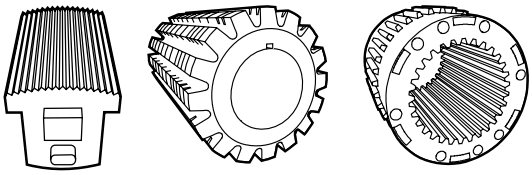
TOOL ALLOYS
DATA SHEET CPM ® REX M4

CERTIFIED TO ISO 9001



CHEMICAL COMPOSITION

Carbon	1.35 %
Chromium	4.25 %
Vanadium	4.00 %
Molybdenum	4.50 %
Tungsten	5.75 %
Manganese	0.30 %
Silicon	0.30 %

CPM® REX M4

is a high speed steel specially developed to meet the most demanding requirements. It is designed to provide high wear resistance and cutting edge stability in tools. Its high vanadium and carbon content lend punching and metal forming tools as well as metal-cutting tools their high tool life quality and cutting speeds. CPM® Rex M4 is characterized by its higher wear resistance compared to S6-5-2 or S6-5-3 steel. Thanks to the Crucible Particle Metallurgy process, CPM® Rex M4 offers better grinding properties than conventional S6-5-3 steel and higher toughness than conventional S6-5-2 steel.

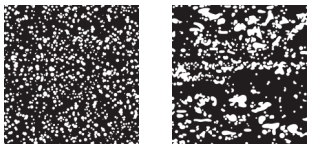
TYPICAL APPLICATIONS

_ 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 [kN/mm²]	230
Specific weight [kg/dm³]	7.97
Thermal conductivity at 65 °C [W/mk]	24.3
Coefficient of thermal expansion over temperature range of 40 - 540 °C [mm/mm °C]	12.25 x 10^{-6}

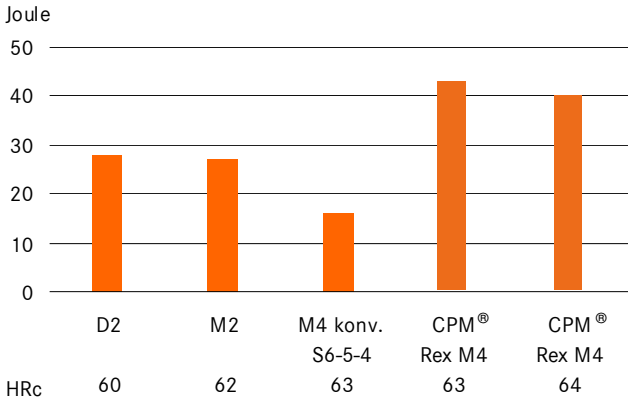
POWDER METALLURGICAL AND CONVENTIONAL MICROSTRUCTURE



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

TOUGHNESS

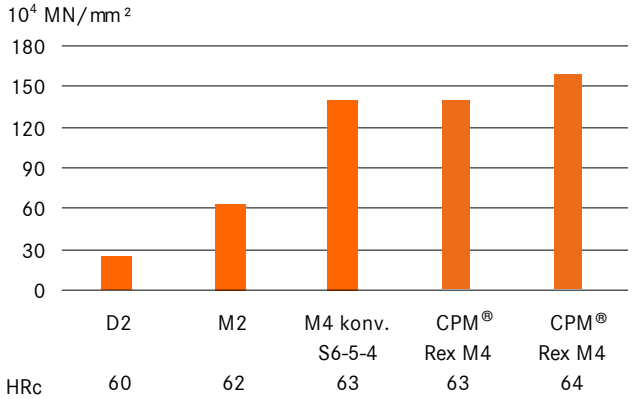
Charpy C-Notch impact test



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

WEAR RESISTANCE

Crossed Cylinder wear test



Reciprocal of wear rate in wear test with non lubricated crossed cylinder in contact with a rotation tungsten carbide cylinder.

HEAT TREATMENT ANNEALING

SOFT ANNEALING

CPM® Rex M 4 is heated uniformly to a temperature of 860 - 870 °C; maintain at this temperature for 2 hours and allow to cool to 550 °C in the furnace at a cooling rate of 10 °C per hour. This is followed by cooling in still air. The strength values achieved by soft annealing are HB 245.

STRESS RELIEVING

Stress relieving follows rough machining by heating to a temperature of 600 – 700 °C. Once complete heat penetration has been reached, the material is allowed to cool in the furnace to approx. 500 °C followed by cooling in air.

HARDENING

Hardening of CPM® Rex M4 usually involves the use of 2 preheating stages (450 – 500 °C/ 850 – 900 °C). The material is then rapidly heated from the preheating temperature to the austenitizing temperature of 1090 – 1180 °C. We recommend hardening in a salt bath at standard temperatures of 1090 – 11800 °C depending on the particular application. The upper range of the austenitizing temperatures (1140 – 1180 °C) should be used for metal-cutting tools. The lower range of the austenitizing temperatures (1070 – 1120 °C) should be selected for cold working tools, for which a greater degree of toughness is required.

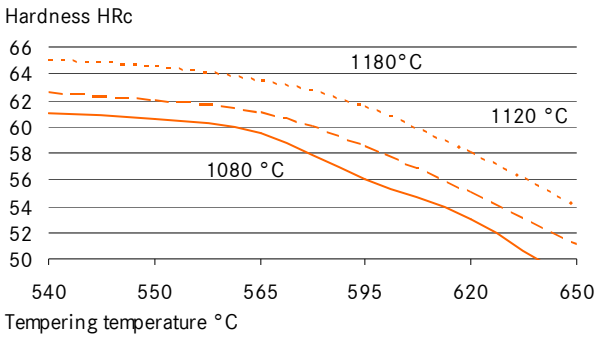
QUENCHING

Quenching can take place in oil, air or pressurized gas. Hot bath quenching at approx. 550°C is recommended. This provides flaw-free surfaces and avoids the risk of abnormal deformation. Material diameters up to max. 20 mm can be quenched with compressed air or compressed gas (in vacuum furnace, depending on type of furnace). This quenching method is too slow for larger cross-sections and results in the hardness values being too low. Quenching in oil ensures the correct hardness level even for large cross-sections, however, there is a risk of excessive distortion. Quenching large-volume tools in the hot bath generally results in slightly lower hardness than oil quenching. Irrespective of which quenching method is used, in all cases, the tools should be quenched to a temperature below 40 °C. The material must be tempered immediately after hardening.

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 two 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. Temperatures below 560 °C should be avoided in order to ensure satisfactory tempering results.

TEMPERING DIAGRAM



HEAT TREATMENT INSTRUCTIONS

1st preheating	450–500 °C
2nd preheating	850–900 °C
Hardening	as specified in table
Tempering	3 x each 2 hours at 560°C

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, sec*	Tempering temperature[°C]
59	1090	35	560
60	1100	35	560
61	1120	35	560
62	1140	25	560
63	1160	20	560
64	1180	15	560
65	1200	10	560

* 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.
Holding time in sec./mm thickness

MACHINING DATA

TURNING

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