



# HIGH PERFORMANCE STEELS FOR PUNCHING AND BLANKING

# MADE-TO-MEASURE DIVERSITY FOR THE WORLD'S BEST

The requirements on **forming, cutting, punching and blanking tools** are constantly rising. Significantly longer service life is expected for tools today compared with just a few years ago, primarily due to continuously rising cost pressure. Consequently the requirements on tool steels are increasing.

BÖHLER offers a broad spectrum of made-to-measure products, along with essential expertise for application advice and coating technology.\*

Depending on customer wishes and requirements profiles, we offer various options for the production of BÖHLER top grades with the following designations:

**ISODUR®**

Cold work tool steels – ESR/PESR

**ISOBLOC®**

Hot work tool steels – ESR/PESR

**MICROCLEAN®**

Powder metallurgical steels

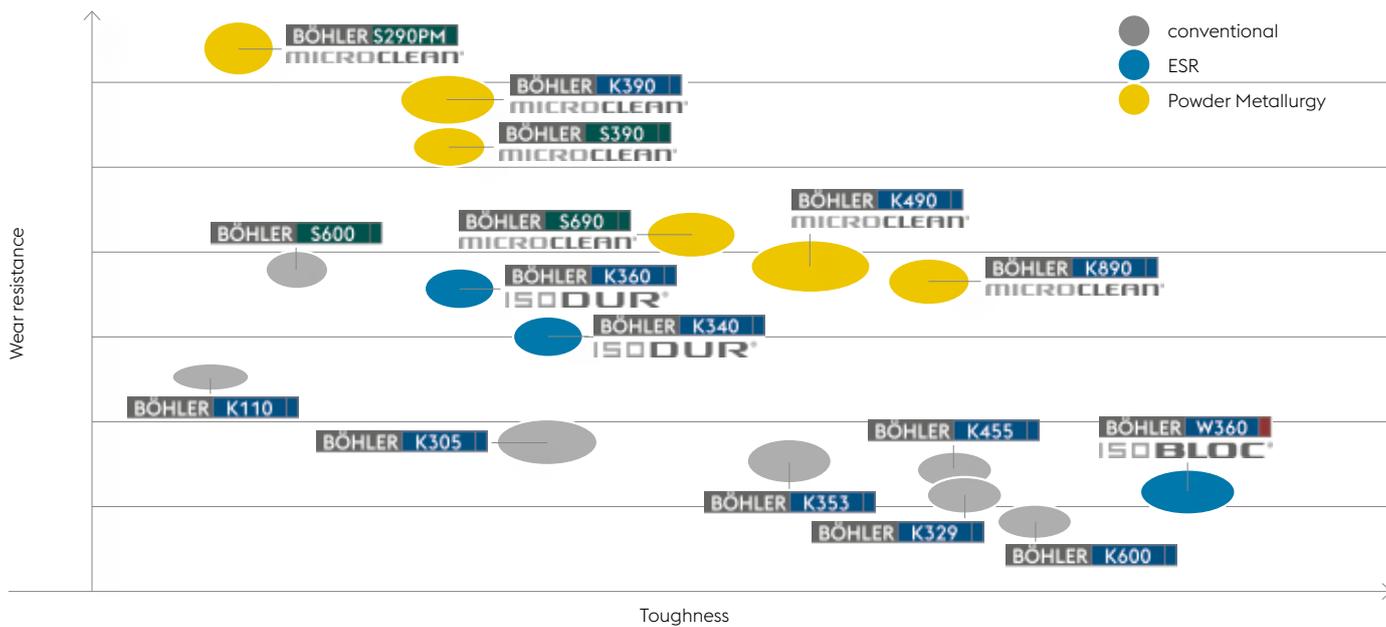
\* Fa. Eifeler



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## COMPARATIVE OVERVIEW OF BÖHLER TOP GRADES

Property profiles of BÖHLER cold work tool steels with various manufacturing technologies



# 3 QUALITY LEVELS 3 TECHNOLOGIES

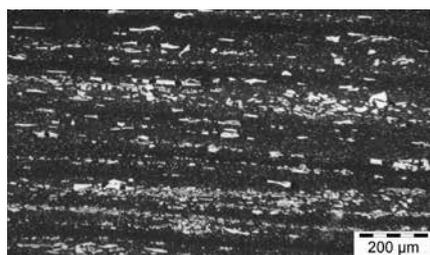
## BASIC



### Conventional production

Products made using the electric arc process are designated as conventionally melted materials and are the “basic materials” for ordinary loading, with the following primary properties:

- » Banded carbide distribution
- » Sufficient cleanliness



Micro structure of conventional 12% chromium steel

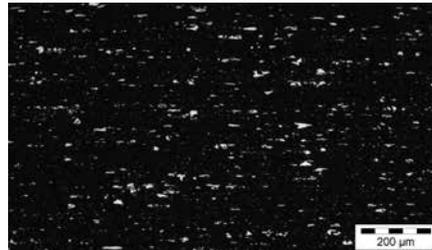
## PREMIUM



### ESR / PESR Manufacture

Products with improved properties can be produced using the ESR or PESR method. Using remelted materials leads to longer tool life due to:

- » High level of cleanliness
- » Low segregation
- » Larger bar dimensions can be produced with the same carbide distribution
- » Uniform dimensional changes
- » Improved toughness



Microstructure of 8% chromium steel in ESR grade

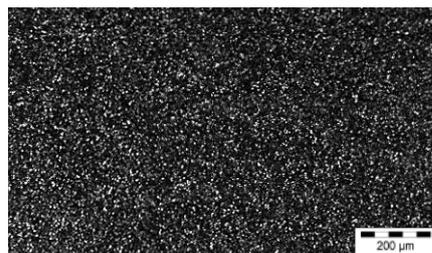
## SUPERIOR



### Powder metallurgical production

Materials produced using powder metallurgy are increasingly being used to meet the most stringent requirements with various processing methods. These materials offer properties that meet demanding requirements:

- » No segregation
- » Extremely fine carbide distribution
- » Homogeneous properties
- » High wear resistance
- » Very good dimensional stability
- » High compressive strength
- » High toughness with high hardness



Microstructure of PM materials

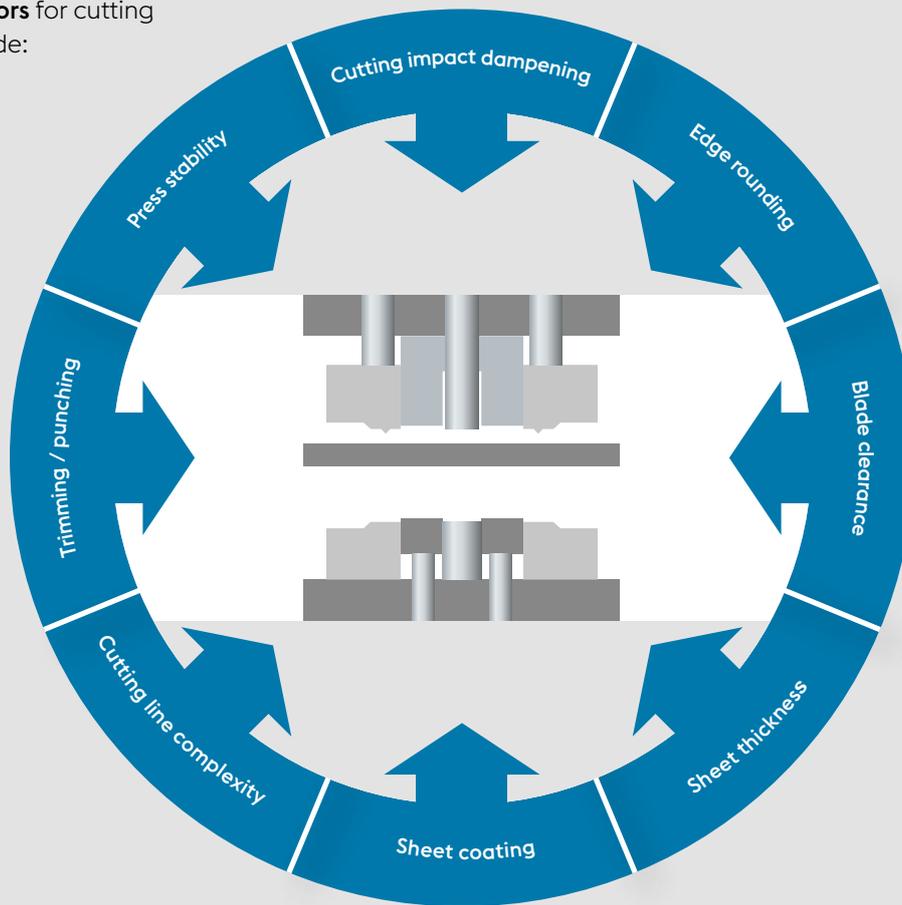
# CUTTING AND STAMPING – MATERIAL REQUIREMENTS

Detailed knowledge of the stress factors in the manufacturing process is needed for selecting a tool material with optimal properties for the process concerned. On the other hand, various damage mechanisms should also be taken into account.

In many cases, conventional tool materials are not able to cope with the extremely high stresses sometimes encountered and are therefore not able to achieve the desired lifetimes.

As a cost-effective alternative, BÖHLER offers a variety of latest-generation materials with performance features precisely aligned to the desired application. Consistently high cutting and stamping performance yield the desired productivity gains.

The significant factors for cutting and stamping include:



## REQUIREMENTS PROFILE

Tool life for cold forming is limited by wear and fatigue, which can lead to considerable downtime costs. By selecting a specific combination of matrix and carbides and a suitable cleanliness grade, BÖHLER offers top grades with properties that achieve optimal results in the relevant application and/or under the relevant stress conditions.

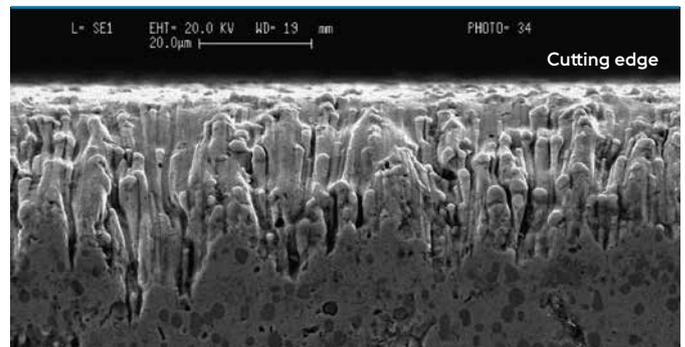
In cold forming operations, 80% of all tool failures in the production of simple high-volume parts are caused by wear.

# DAMAGE MECHANISMS AND THEIR AVOIDANCE

## ABRASIVE WEAR

Abrasion means material removal by gouging, cutting or chipping where two materials are in contact. In the case of cold forming tools, this primarily takes the form of erosion of the matrix of the tool material. Carbides retard this process.

### Abrasive wear – matrix erosion



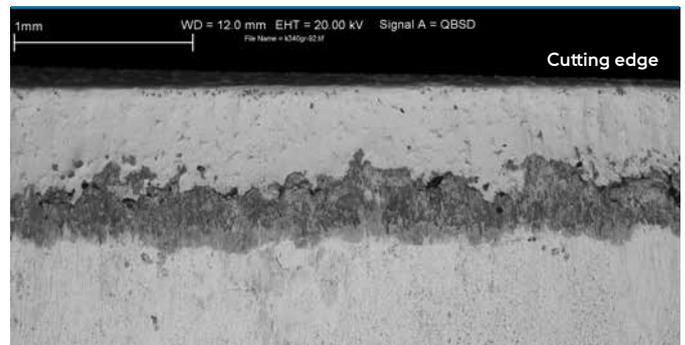
#### Potential solution:

Use a material with high carbide content and a high-strength matrix, such as BÖHLER K390 MICROCLEAN

## ADHESIVE WEAR

Adhesion refers to the tendency to cold welding. Steels with high hardness and strength must be used to counter or prevent this tendency. The carbides embedded in the steel matrix reduce the tendency to adhesion, with a higher carbide content and more uniform carbide distribution both increasing the resistance to adhesive wear.

### Adhesive wear – cold welding, material transfer



#### Potential solution:

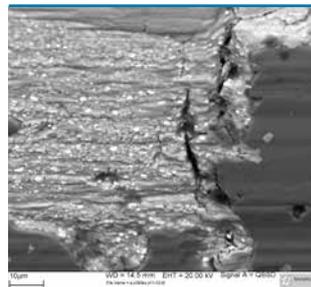
Use a material with fine carbides, uniform distribution and a high-strength matrix, such as BÖHLER K340 ISODUR or use of coated tools



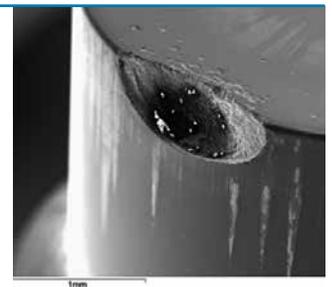
## FATIGUE

Material fatigue means crack initiation and crack growth as a result of cyclic stress. Although tools for cold forming are usually pre-stressed under compression, fatigue fractures may occur under certain conditions, such as pressing operations.

### Fatigue – spalling & plastic deformation



Tangential cracks



Edge chipping due to cyclic plastic deformation

### Potential solution:

Use a material with fine, uniformly distributed carbides, high compressive strength and high purity, such as **BÖHLER S390 MICROCLEAN**

# GOOD TO KNOW

Requirements for tool materials are becoming more demanding and more complex.

With expert product advice and a comprehensive product spectrum, BÖHLER is able to offer solutions individually tailored to your specific requirements and problems. The decision to use high-quality materials for your tooling often pays off quickly, since the material component of high-performance tooling often represents only 5% of the total value.

#### **Cost-effectiveness result from:**

- » Better machining characteristics
- » Longer life
- » Lower maintenance costs
- » Fewer tools
- » Less downtime

In short:

**BY USING RELIABLE TOOL MATERIALS, YOU SAVE TIME AND MONEY AND IMPROVE YOUR COMPETITIVENESS.**



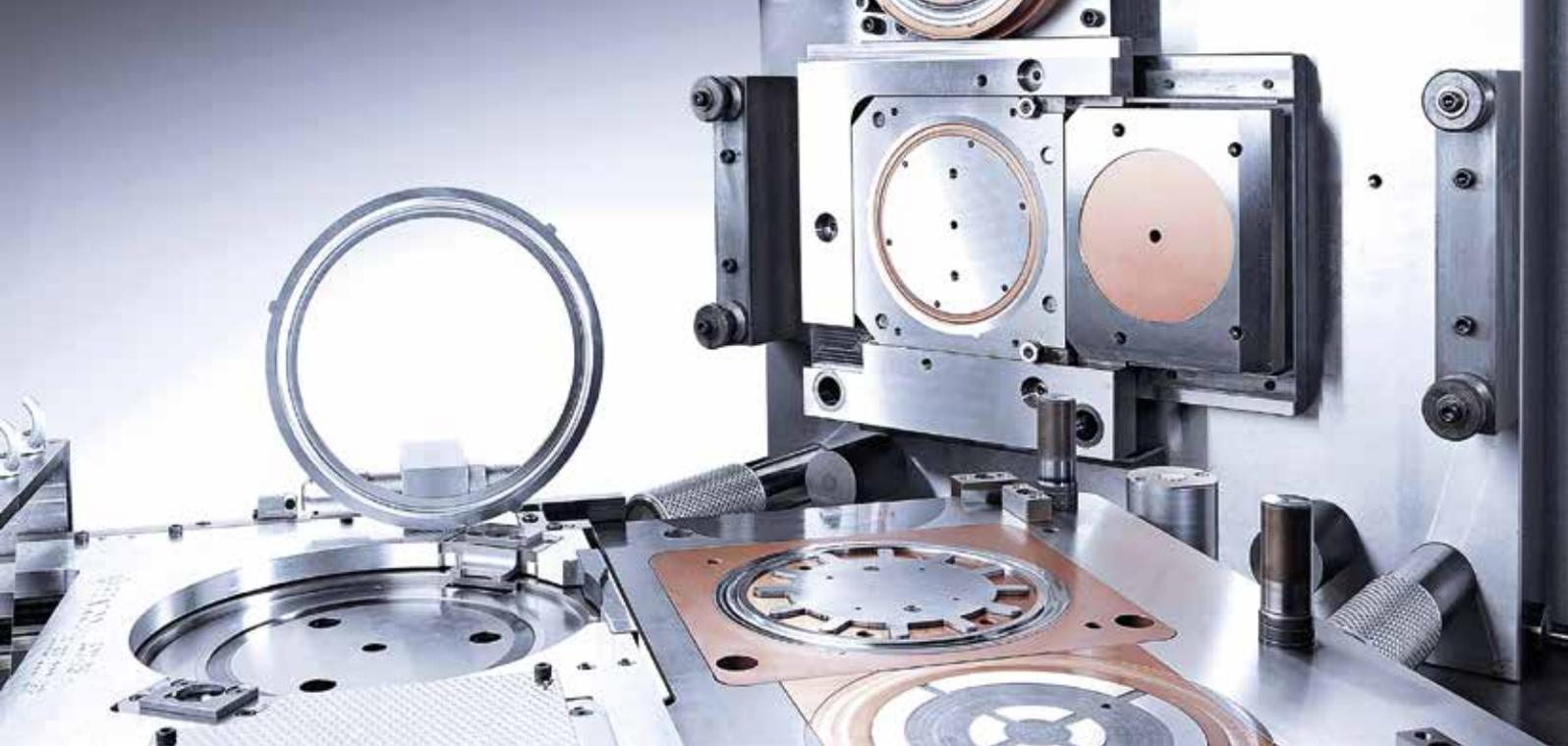
# THE FULL DIVERSITY AT A GLANCE

## CORE PRODUCTS

BÖHLER grade	Chemical composition (nominal in wt.%)						Standards	
	C	Cr	Mo	V	W	Others	DIN/ EN	AISI
<b>BÖHLER K100</b>	2.00	11.50	-	-	-	-	1.2080 X210Cr12	~ D3
<b>BÖHLER K110</b>	1.55	11.50	0.75	0.75	-	-	1.2379 X155CrVMo12-1	D2
<b>BÖHLER K305</b>	1.00	5.20	1.10	0.25	-	-	1.2363 X100CrMoV5-1	A2
<b>BÖHLER K353</b>	0.82	8.00	1.60	0.60	-	+ Al	Patented	-
<b>BÖHLER K455</b>	0.63	1.10	-	0.18	2.00	-	1.2550 60WCrV7	~ S1
<b>BÖHLER K600</b>	0.45	1.30	0.25	-	-	Ni = 4.00	1.2767 45NiCrMo16	-
<b>BÖHLER S600</b>	0.90	4.10	5.00	1.80	6.40	-	1.3343 HS6-5-2	~ M2 reg.C
<b>BÖHLER S630</b>	0.95	4.00	4.00	2.00	4.00	+ Al	1.3330 HS4-4-2	-

BÖHLER grade	Chemical composition (nominal in wt.%)						Standards	
	C	Cr	Mo	V	W	Others	DIN/ EN	AISI
<b>BÖHLER K340</b> <b>ISODUR®</b>	1.10	8.30	2.10	0.50	-	+ Al + Nb	Patented	-
<b>BÖHLER K360</b> <b>ISODUR®</b>	1.25	8.75	2.70	1.18	-	+ Al + Nb	Patented	-
<b>BÖHLER W360</b> <b>ISOBLOC®</b>	0.50	4.50	3.00	0.55	-	-	Patented	-

BÖHLER grade	Chemical composition (nominal in wt.%)						Standards	
	C	Cr	Mo	V	W	Others	DIN/ EN	AISI
<b>BÖHLER K390</b> <b>MICROCLEAN®</b>	2.45	4.15	3.75	9.00	1.00	Co = 2.00	Patented	-
<b>BÖHLER K490</b> <b>MICROCLEAN®</b>	1.40	6.40	1.50	3.70	3.50	+ Nb	Patented	-
<b>BÖHLER K890</b> <b>MICROCLEAN®</b>	0.85	4.35	2.80	2.10	2.55	Co = 4.50	Patented	-
<b>BÖHLER S290</b> <b>MICROCLEAN®</b>	2.00	3.75	2.50	5.00	14.30	Co = 11.00	Patented	-
<b>BÖHLER S390</b> <b>MICROCLEAN®</b>	1.60	4.80	2.00	5.00	10.50	Co = 8.00	-	-
<b>BÖHLER S690</b> <b>MICROCLEAN®</b>	1.33	4.30	4.90	4.10	5.90	-	-	~ M4



BÖHLER grade	Wear resistance		Toughness	Compressive strength	Dimensional stability during heat treatment
	abrasive	adhesive			
<b>BOHLER K100</b>	★★★	★	★	★	★★
<b>BOHLER K110</b>	★★★	★	★	★★	★★
<b>BOHLER K305</b>	★	★	★★★★	★	★
<b>BOHLER K340</b> <b>ISODUR®</b>	★★★	★★★★	★★★	★★★	★★★
<b>BOHLER K353</b>	★★	★★★	★★★★★	★★	★★
<b>BOHLER K360</b> <b>ISODUR®</b>	★★★★	★★★★	★★	★★★	★★★
<b>BOHLER K390</b> <b>MICROCLEAN®</b>	★★★★★	★★★★★	★★★★	★★★★	★★★★
<b>BOHLER K490</b> <b>MICROCLEAN®</b>	★★★★	★★★★	★★★★★	★★★	★★★★
<b>BOHLER K890</b> <b>MICROCLEAN®</b>	★★★	★★★	★★★★★	★★★	★★★★
<b>BOHLER K455</b>	★	★	★★★★★	★	★
<b>BOHLER K600</b>	★	★	★★★★★	★	★
<b>BOHLER S600</b>	★★★★	★★	★	★★★	★★
<b>BOHLER S630</b>	★★	★★★	★★	★★★	★★
<b>BOHLER S290</b> <b>MICROCLEAN®</b>	★★★★★	★★★★★	★★	★★★★★	★★★★
<b>BOHLER S390</b> <b>MICROCLEAN®</b>	★★★★★	★★★★	★★★	★★★★	★★★★
<b>BOHLER S690</b> <b>MICROCLEAN®</b>	★★★★	★★★	★★★★	★★★	★★★★
<b>BOHLER W360</b> <b>ISOBLOC®</b>	★	★	★★★★★	★	★★

Note:

The rating of the properties is based solely on stamping and cutting applications and the steels listed here. Comparative ratings are strongly dependent on specific heat treatment. For detailed advice on material selection, please consult your voestalpine BÖHLER dealer.

# PROFITABLE MATERIAL RECOMMENDATIONS

Material to be cut	Material thickness	BÖHLER grade	Standard hardness of punches and dies in HRc	
			Complex shapes and/or thick sheets	Simple shapes and/or thin sheets
Steel sheet, plate & strip, aluminium and aluminium alloys, copper and copper alloys with tensile strength up to 600 MPa	up to 3 mm	<b>BÖHLER K110</b>	60	62
		<b>BÖHLER K340 ISODUR®</b>	60	63
		<b>BÖHLER K360 ISODUR®</b>	61	63
		<b>BÖHLER K390 MICROCLEAN®</b>	62	64
		<b>BÖHLER S600</b>	60	63
	3 – 6 mm	<b>BÖHLER K110</b>	58	62
		<b>BÖHLER K305</b>	58	62
		<b>BÖHLER K340 ISODUR®</b>	60	62
		<b>BÖHLER K353</b>	60	62
		<b>BÖHLER K360 ISODUR®</b>	60	62
		<b>BÖHLER K390 MICROCLEAN®</b>	61	63
		<b>BÖHLER W360 ISOBLOC®</b>	55	57
		<b>BÖHLER K490 MICROCLEAN®</b>	62	64
		<b>BÖHLER K890 MICROCLEAN®</b>	61	63
		<b>BÖHLER S600</b>	59	62
	6 – 12 mm	<b>BÖHLER K340 ISODUR®</b>	58	60
		<b>BÖHLER K353</b>	60	62
		<b>BÖHLER K390 MICROCLEAN®</b>	60	62
		<b>BÖHLER W360 ISOBLOC®</b>	54	56
		<b>BÖHLER K455</b>	52	56
<b>BÖHLER K490 MICROCLEAN®</b>		61	63	
<b>BÖHLER K890 MICROCLEAN®</b>		60	62	
over 12 mm		<b>BÖHLER K353</b>	58	60
	<b>BÖHLER W360 ISOBLOC®</b>	50	54	
	<b>BÖHLER K490 MICROCLEAN®</b>	58	60	
	<b>BÖHLER K600</b>	52	54	
	<b>BÖHLER K890 MICROCLEAN®</b>	58	60	

Material to be cut	Material thickness	BÖHLER grade	Standard hardness of punches and dies in HRc	
			Complex shapes and/or thick sheets	Simple shapes and/or thin sheets
Steel sheet/plate & strip and metal alloys with tensile strength of 600 to 1000 MPa	up to 3 mm	<b>BÖHLER K110</b>	58	62
		<b>BÖHLER K340</b> <b>ISODUR®</b>	60	62
		<b>BÖHLER K360</b> <b>ISODUR®</b>	60	62
		<b>BÖHLER K390</b> <b>MICROCLEAN®</b>	61	63
		<b>BÖHLER S600</b>	59	62
		<b>BÖHLER S630</b>	59	62
	3 – 6 mm	<b>BÖHLER K110</b>	56	60
		<b>BÖHLER K340</b> <b>ISODUR®</b>	58	60
		<b>BÖHLER K360</b> <b>ISODUR®</b>	58	60
		<b>BÖHLER K390</b> <b>MICROCLEAN®</b>	60	62
		<b>BÖHLER K490</b> <b>MICROCLEAN®</b>	60	62
		<b>BÖHLER K890</b> <b>MICROCLEAN®</b>	60	62
	6 – 12 mm	<b>BÖHLER K340</b> <b>ISODUR®</b>	54	56
		<b>BÖHLER K353</b>	58	60
		<b>BÖHLER K390</b> <b>MICROCLEAN®</b>	58	60
		<b>BÖHLER W360</b> <b>ISOBLOC®</b>	52	54
		<b>BÖHLER K455</b>	50	54
		<b>BÖHLER K490</b> <b>MICROCLEAN®</b>	58	60
		<b>BÖHLER K890</b> <b>MICROCLEAN®</b>	58	60
		<b>BÖHLER K353</b>	57	59
	over 12 mm	<b>BÖHLER W360</b> <b>ISOBLOC®</b>	52	54
<b>BÖHLER K455</b>		48	52	
<b>BÖHLER K490</b> <b>MICROCLEAN®</b>		58	60	
<b>BÖHLER K600</b>		48	52	
<b>BÖHLER K890</b> <b>MICROCLEAN®</b>		58	60	

# PROFITABLE MATERIAL RECOMMENDATIONS

Material to be cut	Material thickness	BÖHLER grade	Standard hardness of punches and dies in HRc	
			Complex shapes and/or thick sheets	Simple shapes and/or thin sheets
Precision blanking tools for metallic sheets and strips	up to 4 mm	<b>BÖHLER K110</b>	60	62
		<b>BÖHLER K305</b>	60	61
		<b>BÖHLER K340</b> <b>ISODUR®</b>	61	63
		<b>BÖHLER K353</b>	60	62
		<b>BÖHLER K360</b> <b>ISODUR®</b>	61	63
		<b>BÖHLER K390</b> <b>MICROCLEAN®</b>	62	64
		<b>BÖHLER K490</b> <b>MICROCLEAN®</b>	62	64
		<b>BÖHLER S290</b> <b>MICROCLEAN®</b>	63	67
		<b>BÖHLER S390</b> <b>MICROCLEAN®</b>	62	64
		<b>BÖHLER S600</b>	60	62
	<b>BÖHLER S630</b>	60	62	
	<b>BÖHLER S690</b> <b>MICROCLEAN®</b>	60	62	
	4 - 8 mm	<b>BÖHLER K110</b>	58	60
		<b>BÖHLER K305</b>	58	60
		<b>BÖHLER K340</b> <b>ISODUR®</b>	60	62
		<b>BÖHLER K353</b>	60	62
		<b>BÖHLER K360</b> <b>ISODUR®</b>	60	62
		<b>BÖHLER K390</b> <b>MICROCLEAN®</b>	61	63
		<b>BÖHLER K490</b> <b>MICROCLEAN®</b>	61	63
		<b>BÖHLER K890</b> <b>MICROCLEAN®</b>	60	63
<b>BÖHLER S390</b> <b>MICROCLEAN®</b>		61	64	
<b>BÖHLER S600</b>		59	62	
<b>BÖHLER S630</b>	59	62		
<b>BÖHLER S690</b> <b>MICROCLEAN®</b>	60	62		

Material to be cut	Material thickness	BÖHLER grade	Standard hardness of punches and dies in HRC	
			Complex shapes and/or thick sheets	Simple shapes and/or thin sheets
Precision blanking tools for metallic sheets and strips	8 - 12 mm		58	60
			58	60
			60	62
			60	62
			59	62
			54	56
			60	63
			58	62
			58	62
			58	62
	over 12 mm		50	54
			58	62
			58	62
			58	62

# PROFITABLE MATERIAL RECOMMENDATIONS

Material to be cut	Material thickness	BÖHLER grade	Standard hardness of punches and dies in HRc		
			Complex shapes and/or thick sheets	Simple shapes and/or thin sheets	
Sheets and strips for dynamos and transformers (highly abrasive)	up to 1 mm	<b>BÖHLER K100</b>	63	65	
		<b>BÖHLER K110</b>	60	62	
		<b>BÖHLER K360</b> <b>ISODUR®</b>	61	63	
		<b>BÖHLER K390</b> <b>MICROCLEAN®</b>	62	64	
		<b>BÖHLER K490</b> <b>MICROCLEAN®</b>	62	64	
		<b>BÖHLER S290</b> <b>MICROCLEAN®</b>	63	68	
		<b>BÖHLER S390</b> <b>MICROCLEAN®</b>	62	66	
		<b>BÖHLER S690</b> <b>MICROCLEAN®</b>	62	64	
	1 – 3 mm	<b>BÖHLER K360</b> <b>ISODUR®</b>	59	62	
		<b>BÖHLER K390</b> <b>MICROCLEAN®</b>	61	63	
		<b>BÖHLER K490</b> <b>MICROCLEAN®</b>	60	63	
		<b>BÖHLER S390</b> <b>MICROCLEAN®</b>	61	63	
	3 – 6 mm	<b>BÖHLER K340</b> <b>ISODUR®</b>	58	60	
		<b>BÖHLER K390</b> <b>MICROCLEAN®</b>	60	62	
		<b>BÖHLER K490</b> <b>MICROCLEAN®</b>	60	63	
		<b>BÖHLER K890</b> <b>MICROCLEAN®</b>	60	63	
		<b>BÖHLER S390</b> <b>MICROCLEAN®</b>	60	62	
	Austenitic steels	up to 3 mm	<b>BÖHLER K340</b> <b>ISODUR®</b>	60	62
			<b>BÖHLER K353</b>	60	62
			<b>BÖHLER K360</b> <b>ISODUR®</b>	60	63
			<b>BÖHLER K390</b> <b>MICROCLEAN®</b>	62	64
<b>BÖHLER K490</b> <b>MICROCLEAN®</b>			62	64	
<b>BÖHLER S390</b> <b>MICROCLEAN®</b>			63	65	
<b>BÖHLER S600</b>			61	63	
		<b>BÖHLER S690</b> <b>MICROCLEAN®</b>	61	63	

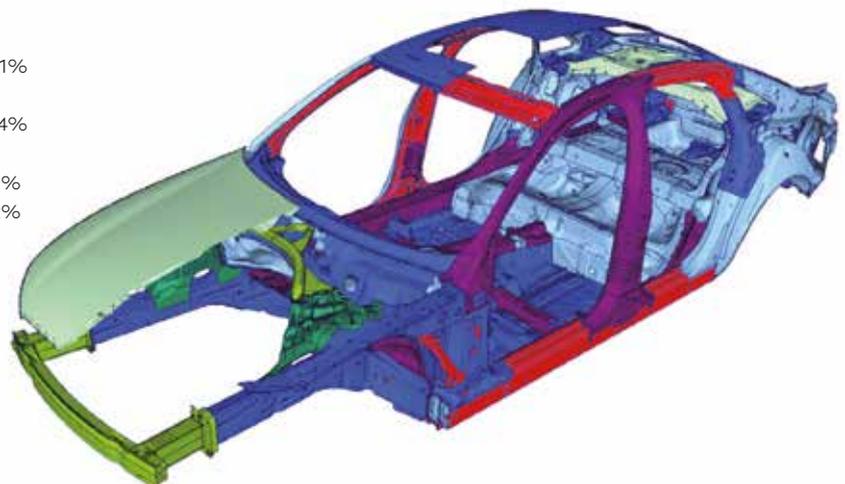
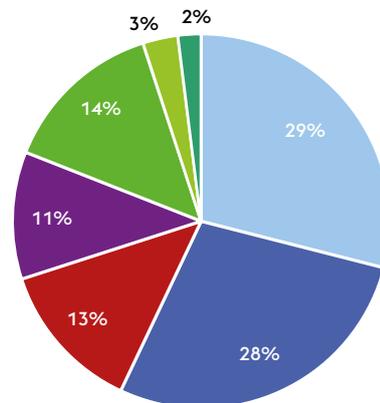
Material to be cut	Material thickness	BÖHLER grade	Standard hardness of punches and dies in HRc	
			Complex shapes and/or thick sheets	Simple shapes and/or thin sheets
Austenitic steels	3 – 6 mm		58	60
			59	61
			61	63
			61	63
			60	63
			60	64
			60	62
	6 – 12 mm		56	58
			58	60
			54	56
			58	60
			59	61
			60	62
			58	60
	over 12 mm		57	59
			54	56
			58	60
			58	60
			58	60

# MACHINING OF HIGH-STRENGTH AND ULTRA HIGH-STRENGTH SHEETS

## APPLICATION

The share of high-strength and ultra high-strength sheet metal in vehicle construction is strongly rising. BÖHLER offers a broad spectrum of grades to provide the optimum solution for demanding machining tasks

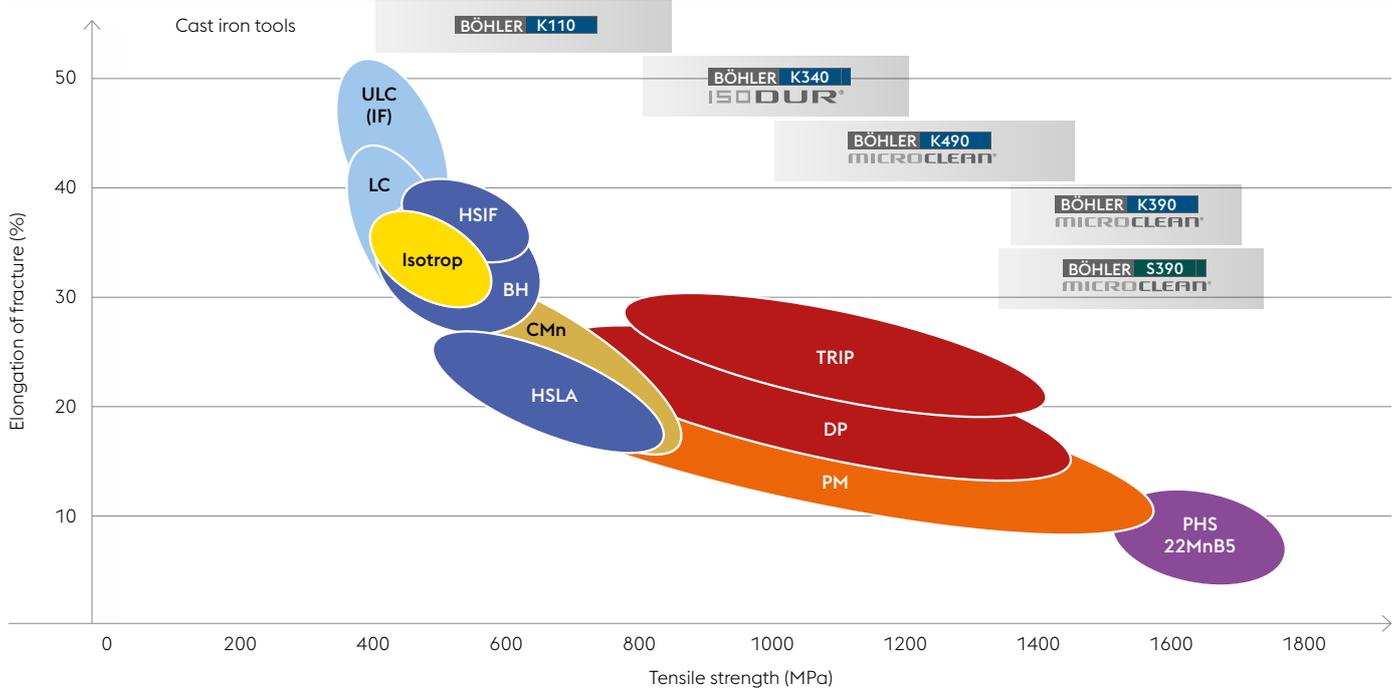
<span style="color: #4F81BD;">■</span> <b>Low-strength steels:</b> Mild steels	29%
<span style="color: #2E5496;">■</span> <b>High-strength steels (HSS):</b> High-strength interstitial-free steels (HSIF), Bake hardening steels (BH), High-strength low alloy steels (HSLA)	28%
<span style="color: #C00000;">■</span> <b>Advanced high-strength steels (AHSS):</b> Dual phase steels (DP), Transformation induced plasticity steels (TRIP)	13%
<span style="color: #3A3A7A;">■</span> <b>Stainless steels:</b> Austenitic stainless steels	
<span style="color: #808080;">■</span> <b>Ultra high-strength steels (UHSS):</b> Complex phase steels (CP), Martensitic steels (MS)	
<span style="color: #6A329F;">■</span> <b>Press hardened steels (PHS)</b>	11%
<span style="color: #3CB371;">■</span> <b>Aluminium sheets:</b> 7xxx series	14%
<span style="color: #9ACD32;">■</span> <b>Aluminium sheets:</b> 6xxx series	
<span style="color: #BDB76B;">■</span> <b>Aluminium sheets:</b> 5xxx series	
<span style="color: #9ACD32;">■</span> <b>Aluminium extrusion profiles</b>	3%
<span style="color: #008000;">■</span> <b>Cast aluminium</b>	2%





## MATERIALS FOR CUTTING, PUNCHING AND BLANKING HIGH-STRENGTH AND ULTRA-HIGH STRENGTH SHEETS

### Tool steels – sheet materials



- |           |                         |        |  |       |                            |
|-----------|-------------------------|--------|--|-------|----------------------------|
| ● ULC     | Ultra low carbon steels | ● BH   | Bake-hardening steels                    | ● DP  | Dual phase steels          |
| ● LC      | Low carbon steels       | ● HSLA | High-strength low alloyed steels         | ● PM  | Partial martensitic steels |
| ● HSIF    | High strength IF steels | ● TRIP | Transformation induced plasticity steels | ● PHS | Presshardened steels       |
| ● Isotrop | Isotropic steels        | ● CMn  | Carbon manganese steels                  |       |                            |

# PROFITABLE MATERIAL RECOMMENDATIONS

Material to be cut	Material thickness	BÖHLER grade	Standard hardness of punches and dies in HRc	
			Complex shapes and/or thick sheets	Simple shapes and/or thin sheets
Steel sheet/plate and strip and metal alloys with tensile strengths over 1000 MPa	up to 2 mm		60	62
			60	62
			62	64
			62	64
			60	64
			62	64
			60	62
	over 2 mm		58	60
			55	57
			60	62
			60	64
			60	62
			60	62
			60	64

The formability and ductility of all of the materials mentioned above decrease with increasing hardening phases.



The data contained in this brochure is merely for general information and therefore shall not be binding on the company. We may be bound only through a contract explicitly stipulating such data as binding. The manufacture of our products does not involve the use of substances detrimental to health or to the ozone layer.



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