

# S390



**BÖHLER S390**  
**MICROCLEAN®**

粉末冶金高速钢

SCHNELLARBEITSSTAHL

HIGH SPEED STEEL

钢材主要性能比较表

Qualitative comparison of the major steel properties

牌号 / Grade BÖHLER	红硬性 Red hardness	耐磨性 Wear resistance	韧性 Toughness	磨削性 Grindability	抗压强度 Compressive strength
S200	Medium	Medium	Medium	Medium	Medium
S400	Medium	Medium	Medium	Medium	Medium
S401	Medium	Medium	Medium	Medium	Medium
S404	Medium	Medium	Medium	Medium	Medium
S500	Medium	Medium	Medium	Medium	Medium
S600	Medium	Medium	Medium	Medium	Medium
S607	Medium	Medium	Medium	Medium	Medium
S700	Medium	Medium	Medium	Medium	Medium
S705	Medium	Medium	Medium	Medium	Medium
S290 MICROCLEAN	High	High	High	High	High
S390 MICROCLEAN	Very High	Very High	Very High	Very High	Very High
S590 MICROCLEAN	High	High	High	High	High
S690 MICROCLEAN	High	High	High	High	High
S790 MICROCLEAN	High	High	High	High	High

该图表旨在助于钢材的选用，而未说明不同用途下所承受的各种应力状态。

我们的专业技术顾问将乐意回答用户在钢材使用和加工方面的有关问题。

This table is intended to facilitate the steel choice. It does not, however, take into account the various stress conditions imposed by the different types of application.

Our technical consultancy staff will be glad to assist you in any questions concerning the use and processing of steels.

## BÖHLER S390 MICROCLEAN

是粉末冶金高速钢。

均质、无偏析的高纯度金属粉末和适当大小的颗粒通过高温、高压下扩散的方式被加工成为具有各向同性的均质、无偏析的高速钢。

## BÖHLER S390 MICROCLEAN

is produced by powder-metallurgy methods.

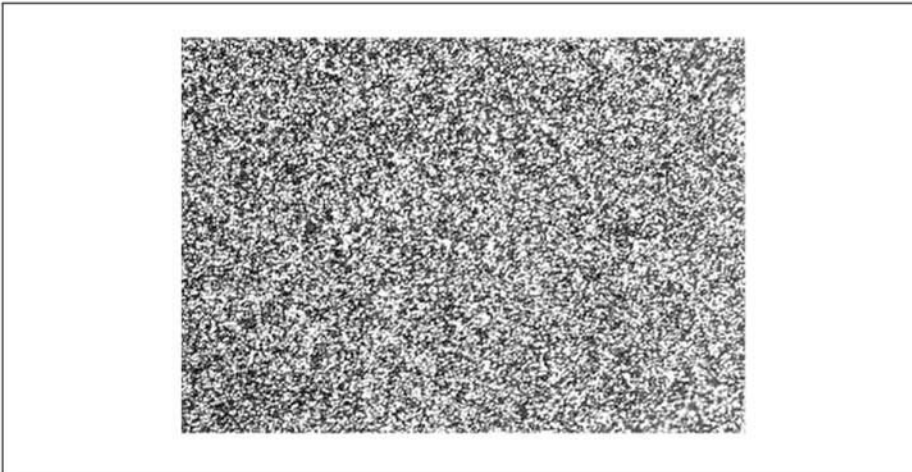
Segregation-free and homogeneous metal powders of highest purity and adequate granulation are processed to homogeneous and segregation-free high speed steels of virtually isotropic properties in a diffusion process taking place at high pressures and temperatures.

## 碳化物分布和大小比较图 ( M=100x )

## Comparison of carbide distribution and carbide size ( M = 100 x)

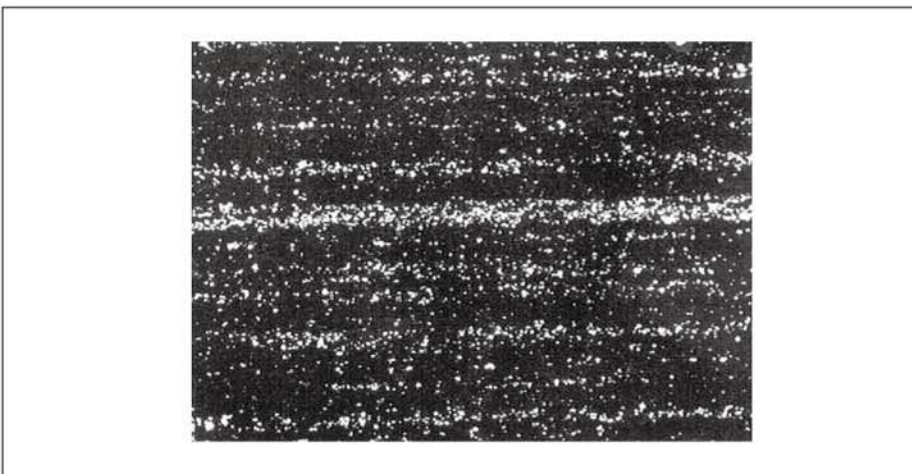
粉末冶金材料

Powder-metallurgy material



普通铸造材料

Conventionally cast material



## 性能

粉末冶金高速钢具有良好的红硬性，抗压强度和耐磨性。粉末冶金技术还赋予钢材极佳的韧性和机加性能，如满意的可磨削性。

## 用途

### 重载机械工具

不但适合钢材加工，而且适合有色金属，例如镍基合金和钛合金

- 成型铣刀
- 滚刀
- 铣刀
- 各种拉刀
- 机用丝锥
- 麻花钻
- 雕镂工具
- 铰刀
- 带锯用双金属钢带

### 在极大压力下使用的工具

如：用于高强度材料的精密冲切工具

- 冲头
- 冲模

## Properties

High speed steel produced by powder- metallurgy methods with good red hardness, compressive strength and wear resistance.

The PM technology imparts to the material also excellent toughness and machinability properties, e.g. highly satisfactory grindability.

## Applications

### Heavy-duty machining tools

Not only for the machining of steels but also for nonferrous metals such as nickel-base and titanium alloys

- shaper cutters
- hobs
- milling cutters
- broaching tools of all types
- taps
- twist drills
- chasing tools
- reamers
- bimetal strips for saw blades

### Tools used under extreme compressive stresses

e. g. precision blanking tools for high-strength materials

- shaping punches
- dies

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

C	Si	Mn	Cr	Mo	V	W	Co
1,64	0,60	0,30	4,80	2,00	4,80	10,40	8,00

## 热成型

### 锻造:

1150–900°C, 随炉慢冷或保温材料中冷。

## 热处理

### 退火:

770–840°C / 4 小时 / 随炉慢冷 (10–20°C/小时) 直至740°C/2小时, 炉冷。

退火后硬度: **最大300HB.**

### 消除应力:

600–650°C (1112 to 1202°F) 随炉慢冷。

消除因广泛加工和形状复杂而产生的应力。

完全加热后, 中性气体中保持1–2小时。

## 淬火

1150–1230°C (2101 to 2246°F) 油冷, 盐浴 (500–550°C), 真空。形状简单的工件采用较高的温度, 复杂的工件采用较低的淬火温度。韧性对冷作工具是重要的, 可取较低的淬火温度。工件烧透后, 均热时间不少于80秒, 以满足碳化物充分溶解的需要。最长的均热时间为150秒, 以避免过热的损害。

通常用工件从预热后进入盐槽至往上拿开的时间来代替均热时间 (包括表面和心部透烧的过程)。见“浸入时间曲线图”。

也可进行真空淬火。

在真空炉内的时间取决于相应的工件尺寸和炉子参数。

## Hot forming

### Forging:

1150 to 900°C (2102 to 1652°F)  
Slow cooling in furnace or in thermoinsulating material.

## Heat treatment

### Annealing:

770 to 840°C (1418 to 1544°F) / 4 h / controlled slow cooling in furnace (10 to 20°C/h / (50 to 68°F/h) to 740°C / 2 h (1364°F/2 h) cooling in furnace.

Hardness after annealing: **max. 300 Brinell.**

### Stress relieving:

600 to 650°C (1112 to 1202°F)

Slow cooling in furnace.

To relieve stresses set up by extensive machining or in tools of intricate shape.

After through heating, hold in neutral atmosphere for 1 to 2 hours.

### Hardening:

1150 to 1230°C (2102 to 2246°F)

Oil, salt bath (500–550°C (932–1022°F), air, gas.

Upper temperature range for parts of simple shape, lower for parts of complex shape. For coldworking tools also lower temperatures are of importance for higher toughness. Soaking time after heating up the whole section of a workpiece 80 seconds minimum is required for dissolving sufficient carbides. Maximum soaking time 150 seconds to avoid detriments by oversoaking.

In practice instead of soaking time the time of exposure from placing the workpiece into the salt bath after preheating until removing (including the stages of heating to the specified surface temperature and of heating to the temperature throughout the whole section) is used. "see immersion time diagrams".

Vacuum hardening is possible.

The time in the vacuum furnace depends on the relevant workpiece size and furnace parameters.

## 浸入时间曲线 (盐浴)

奥氏体化时间  
(淬火温度)

—— 80 秒  
- - - - 150 秒

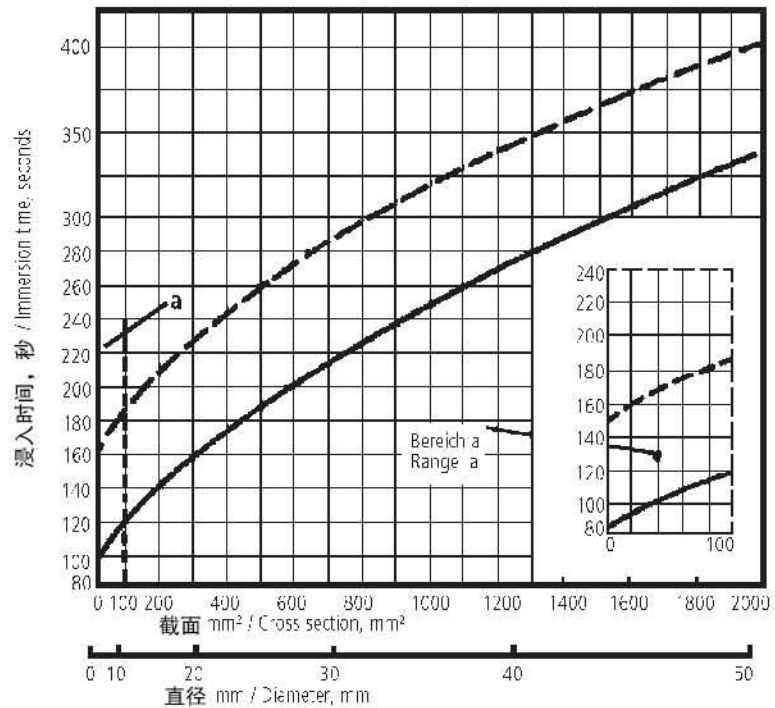
550°C, 850°C和1050°C预热

## Immersion time chart (salt bath)

Austenitising time  
(hardening temperature)

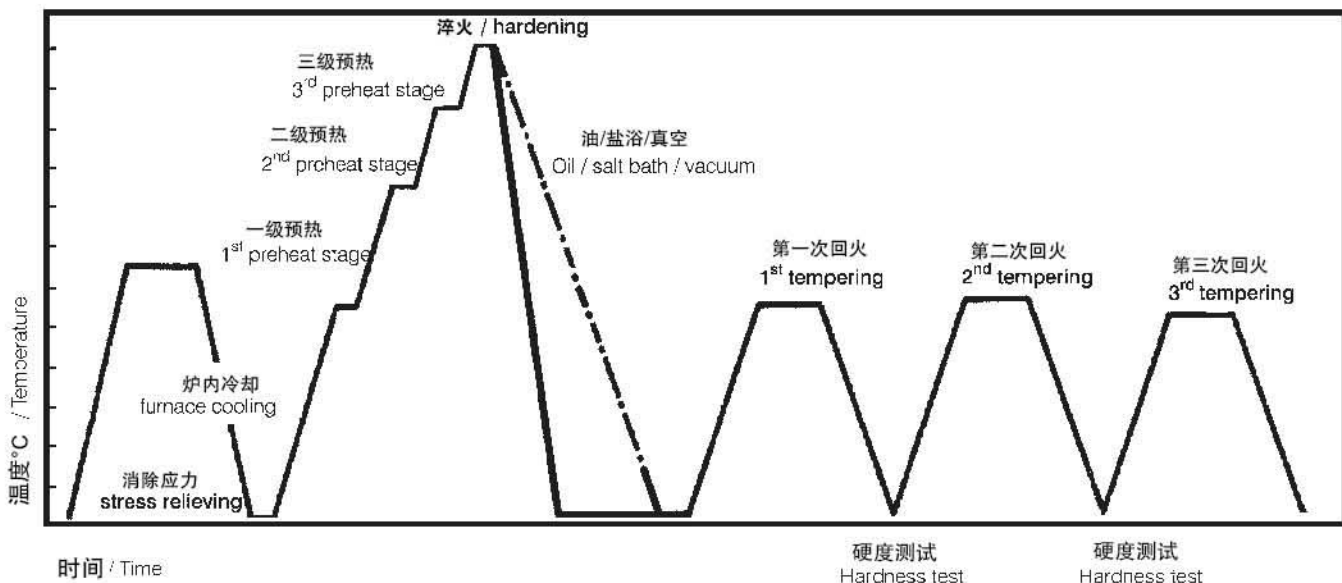
—— 80 seconds  
- - - - 150 seconds

Preheating at 550°C (1022°F), 850°C (1562°F) and 1050°C (1922°F).



## 热处理

## Heat treatment sequence



## 回火:

淬火后立即回火，缓慢加热至回火温度/炉内时间：工件厚度每20mm一个小时，但至少2小时/空冷，（最少保持时间：1小时）。第一次回火和第二次回火至工作温度。

平均硬度值见回火曲线图。

第三次回火用于消除应力，比最高回火温度低30-50°C。

回火后可得硬度：65-69HRC。

## Tempering:

Slow heating to tempering temperature immediately after hardening/time in furnace: 1 hour for every 20 mm of workpiece thickness, but not less than 2 hours/ air cooling (minimum holding time: 1 hour). 1<sup>st</sup> tempering and 2<sup>nd</sup> tempering to desired working hardness.

Average obtainable hardness values are shown in the tempering chart.

3<sup>rd</sup> tempering for stress relieving,

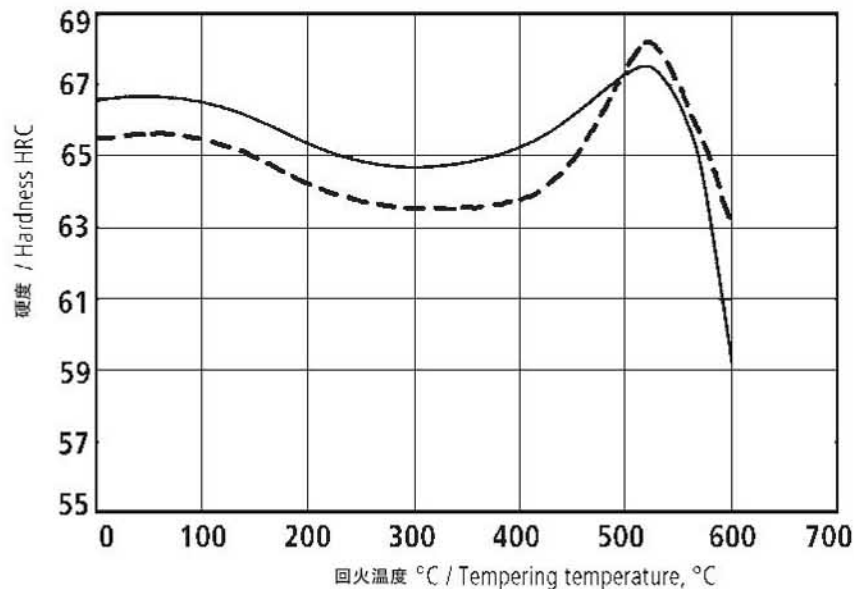
30 - 50°C (86-122°F) below highest tempering temperature.

Obtainable hardness after tempering:

65 - 69 HRC.

回火曲线图

Tempering chart



保持时间3X2小时

样件尺寸：方形25X25mm

盐浴奥氏体化

淬火温度：

—— 1150°C

- - - - 1210°C

Holding time 3 x 2 hours

Specimen size: square 25 mm

Austenitising in salt bath

Hardening temperature:

—— 1150°C (2102°F)

- - - - 1210°C (2210°F)

## 表面处理

### 氮化:

该钢制件适合盐浴，离子和气体氮化。

## Surface treatment

### Nitriding:

Parts made from this steel can be bath, plasma and gas nitriding.

## 涂层

某些用途下建议PVD涂层。

也可以CVD涂层。

## Coating

PVD coating is recommended for certain applications.

CVD coating can also be used.

# BÖHLER S390 MICROCLEAN®

## 连续冷却CCT图 / Continuous cooling CCT curves

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

C	Si	Mn	P	S	Cr	Mo	Ni	V	W	Co	O
1,63	0,30	0,26	0,018	0,018	4,91	2,28	0,20	5,12	10,09	8,32	0,0041

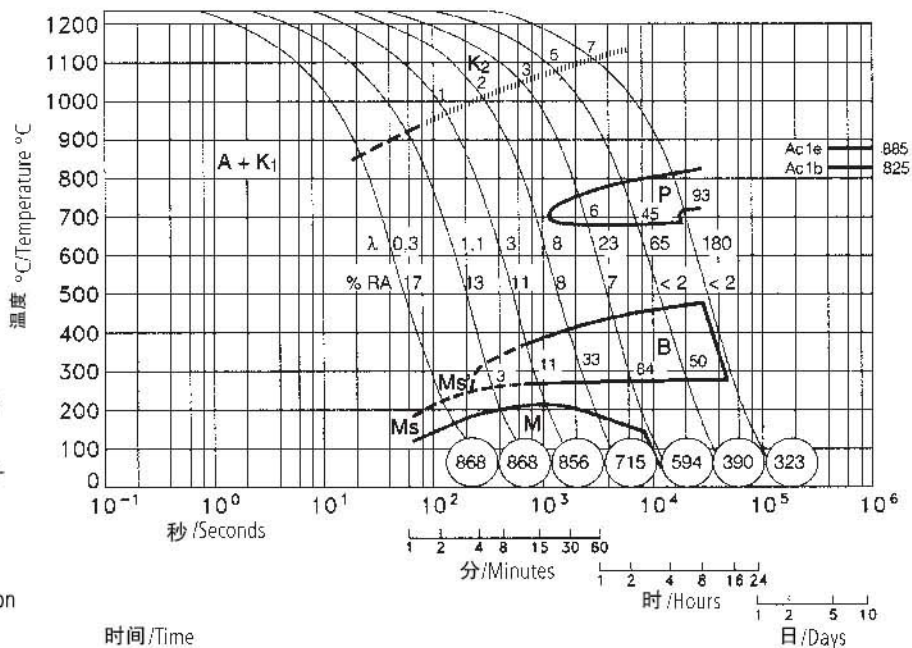
奥氏体化温度: 1230°C  
保持时间: 180秒

Austenitising temperature: 1230°C (2246°F)  
Holding time: 180 seconds

- 维氏硬度
- 3 ... 93 相含量百分比
- 0,30 ... 180 冷却参数, 即从800°C连续冷却到500°C的时间, 单位为: 秒 $\times 10^{-2}$
- K1 . 奥氏体化中未溶解的碳化物(16%)
- K2 . 冷却过程中从奥氏体化温度形成的碳化物
- Ms-Ms' 马氏体形成的晶界范围

- Vickers hardness
- 3 ... 93 phase percentages
- 0.30 ... 180 cooling parameter ( $\lambda$ ), i.e. duration of cooling from 800-500°C (1472-932°F) in  $s \times 10^{-2}$
- K<sub>1</sub> . Carbides which are not dissolved during austenitising (16%)
- K<sub>2</sub> . Carbides which are formed during coolant from austenitising temperature
- Ms-Ms'....Range of grain boundary martensite formation

- A . 奥氏体 / Austenite
- B . 贝氏体 / Bainite
- K . 碳化物 / Carbide
- P . 珠光体 / Pearlite
- M . 马氏体 / Martensite





## 定量相图 / Quantitative phase diagram

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

C	Si	Mn	P	S	Cr	Mo	Ni	V	W	Co	O
1,63	0,30	0,26	0,018	0,018	4,91	2,28	0,20	5,12	10,09	8,32	0,0041

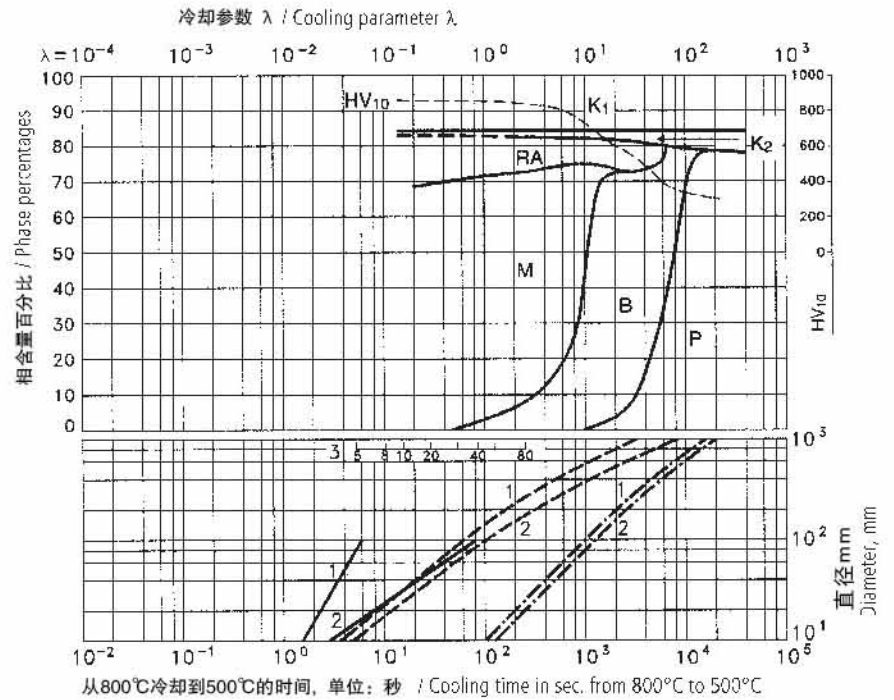
奥氏体化温度: 1230°C  
保持时间: 180秒

Austenitising temperature: 1230°C (2246°F)  
Holding time: 180 seconds

- A .. 奥氏体 / Austenite
- B .. 贝氏体 / Bainite
- K .. 碳化物 / Carbide
- P .. 珠光体 / Pearlite
- M .. 马氏体 / Martensite
- RA .. 残留奥氏体 / Retained austenite

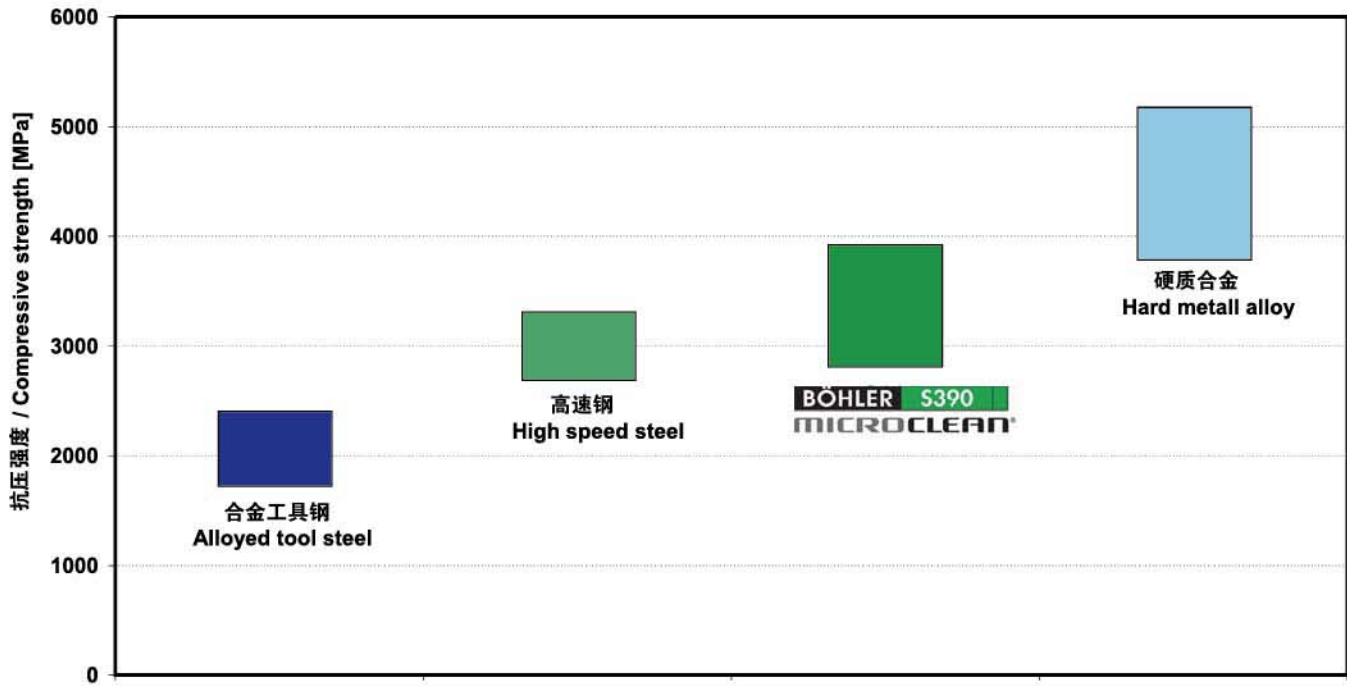
- 水冷 / Water cooling
- - - 油冷 / Oil cooling
- . . . 空冷 / Air cooling

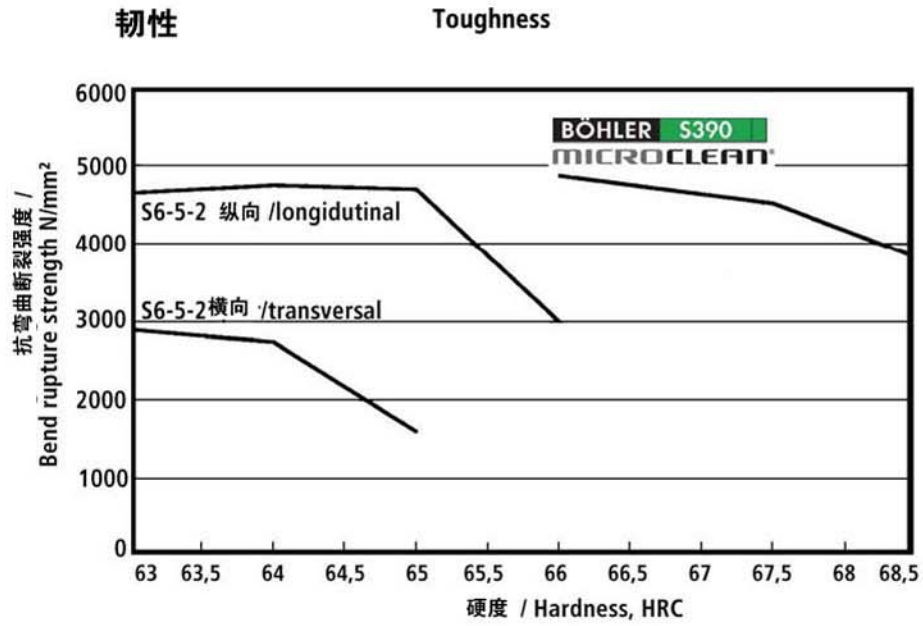
- 1... 边缘或表面 / Edge or face
- 2... 中心 / Core
- 3... 顶端淬火试验 : Abstand von der Stirnfläche
- 3... 从表面到底端的距离 : Distance from end



抗压强度

Compressive strength





## 机加工建议

状态: 退火, 平均值

用硬质合金刀具切削				
切削深度 mm	0,5 bis 1	1 bis 4	4 bis 8	über 8
进给 mm/rev.	0,1 bis 0,3	0,2 bis 0,4	0,3 bis 0,6	0,5 bis 1,5
BOEHLERIT-牌号	SB10,SB20	SB10, SB20, EB10	SB30, EB20	SB30, SB40
ISO 牌号	P10,P20	P10, P20, M10	P30, M20	P30, P40
切削速度 米/分				
换挡硬质合金刀具 持续操作时间15分钟	210 bis 150	160 bis 110	110 bis 80	70 bis 45
钎焊硬质合金刀具 持续操作时间30分钟	150 bis 110	135 bis 85	90 bis 60	70 bis 35
表面强化换挡硬质合金刀具 持续操作时间15分钟 BÖHLERIT ROYAL 121 BÖHLERIT ROYAL 131	bis 210 bis 140	bis 180 bis 140	bis 130 bis 100	bis 80 bis 60
用于钎焊的切削角度硬质合金刀具 后角 前角 倾角	6 bis 12° 6 bis 8° 0°	6 bis 12° 6 bis 8° - 4°	6 bis 12° 6 bis 8° - 4°	6 bis 12° 6 bis 8° - 4°

用高速钢刀具切削				
切削深度 mm	0,5	3	6	
进给 mm/rev	0,1	0,4	0,8	
BÖHLER/DIN- 牌号	S700 / DIN S10-4-3-10			
切削速度 米/分				
持续操作时间60分钟	30 bis 20	20 bis 15	18 bis 10	
前角	14°	14°	14°	
后角	8°	8°	8°	
倾角	-4°	-4°	-4°	

用硬质合金刀具铣削				
进给 mm/齿	bis 0,2		0,2 bis 0,4	
切削速度 米/分				
BÖHLERIT SBF/ ISO P25	150 bis 100		110 bis 60	
BÖHLERIT SB40/ ISO P40	100 bis 60		70 bis 40	
BÖHLERIT ROYAL 131 / ISO P35	130 bis 85		--	

用硬质合金刀具钻孔				
钻头直径 mm	3 bis 8	8 bis 20	20 bis 40	
进给 mm/rev	0,02 bis 0,05	0,05 bis 0,12	0,12 bis 0,18	
BÖHLERIT / ISO- 牌号	HB10/K10		HB10/K10	
切削速度 米/分				
	50 bis 35	50 bis 35	50 bis 35	
顶角	115 bis 120°		115 bis 120°	
后角	5°		5°	

# BÖHLER S390 MICROCLEAN®

## Recommendation for machining

(Condition annealed, average values)

Turning with carbide tipped tools				
depth of cut mm	0,5 to 1	1 to 4	4 to 8	over 8
feed, mm/rev.	0,1 to 0,3	0,2 to 0,4	0,3 to 0,6	0,5 to 1,5
BÖHLERIT grade	SB10, SB20	SB10, SB20, EB10	SB30, EB20	SB30, SB40
ISO grade	P10, P20	P10, P20, M10	P30, M20	P30, P40
cutting speed, m/min				
indexable carbide inserts edge life 15 min	210 to 150	160 to 110	110 to 80	70 to 45
brazed carbide tipped tools edge life 30 min	150 to 110	135 to 85	90 to 60	70 to 35
hardfaced indexable carbide inserts edge life 15 min BÖHLERIT ROYAL 121 BÖHLERIT ROYAL 131	up to 210 up to 140	up to 180 up to 140	up to 130 up to 100	up to 80 up to 60
cutting angles for brazed carbide tipped tools rake angle clearance angle angle of inclination	6 to 12° 6 to 8° 0°	6 to 12° 6 to 8° - 4°	6 to 12° 6 to 8° - 4°	6 to 12° 6 to 8° - 4°

Turning with HSS tools				
depth of cut, mm	0,5	3	6	
feed, mm/rev.	0,1	0,4	0,8	
HSS-grade BOHLER/DIN	S700 / DIN S10-4-3-10			
cutting speed, m/min				
edge life 60 min	30 to 20	20 to 15	18 to 10	
rake angle	14°	14°	14°	
clearance angle	8°	8°	8°	
angle of inclination	-4°	-4°	-4°	

Milling with carbide tipped cutters		
feed, mm/tooth	up to 0,2	0,2 to 0,4
cutting speed, m/min		
BÖHLERIT SBF/ ISO P25	150 to 100	110 to 60
BÖHLERIT SB40/ ISO P40	100 to 60	70 to 40
BÖHLERIT ROYAL 131 / ISO P35	130 to 85	--

Drilling with carbide tipped tools			
drill diameter, mm	3 to 8	8 to 20	20 to 40
feed, mm/rev.	0,02 to 0,05	0,05 to 0,12	0,12 to 0,18
BÖHLERIT / ISO-grade	HB10/K10	HB10/K10	HB10/K10
cutting speed, m/min			
	50 to 35	50 to 35	50 to 35
top angle	115 to 120°	115 to 120°	115 to 120°
clearance angle	5°	5°	5°

## 物理性能

## Physical properties

密度 /

Density at .....20°C (68°F).....8,10 .....kg/dm<sup>3</sup>

热传导系数 /

Thermal conductivity at .....20°C (68°F).....17,0 .....W/(m.K)

比热 /

Specific heat at .....20°C (68°F).....420 .....J/(kg.K)

电阻率 /

Electrical resistivity at .....20°C (68°F).....0,61 .....Ohm.mm<sup>2</sup>/m

弹性模量 /

Modulus of elasticity at .....20°C (68°F).....231x10<sup>3</sup> .....N/mm<sup>2</sup>

热膨胀系数 20°C 与 ...°C, 10 <sup>-6</sup> m/(m.K) bei Thermal expansion between 20°C (68°F) and ...°C (°F), 10 <sup>-6</sup> m/(m.K) at						
100°C 212°F	200°C 392°F	300°C 572°F	400°C 752°F	500°C 932°F	600°C 1112°F	700°C 1292°F
10,0	10,5	10,8	11,2	11,3	11,4	11,6

由于本产品说明书没有描述具体的用途和加工步骤，用户在使用过程中若有疑问，可以就具体问题咨询我方有关人员。

As regards applications and processing steps that are not expressly mentioned in this product description/data sheet, the customer shall in each individual case be required to consult us.



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