TOOLING ALLOYS DATA SHEET
ZAPP Z-MAX PM

ZAPP IS CERTIFIED TO ISO 9001

TOOLING ALLOYS

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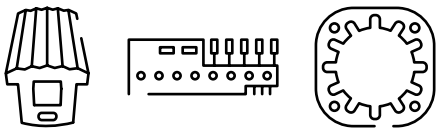


CHEMICAL COMPOSITION

Carbon	2.00 %
Chromium	4.00 %
Vanadium	5.00 %
Tungsten	10.00 %
Molybdenum	5.00 %
Cobalt	9.00 %

DESCRIPTION

Z-Max PM is an ultra-high performance HSS produced by powder metallurgy methods that can be heat treated to a maximum attainable hardness of 68-70Rc. It offers superior levels of wear resistance, red hardness, attainable hardness and compressive strength compared to other cobalt HSS grades. It is suitable for use in various heavy duty cutting tool applications involving difficult to machine materials as well as selected cold work applications when under-hardened to optimize toughness. It can be considered an alternative to carbide when toughness is a concern. The powder metallurgy processing also provides improved machinability, grindability, heat treat response and dimensional stability when compared to similar grades produced by conventional methods.

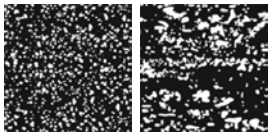
TYPICAL APPLICATIONS

_ Form Tools
_ Gear Tools
_ Gasket Tooling
_ Plastic Extrusion Tooling
_ Powder Compaction Tooling
_ Food and Beverage Packaging

PHYSICAL PROPERTIES

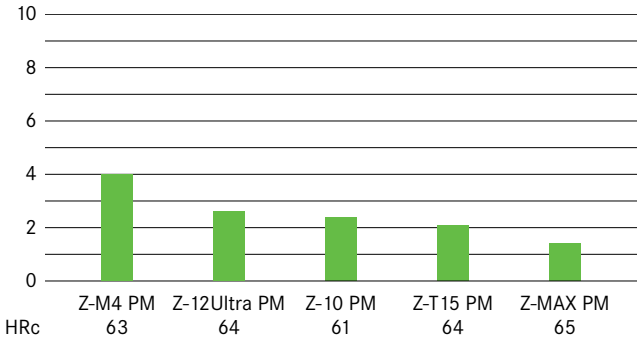
Density [lb/in^3]	0.292

POWDER METALLURGICAL AND CONVENTIONAL MICROSTRUCTURE

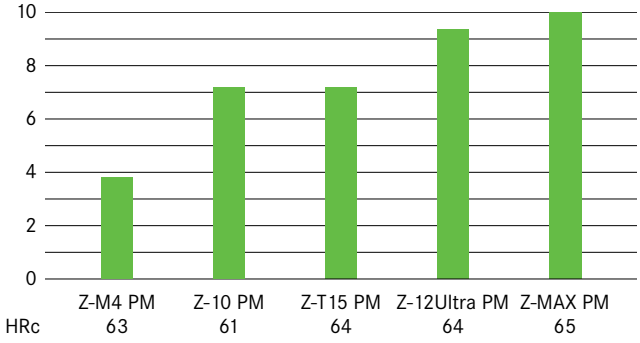


The uniform distribution of smaller spherical carbides in the powder metallurgical structure compared to conventional tool steels with large angular carbides and carbide clusters.

RELATIVE TOUGHNESS



RELATIVE WEAR RESISTANCE



THERMAL PROCESSING

ANNEALING

Heat uniformly in vacuum or a protective atmosphere to 1600°F and soak at this temperature for two hours. Slow cool 30°F per hour to 1000°F, then furnace cool or cool in still air to room temperature. Supplied in the annealed hardness of 285/311 BHN.

STRESS RELIEVING (SOFT)

Rough machined material is stress relieved by heating to 1100°F–1300°F. Soak for two hours and cool in air or furnace.

HARDENING

Vacuum, salt or protective atmosphere methods are generally used. Care should be taken to prevent decarburization.

PREHEAT

Heat to 1550°F–1600°F until temperature is equalized. Additional preheat steps including 1250°F–1300°F and 1850°F–1900°F are suggested when using programmed control during vacuum processing.

AUSTENITIZING

Temperatures in the range of 2025°F–2175°F are commonly used with the specific temperature and soak time determined by the hardness required. Higher hardening temperatures will provide maximum wear resistance and hardness, while temperatures lower in the range will provide increased toughness. Refer to chart for further information.

QUENCHING

Methods include use of high-pressure gas (minimum 6 bar preferred), salt bath or oil. Quench rate through the temperature range of 1900°F to 1300°F is critical to the development of optimum structure and properties. Part temperature can then be equalized at 1000°F–1100°F after which cooling can continue to below 150°F or "hand warm". Step quenching in this manner will help to minimize distortion in larger section sizes.

TEMPERING

Tempering should be performed immediately after quenching. Temperatures in the range of 1000°F–1100°F are generally used depending on the hardness required. Heat uniformly to the selected temperature and soak for two hours. Triple tempering is essential for optimal mechanical properties and a fourth temper is recommended when using high end hardness. Tempering temperatures less than 1000°F should not be used, and care must be taken to cool parts fully to room temperature (hand warm) between each temper.

STRESS RELIEVING (HARDENED)

Heat to 25°F less than the temperature of the last temper and soak for one hour

STRAIGHTENING

Should be done warm (or during quench) using temperatures in the range of 400°F–800°F.

SIZE CHANGE DURING HARDENING

+.0025 in/in (at 67.5Rc)

HEAT TREATMENT INSTRUCTIONS

1st preheating	1250°F–1300°F
2nd preheating	1550°F–1600°F
Hardening	Refer to table below
Tempering	3 x 2 hours each – Refer to table below

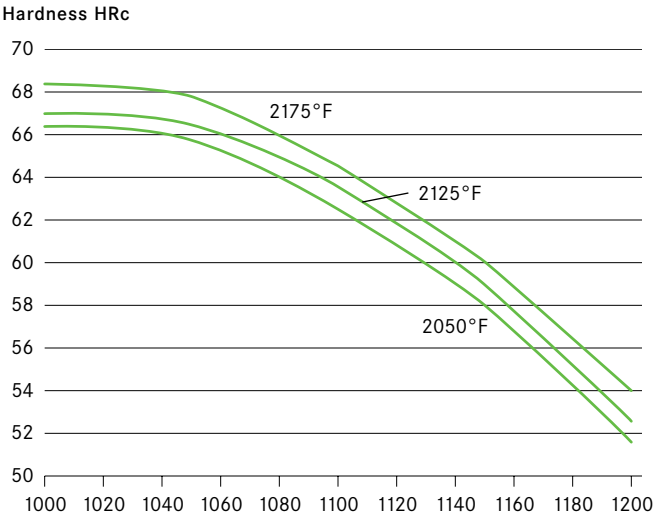
Quenching after hardening in hot bath at approx. 1000°F or in vacuum at least at 6 bar overpressure.

Required Hardness HRc	Austenitizing Temp [°F]	Holding time at Austenitizing Temp [Min]	Tempering temperature [°F]
64–66 (recommended/ max toughness	2050	20	1050
65–67	2100	15	1050
67–69 (recommended/ max wear resistance	2150	15	1025
68–70	2175	15	1025

SURFACE TREATMENT

Z-Max PM is an excellent substrate material for use with the various commercially available PVD coating processes. Conventional nitriding (.001" maximum depth) and steam tempering are also good options. Coating vendors should be consulted to select the optimum process for a given application. Care must be exercised during CVD and other surface treatment processes that can alter the original heat treatment of the tool.

TEMPERING DIAGRAM



Further information regarding Zapp products and locations is available in the Z-series PM brochure and at **www.zapp.com**

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