TG Steels

TPM5W

ULTRACLEAN

High W alloyed PM steel for both superior wear resistance with very good toughness

TPM5W UltraClean tool steel is obtained by powder metallurgy. It is characterized by very good toughness associated with good wear resistance.

Applications

TPM5W UltraClean also finds numerous applications in the field of cold work tools requiring both good toughness and also good wear resistance, as fine cutting and punching tools for thick metal sheets, as well as for punches or dies *(deep drawing tools)*, powder processing tools, rollers, shears, industrial knifes wear parts for plastic molds....

TPM5W UltraClean is particularly recommended for tools where a high toughness level is required.

Main properties

- Very good toughness associated with a good wear resistance
- Good wear resistance
- Good compressive strength
- Very good stability

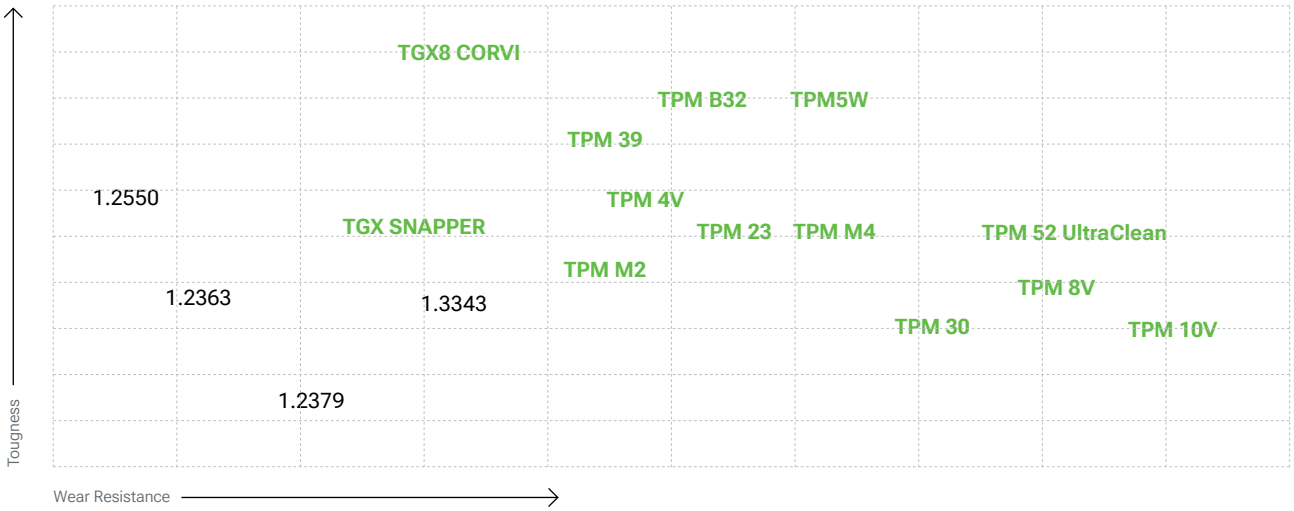
Comparison with the other PM tool steels available at TG Steels, the position on the toughness vs wear resistance diagram is shown here under.

Chemical composition *(typical)*

C	W	Mo	Cr	V	Co
1.50	2.40	2.50	4.00	4.00	-

Designation

Werkstoff Nr	ISO	China GB	JIS Japan	UK	AISI USA	Russia Gost	AFNOR	Other / Special
1.3377	PM HS 3-3-4 / X150CrVMoW 4-4-3-3	-	-	-	-	-	-	-



Structure

The structure of the TPM5W UltraClean is fine and homogeneous without precipitation or alignments of carbides.

Due to its elaboration by powder metallurgy with Hot Isostatic Compression the typical size of the carbides is about 2 μm and the level of cleanliness is far better than conventional cold work tool steels.

Hardness at the time of delivery

Annealed for 310 HB max.

Typical mechanical properties in hardened conditions *(results from internal tests not indicated on the certificates)*

Hardness	Compressive yield strength MPa	Impact test unnotched probe J at 23°C
58	2300	120
60	2500	100
62	2700	85

Physical properties

Temperature	20°C	400°C	600°C
Volumic mass kg/m³	7800	77200	7550
Young Modulus N/mm²	220000	195000	173000
Thermal conductivity W/m.K	24	28	28
Coefficient of linear expansion 10^{-6}/K	11.9	12.1	12.6

Heat treatment

SOFT ANNEALING

Temperature: 870 - 890°C, duration 1h + 1h for 25 mm thickness. Slow cooling in the furnace *(10 to 20°C/h)*. The atmosphere in the furnace must be reducing to avoid decarburization of the steel.

STRESS RELIEVING

After machining, it is recommended to perform stress relieving at 650°C for a minimum of 2 hours, followed by slow cooling in the furnace to 450°C.

AUSTENITIZATION

In order to avoid any risk of cracking it is recommended to preheat in 2 steps.

- 1st preheating step:
  temperature: 500°C time: 30 s/mm of thickness
- 2nd preheating step:
  temperature: 875°C time: 30 s/mm of thickness

Recommended austenitizing temperature: 1050 - 1100°C. The holding time should not be too long to avoid a risk of grain coarsening and a loss of toughness. It is recommended to keep the part at the austenitizing temperature 30 minutes per inch of thickness as soon as the temperature of the surface reach the austenitization temperature.

Temperatures over 1020°C are not recommended in order to avoid big amounts of retained austenite leading to a poor stability and the risk of cracks.

QUENCHING MEDIUM

Oil at 80°C, vacuum *(pressure > 6 bars)*, salt bath 500 - 550°C.
To ensure good toughness, treatment with oil or salt bath is preferable.

SUB ZERO TREATMENT

For parts that need to have high dimensional stability and to increase wear resistance without reducing toughness, it is recommended to perform a subzero treatment at a temperature between -70°C and -190°C for 1 hour for 25 mm of thickness of the part.

The temperature range from -70°C up to -120°C *(named cold treatment of steel)* leads to the complete transformation of austenite into martensite and as a consequence to better stability associated with improved hardness and better wear resistance and the temperature range from -135°C down to -190°C *(named cryotreatment of steel)* leads also to the complete transformation of austenite and also the precipitation of ultrafine carbides improving a lot the wear resistance without modification of the toughness.

This treatment is optional for common applications.

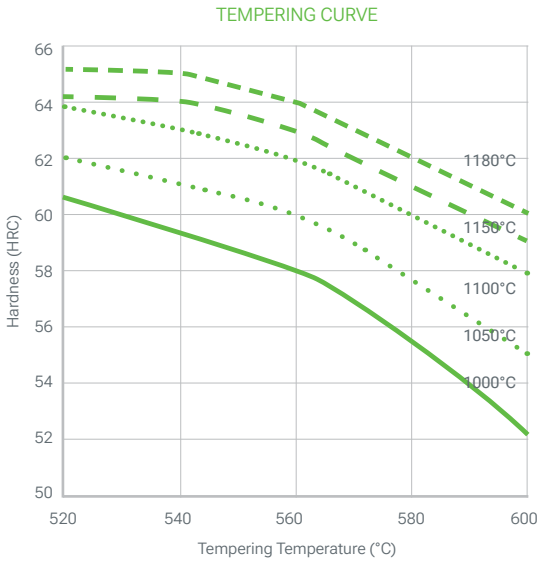
TEMPERING

To ensure a minimum residual austenite rate as well as greater tool stability, it is essential to perform double *(better triple)* tempering. Each tempering is followed by a cooling under 100°C.

Depending on the use of the final part the following tempering temperatures are recommended:

Austenitizing temperature	Tempering temperature	Hardness	Properties
1050 / 1100°C	530°C	61 / 63 HRC	Better wear resistance
	550°C	60.5 / 62.5 HRC	Wear and toughness
	570°C	59 / 61 HRC	Better toughness

Each tempering time must be at least equal to 1h + 1h for 25 mm of thickness of the treated part *(equivalent thermal thickness)*.



Surface treatment

NITRIDING

TPM5W UltraClean can be nitrided at temperatures less than or equal to 20°C below tempering temperatures without risk of deterioration of the mechanical characteristics.

Ionic nitriding at a temperature of 500°C is recommended. The surface hardness after nitriding is about 1200 $HV_{0.2kg}$.

PVD, CVD

TPM5W UltraClean is suitable for all kind of PVD and CVD treatment as soon as the treatment temperature is 30°C lower than the last tempering temperature.

Machining

The machining parameters below are given for information only and must be adapted according to the equipment and usual machining conditions.

GRINDING IN ANNEALED CONDITIONS

	Carbide insert		Solid tool
	Rough machining	½ Finishing	Finishing
Cutting speed m/min	120 - 140	60 - 90	50 - 90
Feed mm/r	0.35	0.15	0.05 - 0.15
Depth of cut mm	2 - 3	1 - 1.5	0.1

TURNING IN ANNEALED CONDITIONS

	Carbide insert		HSS tool
	Rough turning	Finishing	Turning
Cutting speed m/min	70 - 90	90 - 120	17
Feed mm/r	0.30	0.15	0.1 - 0.2
Depth of cut mm	2 - 3	1 - 1.5	0.5 - 2.0

DRILLING IN ANNEALED CONDITIONS CARBIDE DRILL

	Insert	Solid
Cutting speed m/min	100	40
Feed mm/r	0.10	0.15

HSS TWIST DRILL

Drill diameter mm	Cutting speed m/min	Feed mm/r
< 5	7	0.10
5 - 10		0.20
10 - 15		0.30
15 - 20		0.35

FINE GRINDING

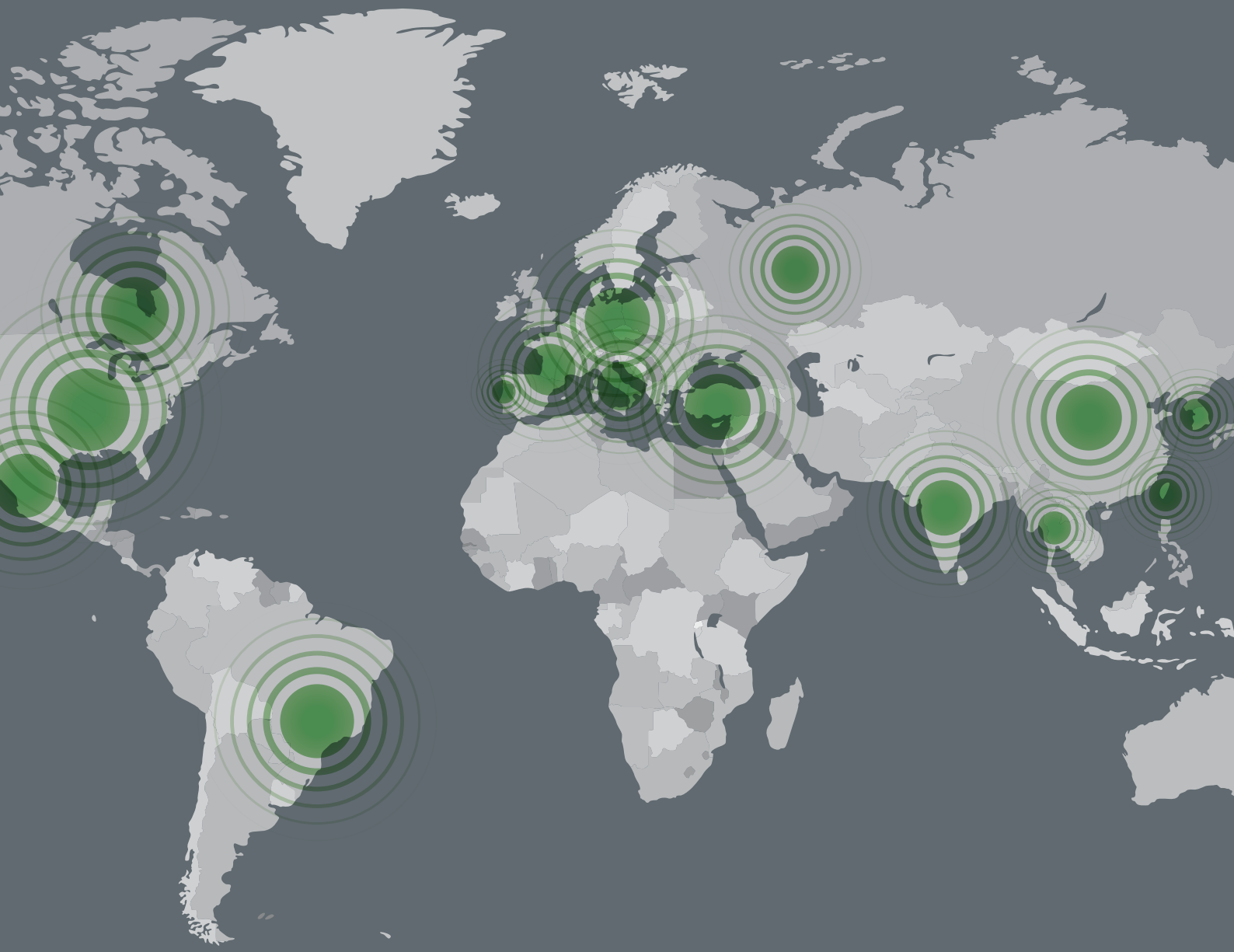
General indications for grinding wheels to be used on TPM5W UltraClean in the heat treated condition Usually, rather soft vitrified aluminum oxide grinding wheels *(grades G for plane grinding to K for cylindrical grinding)* are used.

Particular attention will be paid to effective cooling of the surface during grinding to prevent degradation of the material surface.

ELECTRO-DISCHARGE MACHINING

TPM5W UltraClean is also suitable for EDM machining *(wire or electrode)*. Preferably, the machining will be carried out with a low current density and a high frequency in order to limit the thickness of the white layer as much as possible.

Then it is necessary to carry out a stress relieving at 25°C below the last tempering in order to reduce the level of residual stresses *(which could lead to a risk of cracking)* and to carry out a polishing to completely remove the white layer formed during the discharge machining process.



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