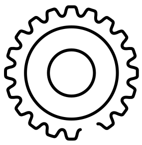
Data Sheet CPM® Rex 121
Tooling Alloys

Zapp is Certified to ISO 9001

Chemical composition

Carbon	3.4 %
Chromium	4.0 %
Vanadium	9.5 %
Tungsten	10.0 %
Cobalt	9.0 %
Molybdenum	5.0 %
Sulfur	0.1 %

CPM® Rex 121

CPM® Rex 121 is the Super-HSSE of the CPM® tool steel family. Maximal hardness and a compressive strength equal to solid carbide, combined with a high wear resistance and hot hardness make CPM® Rex 121 the "tough" alternative to solid carbide for a wide array of applications.
CPM® Rex 121 is frequently used as the ultimate phase in tool performance optimization of Super HSSE grades for fine blanking and cold forming but also for the production of high temperature resistant and tough cutting tools used for dry cutting.

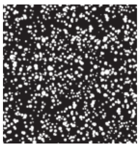
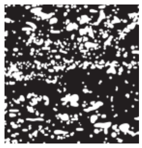
Typical applications

- End mills
- Form tools
- Milling cutters
- Shaper cutters
- Broaching tools
- Tool bits
- Wear parts

Physical properties

Modulus of elasticity E [GPa]	214
Density [kg/dm³]	8.26
Coefficient of thermal expansion [mm/mm/K] over temperature range of	
20 – 200 °C	10.8 x 10^{-6}
20 – 315 °C	11.1 x 10^{-6}
20 – 425 °C	11.4 x 10^{-6}
20 – 540 °C	11.7 x 10^{-6}
20 – 650 °C	12.1 x 10^{-6}

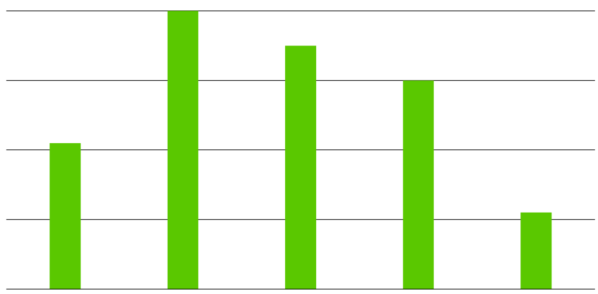
Powder metallurgical and conventional microstructure

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

Toughness

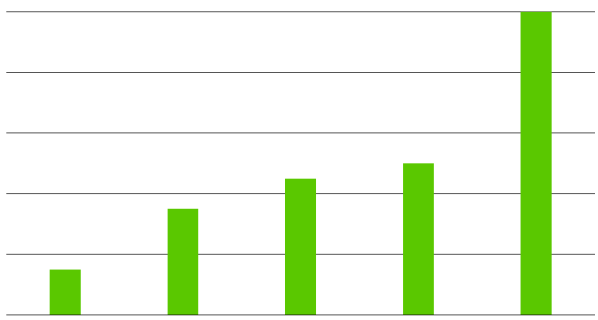
Charpy C-Notch impact test



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

Wear resistance

Relative wear resistance



Heat treatment

Annealing

The material is heated uniformly to a temperature of 900 °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 360-410 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 CPM® Rex 121 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. Maximum toughness is attained by austenitizing at 1025 °C, whilst maximum wear resistance is attained by austenitizing at 1200 °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.

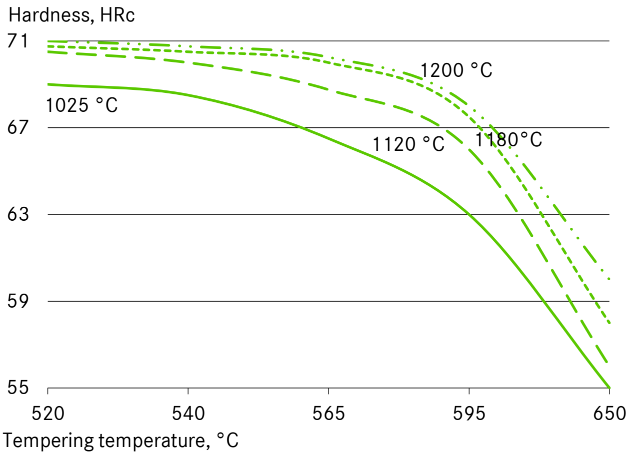
Quenching

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 at 550 °C.

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 absolutely necessary. For complex tool shapes, tempering of 5 times can lead to further improved properties. It is important to ensure that the tools are cooled down to room temperature between the individual tempering stages.

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 as specified in table

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	Minimum Holding time at austenitizing temperature, min.*	Tempering temperature °C
55	1025	30	650
63	1025	30	595
67	1025	30	565
68	1025	30	550
68	1205	10	595
69	1120	20	550
70	1175	15	550
71	1200	10	550

* 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 1220 °C must not be exceeded

Surface treatments

CPM® Rex 121 can be nitrided and/or PVD/CVD coated. In case of CVD-coating, a subsequent hardening is required in order to minimize distortion. This grade is especially suited for TiAlN-or similar coatings which allow high application temperatures.

Machining data

Turning

Cutting parameter	Turning with cemented carbide medium turning	finish turning	HSS
Cutting speed (V_C) m/min.	80-110	110-150	15-20
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 20*	–

* 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.	80-130	130-160	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

	Solid carbide	Milling cutter w. indexable tips	Coated HSS
Cutting speed (V_C) m/min.	45-50	90-110	5-8
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	10-12*	0.05–0.15
5 – 10	10-12*	0.15–0.25
10 – 15	10-12*	0.25–0.35
15 – 20	10-12*	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.	120-150	60-80	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
** finding wheel from the company Norton Co.

Zapp Precision Metals GmbH
TOOLING ALLOYS
Zapp-Platz 1
40880 Ratingen
Germany
Phone +49 2102 710-7200
Fax +49 2102 710-596
toolingalloys@zapp.com
www.zapp.com

Further information regarding our products and locations are available in our image brochure and under www.zapp.com

The illustrations, drawings, dimensional and weight data and other information included in these data sheets are intended only for the purposes of describing our products and represent non-binding average values. They do not constitute quality data, nor can they be used as the basis for any guarantee of quality or durability. The applications presented serve only as illustrations and can be construed neither as quality data nor as a guarantee in relation to the suitability of the material. This cannot substitute for comprehensive consultation on the selection of our products and on their use in a specific application. The brochure is not subject to change control.
Last revision: January 2022