Crucible Bearing Alloys

CPM® VIM CRU® 20®

Crucible's advanced CPM technology provides material with an excellent combination of attainable hardness, wear resistance and microstructural characteristics for the demanding requirements of the bearing industry.

Advantages of CPM® VIM CRU® 20®

High Attainable Hardness

Excellent Hot Hardness

Fine Carbide Size

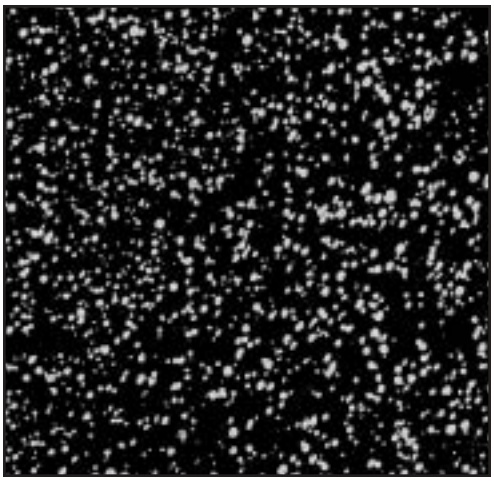
Uniform Carbide Distribution

Excellent Wear Resistance

Nominal CHEMICAL COMPOSITION

Percent by Weight

Carbon	**1.35%**
Manganese	**0.35%**
Silicon	**0.25%**
Chromium	**3.75%**
Vanadium	**2.00%**
Tungsten	**6.25%**
Molybdenum	**10.50%**
Sulfur	**0.035% max**
Iron	**Balance**



CPM® VIM CRU® 20® at 500X

VIM CRU PROCESSING FOR BEARING TOOL STEELS

CPM® VIM CRU® 20® is a vacuum induction melted, cobalt-free super high speed steel manufactured by the Crucible Particle Metallurgy (CPM®) process. VIM CRU processing is designed to meet the cleanliness and property requirements needed for critical bearing applications.

Customer Evaluations

Testing has shown that VIM CRU 20 has greater static load capacity and greater brinelling resistance at HRC 66-67 than standard bearing materials such as 52100 at HRC 60-62 and M50 at HRC 62-64. Three-Ball-on-Rod RCF test results are excellent when compared to 52100 and M50. CPM VIM CRU 20 shows a minimum of 5 times the life of M50 in full-size laboratory bearing component tests.

Thermal Treatments

Critical Temperature: 1490°F (810°C).

Forging: 2000°-2100°F (1095°-1150°C). Do not forge below 1700°F (925°C). Slow cool after forging.

Annealing: 1600°F (870°C), hold 2 hours, slow cool maximum 30°F (15°C)/hour to 1000°F (540°C), then air or furnace cool. BHN 262-285.

Stress Relieveing (Annealed Parts): 1100°-1300°F (595°-740°C), hold 2 hours and air or furnace cool.

Stress relieving (Hardened Parts): Temper 25°F (15°C) below original tempering temperature or 1000°F (540°C) minimum.

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

Hardening: (Salt, Vacuum or Atmosphere)

Preheat: 1500°-1550°F (820°-845°C), equalize. Second preheat stage at 1850°-1900°F (1010°-1040°C) suggested for hardening in vacuum or atmosphere.

High Heat: 2100°-2200°F (1150°- 1205°C). Standard recommendation to achieve HRC 66-68 is 2150°-2175°F (1175°-1190°C).

Quench: Salt, oil or atmosphere quench to 1000°-1100°F (540°-595°C), equalize, then air cool to below 125°F (50°C) or hand warm. Vacuum or atmosphere quench rate through 1850°-1300°F (1010°-705°C range is critical to achieve optimum heat treat response.

Temper: 1000°F (540°C) minimum recommended and 1025°F (550°C) preferred. Triple tempering required.

Size Change During Hardening

Hardening Temperature	Tempering Temperature	Hardness (HRC)	Longitudinal Size Change
2175°F (1190°C)	1025°F (550°C)	67.5	+0.0022 in/in (0.056 mm/mm)

Crucible Compaction Metals

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Physical Properties

Modulus of Elasticity.....34 psi X 10^6.....235 GPa
Specific Gravity.....8.17
Density.....0.295 lbs./in^3..... 8.172 g/cc
Coefficient of Thermal Expansion

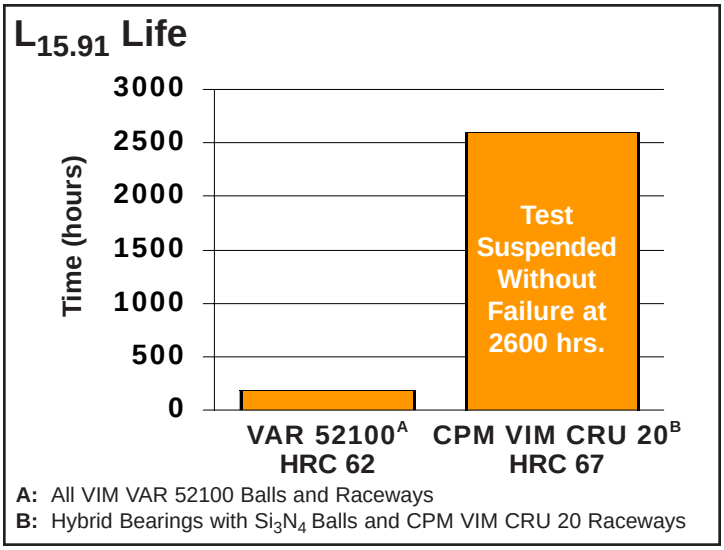
Temperature Range	in/in/°F	mm/mm/°C
100°-500°F (38°-260°C)	6.2 X 10^{-6}	11.2 X 10^{-6}
100°-800°F (38°-427°C)	6.6 X 10^{-6}	11.9 X 10^{-6}
100°-1000°F (38°-540°C)	6.9 X 10^{-6}	12.4 X 10^{-6}

Annealed Hardness.....BHN 262/285
Machinability in the annealed condition is approximately 35% that of W1 Tool Steel (1% Carbon).

Rolling Contact Fatigue

Full Scale Bearing Tests:

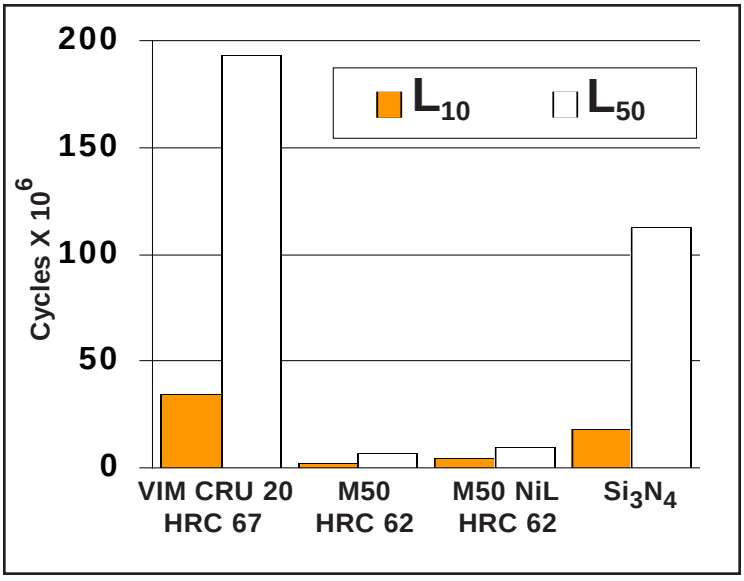
Bearing Size = 207
Speed = 5400 rpm
Hertzian Contact Stress = 1882 MPa (273 ksi)
Lubricant = MIL-L-7808 (filtered to 3mm)
Lubricant Temperature = 71°C
Lubricant Flow = 0.95 liters/min./bearing
Lambda = 1



A: All VIM VAR 52100 Balls and Raceways
B: Hybrid Bearings with Si_3N_4 Balls and CPM VIM CRU 20 Raceways

Three-Ball-on-Rod Tests:

Speed = 3600 rpm
Hertzian Contact Stress = 5.42 GPa (786 ksi)
Lubricant = Synthetic Turbine Oil
Lubricant Flow = 8-12 drops/min.



Hardening Data

HEAT TREAT RESPONSE ±1 HRC (NOTE A)

Tempering Temperature		Hardening Temperature				
		2100°F	2125°F	2150°F	2175°F	2200°F
°C	°F	(1150°C)	(1165°C)	(1175°C)	(1190°C)	(1205°C)
As Quenched		66	66	65	64	63
540	1000	65.5	66	66.5	67	67.5
OPTIMUM FOR MAXIMUM TOUGHNESS AND EFFECTIVE STRESS RELIEVING						
550	1025	65	66	66.5	67	67.5
565	1050	64	65	65.5	66.5	67
595	1100	61.5	62.5	63	64.5	65
620	1150	57	58	59	61	62
650	1200	52	53	54	56	57
Minimum Time at Austenitizing Temp. (minutes)		10	10	5	5	3

NOTE A: Results may vary with hardening method and section size. Salt or oil quenching will give maximum response. Vacuum or atmosphere cooling will result in up to 1-2 HRC points lower.
NOTE B: The minimum number of tempers at 2 hours each is 3 for all conditions.

Hot Hardness

Material	Hardness (HRC)								
	Before Test*	Test Temperature (°F)							After Test*
		700	950	1000	1050	1100	1150	1200	
M50	63.5	50	---	---	---	---	---	---	57
CPM T15	67	---	58.5	58	57	55	52.5	47.5	63.5
CPM VIM CRU 20	67.5	---	58.5	58	57	56	---	47.5	64

*Hardness before and after test at room temperature.

Toughness

CPM VIM CRU 20 has good toughness at hardness levels of HRC 66/68. Toughness is enhanced by lowering the hardening temperature (underhardening).

Hardening Temperature		Tempering Temperature		Hardness	Charpy C-Notch Impact Strength		Bend Fracture Strength	
°F	°C	°F	°C	HRC	ft-lb	J	ksi	MPa
2200	1205	1025	550	67.5	11	15	---	---
2175	1190	1025	550	67	12	16	581	4005
2150	1175	1025	550	66	13	18	---	---
2100	1150	1025	550	65.6	13	18	574	3957

Thermal Conductivity

°F	°C	BTU-in/hr-ft^2-°F	W/m-°K
74	23	144	20.7
122	50	154	22.2
212	100	159	22.9
392	200	171	24.7
572	300	178	25.7
752	400	182	26.2
932	500	190	27.3
1022	550	192	27.7

Surface Treatments

CPM VIM CRU 20 can be nitrided or PVD coated. If a CVD treatment is used, subsequent hardening is required and may result in undesirable distortion.

Properties shown in this data sheet are typical values. Normal variations in chemistry, size and conditions of heat treatment may cause deviations from these values. For additional data and metallurgical assistance, please call your Crucible technical service representative.