# Z-23 PM$^{speed}$, PM High-Speed Steel
## Data Sheet - Tooling Alloys

Zapp is certified to ISO 9001

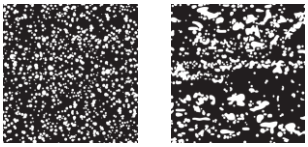
### Key Features of Zapp's Powder Metallurgical High Speed Steel Z-23 PM$^{speed}$

- PM 6-5-3
- Produced using powder metallurgical processes
- Standard powder high-speed steel
- Case hardness up to 66 HRC possible

### Typical Areas of Application

- Cutting, punching, and fine blanking tools
- Pressing and forming tools
- Machining tools

### Powder metallurgical vs. conventional microstructure



The homogeneous microstructure which is obtained by using powder metallurgical processes vs. the coarse carbide structure of conventionally produced steel

### Physical properties

| | |
|---|---|
| Modulus of elasticity E [GPa] | 230 |
| Density [kg/dm³] | 7.97 |
| Thermal expansion coefficient [mm/(mm/K)] in a temperature range up to | 11.5 x $10^{-6}$ |
| 400 °C | 12.4 x $10^{-6}$ |
| 600 °C | 13.0 x $10^{-6}$ |
| Thermal conductivity [W/(m*K)] | 24.0 |

### Delivery condition

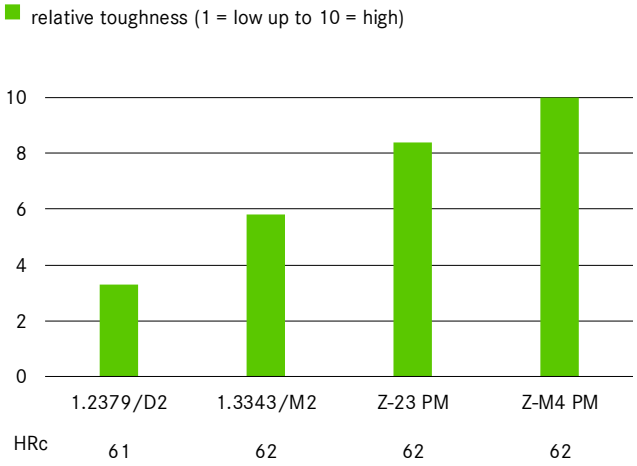
| | |
|---|---|
| As-delivered condition | Soft-annealed, approx. 300 HB |
| Product form | Round bars, flat bars, sheets |
| Surface finish | Mechanically machined |

### Typical chemical composition (weight %)

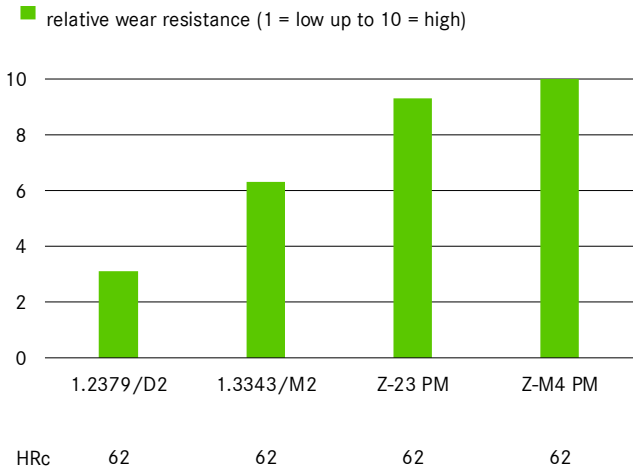
| C | Cr | Mo | W | V |
|---|---|---|---|---|
| 1.3 | 4.2 | 5.0 | 6.4 | 3.0 |

### Qualitative comparison of the most important properties

**Toughness**




**Wear resistance**



## Heat Treatment

### Soft Annealing

- In neutral atmosphere at ~ 870 °C and ~ 4 h exposure time (after through-heating)
- Followed by furnace cooling (optimum cooling rate max. 10 °C/h up to 540 °C)
- Soft annealing hardness ~ 300 HB

### Stress Relief Annealing

~ 650 °C/ ~ 2 h exposure time (after through-heating) followed by furnace cooling

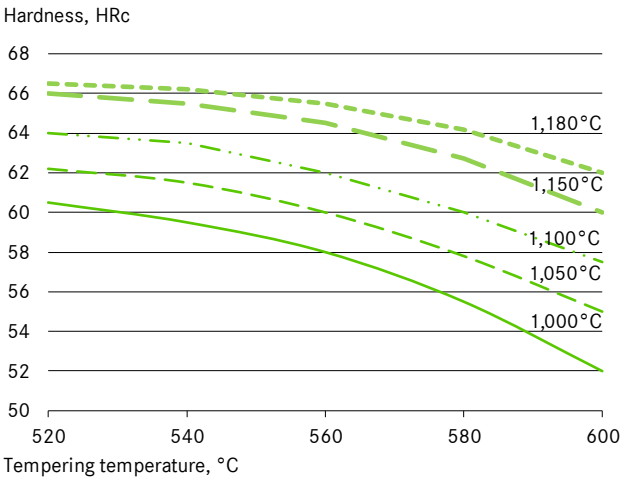
### Surface Treatments

Tempering temperatures of ≥ 560 °C provide the prerequisite for subsequent nitriding or PVD coating.

You can find more materials at:
www.zapp.com/en-uk/materials/powder-metallurgical-tool-steel

Zapp Precision Metals GmbH ensures professional execution of all heat treatment steps as well as their preparation and post-processing (e.g., charging, hardness testing, straightening processes, etc.) – always with the aim of obtaining the optimum component properties!
We are happy to assist you with constructive advice!

**Tempering diagram**




**Vacuum heat treatment instructions**

| | |
|---|---|
| Pre-heating | professional heating,<br>3 pre-heating stages recommended |
| Vacuum heating | from 1,000 to 1,180 °C<br>see table |
| Exposure time | from 10 to 30 minutes after through-heating, see table |
| Cooling | in vacuum, a quenching pressure of at least 6 bar is required |
| Tempering | at least 3 times for 2 hours each according to table, fourth tempering recommended, allow to equilibrate to room temperature in between |

| Desired hardness HRC ± 1 | Hardening temperature °C | Exposure time at hardening temperature minutes | Tempering °C |
|---|---|---|---|
| 58 | 1,000 | 30 | 560 |
| 60 | 1,050 | 25 | 560 |
| 62 | 1,100 | 15 | 560 |
| 64 | 1,150 | 15 | 560 |
| 66 | 1,180 | 10 | 560 |

The maximum specified hardening temperature of 1,180 °C should not be exceeded.
Hardening with further heat treatment processes is possible, but should be discussed in advance!

TOOLING ALLOYS

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