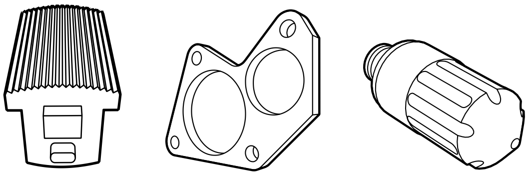
Z-TUFF PM

Chemical Composition

C	0.7%	Cr	7.5%
Mo	2.0%	V	1.0%
Ni	1.5%		



Z-TUFF PM

Z-Tuff PM is a powder metallurgy tool steel designed with toughness as the primary criteria. Its attributes include:

- High impact strength and resistance to fracture while retaining exceptional compressive strength
- Good wear resistance
- Attainable hardness approaching HRC 62
- Easily heat treated using common tool steel cycles
- Consistency and reliability inherent with PM tool steel
- Thermo-shock resistant.

This unique combination of properties makes Z-Tuff the choice in difficult applications involving high mechanical loads and risk of failure due to chipping and fracture. It offers a distinct advantage over standard air hardening grades in terms of toughness. At the same time it is clearly superior to the S series grades in terms of compressive strength and wear performance. It is a deep hardening grade that will maintain a high degree of dimensional stability, and a highly effective substrate for a variety of common tool coatings and surface treatments.

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Rectangular sections from 25mm³ up to 430 x 430 x 150mm can be delivered fine milled on all six faces to -0 +0.1mm and with squareness guaranteed to 0.1mm/m.

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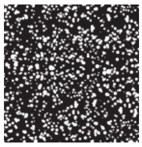
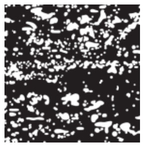
Typical Applications

- General tool and die
- Stamping, forming and fine blanking
- Punches
- Powder compaction

POWDER METALLURGICAL AND CONVENTIONAL MICROSTRUCTURE



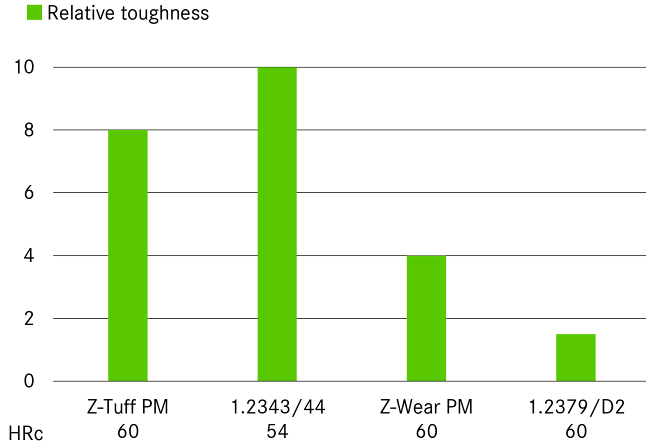


The uniform distribution of carbides in the powder- metallurgical structure compared to conventional tool steels with big carbides and carbide clusters.

PHYSICAL PROPERTIES

Modulus of elasticity E [GPa]	207
Density [g/cm³]	7.66
Coefficient of thermal expansion over a temperature range of 20 - 540 °C [mm/mm/°C]	11.5 x 10^{-6}
Thermal conductivity [W/(m*K)]	24.2

TOUGHNESS



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HEAT TREATMENT

Soft Annealing

The material is heated uniformly to a temperature of 860-760°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 15°C per hour. It is then further cooled in still air down to room temperature. The typical hardness achieved by soft annealing is approximately 225-250 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 to approximately 500°C 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.

Hardening

Hardening of Z-Tuff PM usually involves the use of two preheating steps according to the table on the right. Depending on furnace and charging, additional preheating steps can be implemented. In order to achieve a corresponding degree of dissolution of the alloying elements, as well as an appropriate hardening, minimum heat penetration times as given in the table are recommended. These holding times should be correspondingly adapted for thick or thin-walled material cross sections.

Straightening

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

Quenching

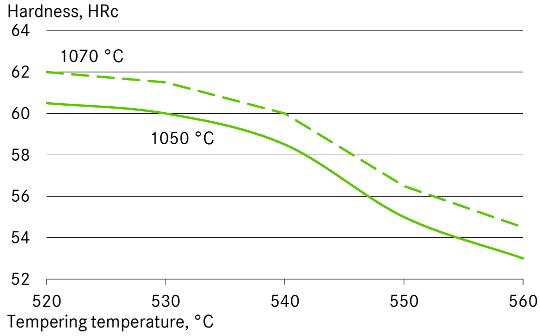
Quenching can take place in hot bath at 540°C, oil or pressurized gas. Quenching in salt bath or oil leads to maximum hardness, whereas cooling in vacuum can lead to lower values of 1-2 HRc. By use of vacuum quenching a minimum pressure of 6 bar is recommended. The appropriate pressure needs to be adjusted for complex tool shapes in order to minimise risk of cracking and tool distortion. For attaining ideal toughness properties, it is recommended to apply the hot bath quenching method. For attaining maximum hardness after quenching the cooling rate between 1000°C and 700°C needs to be maximised in order to minimise distortion in larger section sizes.

Quenching

Quenching in air, hot bath or oil is possible. When using vacuum treatment, a quenching pressure of min. 6 bar is needed. To reach the highest toughness level, quenching in hot bath (app. 550°C) is recommended.

Tempering

The tempering procedure must start immediately after the tool has cooled down to below 40°C or when the tool can be held with hands. Triple tempering with a holding of 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.



HEAT TREATMENT INSTRUCTIONS

1st preheating	450-500°C
2nd preheating	850-900 °C
Hardening	as specified in table
Tempering	3 x each 2 hours as specified in table

Preferred quench method is high pressure inert gas (minimum 4 bar) or molten salt at 1025°F.

Required hardness HRc ± 1	Austenit-izing soak temp [°C]	Austenit-izing soak time [min]*	Tempering tempera-ture[°C]**
59	1050	30	540
60	1050	30	530
61	1050	30	520
62	1070	20	530

* 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 15°C can be used to reduce hardness 1 to 2 points HRc.

Surface Treatment

The 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.

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MACHINING DATA

TURNING

Cutting parameter	Turning with cemented carbide medium turning	finish turning	HSS
Cutting speed (V_C) m/min.	100-150	150-200	12-15
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 EDGEMILLING

Cutting parameter	Milling with cemented carbide Medium turning	finish turning	HSS
Cutting speed (V_C) m/min.	90-120	120-150	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	90-110	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	5 - 8*	0.05–0.15
5 – 10	5 - 8*	0.15–0.25
10 – 15	5 - 8*	0.25–0.35
15 – 20	8 – 8*	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.	80–110	40	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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