Technical Datasheet CARPENTER TECHNOLOGY

CarTech® CTS® BD1 Alloy

Type Analysis

Single figures are nominal except where noted.

Carbon	0.85 to 0.95 %	**Manganese (Maximum)**	1.00 %
Phosphorus (Maximum)	0.040 %	**Sulfur (Maximum)**	0.030 %
Silicon (Maximum)	1.00 %	**Chromium**	15.00 to 17.00 %
Molybdenum (Maximum)	0.50 %	**Iron**	Balance

General Information

Description

CarTech CTS BD1 alloy is a high-carbon chromium steel that provides stainless properties with high hardness and excellent wear resistance. In terms of hardness and wear resistance, CarTech CTS BD1 alloy behaves very similarly to tool steels. CarTech CTS BD1 alloy attains a hardness of Rockwell C 58-60 when heat treated and has been used for cutlery, ball bearings and small machinery parts subjected to high wear conditions. This steel has a finely balanced chemistry with proprietary additions to improve cutting edge retention.

In CATRA (Cutlery and Associated Trades Research Association) testing, CarTech CTS BD1 alloy has a TCC (Total Card Cut) rating of 570 mm, which is equivalent to the cutting performance of high quality 440C stainless steel. The finely balanced chemistry enhances the processing of the steel especially during cutlery manufacture.

Elevated Temperature Use

Carpenter CTS BD1 alloy is not usually recommended for elevated temperature applications because corrosion resistance is reduced when used in the annealed condition or hardened condition and tempered above about 800°F (427°C).

Corrosion Resistance

Carpenter CTS BD1 alloy has corrosion resistance similar to that of Type 410. It can resist corrosion from mild atmospheres, fresh water, steam, ammonia, many petroleum products and organic materials and several mild acid environments.

This grade is used in the hardened plus tempered condition. Optimum corrosion resistance is obtained with a temper below about 800°F (427°C).

For optimum corrosion resistance, surfaces must be free of scale, lubricants, foreign particles, and coatings applied for drawing and heading. After fabrication of parts, cleaning and/or surface passivation should be considered.

Notes: Acetic acid resistance based on testing in 3% boiling solution. Phosphoric acid resistance based on testing in a 10% boiling solution.

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	Moderate	Sulfuric Acid	Restricted
Phosphoric Acid	Good	Acetic Acid	Good
Sodium Hydroxide	Moderate	Salt Spray (NaCl)	Restricted
Humidity	Excellent		

Properties

Physical Properties

Specific Gravity	7.65	
Density	0.2760	lb/in³

Mean Specific Heat (32 to 212°F)	0.1100	Btu/lb/°F
Mean CTE (32 to 212°F)	5.60	x 10^{-6} in/in/°F
Electrical Resistivity (70°F)	361.0	ohm-cir-mil/ft

Typical Mechanical Properties

Room Temperature Impact Strength – Carpenter CTS BD1 Alloy

Orientation	Temper 1 hr	Charpy Impact (ft.-lb.)
Longitudinal	300°F/149°C	21
Longitudinal	350°F/177°C	25
Longitudinal	400°F/204°C	28
Transverse	350°F/177°C	7

* Hardened at 1900°F (1038°C) for 30 min 10 bar vacuum

Heat Treatment

Annealing

For maximum softness, this steel should be heated uniformly to 1550/1600°F (843/871°C). Soak and cool very slowly in the furnace. Brinell hardness will be approximately 223.

For an intermediate or process annealing treatment-heat uniformly to 1350/1400°F (732/760°C). Air cool. Brinell hardness will be approximately 241.

Hardening

Heat to 1850/1950°F (1010/1066°C); soak; quench in warm oil or cool thin sections in air. Do not overheat. When overheated, full hardness cannot be obtained.

Tempering

To remove peak stresses and yet retain maximum hardness, temper at least one hour at 300/350°F (149/177°C). Hardness of approximately Rockwell C 58/59 will be obtained.

Tempering Response of Carpenter CTS BD1 Alloy 0.125"-thick Strip

	Hardness (HRC)*					
Temper	1850F (1010C)	1850F + -100F (1010C + -73C)	1900F (1038C)	1900F + -100F (1038C + -73C)	1950F (1066C)	1950F + -100F (1066C + -73C)
300F (149C)	59	59	59.5	60	59.5	60.5
400F (204C)	56	56.5	58	58	58	58
500F (260C)	55	55	56	56	55	55.5
600F (316C)	55	55	55	55.5	55	55
700F (371C)	55	55	55	55	55.5	55.5
800F (427C)	54	54.5	55	55	55	55

*Hardening treatments performed for 30 minutes, air cool to room temperature.
Refrigeration treatments performed for 1 hour, air warm to room temperature.
Tempering treatments performed for 1 hour, air cool to room temperature.

Workability

Hot Working

Carpenter CTS BD1 alloy should be handled like high-speed tool steel. Preheat to 1400/1500°F (760/816°C), then heat slowly and uniformly to 1900/2150°F (1038/1177°C). Do not forge below 1700°F (927°C), and reheat as often as necessary. Cool in a furnace, if possible, or in warm dry lime or ashes. Anneal after forging; cool to room temperature before annealing.

Cold Working

If annealed for maximum softness, this steel can be moderately cold formed, headed and upset.

Machinability

For most machining operations, this steel cuts best when in the dead soft annealed condition. Due to its high carbon content, it machines somewhat like high-speed steel. Because chips are tough and stringy, chip curlers and breakers are important.

Following are typical feeds and speeds for Carpenter CTS BD1 alloy.

Turning – Single Point and Box Tools

Depth Of Cut (inches)	High Speed Tools			Carbide Tools (Inserts)			
	Tool Material	Speed (fpm)	Feed (ipr)	Tool Material	Speed, fpm		Feed ipr
					Uncoated	Coated	
.150	T15	75	.015	C6	325	375	.015
.025	M42	80	.007	C7	400	500	.007

Turning – Cut Off and Form Tools

Tool Material		Speed, fpm	Feed, (ipr)						
High Speed Tools	Carbide Tools		Cut-Off Tool Width, Inches			Form Tool Width, Inches			
			1/16	1/8	1/4	1/2	1	1-1/2	2
T15		55	.001	.001	.0015	.001	.001	.001	.0005
	C6	205	.004	.0055	.007	.005	.004	.0035	.0035

Rough Reaming

High Speed		Carbide Tools		Feed (ipr) Reamer Diameter, Inches					
Tool Material	Speed (fpm)	Tool Material	Speed (fpm)	1/8	1/4	1/2	1	1-1/2	2
T15	65	C2	85	.003	.006	.010	.015	.018	.021

Drilling

High Speed Tools									
Tool Material	Speed (fpm)	Feed (inches per revolution) Nominal Hole Diameter (inches)							
		1/16	1/8	1/4	1/2	3/4	1	1-1/2	2
T15, M42	45-55	.001	.003	.006	.010	.014	.017	.021	.025

Die Threading

FPM for High Speed Tools				
Tool Material	7 or Less, tpi	8 to 15, tpi	16 to 24, tpi	25 and up, tpi
T15, M42	5-12	8-15	10-20	15-25

Milling – End Peripheral

Depth Of Cut, In	High Speed Tools						Carbide Tools					
	Tool Material	Speed (fpm)	Feed – Inches Per Tooth Cutter Diameter, Inches				Tool Material	Speed (fpm)	Feed – Inches Per Tooth Cutter Diameter, Inches			
			1/4	1/2	3/4	1-2			1/4	1/2	3/4	1-2
.050	M2, M7	75	.001	.002	.003	.004	C6	240	.001	.002	.004	.006

Tapping

High Speed Tools	
Tool Material	Speed (fpm)
M1, M7, M10	10-20

Broaching

High Speed Tools		
Tool Material	Speed, fpm	Chip Load (ipt)
T15, M42	15	.002

Additional Machinability Notes

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

Figures used for all metal removal operations covered 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

In cutlery applications, grinding and polishing are very important. Carpenter CTS BD1 alloy works well in these operations but considerable care must be used not to overheat since the corrosion resistance may be lowered.

Weldability

Because of its high hardness capability, this steel is seldom welded. However, if welding is necessary, the parts should be preheated and maintained at about 500°F (260°C), welded, and then immediately given a 6-8 hour anneal at 1350/1400°F (732/760°C) with a slow furnace cool. The parts should not be allowed to cool below 500°F between welding and annealing. High welding heat inputs should be used. To obtain mechanical properties in the weld similar to the base metal, welding consumables of like composition should be considered. Otherwise, AWS E/ER309 should be considered.

Other Information

Applicable Specifications

Note: While this material meets the following specifications, it may be capable of meeting or being manufactured to meet other general and customer-specific specifications.

Forms Manufactured

- Bar
- Plate
- Billet
- Strip

Technical Articles

- Blade Alloys 101: What You Need to Know About the Alloys Used for Knife Blades

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