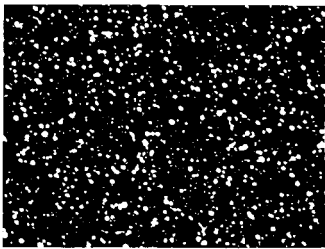


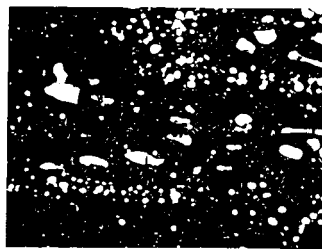
CRUCIBLE

CPM 15V is intended for applications requiring exceptional wear resistance. It has more vanadium carbides in its microstructure than CPM 10V and provides more wear resistance and longer tool life in those applications where 10V has proven to be successful. CPM 15V also offers an alternative to solid carbide where carbide fails by fracture or where intricate tool design makes carbide difficult or risky to fabricate.

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

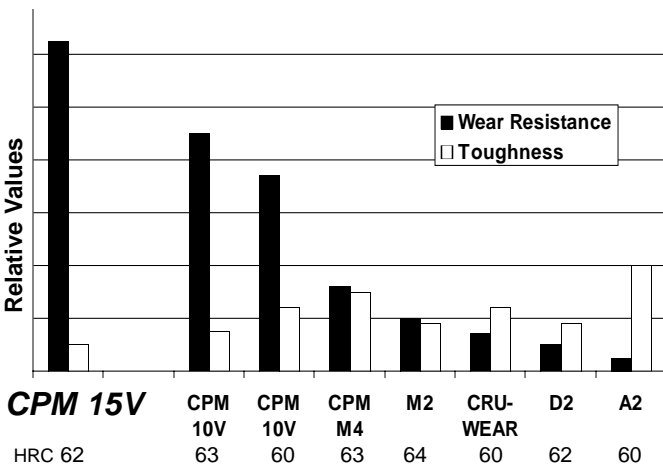


CPM Steel



Conventional Steel

Tool Steel Comparagraph



Typical Applications

- Powder Compaction Tooling: Dies, Core Rods
- Plastic Processing Equipment: Barrel Liners, Screw Tips
- Industrial Knives: Granulator Blades, Slitter Knives
- Dies/Punches for Cold Work:
 - Forming, Extrusion, Drawing, and Piercing
- Woodworking Tools
- Ceramic Dies
- Wear Parts

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

Crucible...
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DATA SHEET

CRUCIBLE CPM® 15V®

Issue #5

Carbon	3.40%
Chromium	5.25%
Vanadium	14.50%
Molybdenum	1.30%

Physical Properties

Elastic Modulus	34 X 10 ⁶ psi	(235 GPa)
Density	0.262 lbs./in ³	(7.25 g/cm ³)
Coefficient of Thermal Expansion		
°F	°C	in/in/°F X10 ⁻⁶ in/in/°C X10 ⁻⁶
70-200	(21-93)	5.8 10.5
70-500	(21-260)	6.2 11.1
70-800	(21-427)	6.5 11.7
70-1100	(21-593)	6.7 12.1

Mechanical Properties

Wear Resistance

With its nearly 15% vanadium content, CPM 15V has the highest wear resistance of any cold work tool steel available today.

Impact Toughness

The CPM process makes possible the production of high vanadium grades without sacrificing toughness. For example, although both CPM 10V and CPM 15V have significantly higher wear resistance than the conventional high vanadium tool steel D7, they also offer greater toughness. (See Table)

	Heat Treatment ⁽¹⁾ Austenitizing Temperature	HRC	Wear Resistance ⁽²⁾ Adhesive	Impact Toughness ⁽³⁾ ft.-lb. (J)
CPM 15V	2150°F (1175°C)	64	124	8 (11)
CPM 15V	2050°F (1120°C)	61	-	9 (12)
CPM 15V	2050°F (1120°C)	58	-	13 (18)
CPM 10V	2150°F (1175°C)	63	90	14 (19)
CPM M4	2120°F (1160°C)	63	31	31.5 (43)
D2	1850°F (1010°C)	60	4	17 (23)
D7	1900°F (1040°C)	61	7	6 (9)

(1) Heat Treatment: Austenitized as indicated and tempered to hardness.

(2) Crossed cylinder adhesive wear test (higher number = better wear resistance)

(3) Charpy C-Notch Impact Test (Avg. value)

Thermal Treatments

Critical Temperature: 1540°F (838°C)

Forging: 2000-2100°F (1095-1150°C) 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 (595-705°C), hold 2 hours, then furnace cool or cool in still air.

Hardened Parts: Heat to 25-50°F (15-30°C) below original tempering temperature, hold 2 hours, then furnace cool or cool in still air.

Hardening

Preheat: Heat to 1500-1550°F (815-845°C) Equalize. A second pre-heat stage at 1850-1900°F (1010-1040°C) is suggested for vacuum or atmosphere hardening.

Austenitize: 1950-2150°F (1065-1175°C), hold time at temperature 20-30 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 the maximum attainable toughness for a given hardening treatment.

Temper: Two times at 1000°F (540°C), 2 hrs. minimum each time. Temper three times for hardening temperatures over 2100°F (1150°C). See Table for data.

Size Change: +0.04/0.05%

Recommended Heat Treatment: For maximum wear resistance, austenitize at 2150°F (1175°C), hold 10 minutes, and quench. Temper 3 times at 1025°F (550°C).

Aim hardness: HRC 61-63

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	714-632-1131	800-365-1179	714-632-1181

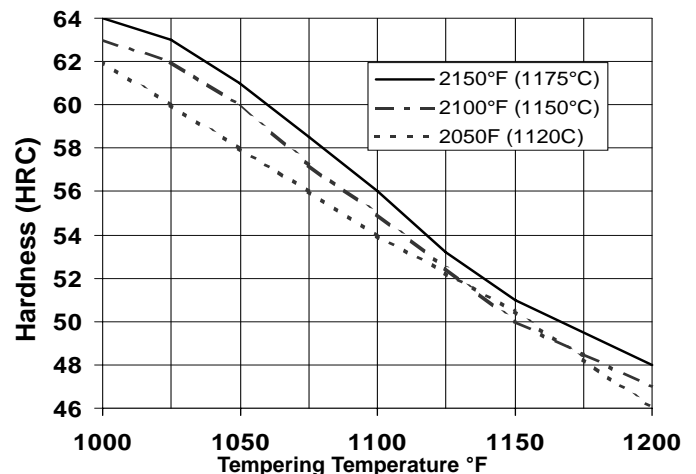


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Heat Treat Response

Tempering Temperature	Hardness HRC		
	Austenitizing Temperature		
	2050°F (1120°C)	2100°F (1150°C)	2150°F (1175°C)
Minimum Time at Austenitizing Temp.	30 minutes	20 minutes	10 minutes
1000°F (540°C)	62	63	64
Optimum for Maximum Toughness and Effective Stress Relieving			
1025°F (550°C)	60	62	63
1050°F (565°C)	58	60	61
1100°F (595°C)	54	55	56
1150°F (620°C)	48	50	51
1200°F (650°C)	46	47	48
Minimum Number of Tempers	2	2	3

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.



Surface Treatments

Because of its high tempering temperatures (>1000°F) CPM 15V 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.	52-818-351-7220		52-818-351-2981
Naucalpan, E de M	52-555-576-4011		52-555-360-1865

CRUCIBLE SERVICE CENTERS DIVISIONAL HEADQUARTERS:

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