CARPENTER TECHNOLOGY

DATASHEET

NIMARK® T-250

Applicable specifications: AMS 6519; MIL-S-47319A Type I, Class 1

Associated specifications: K92150

Type analysis

Single figures are nominal except where noted.

Iron	Balance	**Nickel**	18.00–20.00 %	**Molybdenum**	2.75–3.25 %
Titanium	1.30–1.45 %	**Chromium**	Max 0.50 %	**Cobalt**	Max. 0.50 %
Copper	Max 0.50 %	**Aluminum**	0.05–0.15 %	**Manganese**	Max 0.10 %
Silicon	Max 0.10 %	**Carbon**	Max 0.030 %	**Zirconium**	0.020 %
Phosphorus	Max 0.010 %	**Sulfur**	Max 0.010 %	**Boron**	0.003 %

Forms manufactured

Bar	**Billet**

Description

NiMark T-250 is a titanium-strengthened 18% nickel maraging steel designed to achieve ultra-high strength (250 ksi UTS) and toughness of NiMark 250 (cobalt-strengthened 18% nickel maraging steel). NiMark T-250 contains no cobalt and less molybdenum than NiMark 250 to reduce raw material cost without sacrificing mechanical strength or toughness. NiMark T-250 is vacuum induction melted (VIM) plus vacuum arc remelted (VAR) to achieve a very clean and homogeneous microstructure, which contributes to toughness and fatigue performance. Like other nickel maraging alloys, NiMark T-250 is typically supplied in the solution annealed condition, and peak properties are developed after a simple one-step, low-temperature aging thermal treatment (900°F, 4–6 hours, air cool). A high degree of dimensional stability is maintained through the aging process.

Key Properties:

- Ultra-high strength
- High toughness
- Machinable
- Good formability
- Good hot workability
- Weldable

Markets:

- Aerospace
- Defense

Applications:

- Actuators
- Gears and shafts
- Fasteners and pins
- Missile and rocket motor cases

info@cartech.com | 610 208 2000

> NIMARK T-250

Description, continued

In the solution annealed condition, the low hardness ~30 HRC promotes good machinability and good formability. NiMark T-250 also has good hot workability for applications requiring hot forging or hot rolling.

Corrosion resistance

Like other 18% nickel maraging alloys, NiMark T-250 does not possess inherent corrosion resistance and requires protection. Conventional cathodic protection is not recommended due to hydrogen embrittlement concerns.

IMPORTANT NOTE:
The following 4-level rating scale (Excellent, Good, Moderate, Restricted) is intended for comparative purposes only and is derived from experiences with wrought product. Additive manufactured material may perform differently; corrosion testing is recommended. Factors that affect corrosion resistance include temperature, concentration, pH, impurities, aeration, velocity, crevices, deposits, metallurgical condition, stress, surface finish, and dissimilar metal contact.

Humidity	Restricted

Physical properties

PROPERTY	At or From	English Units	Metric Units
SPECIFIC GRAVITY	—	8.02	8.02
DENSITY	—	0.290 lb/in^3	8027 kg/m^3
MEAN COEFFICIENT OF THERMAL EXPANSION ANNEALED MATERIAL	75 to 200°F (25 to 93°C)	5.40 x 10^{-6} in/in/°F	9.72 x 10^{-6} cm/cm/°C
	75 to 400°F (25 to 204°C)	5.69 x 10^{-6} in/in/°F	10.2 x 10^{-6} cm/cm/°C
	75 to 800°F (25to 427°C)	6.04 x 10^{-6} in/in/°F	10.9 x 10^{-6} cm/cm/°C
MODULUS OF ELASTICITY (E)	—	27.5 x 10^6 psi	189.6 x 10^3 MPa
ELECTRICAL RESISTIVITY	70°F (21°C)	300 ohm-cir-mil/ft	49.9 microohm·cm
MELTING RANGE	—	2600–2650°F	1427–1454°C

> NIMARK T-250

CHEMISTRY VS. NIMARK 250				
	NIMARK T-250		NIMARK 250	
	MIN	MAX	MIN	MAX
Carbon	—	0.030	—	0.030
Manganese	—	0.10	—	0.10
Silicon	—	0.10	—	0.10
Phosphorus	—	0.010	—	0.010
Sulfur	—	0.010	—	0.010
Nickel	18.00	20.00	17.00	19.00
Molybdenum	2.75	3.25	4.60	5.20
Titanium	1.2	1.6	0.30	0.50
Aluminum	0.05	0.15	0.05	0.15
Chromium	—	0.50	—	0.50
Cobalt	—	0.50	7.00	8.50
Copper	—	0.50	—	0.50
Iron	—	Balance	—	Balance

Typical mechanical properties

Material normalized and solution annealed at full cross section and aged at 0.25–0.50 in. gauge diameters.

ROOM TEMPERATURE MECHANICAL PROPERTIES, BAR 1.00–4.50 IN.								
FORM & HEAT TREATMENT	ORIENTATION	0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION IN 4D	REDUCTION OF AREA
		ksi	MPa	ksi	MPa	%	%
0.25 in. gauge As forged	L	125	862	156	1076	15.2	63.8
0.250 or 0.50 in. gauge Solution annealed at 1500°F, 1 hr, AC	L	118	814	158	1089	17.6	73.5
0.250 or 0.50 in. gauge Solution annealed at 1700°F, 1 hr, AC	L	109	752	146	1007	17.3	75.7
0.25 or 0.50 in. gauge Solution annealed at 1500°F, 1 hr, AC, and aged at 900°F, 6 hrs, AC	L	262	1806	276	1903	10	44
0.25 or 0.50 in. gauge Normalized at 1700°F, 1 hr, AC; solution annealed at 1500°F, 4 hrs, AC, and aged at 900°F, 6 hrs, AC	L	264	1820	276	1903	12	51
0.25 in. gauge, Normalized at 1700°F, 1 hr, AC; solution annealed at 1500°F, 4 hrs, AC, and aged at 900°F, 6 hrs, AC	T	260	1793	274	1889	11	49

> NIMARK T-250

ROOM TEMPERATURE MECHANICAL PROPERTIES, BAR 1.00–4.50 IN.	
HEAT TREATMENT	**HARDNESS**
	HRC
As forged	32
Solution annealed at 1500°F, 1 hr, AC	34
1500° F, 1 hr, AC, 900°F, 6 hrs, AC	54
Solution annealed at 1700°F, 1 hr, AC	28
Solution annealed at 1700°F, 1 hr, AC, and aged at 900°F, 6 hrs, AC	52
Normalized at 1700°F, 1 hr, AC, and solution annealed at 1500°F, 4 hrs, AC	31
Normalized at 1700°F, 1 hr, AC; solution annealed at 1500°F, 4 hrs, AC, and aged at 900°F, 6 hrs, AC	52

ELASTICITY AND IMPACT		
HEAT TREATMENT	**ELASTIC MODULUS (IN TENSION)**	
	KSI X 10^3	**MPA X 10^3**
Normalized at 1700°F, 1 hr, AC; solution annealed at 1500°F, 4 hrs, AC, and aged at 900°F, 6 hrs, AC	27.5	189.6
Solution annealed at 1500°F, 4 hrs, AC, and aged at 900°F, 6 hrs, AC	27.5	189.6

Heat treatment

Solution annealing	1500–1700°F, 1–2 hours or 1 hour/in. of thickness (depending on specification), air cool.
Aging	900°F, 6 hours, air cool.
Normalizing	1700°F, 1 hour, air cool. Normalizing is recommended prior to solution annealing to achieve a uniform microstructure and optimal combination of strength and toughness..

> NIMARK T-250

Workability

Cold working	Despite having a martensitic structure in the solution annealed condition and a high hardness ~30 HRC, NiMark T-250 is readily cold worked.
Hot working	Hot working is readily accomplished by conventional methods over a broad temperature range extending up to 2300°F. It is suggested that finishing temperatures be close to 1700°F to obtain the optimal properties. Avoid heating above 2200°F followed by cooling and holding at 1700–1800°F. The former temperature will solution anneal carbides, which will re-precipitate on grain boundaries during the latter exposure, resulting in embrittlement.
Machinability	NiMark T-250 is readily machined in the solution annealed condition at 28–34 HRC. Limited machining can be performed in the age hardened condition.
Weldability	NiMark T-250 is weldable.

> NIMARK T-250

Typical feeds and speeds

The feeds and speeds in the following charts are conservative recommendations for initial setup. Higher feeds and speeds may be attainable depending on machining environment.

TURNING — SINGLE-POINT AND BOX TOOLS

CONDITION	DEPTH OF CUT, IN	HIGH-SPEED TOOLS			CARBIDE TOOLS			
		SPEED, FPM	FEED, IPR	TOOL MATERIAL	SPEED, FPM		FEED, IPR	TOOL MATERIAL
					UNCOATED	COATED		
Annealed	.040	90	.005	M-42, T-15	360	650	0.007	C-3/CC-3
	.150	70	.010		300	525	0.015	
	.300	50	.015		230	400	0.020	
Aged	.040	60	.005		135	—	0.005	
	.150	45	.010		110	—	0.010	

TURNING — CUT-OFF AND FORM TOOLS

CONDITION	SPEED, FPM	FEED, IPR							TOOL MATERIAL	
		CUT-OFF TOOL WIDTH, IN			FORM TOOL WIDTH, IN				HIGH-SPEED TOOLS	CARBIDE TOOLS
		1/16	1/8	1/4	1/2	1	1-1/2	2		
Annealed	55	.001	.0015	.002	.0015	.001	.001	.0007	M-42	—
Annealed	200	.003	.004	.005	.003	.0025	.0025	.0015	—	C-6

DRILLING — HIGH-SPEED TOOLS

CONDITION	SPEED, FPM	FEED, IPR								TOOL MATERIAL
		NOMINAL HOLE DIAMETER, IN								
		1/16	1/8	1/4	1/2	3/4	1	1-1/2	2	
Annealed	55	—	.003	.005	.007	.009	.010	.013	.015	M-1, M-7, M-10
Aged	20	—	.002	.003	.004	.004	.004	.004	.004	M-42, T-15

TAPPING — HIGH-SPEED TOOLS

CONDITION	SPEED, FPM	TOOL MATERIAL
Annealed	20	M-1, M-7, M-10
Aged	5	Nitrided M-1, M-7, M-10

DIE THREADING

CONDITION	SPEED, FPM				TOOL MATERIAL
	7 OR LESS, TPI	8 TO 15, TPI	16 TO 24, TPI	25 AND UP, TPI	
Annealed	4–6	5–8	6–10	8–12	M-2, M-7, M-10
Aged	3–4	3–5	4–8	5–10	M-42

> NIMARK T-250

MILLING — END PERIPHERAL

DEPTH OF CUT, IN	HIGH-SPEED TOOLS						CARBIDE TOOLS					
	SPEED, FPM	FEED, IN PER TOOTH — CUTTER DIAMETER, IN				TOOL MATERIAL	SPEED, FPM	FEED, IN PER TOOTH — CUTTER DIAMETER, IN				TOOL MATERIAL
		1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2	
.050	140	.002	.002	.004	.005	M-2, M-7	400	.001	.002	.005	.007	C-6

TURNING — CUT-OFF AND FORM TOOLS

CONDITION	DEPTH OF CUT, IN	HIGH-SPEED TOOLS						CARBIDE TOOLS					
		SPEED, FPM	FEED, IN PER TOOTH — CUTTER DIAMETER, IN				TOOL MATERIAL	SPEED, FPM	FORM TOOL WIDTH, IN — CUTTER DIAMETER, IN				TOOL MATERIAL
			1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2	
Annealed	.050	55	.001	.0015	.002	.004	M-2, M-7, M-42	275	.0015	.001	.001	.0007	C-6
Aged	.050	200	.003	.004	.005	.001	M-2, M-7, M-42	75	.003	.0025	.0025	.0015	C-6

BROACHING — HIGH-SPEED TOOLS

CONDITION	SPEED, FPM	CHIP LOAD, IPT	TOOL MATERIAL
Annealed	15	002	M-42

For additional information, please contact your nearest sales office:
info@cartech.com | 610 208 2000

The information and data presented herein are typical or average values and are not a guarantee of maximum or minimum values. Applications specifically suggested for material described herein are made solely for the purpose of illustration to enable the reader to make his/her own evaluation and are not intended as warranties, either express or implied, of fitness for these or other purposes. There is no representation that the recipient of this literature will receive updated editions as they become available.