KALTARBEITSSTAHL
COLD WORK TOOL STEEL

BÖHLER K890
MICROCLEAN®

冷作工具钢
COLD WORK TOOL STEEL

BÖHLER K890 MICROCLEAN®

BÖHLER K890 MICROCLEAN – 高延展性

粉末冶金冷作工具钢，拥有优良的抗塑性变形能力与高疲劳强度。

特性概述

- 高强度
- 高延展性
- 高抗疲劳强度
- 高抗压强度
- 高耐磨性
- 优良的热稳定性

应用领域

BOHLER K890 MICROCLEAN 由于具备优良的抗塑性变形能力与高疲劳强度，特别适合于对于刃口保持性要求高的模具。

范例

- 冲切与冲压
- 精冲
- 冷成型
- 重冷压成型
- 粉末压实
- 温锻

BÖHLER K890 MICROCLEAN – highly ductile

A powder metallurgy cold work tool steel with an outstanding capacity for plastic yield and a high fatigue strength.

The property profile

- **high strength**
- **highest ductility**
- **highest fatigue strength**
- **good compressive strength**
- **good wear resistance**
- **good thermal stability**

Areas of use

BÖHLER K890 MICROCLEAN is particularly suitable for tooling which requires a high edge stability and therefore a high capacity for plastic yield and a high fatigue strength.

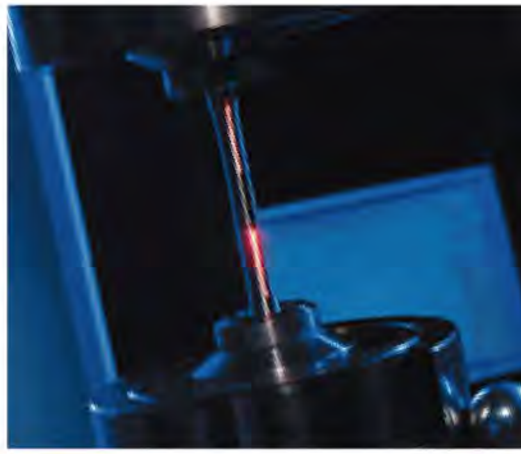
Examples

- **cutting and blanking**
- **fine cutting**
- **cold forming**
- **cold massive forming**
- **powder compaction**
- **warm forging at lower temperatures**

高延展性冷作工具钢
A HIGHLY DUCTILE COLD WORK TOOL STEEL

一般而言，延展性是指材料的屈服极限，即在断裂之前的塑性变形能力。当应变超过材料的断裂应变值时，材料将失效。断裂应变是衡量材料延展性的重要指标。具备高断裂应变值的材料具备良好的安全性以抵抗断裂。

In general, ductility is understood to be the capacity of a material to yield; the ability to deform plastically before fracture. The material fails when the fracture strain of the material is exceeded. Fracture strain is a characteristic material property used to quantify ductility. This means that a material with a high fracture strain has a better safety against fracture.



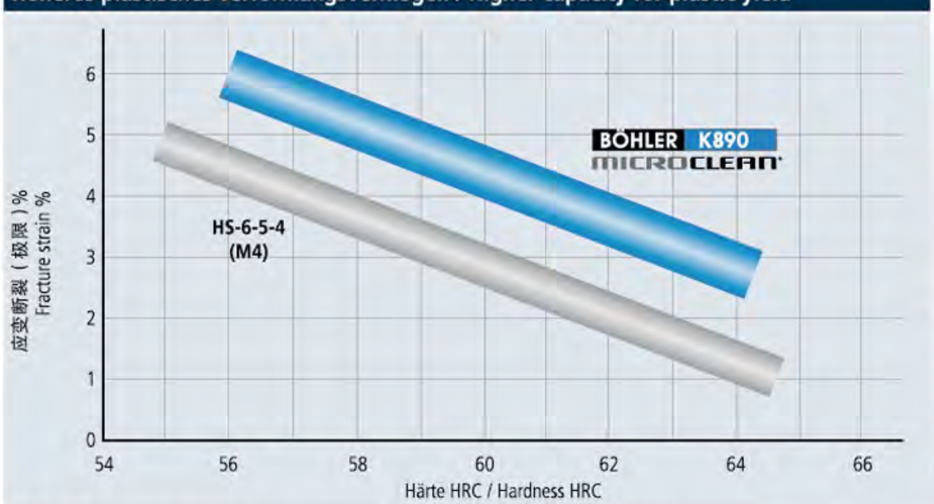
最重要的检测工具钢强度与延展性的方式是轴向抗拉实验，由于没有合适的试样来检测高强度工具钢，BOHLER因此与Leoben Forschung GmbH材料中心一起研发了标准合适的检测试样。

The most important test used to characterise the strength and ductility of a tool steel is the uniaxial tensile test. Since none of the standard test piece geometries is suitable for use with high-strength tool steels, BÖHLER has developed a suitable test piece in cooperation with the Materials Center Leoben Forschung GmbH.

采用此特别设计的高强度工具钢试样进行的抗拉强度试验结果汇总于下述图表中。

The results of tensile tests carried out using the test piece specially designed for high-strength tool steels are summarised in the following diagram.

Höheres plastisches Verformungsvermögen / Higher capacity for plastic yield



数据来源于针对Leoben Forschung GmbH 材料中心特别设计的高强度工具钢轴向抗拉样件进行的材料测试。

Values obtained from uniaxial tensile tests using test pieces developed specifically for high-strength tool materials at the Materials Center Leoben Forschung GmbH.

脆性材料
（脆性断裂）/
Brittle material
(brittle fracture)

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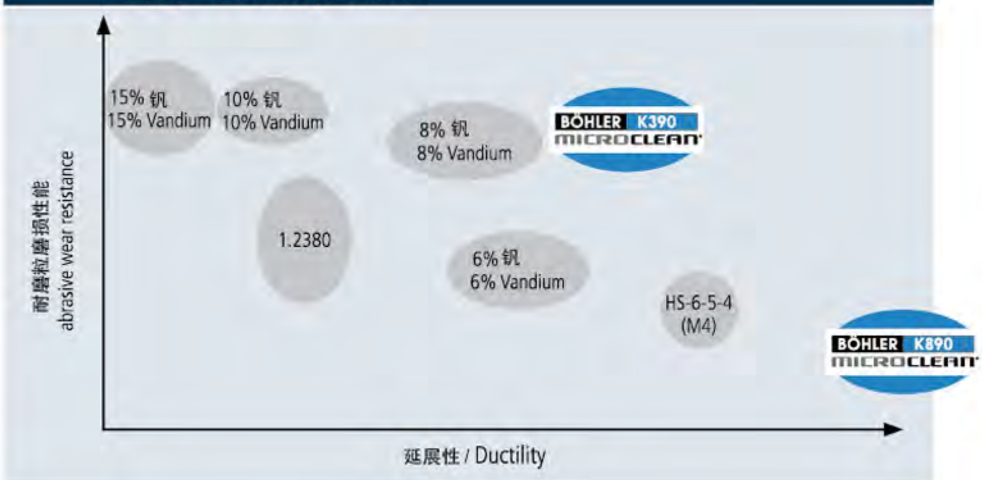
与HS-6-5-4（M4）相比具备相同的强度，主要是因为其更高的断裂应变值。对于承受极高的重挂载荷的工具BOHLER K890 MICROCLEAN 提供了更高的抵抗断裂的安全性能，进而保证了更高的模具寿命。

BÖHLER K890 MICROCLEAN stands out from, i.e., HS-6-5-4 (M4) tool steel with the same strength due to its much higher strain at fracture. For tools under extremely high plastic loading, BÖHLER K890 MICROCLEAN offers a higher safety against fracture and therefore a longer tool life.

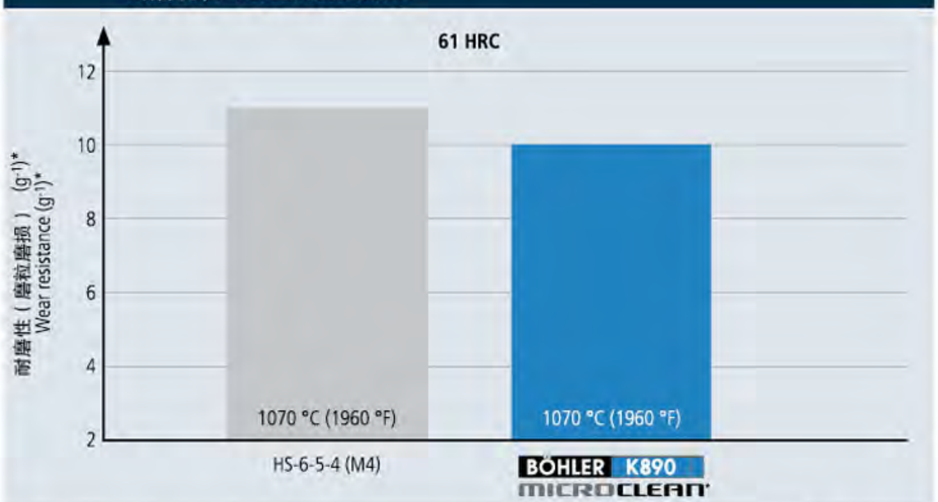
化学成份（平均值%） / Chemical composition (average %)

C	Si	Mn	Cr	Mo	V	W	Co
0,85	0,55	0,40	4,35	2,80	2,10	2,55	4,50

产品定位 / Product placement



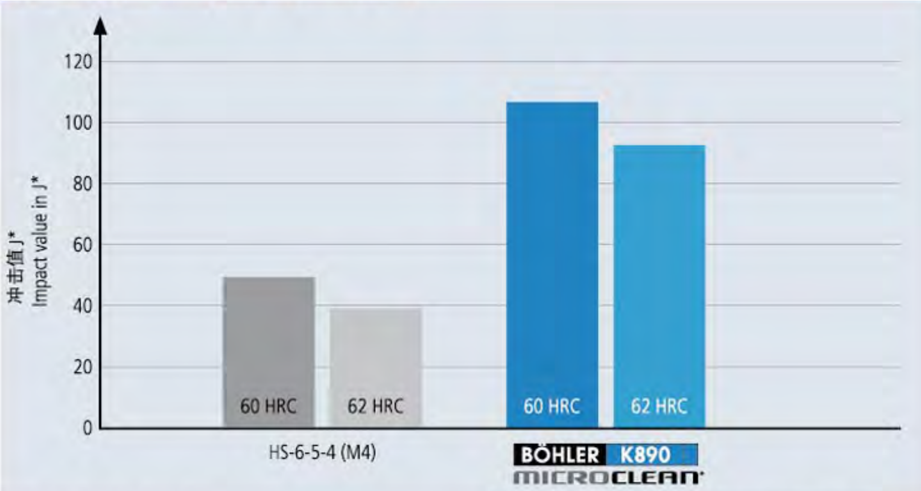
耐磨耗性 / Wear resistance



* 在实验室以碳化硅研磨砂纸检测

* determined in laboratory tests using SiC grinding paper

无凹槽冲击韧性 / Impact tests unnotched



* 试样取自轧棒长轴方向
热处理淬火冷却速率 λ ≤ 0,5.

* Samples taken from rolled bars in longitudinal direction, heat treated with a cooling rate of λ ≤ 0,5.

物理性能 / Physical properties

状态：淬火+回火 / Condition: hardened and tempered		
弹性模量 / Modulus of elasticity at	20 °C	217,6 GPa
	68 °F	31.6 x 10^3 ksi
密度 / Density at	20 °C	7,85 kg/dm^3
	68 °F	0.284 lbs/in^3
电阻率 / Electrical resistivity at	20 °C	0,50 Ohm.mm^2/m
	68 °F	301 Ohm circular-mil per ft
比热 / Specific heat capacity at	20 °C	450 J/(kg.K)
	68 °F	0.107 Btu/lb°F
热传导系数 / Thermal conductivity at	20 °C	22,5 W/(m.K)
	68 °F	13.0 Btu/ft h°F

热膨胀系数于20℃与…℃
Thermal expansion between 20 °C (68 °F) and ... °C (°F)

100 °C	200 °C	300 °C	400 °C	500 °C	600 °C	700 °C	
10,5	11,0	11,3	11,7	12,1	12,4	12,9	10^{-6} m/(m.K)
210 °F	390 °F	570 °F	750 °F	930 °F	1110 °F	1290 °F	
5.83	6.11	6.28	6.50	6.72	6.89	7.16	10^{-6} in/in°F

资料来源 / Source: Materials Center Leoben Forschung GmbH, ÖGI

BÖHLER MICROCLEAN®

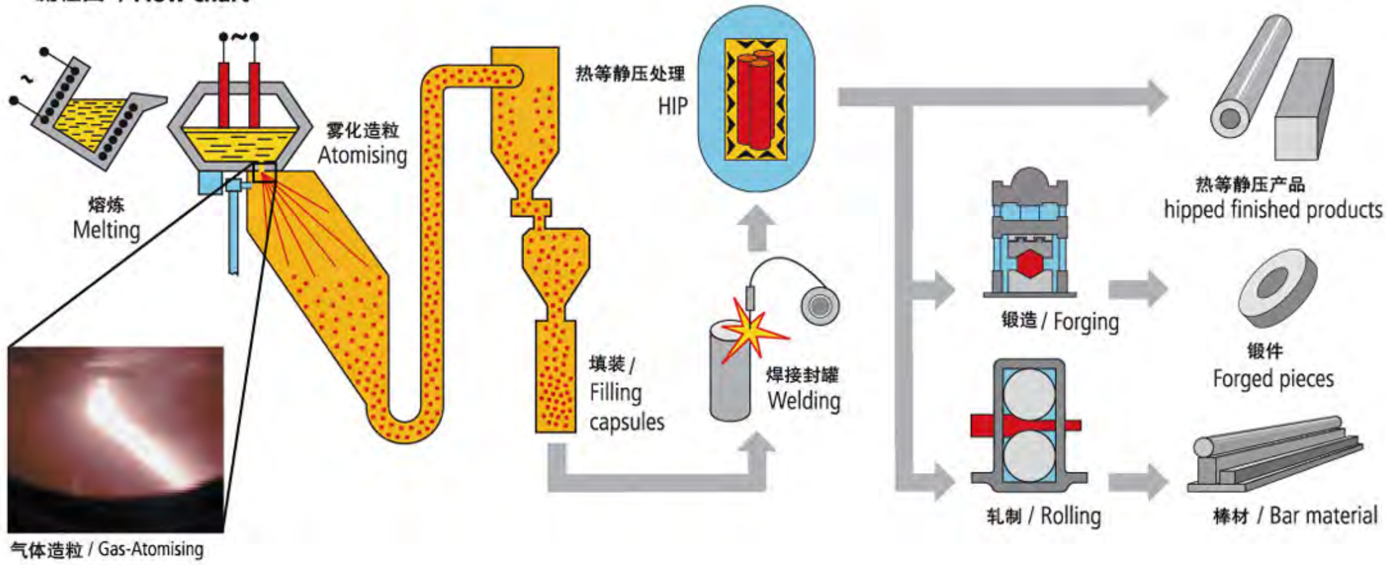
世界上最先进的粉末钢制造工厂。

The world's most modern PM steel production plant.

BOHLER研发制造的高性能粉末冶金高速钢・工具钢使模具寿命提升数倍。这主要来自于BOHLER自身的技术飞跃。第三代粉末冶金材料。这些材料被冠名为MICROCLEAN，进一步提升了耐磨性、抗压强度、韧性、疲劳强度和抛光性。

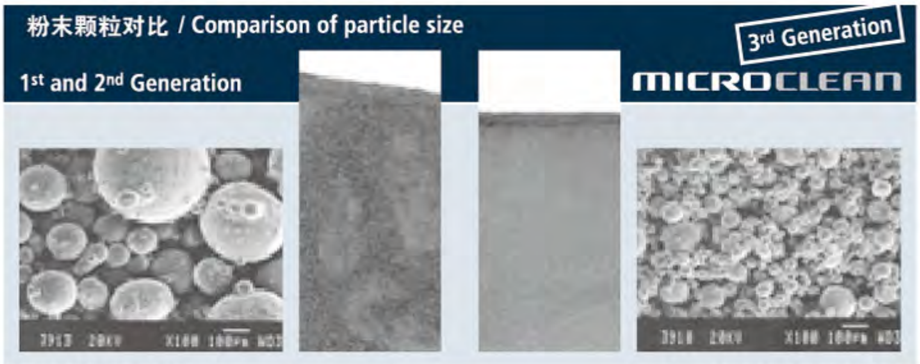
BÖHLER developes and produces high-performance PM-high speed steels and -tool steels, which increase the life of the tool by several hundred percent. We consider this to be a technological leap of BÖHLER's own making: 3rd generation PM materials. These materials, known by the name MICROCLEAN, offer even further improvements in **wear resistance, compressive strength, toughness, fatigue strength** and **polishability**.

流程图 / Flow chart



MICROCLEAN 材料的优点

THE ADVANTAGES OF MICROCLEAN MATERIALS



第1代与第2代

MICROCLEAN第3代

制造出更加细化同时具备更高纯净度的粉末颗粒，是达到前面所述材料性能改善的先决条件。

The manufacturing of a fine powder with higher cleanliness is a prerequisite in achieving the aforementioned improvements in material properties.

Powder compaction 粉末压实

高纯净度，各向同性的合金粉末配以高温高压过程保证的均匀颗粒度与分布造就了各向同性，无偏析的工具钢。

High purity, homogeneous alloyed powders, with appropriate particle size and distribution are subjected to a high pressure, high temperature process to obtain a homogeneous, segregation-free tool steel with virtually isotropic properties.

之后通过热成型加工达到所需要的最终尺寸。

Following this,the desired final dimension is achieved by hot forming.

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热处理说明

建议

- 要求最高韧性：1030℃/3 × 2h 560℃
- 要求高强度与高韧性的综合性能：
  1100℃/3 × 2h 540℃
- 最高强度/抗压强度：1180℃/3 × 2h 540℃

退火

- 退火后硬度最高280HB

应力消除

- 650℃–700℃
- 烧透后中性气体中保温1–2小时
- 炉内缓慢冷却

淬火

- 1030到1180℃/油，氮气
- 工件热透后
  淬火温度1030–1100℃，热透后保温20–30分钟
  淬火温度1150–1180℃，热透后保温6分钟

回火

- 淬火后立刻缓慢加热至回火温度
- 炉内保温时间：工件厚度每20mm保温1小时
  最少2h
- 空冷
- 我们建议最少回火三次
- 可达硬度：58–64HRC

Instructions for heat treatment

Recommendations

- For highest ductility: 1030 °C / 3 x 2 h 560 °C
  (1885 °F / 3 x 2 h 1040 °F)
- For a combination of high strength and high ductility: 1100 °C / 3 x 2 h 540 °C
  (2010 °F / 3 x 2 h 1005 °F)
- For highest strength / compressive strength:
  1180 °C / 3 x 2 h 540 °
  (2155 °F / 3 x 2 h 1005 °F)

Annealing

- Hardness after annealing: max. 280 HB

Stress relieving

- 650 to 700 °C (1200 to 1290 °F)
- After through-heating, soak for 1 to 2 hours in a neutral atmosphere.
- Cool slowly in furnace.

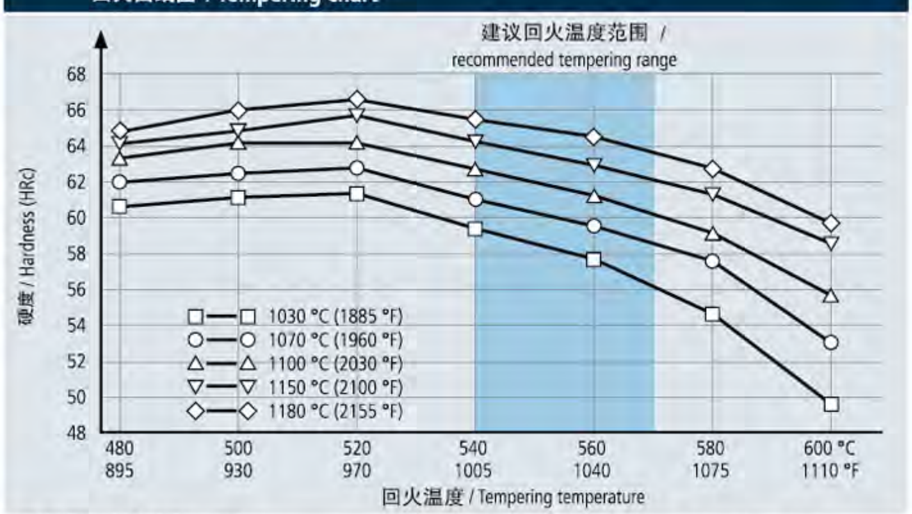
Hardening

- 1030 to 1180 °C (1885 to 2155 °F) /oil, N_2
- Following temperature equalisation:
  20 – 30 minutes for a hardening temperature of 1030 – 1100 °C (1885 – 2010 °F)
  6 minutes for a hardening temperature of 1150 – 1180 °C (2100 – 2155 °F)

Tempering

- Slowly heat to tempering temperature immediately after hardening.
- Time in furnace: 1 hour for every 20 mm (0.79 inch) of workpiece thickness but at least 2 hours.
- Cool in air.
- We recommend that the steel be tempered at least 3 times.
- Obtainable hardness: 58 – 64 HRC

回火曲线图 / Tempering chart



真空淬火：氮气冷却，5bars

hardened in vacuum furnace: N_2 cooling, 5 bar

连续冷却CCT曲线图 / Continuous cooling CCT curves

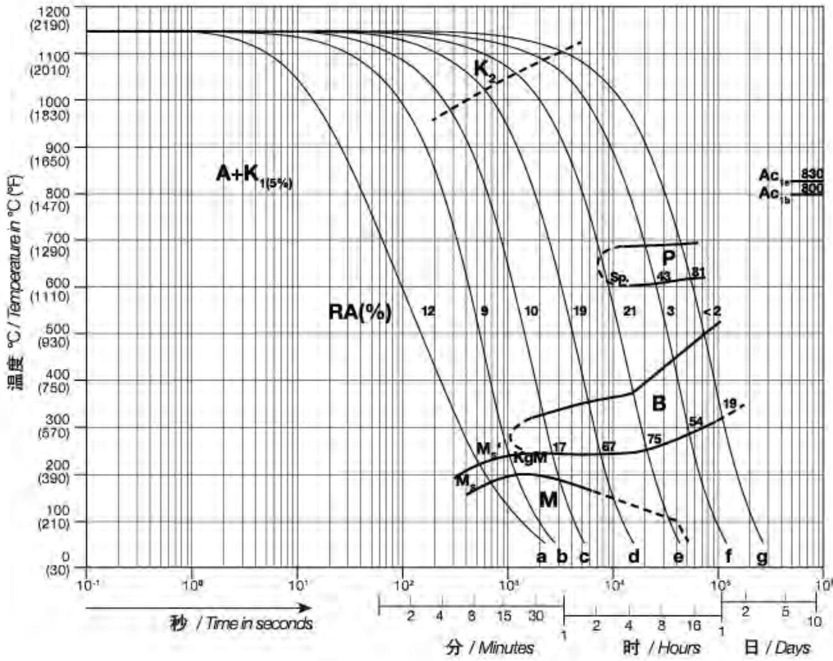
奥氏体化温度: 1150 °C
保温: 30分钟

时间 0,4 … 400 冷却参数由800℃冷却500℃所需时间，单位：秒x10^{-2}

Austenitizing temperature: 1150 °C (2100 °F)
Holding time: 30 minutes

0,4 … 400 cooling parameter, i.e. duration of cooling from 800 – 500 °C (1470 – 930 °F) in s x 10^{-2}

试片 / Sample	λ	HV_{10}
a	0,4	841
b	3,0	824
c	8,0	755
d	23,0	585
e	65,0	515
f	180,0	412
g	400,0	329



定量相图 / Quantitative phase diagram

K1 未溶解的碳化物（5%） / carbides which are not dissolved during austenitization 5%)

K2 由奥氏体温度淬火时碳化物析出温度 / start of carbide precipitation during quenching from austenitizing temperature

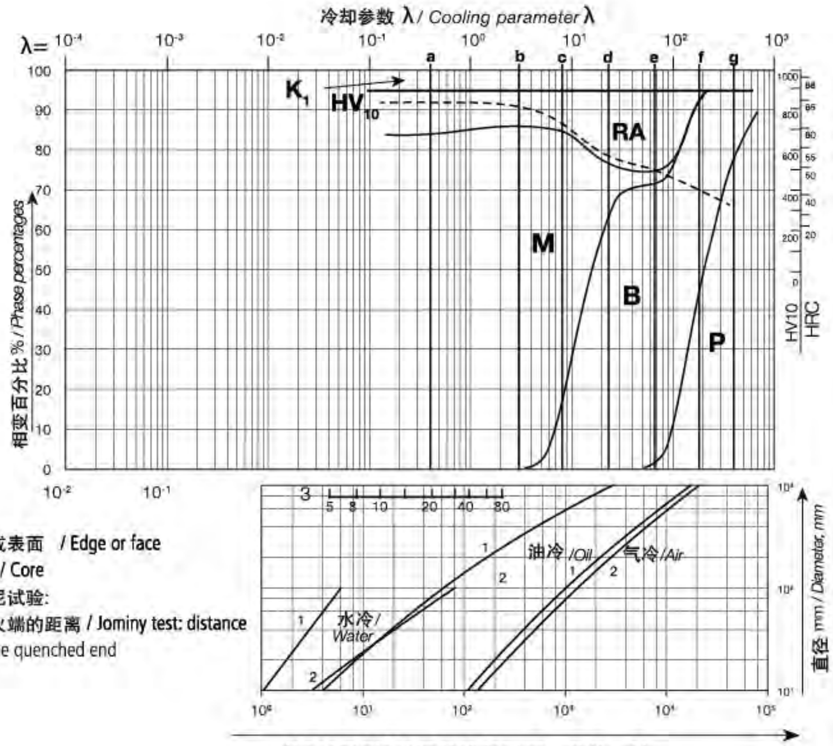
RA 残余奥氏体 / Retained austenite

A 奥氏体 / Austenite

M 马氏体 / Martensite

P 珠光体 / Perlite

B 贝氏体 / Bainite



1 边缘或表面 / Edge or face
2 心部 / Core
3 乔米尼试验: 到淬火端的距离 / Jominy test: distance from the quenched end

从800℃到500℃的冷却时间，单位：秒 / Cooling time in sec. from 800 °C to 500 °C (1470 to 930 °F)

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状态：退火，平均值

用烧结硬质合金车削				
车削深度 mm	0,5 – 1	1 – 4	4 – 8	über 8
进给 mm/rev.	0,1 – 0,3	0,2 – 0,4	0,3 – 0,6	0,5 – 1,5
ISO 牌号	HC-K10, HC-P15, HC-P25	HC-K10, HC-P25, HC-M35	HW-P30, HC-M35	HW-P40
		切削速度 v_c (m/min)		
BOEHLERIT LC 215 B / ISO P15	140 – 180	100 – 150	80 – 130	60 – 90
BOEHLERIT LC 620 H / ISP K15	140 – 180	100 – 150	80 – 130	60 – 90
BOEHLERIT LC 225 C / ISO P25	120 – 150	85 – 130	70 – 100	50 – 80
BOEHLERIT LC 235 C / ISO P35	110 – 140	80 – 120	60 – 90	40 – 70

状态：淬火 回火 材料硬度 ≥ 60 HRC; 平均值

用CBN切削-立方氮化硼			
车削深度 mm	0,5 – 1	1 – 4	
进给 mm/rev.	0,1 – 0,3	0,2 – 0,4	
		切削速度 v_c (m/min)	
BOEHLERIT BN 022	80 – 120	60 – 100	

状态：退火，平均值

以镶齿铣刀铣削			
进给 mm/rev.	< 0,2	0,2 – 0,4	
		切削速度 v_c (m/min)	
BOEHLERIT LC 610 T / ISO K10	160 – 220	120 – 180	
BOEHLERIT LC 225 T / ISO P25	120 – 160	90 – 150	
BOEHLERIT LC 230 F / ISO P30	110 – 180	70 – 150	

状态：淬火 回火 材料硬度 ≥ 60 HRC; 平均值

以CBN切削-立方氮化硼		
进给 mm/rev.	< 0,2	
		切削速度 v_c (m/min)
BOEHLERIT BN 022	50 – 120	

状态：退火，平均值

以可换式硬质合金钻孔				
钻头直径mm	3 – 8	8 – 20	20 – 40	
进给 mm/rev	0,02 – 0,05	0,05 – 0,1	0,1 – 0,15	
BOEHLERIT LC 610 S / ISO HC-K10				
		切削速度 v_c (m/min)		
	30 – 50	30 – 50	30 – 50	
顶角	115° – 120°	115° – 120°	115° – 120°	
后角	5°	5°	5°	

Condition: annealed; average values

Turning with sintered carbide				
Depth of cut mm (inches)	0.5 – 1 (.02 – .04)	1 – 4 (.04 – .16)	4 – 8 (.16 – .31)	over 8 (over .31)
Feed mm / rev. (inches / rev.)	0.1 – 0.3 (.004 – .012)	0.2 – 0.4 (.008 – .016)	0.3 – 0.6 (.012 – .024)	0.5 – 1.5 (.020 – .060)
ISO grade	HC-K10, HC-P15, HC-P25	HC-K10, HC-P25, HC-M35	HW-P30, HC-M35	HW-P40
	Cutting speed v_c m/min (f.p.m)			
BOEHLERIT LC 215 B / ISO P15	140 – 180 (460 – 590)	100 – 150 (330 – 490)	80 – 130 (260 – 425)	60 – 90 (195 – 295)
BOEHLERIT LC 620 H / ISP K15	140 – 180 (460 – 590)	100 – 150 (330 – 490)	80 – 130 (260 – 425)	60 – 90 (195 – 295)
BOEHLERIT LC 225 C / ISO P25	120 – 150 (395 – 490)	85 – 130 (280 – 425)	70 – 100 (230 – 330)	50 – 80 (165 – 260)
BOEHLERIT LC 235 C / ISO P35	110 – 140 (360 – 460)	80 – 120 (260 – 395)	60 – 90 (195 – 295)	40 – 70 (135 – 230)

Condition: hardened and tempered ≥ 60 HRC; average values

Turning with CBN – Cubic boron nitride		
Depth of cut mm (inches	0.5 – 1 (.02 – .04)	1 – 4 (.04 – .16)
Feed mm / rev. (inches / rev.)	0.1 – 0.3 (.004 – .012)	0.2 – 0.4 (.008 – .016)
	Cutting speed v_c m/min (f.p.m)	
BOEHLERIT BN 022	80 – 120 (260 – 395)	60 – 100 (195 – 330)

Condition: annealed; average values

Milling with inserted tooth cutter		
Feed mm/tooth (inches/tooth)	up to 0.2 (.008)	0.2 – 0.4 (.008 – .016)
	Cutting speed v_c m/min (f.p.m)	
BOEHLERIT LC 610 T / ISO K10	160 – 220 (525 – 720)	120 – 180 (395 – 590)
BOEHLERIT LC 225 T / ISO P25	120 – 160 (395 – 525)	90 – 150 (295 – 490)
BOEHLERIT LC 230 F / ISO P30	110 – 180 (360 – 590)	70 – 150 (230 – 490)

Condition: hardened and tempered ≥ 60 HRC; average values

Milling with CBN – Cubic boron nitride	
Feed mm/tooth (inches/tooth)	up to 0.2 (.008)
	Cutting speed v_c m/min (f.p.m)
BOEHLERIT BN 022	50 – 120 (165 – 395)

Condition: annealed; average values

Drilling with sintered carbide			
Drill diameter mm (inhes)	3 – 8 (.12 – .31)	8 – 20 (.31 – .80)	20 – 40 (.80 – 1.6)
Feed mm / rev. (inches / rev.)	0.02 – 0.05 (.001 – .002)	0.05 – 0.1 (.002 – .004)	0.1 – 0.15 (.004 – .005)
BOEHLERIT LC 610 S / ISO HC-K10			
	Cutting speed v_c m/min (f.p.m)		
	30 – 50 (100 – 165)	30 – 50 (100 – 165)	30 – 50 (100 – 165)
Point angle	115° – 120°	115° – 120°	115° – 120°
Clearance angle	5°	5°	5°

使用无氯漂白纸张 无环境污染 / Printed on chlorine-free bleached paper having no pollution effects.

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K890 DE – 01.2011 – EM-WS