Technical Datasheet

CarTech® L-605 Alloy

Identification

UNS Number

• R30605

Type Analysis

Single figures are nominal except where noted.

Carbon	0.05 to 0.15 %	**Manganese**	1.00 to 2.00 %
Phosphorus (Maximum)	0.030 %	**Sulfur (Maximum)**	0.030 %
Silicon (Maximum)	0.40 %	**Chromium**	19.00 to 21.00 %
Nickel	9.00 to 11.00 %	**Cobalt**	Balance
Tungsten	14.00 to 16.00 %	**Iron (Maximum)**	3.00 %

General Information

Description

CarTech L-605 alloy is a nonmagnetic, chromium-nickel-tungsten-cobalt alloy possessing good oxidation and corrosion resistance as well as high strength properties at elevated temperatures.

The high strength properties of this alloy may be obtained through work hardening. It remains nonmagnetic in the work hardened condition.

Although the aging response of CarTech L-605 is considered minimal when compared to typical age hardening alloys, it may be used in the cold worked and aged condition in certain instances.

CarTech L-605 is generally melted using vacuum induction melting (VIM), followed by electroslag remelting (ESR). The finished mill product is supplied in the solution annealed or cold worked condition, depending on section size and application.

Applications

Typical applications for this alloy have included:

Gas turbine rotors
Nozzle diaphragm valves
Springs
Bone drill bits
Heart valves

Corrosion Resistance

L-605 has displayed excellent resistance to the hot corrosive atmospheres encountered in certain jet engine operations. Resistance to oxidation is good for intermittent service up to 1600°F (871 °C) and continuous service up to 2000°F (1093°C).

L-605 is highly resistant to scaling and oxidation at elevated temperatures, with particularly good qualities under extreme oxidizing conditions.

This material also possesses excellent resistance to chemical oxidizing agents, and extraordinary resistance to hydrochloric and nitric acids at certain concentrations and temperatures. Resistance to salt spray corrosion is very good.

Important Note: *The following 4-level rating scale is intended for comparative purposes only. Corrosion testing is recommended; factors which affect corrosion resistance include temperature, concentration, pH, impurities, aeration, velocity, crevices, deposits, metallurgical condition, stress, surface finish and dissimilar metal contact.*

Nitric Acid	Good	Sulfuric Acid	Moderate
Phosphoric Acid	Moderate	Acetic Acid	Good

Sodium Hydroxide	Good	Salt Spray (NaCl)	Excellent
Sea Water	Moderate	Sour Oil/Gas	Good
Humidity	Excellent		

Properties

Physical Properties

Specific Gravity	9.20	
Density	0.3330	lb/in³
Mean Specific Heat (70 to 212°F)	0.09011	Btu/lb/°F

Specific heat

Temperature	Btu/lb • °F	kJ/kg • K
70° - 212°F	0.090	0.377

Mean CTE

70 to 600°F	7.61	x 10 $^{-6}$ in/in/°F
70 to 1000°F	8.31	x 10 $^{-6}$ in/in/°F
70 to 1500°F	9.08	x 10 $^{-6}$ in/in/°F

Mean coefficient of thermal expansion

Temperature		10⁻⁶/°F	10⁻⁶/°C
70°F to	21°C to		
600	316	7.61	13.7
1000	538	8.31	14.9
1500	816	9.08	16.3

Thermal Conductivity

70°F	88.00	BTU-in/hr/ft²/°F
800°F	134.0	BTU-in/hr/ft²/°F
1200°F	153.0	BTU-in/hr/ft²/°F

Thermal conductivity

Temperature		Btu-in/ft² • hr • °F	W/m • K
°F	°C		
70	21	88	12.7
800	427	134	19.3
1200	649	153	22.0

Modulus of Elasticity (E) (70°F)	35.3	x 10 ^{3} ksi
Modulus of Rigidity (G)	12.6	x 10 ^{3} ksi
Melting Range	2570 to 2620	°F

Magnetic Properties

L-605 is nonmagnetic in all conditions.

Typical Mechanical Properties

Fatigue Strength — Carpenter L-605 Alloy

Test Temperature		Endurance Limit, 10^8 cycles	
°F	°C	ksi	MPa
1200	649	63.5	438
1400	760	60.5	417
1600	871	47.0	324
1800	982	20.0	138

Secondary Creep Rates — Carpenter L-605 Alloy

Specimens taken from 0.040" (1.016mm) sheet

Test Temperature		Stress for Minimum Creep Rate of:					
		0.001% Hr.		0.0001% Hr.		0.00001% Hr.	
°F	°C	ksi	MPa	ksi	MPa	ksi	MPa
1500	816	17.0	117	13.0	90	9.0	62
1600	871	12.5	83	7.1	49	5.3	37
1700	927	—	—	4.3	30	3.0	21
1800	982	—	—	2.9	20	2.0	14

Stress Relaxation — Carpenter L-605 Alloy

Test Temperature		Initial Stress		Residual Stress, After:			
				100 hours		1000 hours	
°F	°C	ksi	MPa	ksi	MPa	ksi	MPa
1050	566	70	482	42.0	290	39.0	269
1200	649	45	310	19.4	134	17.2	119
1350	732	25	172	14.0	97	12.5	86

Stress Rupture Properties — Carpenter L-605 Alloy

Bar

Test Temperature		Average Stress for Rupture in:					
		10 hours		100 hours		1000 hours	
°F	°C	ksi	MPa	ksi	MPa	ksi	MPa
1350	732	42.5	293	36.5	252	30.25	209
1500	816	30.0	207	22.0	152	17.00	117
1600	871	23.0	159	16.5	114	12.00	83
1700	927	17.0	117	12.0	83	8.40	58
1800	982	11.5	77	7.5	52	5.00	34

Typical Room Temperature Tensile Properties* — Carpenter L-605 Alloy

Bar

Condition	Diameter or Thickness		Ultimate Tensile Strength		0.2% Offset Yield Strength		% Reduction of Area	% Elongation (x 4D)
	inches	mm	ksi	MPa	ksi	MPa		
Annealed	.0625	>1.6	133	917	69	476	33	41
Cold Worked 30%	.0625-.375	1.6-9.5	195	1345	145	1000	18	16

*Tensile Specimen Preparation — Room temperature tensile ductility and ultimate tensile strength of Carpenter L-605 are strongly dependent on surface finish. A finely ground (320 grit) surface finish is recommended.

Typical Short-Time Elevated Temperature Properties — Carpenter L-605 Alloy
Material in annealed condition.

Test Temperature		Tensile Strength		0.2% Yield Strength		% Elongation in 2" (50.8mm)
°F	°C	ksi	MPa	ksi	MPa	
R.T.		150	1034	70	483	50
1200	649	98	676	48	331	28
1400	760	53	365	37	255	14
1500	816	50	345	35	241	17
1600	871	37	255	34	234	18
1800	982	24	165	—	—	18
2000	1093	13	89	—	—	23

Heat Treatment

Annealing

L-605 should be annealed at 2150/2250°F (1175/1230°C) for not less than 15 minutes, followed by water quenching or air cooling depending on section size. Typical annealed hardness is 20 HRC.

Workability

Hot Working

L-605 should be forged from approximately 2150°F (1177°C). Below 1850°F (1010°C) this alloy is difficult to hot work.
The rate of cooling from the hot working or hot forging operation is not critical - air cooling is generally employed.

Cold Working

The strength levels developed by L-605 are primarily the result of cold working. Cold working can be accomplished by drawing, extruding, forging, swaging or a combination of these methods.

The work hardening rate of this alloy is extremely high. Total cold work reduction generally should not exceed 40%.

Machinability

L-605 is machinable using conventional techniques; however, cobalt grades of high-speed steel or carbide tools combined with rigid machine setups are recommended.

L-605 is more difficult to machine than the austenitic stainless steels (i.e. Types 302, 304, 321, and 347 stainless). Generally, lower feeds, speeds and depths of cut are suggested. A very high work hardening rate, generation of heat during cutting and high shear strength complicate machining.

Other Information

Applicable Specifications

Specification: AMS 5759F Form: Bar, Forging Stock

Specification: ASTM F90 Form: Bar, Wire (all implant quality)

- AMS 5537
- AMS 5759F
- AMS 5796
- ASTM F90
- ISO 5832-5

Forms Manufactured

- Bar-Rounds
- Billet
- Wire
- Wire-Rod

Technical Articles

- Trends in High Temperature Alloys
- Unique Properties Required of Alloys for the Medical and Dental Products Industry

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