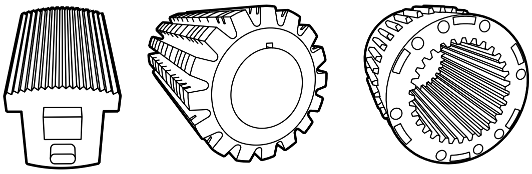
CPM® Rex M4 Data Sheet
Toolling Alloys

Zapp is certified to ISO 9001



Chemical composition

Carbon	1.4 %
Manganese	0.3 %
Silicon	0.5 %
Chromium	4.0 %
Vanadium	4.0 %
Molybdenum	5.2 %
Tungsten	5.5 %

CPM® Rex M4

CPM® Rex M4 is the „all-rounder" of the CPM® tool steel family. With its well-balanced characteristics with regards to toughness, wear resistance and compressive strength CPM® Rex M4 is suitable for a vast range of applications. CPM® Rex M4 has a much better machinability and dimensional stability after heat treatment compared to the conventional high-speed steels like 1.3343 and 1.3344. Thanks to its versatility, it is possible to utilize CPM® Rex M4 for first series tooling and for optimizing tool life in blanking, cutting and cold forming as well as for cutting tools with enhanced performance.

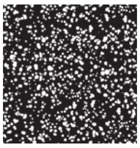
Typical Applications

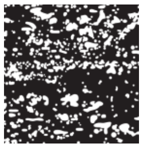
- cutting tools
- punches and dies
- fine blanking tools
- shears, rotary shears
- sinter pressing dies
- cold extrusion dies
- broaching tools
- reamers
- milling tools

Physical properties

Modulus of elasticity E [GPa]	214
Density [kg/dm³]	7.97
Coefficient of thermal expansion [mm/mm/K] over temperature range of 40 - 260 °C 40 - 540 °C	 11.5 x 10 $^{-6}$ 12.1 x 10 $^{-6}$
Thermal conductivity [W/(m*K)] at 20 °C 540 °C	 19.0 26.1

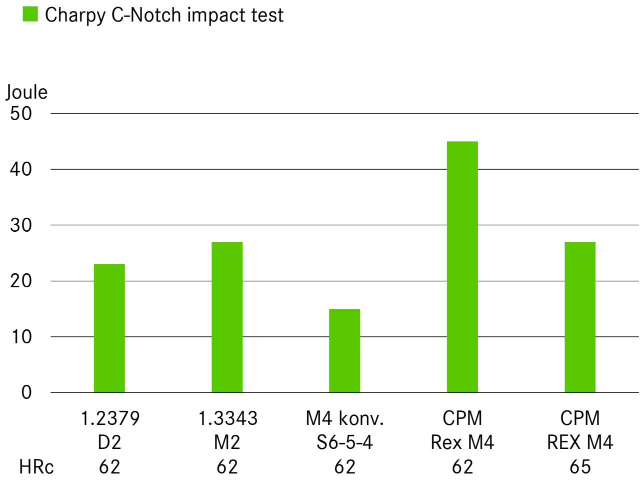
Powder metallurgical and conventional microstructure





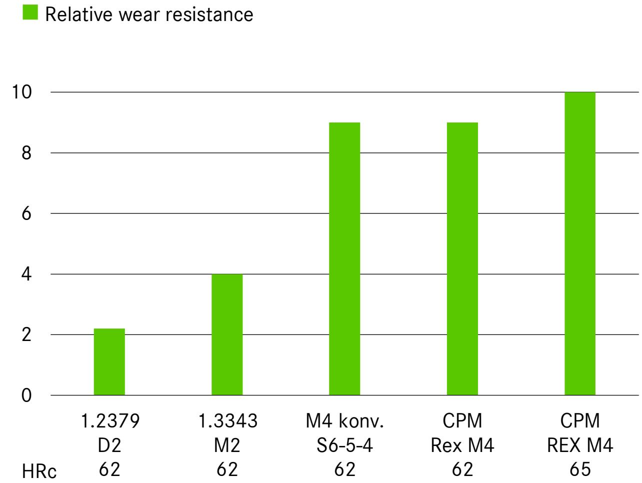
The uniform distribution of carbides in the powder-metallurgical structure compared to conventional tool steels with big carbides and carbide clusters.

Toughness



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

Wear resistance



Heat treatment annealing

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 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 230-260 HB. Peeled bars can show soft annealing hardness of up to 300 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.

Straightening

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

Hardening

Hardening of CPM® Rex M4 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. Best combination of toughness and wear resistance is attained by austenitizing at 1150 °C. 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.

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. For attaining maximum hardness after quenching, the cooling rate between austenitizing temperature and 600°C needs to be maximized.

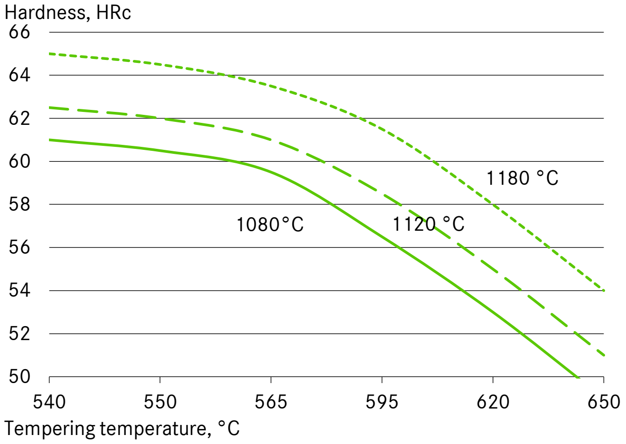
Tempering

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 of 560 °C is necessary. It is important to ensure that the tools are cooled down to room temperature between the individual tempering stages.

Surface Treatments

CPM® Rex M4 can be nitrided and/or PVD/CVD coated.

Tempering diagram



Heat treatment instructions

1st preheating	450–500 °C
2nd preheating	850–900 °C
3rd preheating	1000-1050 °C
Hardening	As specified in table
Tempering	3 x each 2 hours

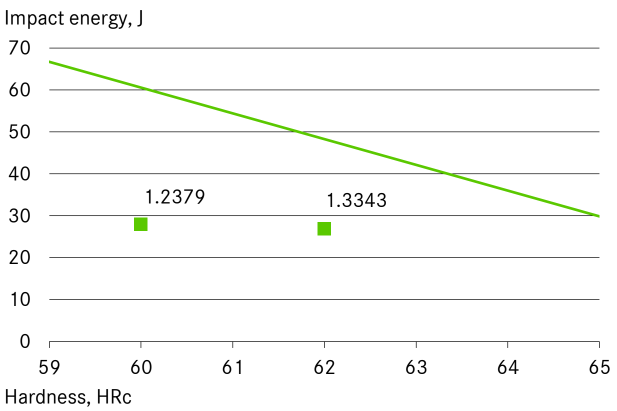
Quenching after hardening in hot bath at approx. 550°C or in vacuum at least at 5 bar overpressure.

Required hardness HRc ± 1	Austenitizing temperature °C	Holding time at austenitizing temperature, min*	Tempering temperature °C
59	1080	30	560
60	1100	25	560
61	1120	20	560
62	1150**	15	560
63	1160	15	560
64	1180	10	560
65	1200	5	560

* In case of previous preheating at 870 °C. The data referred to 13 mm round bar samples. The holding times at austenitizing temperature should be correspondingly adapted for large and very thin profile dimensions. The maximum permissible austenitizing temperature of 1200 °C must not be exceeded.

** Best combination of wear resistance/toughness

Toughness values



Machining Data

Turning

Cutting parameter	Turning with cemented carbide medium turning	finish turning	HSS
Cutting speed (V_C) m/min.	70-90	90-130	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 edge milling

Cutting parameter	Milling with cemented carbide medium turning	finish turning	HSS
Cutting speed (V_C) m/min.	70-90	90-130	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.	20–35	50-80	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	8 - 14*	0.05–0.15
5 – 10	8 - 14*	0.15–0.25
10 – 15	8 - 14*	0.25–0.35
15 – 20	8 - 14*	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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