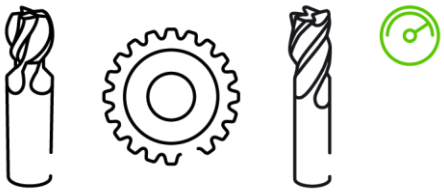
Z-Max PM^{speed} Data Sheet
Tooling Alloys

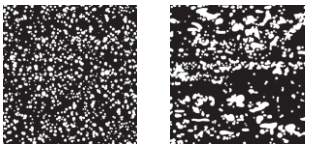
Zapp is certified To ISO 9001



Chemical Composition

Carbon	2.0 %
Chromium	4.0 %
Vanadium	5.0 %
Tungsten	10.0 %
Molybdenum	5.0 %
Cobalt	9.0 %

Powder Metallurgical and Conventional Powder

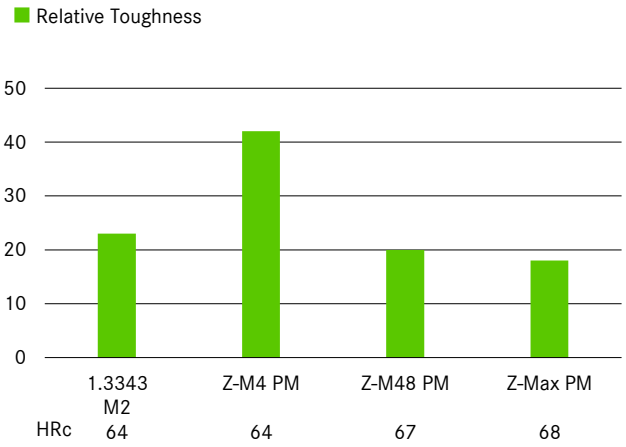


The uniform distribution of carbides in the powder- metallurgical structure compared to conventional tool steels with big carbides and carbide clusters.

Z-Max PM^{speed}

Z-Max PM^{speed} is an ultra-high performance HSS produced by powder metallurgy methods that can be heat treated to a maximum attainable hardness of HRc 68 – 70. It offers maximized 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 underhardened to optimize toughness. It can be considered as a possible alternative to carbide when toughness is a concern. The particle metallurgy processing also provides improved machinability, grindability, heat treat response, and dimensional stability when compared to similar grades produced by conventional methods.

Toughness

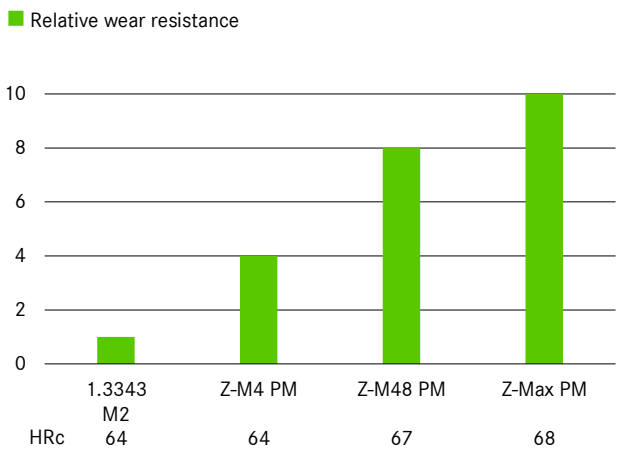


Standard size of the Charpy-test-piece with a 12.7 mm notch radius.

Typical Applications

- Form tools
- Gear tools
- Broaches
- Miscellaneous cutting tools
- Precision wear parts
- Powder compaction tooling
- Roll forming tools
- Punches and dies

Wear Resistance



Physical Properties

Modulus of elasticity E [GPa]	214
Density [kg/dm³]	8.26
Coefficient of thermal expansion [mm/mm/K] over temperature range of 40 - 540 °C	10.9 x 10 $^{-6}$
Thermal conductivity [W/(m*K)] at 20 °C	24.2

Thermal Treatments

Soft Annealing
The material is heated uniformly to a temperature of 870 °C and then maintained at this temperature for 2 hours. Then, the material is cooled to 540 °C in a furnace at a cooling rate of maximum 10 °C per hour.

It is then further cooled in still air down to room temperature. The typical hardness achieved by soft annealing is approximately 285 – 310 HB.

Stress Relieving
Rough machined material is stress relieved by heating to 600 – 700 °C. Once complete heat penetration has been reached (minimum 2 hours), the material is allowed to cool in the furnace followed by cooling in air.

Hardened material is stress relieved at 15 – 30°C for 2 hours below last tempering temperature followed by cooling in air.

Straightening
Straightening should be done in the temperature range of 200 – 430 °C.

Hardening
When hardening Z-Max PM^{speed}, two preheating stages are usually used according to the table. Further preheating stages can be added depending on the furnace type and furnace load.

Hardening can be carried out in a vacuum, salt bath or in an inert gas atmosphere. The best combination of toughness and wear resistance is achieved by austenitizing at 1,150 °C.

In order to achieve an appropriate degree of solution of the alloying elements and a suitable degree of quenching and tempering, adapted holding times are recommended in the different temperature ranges. The holding times should be adapted for large or very thin-walled tool cross-sections.

Quenching
Quenching can take place in hot bath at 540°C, oil or pressurized gas. Quenching in salt bath or oil leads to maximum hardness, whereas cooling in vacuum can lead to lower values of 1 – 2 HRc.

By use of vacuum quenching a minimum pressure of 6 bar is recommended.

The appropriate pressure needs to be adjusted for complex tool shapes in order to minimize risk of cracking and tool distortion.

For attaining ideal toughness properties, it is recommended to apply the hot bath quenching method.

Tempering
Tempering should be carried out immediately after the material has cooled down to below 40 °C or when the tool can be held with hands.

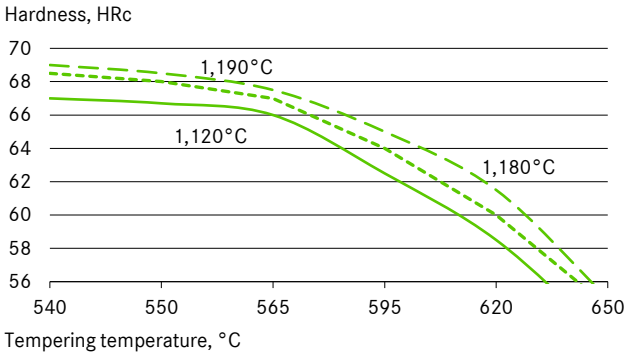
Triple tempering with a holding time of 2 hours in each stage at the tempering temperature is necessary.

It is important to ensure that the tools are cooled down to room temperature between the individual tempering stages.

Surface Treatments
This grade is an excellent substrate material for use with the various commercially available PVD coating processes. Conventional nitriding and steam tempering can also be used.

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



Heat Treatment Instructions

1st preheating	450–500 °C
2nd preheating	850–900 °C
(3rd preheating)	1,000-1,050 °C
Hardening	As specified in table
Tempering	3 x each 2 hours as specified in table

Quenching after hardening in hot bath at approx. 550°C or in vacuum at least at 6 bar overpressure.

Required hardness HRc ± 1	**Austenitizing soak temp [°C]**	**Austenitizing soak time [min]***	**Tempering temperature[°C]****
66	1,120	15	560
68	1,190	10	550
70	1,200	5	540

* Process variation and part section size can affect results. Soak times should be based on actual part temperatures. Use of load thermocouples is highly recommended during batch processing.

** An increase in tempering temperature by 10°C can be used to reduce hardness 1 to 2 points HRc. Tempering temperatures less than 540°C should not be used.

Machining Data

Turning

Cutting parameter	Turning with cemented carbide medium turning	finish turning	HSS
Cutting speed (V_C) m/min.	80-110	110-140	8-10
Feed (f) mm/U	0.2–0,4	0.05–0.2	0.05–0.3
Cutting depth (a_p) mm	2–4	0.05–2	0.5–3
Tools according ISO	P 10–P 20*	P 10*	–

* Use wear resistant coated cemented carbide, e. g. Coromant 4015 or Seco TP 100.

Milling

Face- and Edge Milling

Cutting parameter	Milling with cemented carbide medium turning	finish turning	HSS
Cutting speed (V_C) m/min.	60-80	80-110	15
Feed (f) mm/U	0.2–0.3	0.1–0.2	0.1
Cutting depth (a_p) mm	2–4	1–2	1–2
Tools according ISO	K 15*	K 15*	–

* Use wear resistant coated cemented carbide, e.g. Coromant 4015 or Seco TP 100.

End Milling

Cutting parameter	Solid carbide	Milling cutter w. indexable tips	Coated HSS
Cutting speed (V_C) m/min.	45-55	50-70	12*
Feed (f) mm/U	0.01–0.20**	0.06–0.20**	0.01–0.30**
Tools according ISO	K 20	P 25***	–

* for TiCN-coated end mills made of HSS V_C ~ 25-30 m/min.
** depends on radial depth of cut and on milling cutter - diameter
*** Use wear resistant coated cemented carbide, e.g. Coromant 3015 or SECO T15M.

Drilling

Spiral Drill Made of HSS

Driller-⌀ mm	Cutting speed (V_C) m/min.	Feed (f) mm/U
0– 5	12-16*	0.05–0.15
5 –10	12-16*	0.15–0.25
10 –15	12-16*	0.25–0.35
15 –20	12-16*	0.35–0.40

* for TiCN-coated end mills made of HSS V_C ~ 25-30 m/min.

Carbide Metal Driller

Cutting parameter	Drill type insert drill	Solid carbide tip	Coolant bore driller with carbide tip*
Cutting speed (V_C) m/min.	70-90	40-60	35
Feed (f) mm/U	0.08–0.14**	0.10–0.15**	0.10–0.20**

* driller with coolant bores and a soldered on carbide tip
** depends on driller-diameter

Grinding

Grinding method	Soft annealed	Hardened
Surface grinding, straight grinding wheels	A 13 HV	B 107 R75 B3* 3SG 46 GVS** A 46 GV
Surface grinding	A 24 GV	3SG 36 HVS**
Cylindrical grinding	A 60JV	B126 R75 B3* 3SG 60 KVS** A 60 IV
Internal grinding	A 46 JV	B126 R75 B3* 3SG 80 KVS** A 60 HV
Profile grinding	A 100 LV	B126 R100 B6* 5SG 80 KVS** A 120 JV

* for these applications we recommend CBN-wheels
** grinding wheel from the company Norton Co.

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