PLASTIC MOULD STEEL

BÖHLER M398
MICROCLEAN®

FOR HIGHLY WEAR-STRESSED TOOLS

IN RESPECT OF VERSATILITY AND PERFORMANCE

BÖHLER M398 MICROCLEAN is a martensitic chromium steel produced with powder metallurgy. Due to its alloying concept this steel offers **extremely high wear resistance** and **high corrosion resistance** – the perfect combination for highly wear-resistant tools.

MARKET REQUIREMENTS

Trends

» Processing of reinforced plastics (glass fibres, …)
» Increasing screw speeds to increase capacity

↓

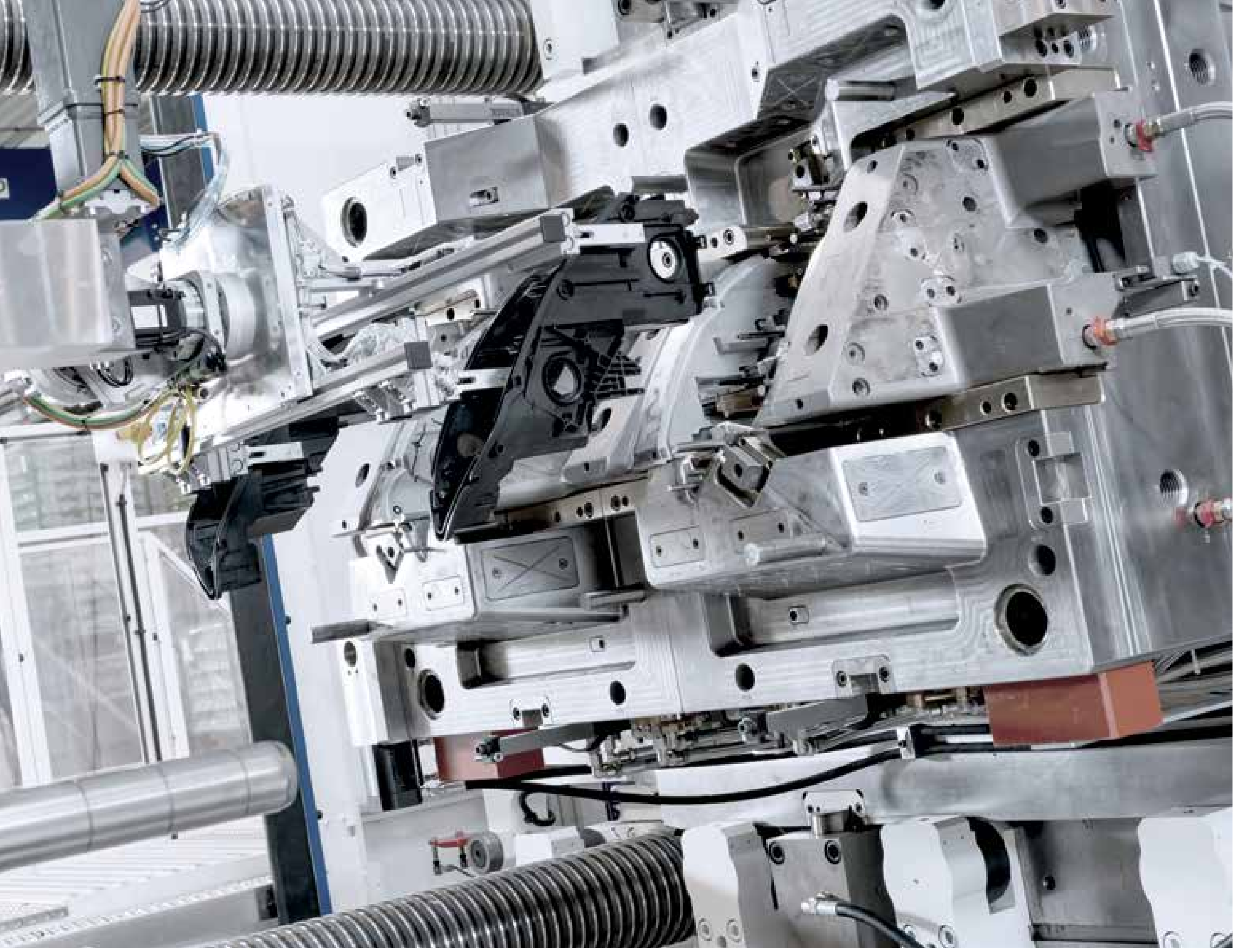
Consequences

» Clear reduction of tool lifetime
» Higher costs for spare parts and maintenance
» Diminished quality of the injection molded parts

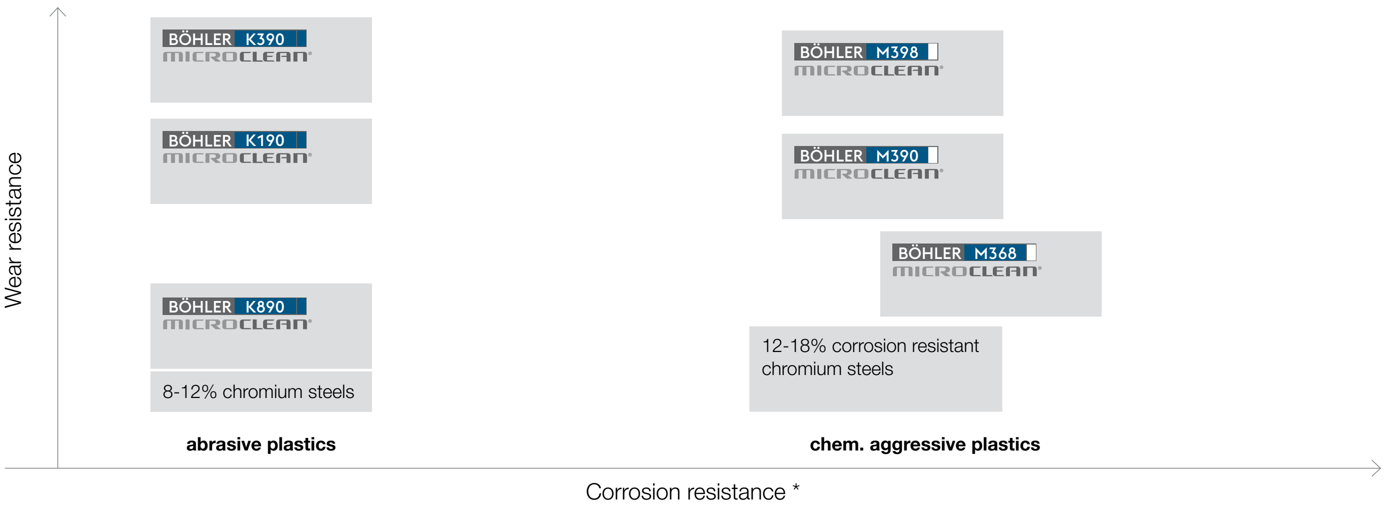
↓

Aim

New PM plastic mold steel obtaining:
» Extremely high wear resistance
» Achievable hardness > 60 HRc in vacuum heat treatment
» Good corrosion resistance



Property profile of BÖHLER tool steels for the plastics processing industry



* High tempered, weight loss test with 20% boiling acetic acid, 24 h.

IMPROVED PROPERTIES

ALLOYING CONCEPT

Increasing macro-hardness by increasing the primary carbide volume consisting of:

» Vanadium-rich MC-carbides (VC ~3,000 HV)

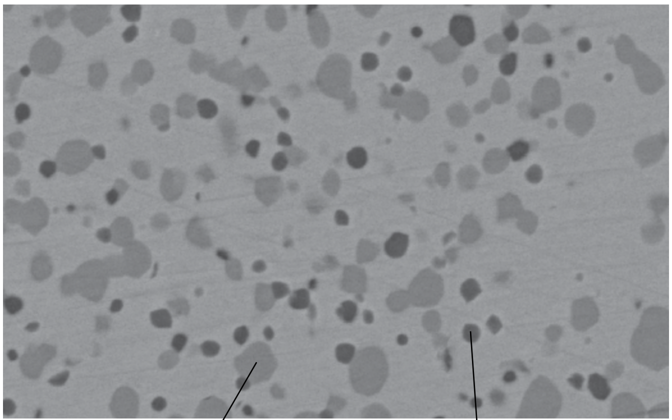
» Chromium-rich M_7C_3-carbides (Cr_7C_3 ~2,200 HV)

Comparison of the chemical composition (%)

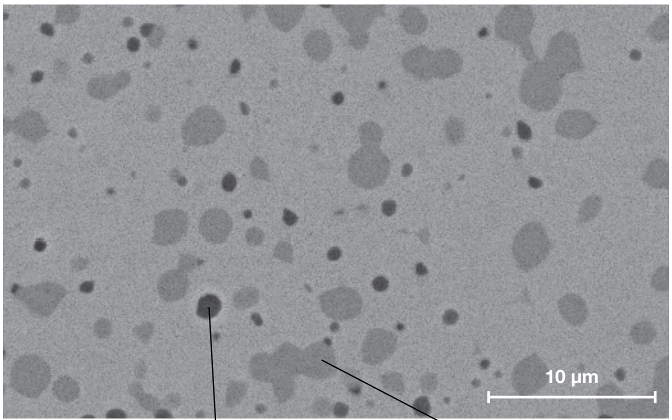
	C	Si	Mn	Cr	Mo	V	W
BÖHLER M390 MICROCLEAN®	1.90	0.70	0.30	20.00	1.00	4.00	0.60
BÖHLER M398 MICROCLEAN®	2.70	0.50	0.50	20.00	1.00	7.20	0.70

MICROSTRUCTURE

BÖHLER M398 MICROCLEAN



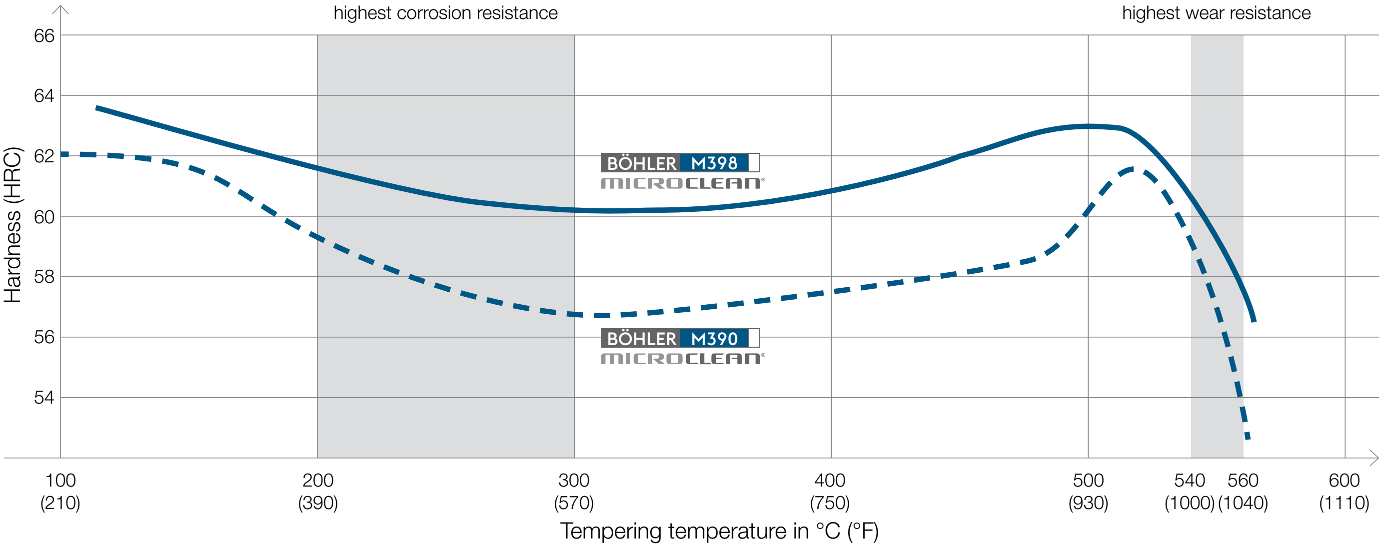
BÖHLER M390 MICROCLEAN



→ **Primary carbide content increased to about 30 vol.%**

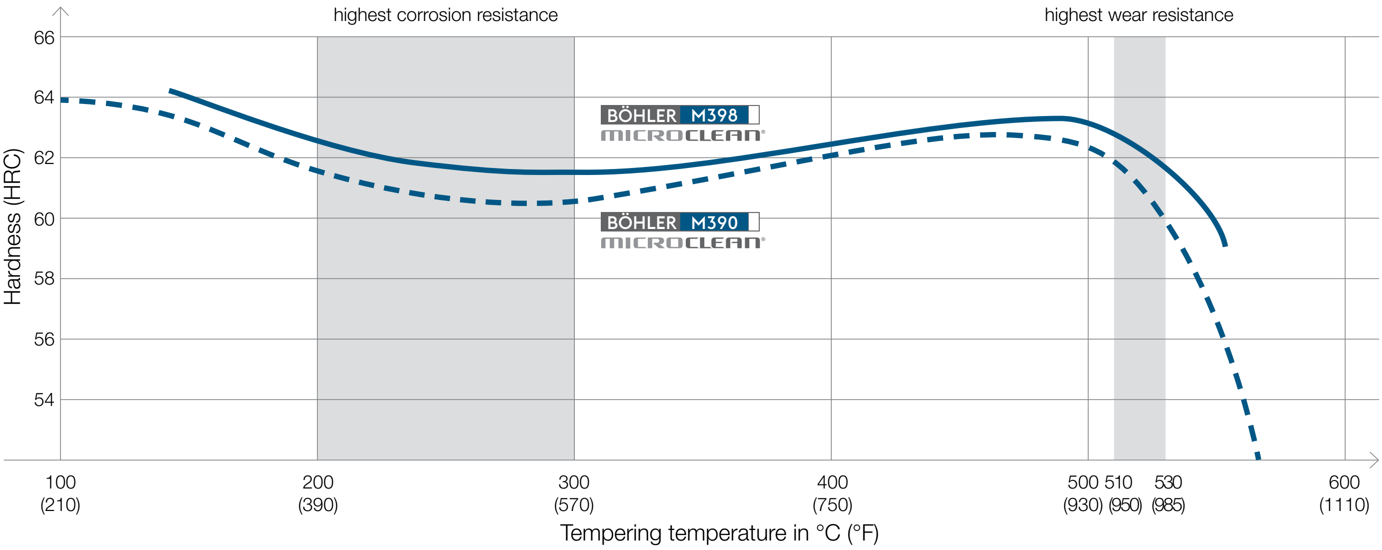
MATERIAL PROPERTIES

Tempering chart (without subzero treatment)



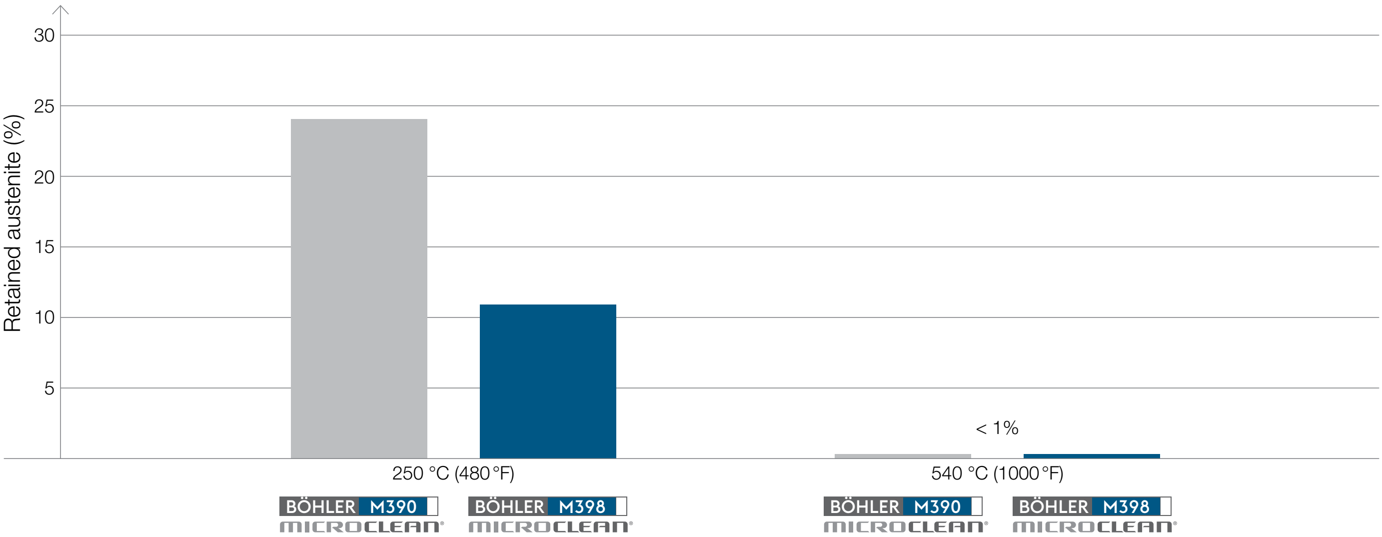
Heat treatment: Austenitizing at 1150 °C (2100 °F) / 20 min. / 5 bar; Tempering 2 x 2 h

Tempering chart (with subzero treatment)



Heat treatment: Austenitizing at 1150 °C (2100 °F) / 20 min. / 5 bar; Subzero cooling: -70 °C, 1 x 2 h; Tempering 2 x 2 h

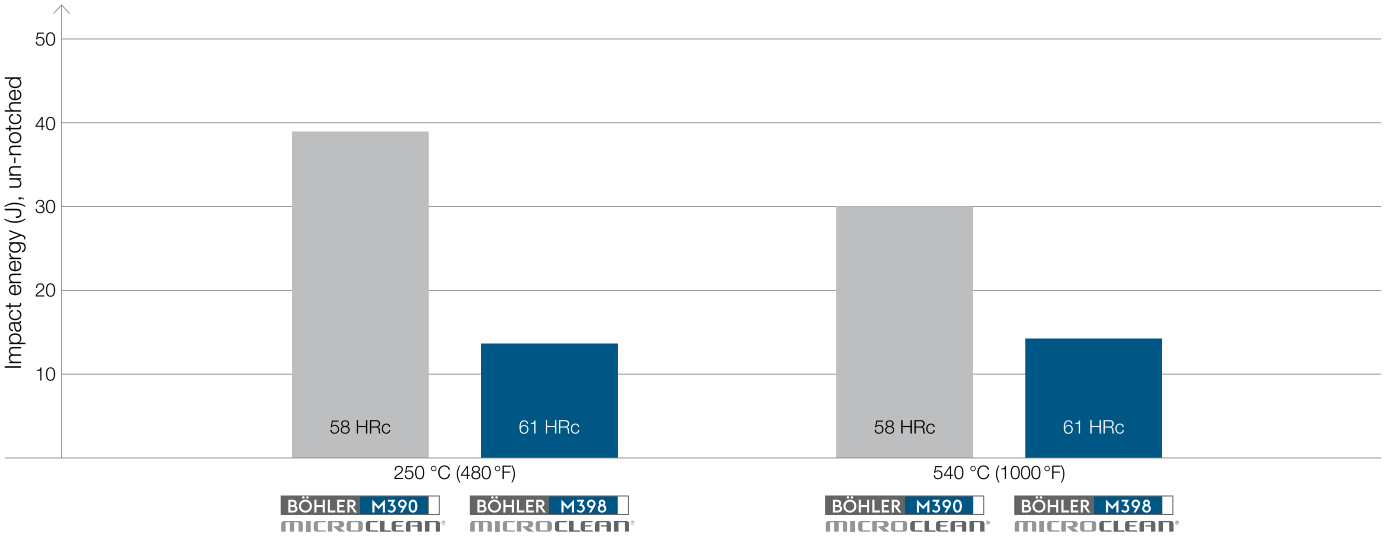
Retained austenite



Heat treatment: Austenitizing at 1150 °C (2100 °F) / 20 min. / 5 bar; without subzero cooling ; Tempering 2 x 2 h

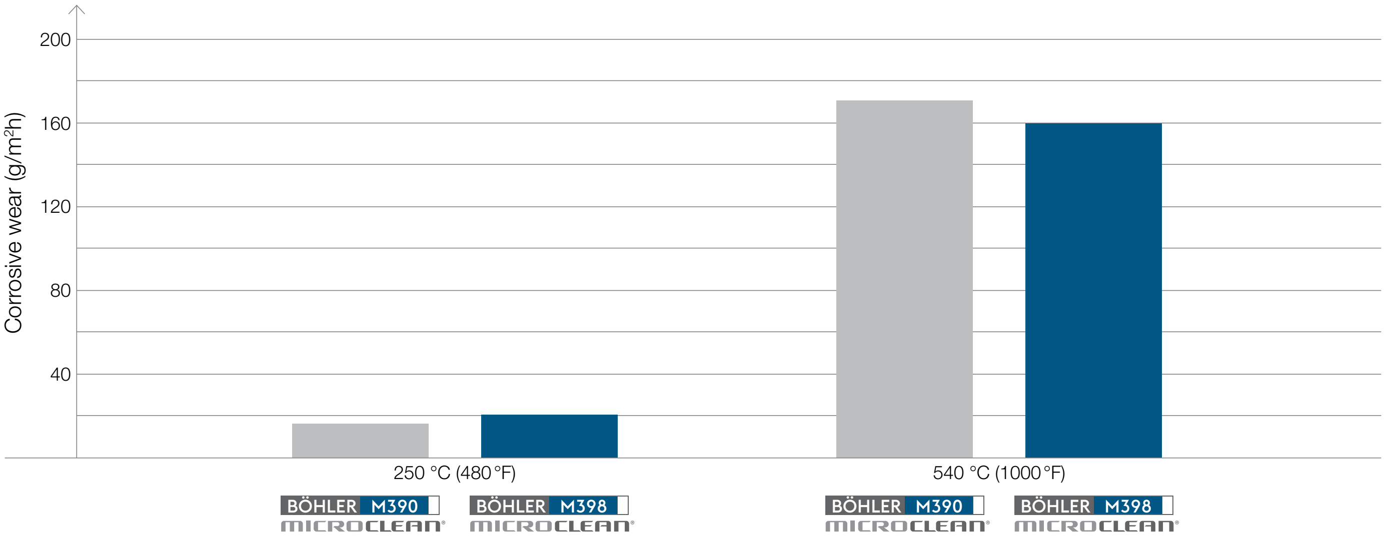
→ **Low amounts of retained austenite after hardening and low tempering improve hardenability of BÖHLER M398 MICROCLEAN, especially when deep-freezing is not performed or possible.**

Impact energy



Heat treatment: Austenitizing at 1150 °C (2100 °F) / 20 min. / 5 bar; without subzero cooling; Tempering 2 x 2 h
Tested sizes:
BÖHLER M390 MICROCLEAN: Round bar, longitudinal, approx. 80 mm (3.15 inches)
BÖHLER M398 MICROCLEAN: Mother block, longitudinal, approx. 373 x 343 mm (14.7 x 13.5 inches)

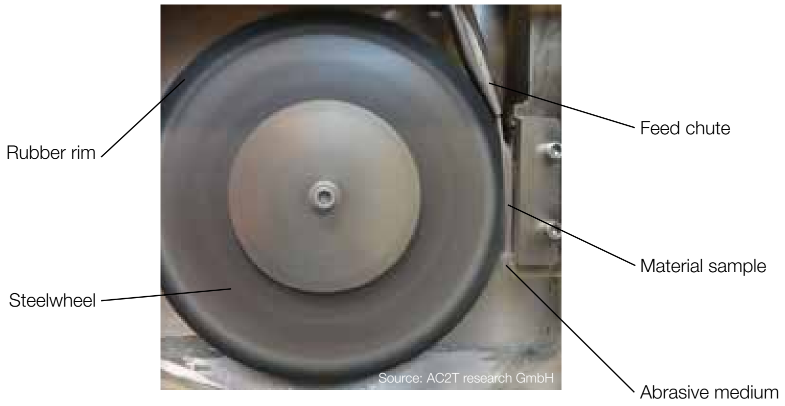
Corrosion resistance



Heat treatment: Austenitizing at 1150 °C (2100 °F) / 20 min. / 5 bar; without subzero cooling; Tempering 2 x 2 h
Weight loss test: Measured after 24h in 20% boiling acidic acid

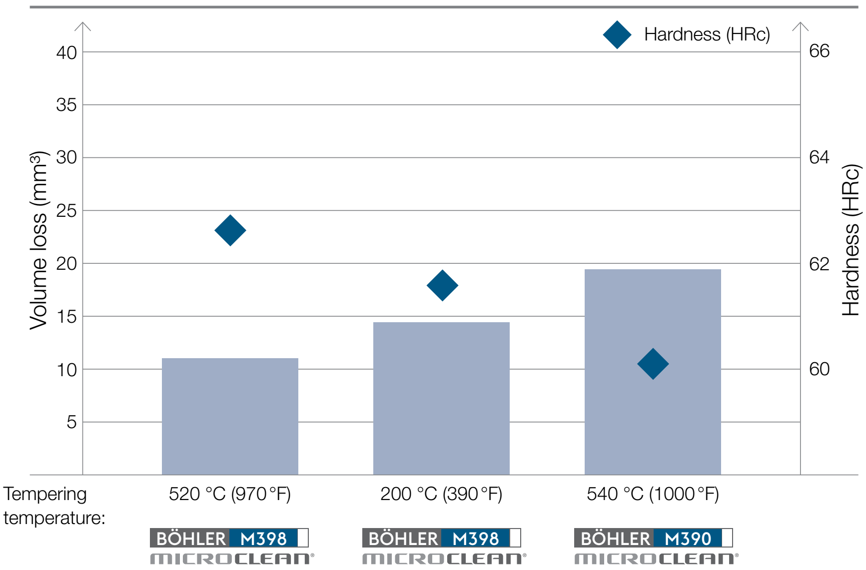
WEAR RESISTANCE

ASTM G65 rubber wheel dry sand test

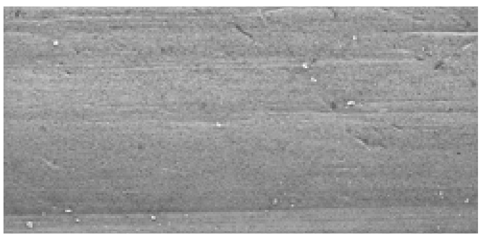


Test method A	
Test load	130 N
Sand grain size	100–400 µm
Feed rate	340 g/min.
Testing time	30 min.
Sliding distance	4309 m

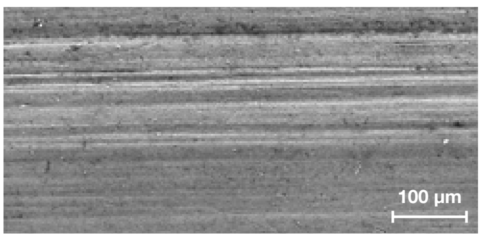
→ Wear volume caused by abrasion is calculated from mass loss and density of the sample.



BÖHLER M398 MICROCLEAN



BÖHLER M390 MICROCLEAN



→ BÖHLER M398 MICROCLEAN shows highest abrasive wear resistance

ECONOMICAL ADVANTAGES

PROPERTIES

» Extremly high wear resistance
» High and isotropic dimensional stability during heat treatment
» High hardenability and compressive strength with >60 HRc
» Good toughness
» Good corrosion resistance
» Good grindability
» High gloss polishability

enable
» Long tool life, therefore reduced downtimes and maintenance costs
» High precision components
» Consistant tool life

Advantages
» **Increased productivity**
» **Reduced unit costs**

APPLICATIONS

Due to its property-profile BÖHLER M398 MICROCLEAN can be used for following applications:
» Non return valves
» Screws for injection moulding machines
» Tool inserts for injection moulding
» Extrem wear resistant components
» Cutting type instruments and knives

BÖHLER M398 MICROCLEAN® VS. BÖHLER M390 MICROCLEAN®

- » Due to higher amount of primary carbides in M398MICROCLEAN (ca. 30 Vol.%) hardness, wear resistance and compressive strength is significantly increased.
- » In contrast impact energy is slightly lower in comparison to M390MICROCLEAN.
- » Similar corrosion resistance.

BÖHLER grade	Wear resistance	Toughness	Corrosion resistance
BÖHLER M390 MICROCLEAN® vs. BÖHLER M398 MICROCLEAN®	+	–	=

HEAT TREATMENT RECOMMENDATIONS

Supplied condition

- Soft annealed with max. 330 HB

Hardening

- Austenitizing temperature: 1,120 to 1,180 °C (2,050 to 2,155 °F)
- Holding time after through-heating:
  20 – 30 minutes for a hardening temperature of 1,120 to 1,150 °C (2,050 to 2,100 °F)
  5 – 10 minutes for a hardening temperature of 1,180 °C (2,155 °F)
- Quenching media: Oil, N_2

Achievable hardness

- 60 to 63 HRc

Tempering for highest corrosion resistance

- Deep freezing for transformation of retained austenite
- Slow heating to tempering temperature
- Time in furnace 1 hour for each 20 mm (0.79 inch) of workpiece thickness, but at least 2 hours
- For information on the achievable hardness after tempering please refer to the tempering chart.
- Tempering: 200 to 300 °C (390 – 570 °F)

Tempering for highest wear resistance

- Deep freezing recommended
- A deep freezing treatment immediately following hardening leads to increased tempering hardness values at austenitising temperatures ≥ 1,150 °C (≥ 2,100 °F), [Risk of stress cracking]
- Slow heating to tempering temperature
- Time in furnace 1 hour for each 20 mm (0.79 inch) of workpiece thickness, but at least 2 hours
- For information on the achievable hardness after tempering please refer to the tempering chart.
- Triple tempering 20 °C (68 °F) above the secondary hardening maximum is necessary in order to achieve a complete transformation of retained austenite.

NUMBERS, FACTS AND DATES

Physical properties

Modulus of elasticity at	20 °C (68 °F	231 x 10^3 N/mm^2
Density at	20 °C (68 °F)	7,46 kg/dm^3 (0.268 lbs/in^3)
Specific heat capacity at	20 °C (68 °F	490 J/(kg.K)
Thermal conductivity at	20 °C (68 °F	15,2 W/(m.K) (105 Btu in/ft^2 h°F)

Regarding 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**.

Thermal expansion between 20 °C and … °C (68 – … °F)

100 °C	**200 °C**	**300 °C**	**400 °C**	**500 °C**	
10.4	10.6	10.9	11.2	11.5	10^{-6} m/(m.K)
210 °F	**390 °F**	**570 °F**	**750 °F**	**930 °F**	
5.78	5.89	6.06	6.22	6.38	10^{-6} in/in°F

MACHINING RECOMMENDATIONS

Turning with sintered carbide

Depth of cut mm (inch)	0.5 – 2 (.02 – .04)	1 – 4 (.04 – .16)	4 – 8 (.16 – .31)	over 8 (over .31)
Feed mm / rev. (inch/rev.)	0.1 – 0.3 (.004 – .012)	0.2 – 0.4 (.008 – .016)	0.3 – 0.8 (.012 – .031)	0.5 – 1.5 (.020 – .060)
Cutting speed vc (m/min) (f.p.m)	130 – 200 (425 –655)	100 – 170 (330 – 560)	70 – 120 (230 – 395)	30 – 70 (100 – 230)
Recommended BOEHLERIT-geometry	FP, FMP, MM	MP, MRP, MM	MRP, BMRS	RP, BR, BRP
BOEHLERIT grade	LCP15T, BCM25T	LCP15T, LCP25T, BCM25T	LCP25T, LC240F, BCM40T	LC240F
ISO grade	P15, M25	P15, P20, M25	P20, P30, M40	P30, P40

Condition: soft annealed. Figures given are guidelines only.

Turning with high speed steel

Depth of cut mm (inch)	0.5 (.02)	3 (.12)	6 (.24)
Feed mm / rev. (inch/rev.)	0.1 (.004)	0.4 (.016)	0.8 (.031)
BÖHLER-/DIN-grade	S700 / DIN S10-4-3-10		
Cutting speed vc (m/min) (f.p.m)			
Tool life 60 min.	30 – 20 (100 – 65)	20 – 15 (65 – 50)	18 – 10 (60 – 35)
Rake angle	14°	14°	14°
Clearance angle	8°	8°	8°
Inclination angle	-4°	-4°	-4°

Milling with sintered carbide

Cutting speed vc (m/min) (f.p.m)	150 – 180 (490 – 590)	130 – 160 (425 – 525)	80 – 140 (260 – 460)
BOEHLERIT grade	BCH10M, BCM35M	BCH30M, BCM40M	BCM40M, BCP40M
ISO grade	H10, M35	H30, M40	M40, P40
F_z Milling 90° mm (inch)	0.1 – 0.25 (.004 – .010)	0.1 – 0.25 (.004 – .010)	0.1 – 0.3 (.004 – .012)
F_z Milling 45° mm (inch)	0.15 – 0.6 (.006 – .024)	0.15 – 0.6 (.006 – .024)	0.15 – 0.6 (.006 – .024)
F_z High feed cutting mm (inch)	0.6 – 1.8 (.024 – 0.071)	0.6 – 2.0 (.024 – 0.08)	0.6 – 2.0 (.024 – 0.08)

Drilling with sintered carbide

Drill diameter mm (inch)	3 – 8 (.12 – .31)	8 – 20 (.31 – .80)	20 – 40 (.80 – 1.6)
Feed mm/rev. (inch/rev.)	0.02 – 0.05 (.001 – .002)	0.05 – 0.12 (.002 – .005)	0.12 – 0.18 (.005 – .007)
BOEHLERIT/ISO-grade	HB10 / K10		
Cutting speed vc (m/min) (f.p.m)	50 – 35 (165 – 115)	50 – 35 (165 – 115)	50 – 35 (165 – 115)
Point angle	115° – 120°	115° – 120°	115° – 120°
Clearance angle	5°	5°	5°

Condition: soft annealed. Figures given are guidelines only.

BÖHLER SPECIAL STEELS FOR THE WORLD'S TOP PERFORMERS

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