

STEELS & COATINGS  
FOR CUTTING TOOL APPLICATIONS

# Requirements for cutting tools

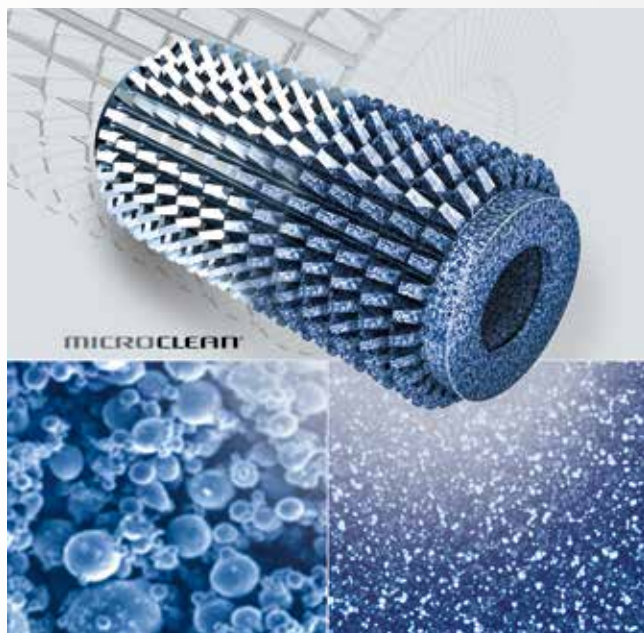
**There are several characteristics that are essential to the good performance of a cutting tool.**

## Powder Metal High Speed Steels

Use of the powder metallurgical production process is essential to the development of highly alloyed high speed steels, when other methods would not provide the uniformity of structure needed for highly critical cutting tools. BOHLER has improved the production process for powder metallurgical high speed steels. **MICROCLEAN®** material of the third generation with improved performance are produced in our own mills.

The process offers:

- **Extremely high wear resistance**
- **Excellent grindability**
- **High degree of toughness**
- **Very good dimensional stability**
- **Reproducible heat treatment response**



The cutting tool material must have good resistance to the wear mechanisms that take place, primarily that of abrasive wear, which is the wear that takes place between the flank of the tool and the workpiece. The rate of wear increases as the speed and feed increase. The presence of vanadium in the steel helps improve the wear resistance of the steel.

High strength and ductility are also critical factors. The higher the strength and the capability of the steel to resist compressive loading, the more important it is that the steel be better able to absorb energy and withstand plastic deformation without fracturing. The use of production techniques like the powder metallurgy process permit this needed combination to occur in unique chemistries developed specifically for cutting tools.

Red hardness – the ability of the steel to maintain its strength at elevated temperatures which in turn improves the overall cutting efficiency of the tool - is one of the key characteristics of high speed steel and heat treatment techniques (via composition and secondary hardening response) developed to improve this feature. The demand for this property has led to the development of new alloys with varying degrees of tungsten, molybdenum, and cobalt. Recovery hardness, which is the room temperature ability to retain hardness after being exposed to elevated temperatures, is also critical.

High speed steels in cutting tools applications are essential because of their ability to obtain high hardness at room temperature, up to as high as 70 HRC for some alloys, while being able to maintain high hardness at cutting temperatures. The ability to form carbides in high speed steel increases its wear resistance while still permitting good grindability. And, what sets the high speed steels apart from other types of cutting tool materials is their ability to absorb shock loading, present in interrupted cutting.

## Conventional high speed steels

Conventional steel production consists of melting selective scrap in an Electric Arc Furnace, further refined in a ladle furnace, and uphill cast into ingots that are then heated followed by rolling or forging to the final dimension required.

**BOHLER HIGH SPEED STEEL USA** carries a wide range of high speed steels as required by the cutting tool industry.

## Nominal Compositions of Powder Metal High Speed Steels, in weight %

BÖHLER Designation	AISI Designation	C	Cr	W	Mo	V	Co	Other	Applications
<b>BÖHLER S290</b> <b>MICROCLEAN®</b>	Bridge Alloy	2.00	3.8	14.3	2.5	5.1	11.0	-	Heavy duty machining tools, for nonferrous metals
<b>BÖHLER S390</b> <b>MICROCLEAN®</b>	PM T15, Modified	1.64	4.8	10.4	2.0	4.8	8.0	-	For heavy cuts, high speeds and feeds: Broaches, reamers, milling cutters, chasers, lathe and planer tools, spade drills, taps
<b>BÖHLER S392</b> <b>MICROCLEAN®</b>	PM T15, Modified + S	1.67	4.8	10.4	2.0	4.8	8.0	S 0.25	For heavy cuts, high speeds and feeds: Broaches, reamers, milling cutters, chasers, lathe and planer tools, spade drills, taps, higher sulfur aids machinability and grindability
<b>BÖHLER S393</b> <b>MICROCLEAN®</b>	PM T15, Modified	1.55	4.4	12.4	-	4.9	5.0	-	For heavy cuts, high speeds and feeds: Broaches, reamers, milling cutters, chasers, lathe and planer tools, spade drills, taps
<b>BÖHLER S590</b> <b>MICROCLEAN®</b>	PM 30	1.30	4.2	6.3	5.0	3.0	8.4	-	Heavy duty machining of steel and nonferrous grades: shaper and milling cutters, broaches, taps, twist drills, chasers, reamers, bimetallic saw blades
<b>BÖHLER S592</b> <b>MICROCLEAN®</b>	PM30 + S	1.30	4.1	6.3	5.0	3.0	8.4	S 0.25	Heavy duty machining of steel and nonferrous grades: shaper and milling cutters, broaches, taps, twist drills, chasers, reamers, bimetallic saw blades; higher sulfur aids machinability and grindability
<b>BÖHLER S693</b> <b>MICROCLEAN®</b>	PM M4, AISI M4	1.44	4.0	5.75	5.15	4.0	-	-	Broaches, reamers, milling cutters, chasers, lathe and planer tools, spade drills, taps
<b>BÖHLER S692</b> <b>MICROCLEAN®</b>	PM M4, with Sulfur	1.44	4.0	5.5	5.0	4.0	-	S 0.25	Broaches, reamers, milling cutters, chasers, lathe and planer tools, spade drills taps, higher sulfur aids machinability and grindability
<b>BÖHLER S790</b> <b>MICROCLEAN®</b>	PM M3:2	1.29	4.2	6.3	5.0	3.0	-	-	Broaches, reamers, milling cutters, chasers, lathe and planer tools, spade drills, taps

## Comparison Chart: Powder Metallurgical High Speed Steel Properties

BÖHLER Grade	Red hardness	Wear resistance	Toughness	Machinability	Compressive strength
<b>BÖHLER S290</b> <b>MICROCLEAN®</b>	██████████	██████████	██████████	██████████	██████████
<b>BÖHLER S390</b> <b>MICROCLEAN®</b>	██████████	██████████	██████████	██████████	██████████
<b>BÖHLER S392</b> <b>MICROCLEAN®</b>	██████████	██████████	██████████	██████████	██████████
<b>BÖHLER S393</b> <b>MICROCLEAN®</b>	██████████	██████████	██████████	██████████	██████████
<b>BÖHLER S590</b> <b>MICROCLEAN®</b>	██████████	██████████	██████████	██████████	██████████
<b>BÖHLER S592</b> <b>MICROCLEAN®</b>	██████████	██████████	██████████	██████████	██████████
<b>BÖHLER S693</b> <b>MICROCLEAN®</b>	██████████	██████████	██████████	██████████	██████████
<b>BÖHLER S692</b> <b>MICROCLEAN®</b>	██████████	██████████	██████████	██████████	██████████
<b>BÖHLER S790</b> <b>MICROCLEAN®</b>	██████████	██████████	██████████	██████████	██████████

## Nominal Compositions of Conventional High Speed Steel in weight %

BÖHLER Grade	AISI Designation	C	Cr	W	Mo	V	Co	others	Applications
<b>BÖHLER S401</b>	M1	0.84	3.8	1.8	8.6	1.2	-	-	Taps, twist drills, reamers, milling and broaching tools, end mills, lathe tools
<b>BÖHLER S600</b>	M2 (High Carbon)	0.90	4.1	6.2	5.0	1.8	-	-	Taps, twist drills, reamers, broaching tools, metals saws, milling tools, boring tools, woodworking tools
<b>BÖHLER S601</b>	M2	0.85	4.1	6.4	5.0	1.9	-	-	Taps, twist drills, reamers, broaching tools, metals saws, milling tools, boring tools, woodworking tools
<b>BÖHLER S630</b>	M2 (Lean version)	0.95	4.0	4.0	4.0	2.0	-	Al 0.5	Taps, twist drills, reamers, broaching tools, metals saws, milling tools, boring tools, woodworking tools
<b>BÖHLER S400</b>	M7	1.02	3.8	1.8	8.6	1.9	-	-	Taps, twist drills, end mills, reamers, chasers, milling and broaching tools
<b>BÖHLER S705</b>	M35	0.92	4.1	6.2	5.0	1.9	4.8	-	Turning and planing tools of all types, milling cutters, taps, twist drills, hobs, woodworking tools
<b>BÖHLER S500SD</b>	M42	1.10	3.9	1.4	9.2	1.0	7.8	-	Milling cutters, twist drills, taps, broaching tools
<b>BÖHLER S405</b>	M50	0.83	4.0	-	4.3	1.05	-	-	Drills, taps, chasers, router bits, mandrels, woodworking tools
<b>BÖHLER S404</b>	M52	0.89	3.8	1.0	4.3	1.8	-	-	Taps, twist drills, reamers, milling and broaching tools

\*Grades also available from other group companies

## Comparison Chart: Conventional High Speed Steel Properties

BÖHLER Grade	Red hardness	Wear resistance	Toughness	Grindability	Compressive strength
<b>BÖHLER S401</b>					
<b>BÖHLER S600</b>					
<b>BÖHLER S601</b>					
<b>BÖHLER S630</b>					
<b>BÖHLER S400</b>					
<b>BÖHLER S705</b>					
<b>BÖHLER S500SD</b>					
<b>BÖHLER S405</b>					
<b>BÖHLER S404</b>					

# Additional Cutting Tool Offerings

## BOHLER MC90 **INTERMET**

In addition to High Speed Steels, BOHLER has introduced a new Powder Metallurgical cutting material, designed to address the extremely high stress conditions that exist when cutting difficult to machine materials, such as titanium alloys, nickel based materials, austenitic steels, or other stainless alloys. BOHLER MC90 Intermet, has improved thermal stability. Its high thermal conductivity reduces thermally induced strain and temperatures at the cutting edge.

## BOHLER **BHT** Hardened and Tempered (Hard Bar)

BOHLER has developed a new process to manufacture round bar that is hardened and tempered, in the unmachined or ground bar condition. There is no need for additional heat treating or straightening, and no leveling is required. It is designed to be used for the manufacture of long twist drills, centering drills, ejector and core pins, cold forming dies, and a variety of non-tooling applications. In addition to BOHLER S600 BHT and S500 BHT, BOHLER S705 BHT (AISI M35), BOHLER S390 MICROCLEAN BHT, and BOHLER S790 MICROCLEAN BHT (PM M3:2) can also be produced.

BOHLER Grade	AISI/DIN Designation	Size: Inches (metric)	Hardness (HRC)
<b>BOHLER S600 BHT</b>	High Carbon M2 (DIN 1.3343)	Ø0.12 - Ø0.2 (Ø3 mm - Ø5 mm)	62-64
		> Ø0.2 (>Ø5 mm)	64-66
<b>BOHLER S500 BHT</b>	~M42 (DIN 1.3247)	Ø0.12 - Ø0.2 (Ø3 mm - Ø5 mm)	64-66
		> Ø0.2 (>Ø5 mm)	65-67

For information on these and all other manufacturing parameters, please contact us.



## Coating of Cutting Tools: eifeler Coatings Technology

eifeler Coatings Technology has developed a series of Physical Vapor Deposition (PVD) coatings for the cutting tool industry. The main coating materials are Titanium Nitride (TiN), Titanium Carbo-Nitride (TiCN), and a family of Aluminum Titanium Nitride and Titanium Aluminum Nitride coatings (AlTiN/TiAlN). TiN is one of the oldest coatings and is considered a generic coating, good to a degree for many applications. TiN provides a lower friction coefficient and superior cratering resistance versus an uncoated tool, it will also increase tool life on most any non-exotic work piece materials.

TiN has a gold color, differentiating the coating from the substrate.

Titanium Carbo-Nitride (TiCN) is a very hard coating with a low friction coefficient which performs well on stainless steel, alloyed aluminum such as 6061 and standard materials such as 4140, 1018 etc. outperforming TiN in most cases. TiCN

does not perform well when extreme heat is created at the point of cut.

In alloyed aluminum TiCN is preferred, in brass, copper, bronze and non-alloyed aluminum or other soft gummy materials ZrN (Zirconium Nitride) is preferred.

Aluminum Titanium Nitride (AlTiN - eifeler Varianta) and Titanium Aluminum Carbo-Nitride (TiAlCN - eifeler Variantic) were developed to increase tool life for most exotic or pre-hardened applications.

The unique stoichiometry of these coatings allows them to operate at elevated temperatures during the cutting process.

In addition, eifeler's Exxtral Blue, Sistral and Crosal (our newest product) were designed to extend tool life beyond the norm in extremely difficult to machine materials.

Contact eifeler today for more details.

[www.eifeler.us](http://www.eifeler.us)

# South Boston, VA

Our South Boston, Virginia facility specializes in the manufacture of the cold drawing and annealing of coil, rod, and bar.

It has centerless grinding, hot and cold forming of rectangular shapes, and is the leading producer of High Speed Steel Edgewire for the bi-metal band saw industry in North America.

It has recently undergone a modernization of their Edgewire production equipment and annealing furnaces.

Capabilities also include shot blasting, shaving, drawing, atmosphere annealing, vacuum annealing, pickling, bar end chamfering, straightening and Turks Head profiling and rolling. South Boston has extensive inventory in high speed steels, powder metallurgical high speed steels, and cold work grades. Please contact us for more details.



## Nominal Compositions of Edgewire Steel Grades, in weight %\*

BÖHLER Grade	Edgewire Grades AISI Designations	C	Cr	W	Mo	V	Co
<b>BÖHLER S504SF</b>	Matrix II	0.73	4.1	1.0	5.0	1.0	8.0
<b>BÖHLER S500SF</b>	M42	1.08	3.8	1.5	9.5	1.2	8.0

\* Other Grades Available

**BOHLER HIGH SPEED STEEL USA**  
(877) 992-8764  
[www.bohler.com](http://www.bohler.com)

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