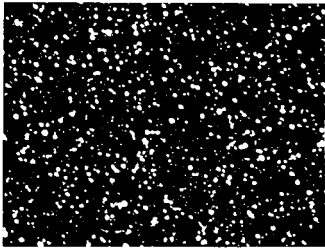


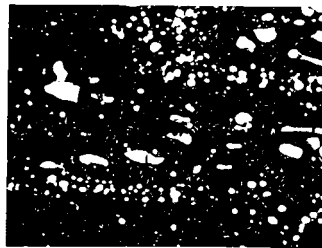
CRUCIBLE

CPM 10V was the first in the family of high vanadium tool steels made by the Crucible Particle Metallurgy process. Crucible engineers optimized the vanadium content to provide superior wear resistance while maintaining toughness and fabrication characteristics comparable to D2 and M2. Since its introduction in 1978, CPM 10V has become recognized world-wide and sets the standard for highly wear resistant industrial tooling. Its exceptional wear resistance and good toughness make it an excellent candidate to replace carbide and other highly wear resistant materials in cold work tooling applications, particularly where tool toughness is a problem or where cost effectiveness can be demonstrated.

The CPM process produces very homogeneous, high quality steel characterized by superior dimensional stability, grindability, and toughness compared to steels produced by conventional processes.

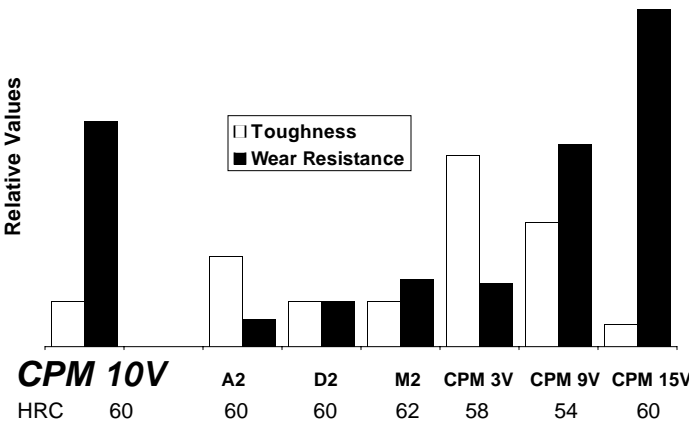


CPM Steel



Conventional Steel

Tool Steel Comparagraph



Typical Applications

Stamping or Forming Tools
Powder Compaction Tooling
Industrial Knives and Slitters
Plastic Mold Inserts
Wear Parts

Punches and Dies
Blanking and Piercing Dies
Woodworking Tools
Plastic Injection Barrels

Note: These are some typical applications. Your specific application should not be undertaken without independent study and evaluation for suitability.

Crucible...

The Tool Steel Pros®

DATA SHEET

CRUCIBLE CPM® 10V® (AISI A11)

Issue #7

Carbon	2.45%
Chromium	5.25%
Vanadium	9.75%
Molybdenum	1.3%

Physical Properties

Elastic Modulus	32 X 10 ⁶ psi	(221 GPa)
Density	0.268 lbs./in ³	(7.418 g/cm ³)
Thermal Conductivity		
	BTU/hr-ft-°F	W/m-°K cal/cm-s-°C
70°F (21°C)	11.78	20.39 0.0487
212°F (100°C)	12.44	21.54 0.0514
572°F (300°C)	14.36	24.85 0.0593
932°F (500°C)	15.19	26.30 0.0628

Coefficient of Thermal Expansion

°F	°C	in/in/°F	mm/mm/°C
70-200	(21- 93)	5.96X10 ⁻⁶	(10.7X10 ⁻⁶)
70-500	(21-260)	6.18X10 ⁻⁶	(11.1X10 ⁻⁶)
70-800	(21-427)	6.54X10 ⁻⁶	(11.8X10 ⁻⁶)
70-1100	(21-593)	6.82X10 ⁻⁶	(12.3X10 ⁻⁶)

Mechanical Properties

Impact Toughness

Depending upon the application requirement for hardness, lowering the hardening temperature (underhardening) increases the toughness.

Hardening Temperature °F °C	Tempering Temperature °F °C	Hardness HRC	Charpy C-Notch Impact Strength		Bend Fracture Strength	
			ft.-lb. (J)	ksi (MPa)		
2150 1175	1000 540	64	15 20	627 4322		
2100 1150	1000 540	63	16 22	615 4239		
2050 1120	1025 550	61	23 30	635 4377		
1950 1065	1025 550	59	26 35	- -		

Machinability and Grindability

Machinability in the annealed condition is similar to T15 high speed steel. Similar grinding equipment and practices used for high speed steels are recommended. "SG" type alumina wheels or CBN wheels have generally given the best performance with CPM steels.

The Crucible logo, Crucible, CPM, 3V, 9V, 10V, 15V, and Crucible Particle Metallurgy, are trademarks of the Crucible Materials Corporation, Syracuse, NY.

Thermal Treatments

Critical Temperature: 1540°F (840°C)

Forging: 2000-2100°F (1095-1150°) Do not forge below 1700°F (930°C). Slow Cool.

Annealing: Heat to 1600°F (870°C), hold 2 hours, slow cool no faster than 30°F (15°C) per hour to 1000°F (540°C), then furnace cool or cool in still air to room temperature.

Annealed Hardness: About BHN 255-277

Stress Relieving

Annealed Parts: Heat to 1100-1300°F (595-700°C), hold 2 hours, then furnace cool or cool in still air.

Hardened Parts: Heat to 30°F (15°C) below original tempering temperature, hold 2 hours, then furnace cool or cool in still air.

Straightening: Best done warm 400-800°F (200-430°C)

Hardening

Preheat: Heat to 1500-1550°F (815-845°C) Equalize.

Second pre-heat stage at 1850-1900°F (1010-1040°C) suggested for vacuum or atmosphere hardening.

Austenitize: 1850-2150°F (1010-1175°C), hold time at temperature 30-45 minutes.

Quench: Air or positive pressure quench (2 bar minimum) to below 125°F (50°C), or salt or interrupted oil quench to about 1000°F (540°C), then air cool to below 125°F (50°C). Salt bath treatment, if practical, will ensure maximum attainable toughness for a given hardening treatment. Vacuum or atmosphere quench rate through 1850-1300°F (1010-705°C) range is critical to achieve optimum heat treat response.

Temper: Double temper at 1000°F (540°C) minimum. 2 hours minimum each time. (See Table)

Size Change: +0.03/0.05%

Recommended Heat Treatment: For the best combination of toughness and wear resistance, austenitize CPM 10V at 2050°F (1120°C), hold 30-45 minutes, and quench. Temper 3 times at 1025°F (550°C).

Aim hardness: HRC 60. Higher austenitizing temperatures can be used to obtain higher hardness, at a slight decrease in impact resistance. The lower austenitizing temperatures provide the best impact toughness.

Service Center Locations

Location	Phone	Toll Free	FAX
Auburn, MA	508-832-5353	800-365-1101	508-832-2217
Charlotte, NC	704-372-3073	800-365-1160	704-342-0985
Chicago, IL	630-378-0093	800-365-1151	630-378-1965
Cincinnati, OH	513-771-1310	800-365-1163	513-771-0119
Cleveland, OH	330-562-3131	800-365-1132	330-562-7818
Columbus, OH	614-262-4959	800-365-1131	614-262-7850
Dallas, TX	817-649-2800	800-365-1168	817-633-8142
Detroit, MI	248-528-0332	800-365-1133	248-528-1977
Grand Rapids, MI	616-554-9699	800-365-1137	616-554-9328
Huntsville, AL	256-772-0201	800-365-1161	256-772-3361
Indianapolis, IN	317-638-4501	800-365-1146	317-634-7375
Los Angeles, CA	714-623-1131	800-365-1179	714-632-1181



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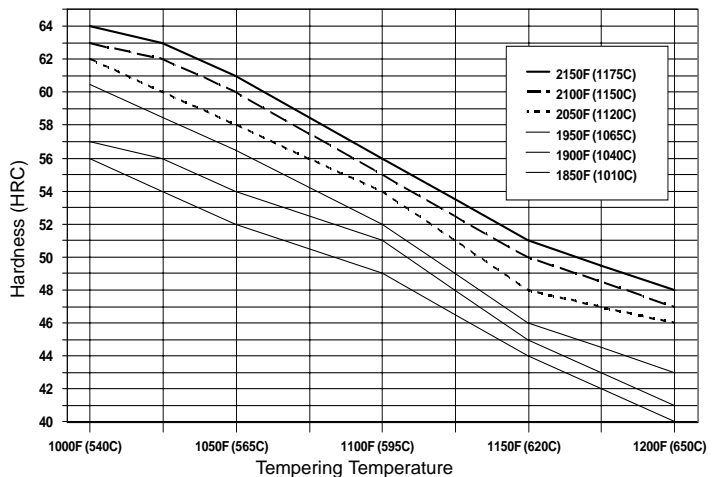
Heat Treat Response

Hardness HRC

Tempering Temperature	Austenitizing Temperature					
	1850°F (1010°C)	1900°F (1040°C)	1950°F (1065°C)	2050°F (1120°C)	2100°F (1150°C)	2150°F (1175°C)
As Quenched	61	63	65	65	64.5	63.5
1000°F (540°C)	56	57	60.5	62	63	64
<i>Optimum for Maximum Toughness and Effective Stress Relieving</i>						
1025°F (550°C)	54	56	58.5	60	62	63
1050°F (565°C)	52	54	56.5	58	60	61
1100°F (595°C)	49	51	52	54	55	56
1150°F (620°C)	44	45	46	48	50	51
1200°F (650°C)	40	41	43	46	47	48

Results may vary with hardening method and section size. Salt or oil quenching will give maximum response. Vacuum or atmosphere cooling may result in up to 1-2 HRC points lower.

Minimum Time at Aust. Temp.	60 min.	45 min.	30 min.	20 min.	15 min.	10 min.
Minimum Number of Tempers	2	2	2	2	3	3



Surface Treatments

Because of its high tempering temperatures (>1000°F) CPM 10V is suitable for nitriding, PVD coating or similar surface treatments. CVD coating processes generally exceed the critical temperature and may result in non-predictable dimensional changes.

Note: Properties shown throughout this data sheet are typical values. Normal variations in chemistry, size and heat treat conditions may cause deviations from these values. For additional data or metallurgical engineering assistance, consult your local Crucible Service Center.

Location	Phone	Toll Free	FAX
Meadville, PA	814-337-8804	800-365-0530	814-337-8808
Milwaukee, WI	262-781-6710	800-242-0948	262-781-6743
Minneapolis, MN	612-331-6320	800-365-1153	612-331-4137
St. Louis, MO	636-272-7220	877-201-4049	636-978-9559
Canada			
Wallaceburg, ONT	519-627-2245	800-265-5293	519-627-2247
Mexico (SISA)			
Monterrey, N.L.	52 81 8351-7220		52 81 8351-2981
Naucalpan, E de M	52 55 5576-4011		52 55 5360-1865

CRUCIBLE SERVICE CENTERS DIVISIONAL HEADQUARTERS:

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