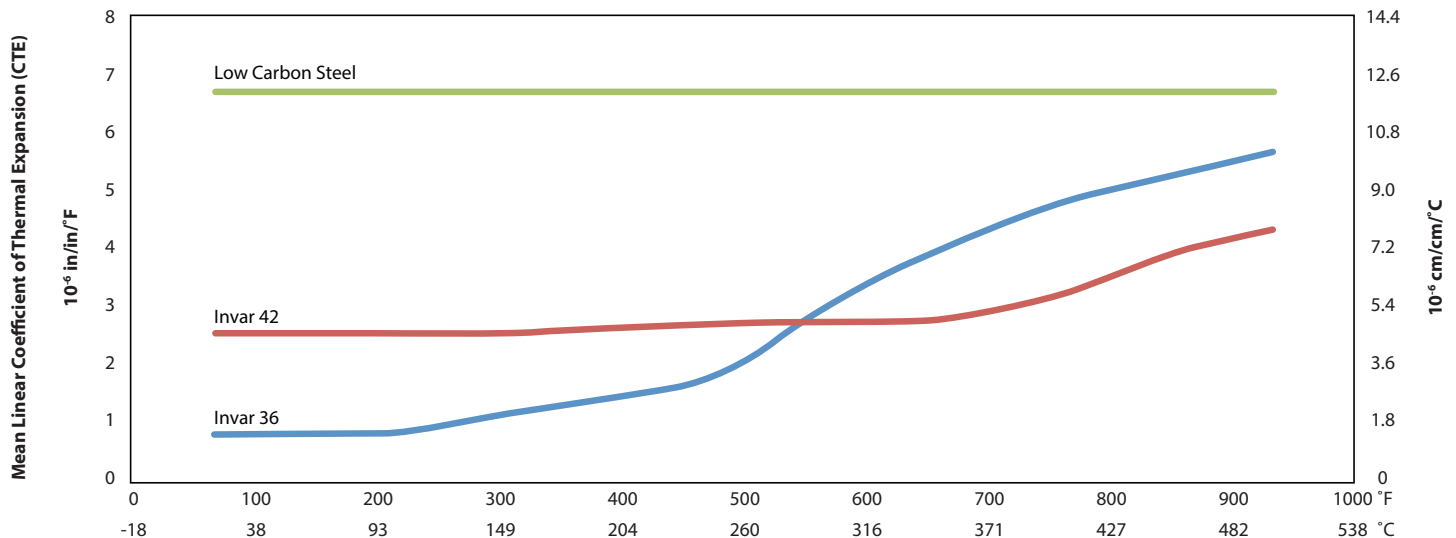
### TYPICAL THERMAL EXPANSION

Temp. Range		Mean Linear Coefficient	
°C	°F	10E-6/°C	10E-6/°F
25-100	77-212	4.47	2.57
25-200	77-392	4.58	2.64
25-300	77-572	4.61	2.71
25-350	77-662	5.02	2.78
25-400	77-752	5.70	3.14
25-450	77-842	7.03	3.83
25-500	77-932	7.78	4.32
25-600	77-1112	9.90	5.50
25-700	77-1292	11.00	6.12
25-800	77-1472	11.99	6.66
25-900	77-1652	12.78	7.10

### TYPICAL PHYSICAL PROPERTIES

Density	lb/ in <sup>3</sup>	0.297
	Kg / m <sup>3</sup>	8221
Modulus of Elasticity @ Room Temp.	x10 <sup>6</sup> PSI	21.0
	x10 <sup>3</sup> MPa	141
Yield Strength 0.2%	KSI (MPa)	37 (248)
Tensile Strength	KSI (MPa)	72 (489)
Hardness	Rb	75
Curie Temp.	°F	680
	°C	360
Melting Point	°F	2600
	°C	1425
Thermal Conductivity	Btu-in/ft <sup>2</sup> /hr/°F	74.5
	W/m · K	9.25

### TYPICAL THERMAL EXPANSION



## ANNEALING

Type	Temp		Duration	Purpose
FULL ANNEAL	1650° F	899° C	60 min / 1" of Thickness	To be done following extensive forming or welding
STRESS RELIEF ANNEAL	800° F	427° C	120 mins.	To be done between rough and final machining or after minor repairs

## WELDING

**Three processes are typically used for welding Invar 42 for tooling applications\*:**

- Gas Metal Arc Welding (GMAW aka MIG)
- Gas Tungsten Arc Welding (GTAW aka TIG)
- Submerged Arc welding (SAW)

\*Re-Steel supplies spooled and cut-to-length Invar weld wire conforming to Boeing D33028-2.

**Additional welding processes may be used for Invar 42:**

- Electron Beam Welding (EBW)
- Laser Beam Welding (LBW)

## TYPICAL MACHINING PARAMETERS

Process		Tool Type		Surface Speed	Feed Rate	Axial Rake	Radial Rake
				fpm (m/min)	in/tooth (mm/tooth)		
Milling	Roughing	End Mill	Carbide	300 (91)	0.004 (0.10)	25°	12°
		Face Mill	Carbide	400 (122)	0.004 (0.10)		
	Finishing	End Mill	Carbide	300 (91)	0.005 (0.13)	45°	15°
		Face Mill	Carbide	400 (122)	0.004 (0.10)		
Lubrication: Water soluble oil flood coolant							

Process		Tool Type		Hole Diameter	Speed	Feed Rate
				inches (mm)	RPM	IPR (mm/revolution)
Drilling	Twist Drill 2 Flute 118° Point Angle	High Speed Steel (HSS)	1/4 (6.4)	600	0.002 (0.051)	
			3/8 (9.5)	300	0.003 (0.076)	
			1/2 (12.7)	175	0.004 (0.102)	
Lubrication: Oil emulsion						