



PLASTIC
MOULD STEEL



POWDER
METALLURGY

PLASTIC MOLD STEEL

BÖHLER M368
MICROCLEAN®



YOUR BENEFIT

BÖHLER M368 MICROCLEAN is a martensitic chromium steel produced with powder metallurgy. Due to its alloying concept this steel offers **high wear resistance, high toughness** and **high corrosion resistance** – the perfect combination for **best application properties**.

- » High wear resistance
- » High toughness
- » High corrosion resistance
- » Excellent grindability
- » Good polishability
- » High dimensional stability

Enable:

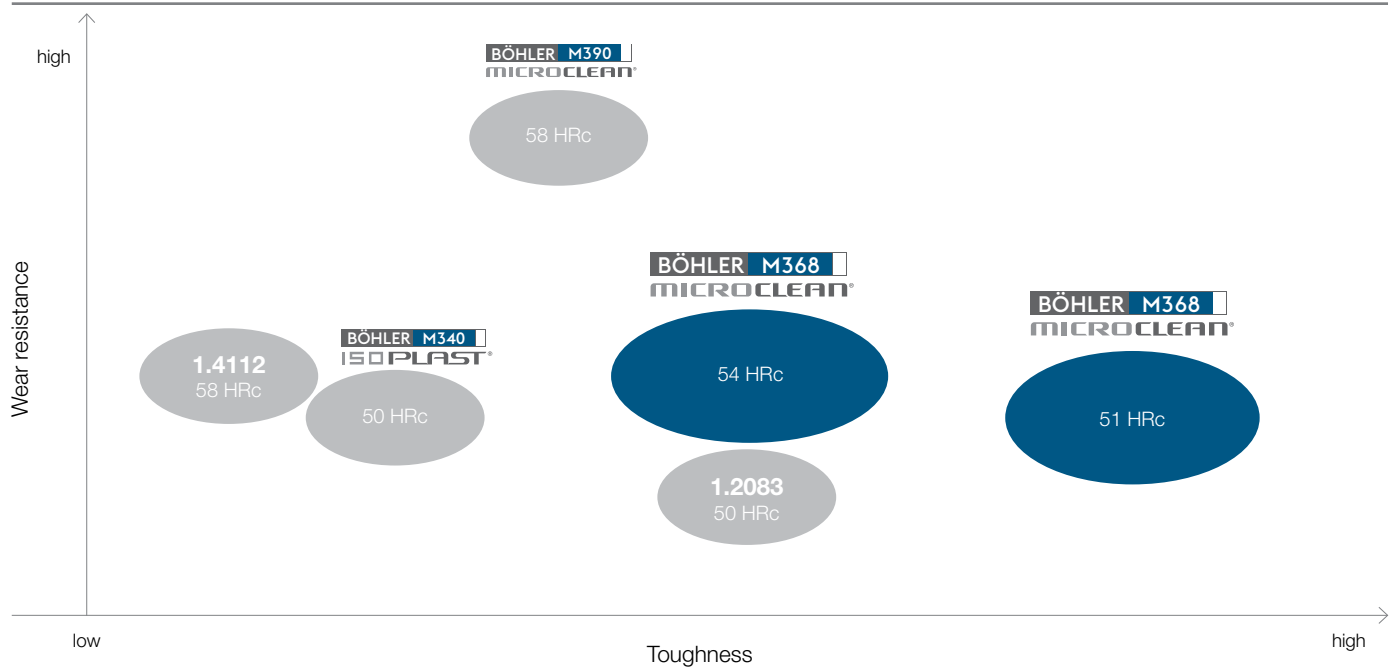
- » Production of big tools
- » Long and constant tool life
- » Reproducibility of production processes
- » High precision components

Benefit:

- » Increased productivity
- » Reduced unit costs



Product positioning



Chemical composition (average %)

C	Si	Mn	Cr	Mo	V	others
0.54	0.45	0.40	17.30	1.10	0.10	+N

patented



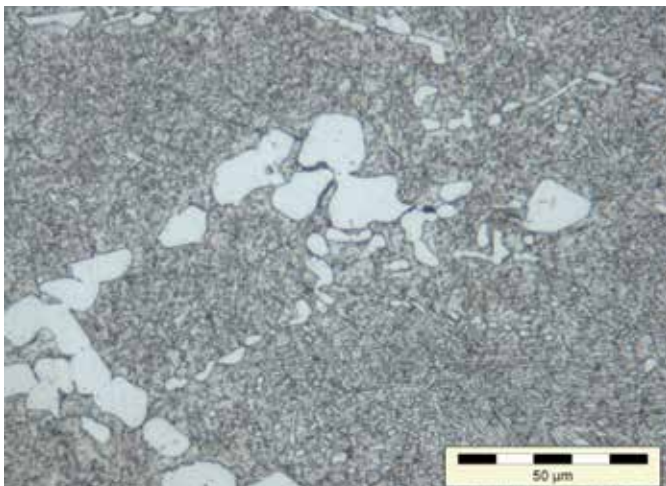
MAXIMUM QUALITY IN USE

for:

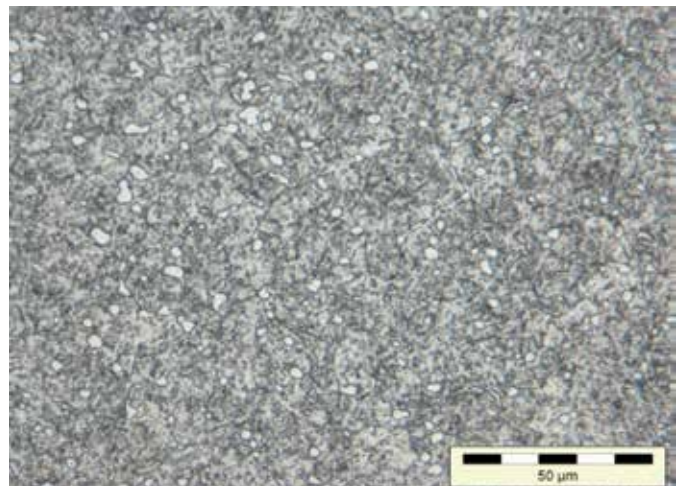
- » Mould inserts
- » Moulds for the processing of chemically aggressive plastics containing highly abrasive fillers
- » Moulds and knives for the food-processing industry
- » Moulds for the electronic industry
- » Screws for injection moulding machines
- » Linings for injection moulding cylinders

IMPRESSIVE HOMOGENEITY

Due to powder metallurgical production of **BÖHLER M368 MICROCLEAN** a segregation-free microstructure with significantly improved homogeneity in comparison to conventional and ESR-produced standard products like e.g. 1.4112 could be achieved.



Microstructure 1.4112



Microstructure BÖHLER M368 MICROCLEAN

HEAT TREATMENT

DELIVERY CONDITION

Soft annealed **max. 280 HB**

STRESS RELIEVING

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

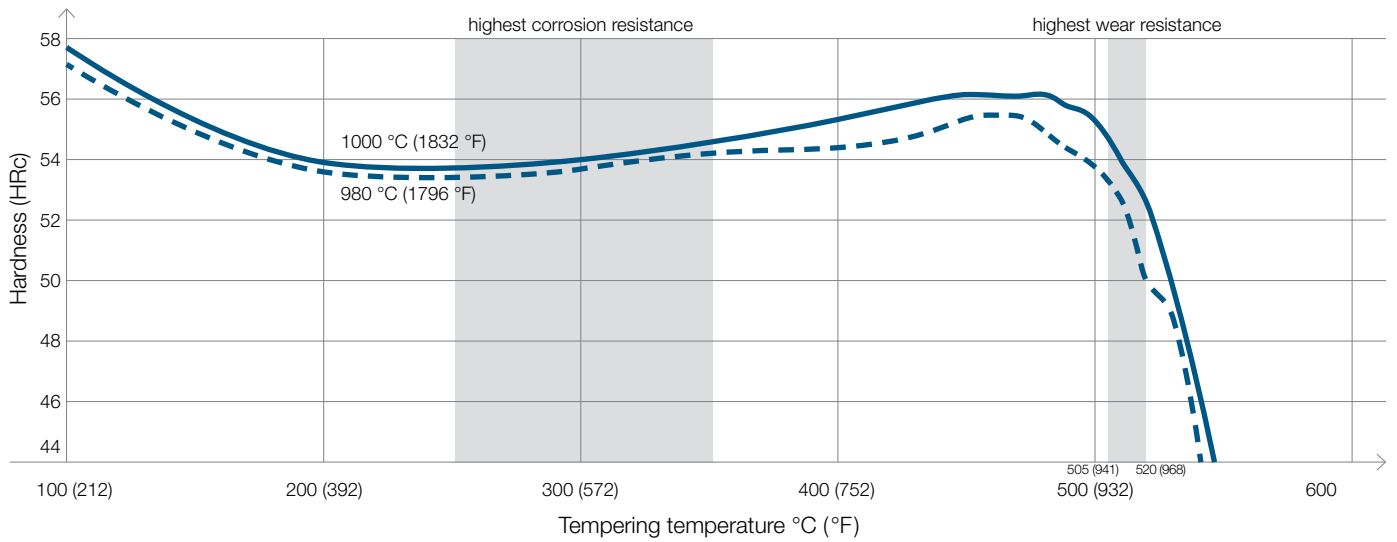
HARDENING

- » 980 to 1000 °C (1796 – 1830 °F), N₂
- » Following temperature equalisation:
15 – 30 min. holding time
- » For big moulds we recommend a low hardening temperature of 980 °C (1796 °F) and a high tempering temperature (505 to 520 °C [941 – 968 °F]).

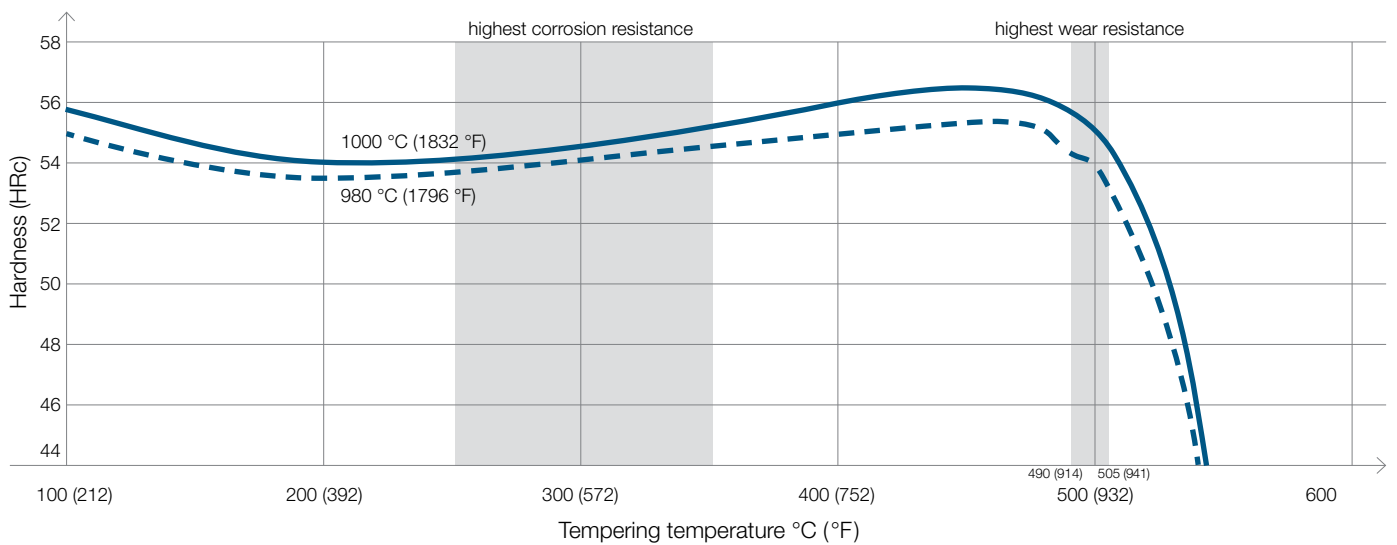
TEMPERING

- » 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 3 times.
- » We recommend for optimal combination of good corrosion and highest wear-resistance and toughness a tempering temperature between 505 – 520 °C (941 – 968 °F). In this case the corrosion-resistance will be suitable for most plastic mould applications.
- » We recommend to use, for highest hardness, a tempering temperature between 490 – 505 °C (914 – 941 °F), whereas a subzero-cooling directly after hardening is recommended.
- » For highest corrosion-resistance optional a tempering at approx. 300 °C (572 °F) is possible. If additional highest requirements for dimensional stability are necessary, an additional subzero-treatment is recommended.
- » Obtainable hardness: 50 – 55 HRc

Tempering chart (no subzero treatment)



Tempering chart (with subzero treatment)



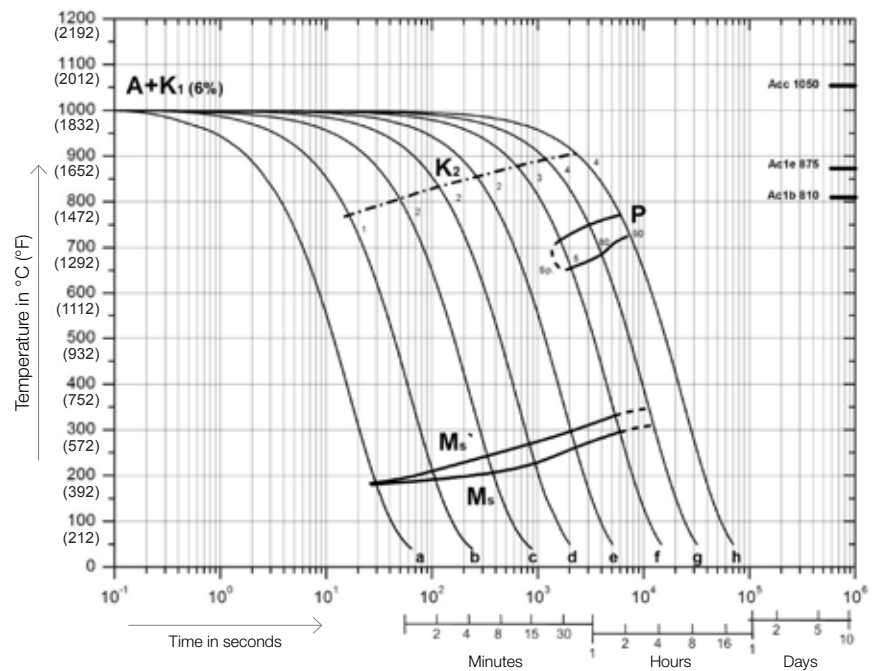


HEAT TREATMENT RECOMMENDATIONS

Continuous cooling CCT curves

Austenitizing temperature: 1000 °C (1830 °F)
 Holding time: 15 minutes
 7 ... 60 phase percentages
 0.08 ... 110 cooling parameter,
 i.e. duration of cooling from
 800 – 500° C (1470 – 930 °F)
 in $s \times 10^{-2}$

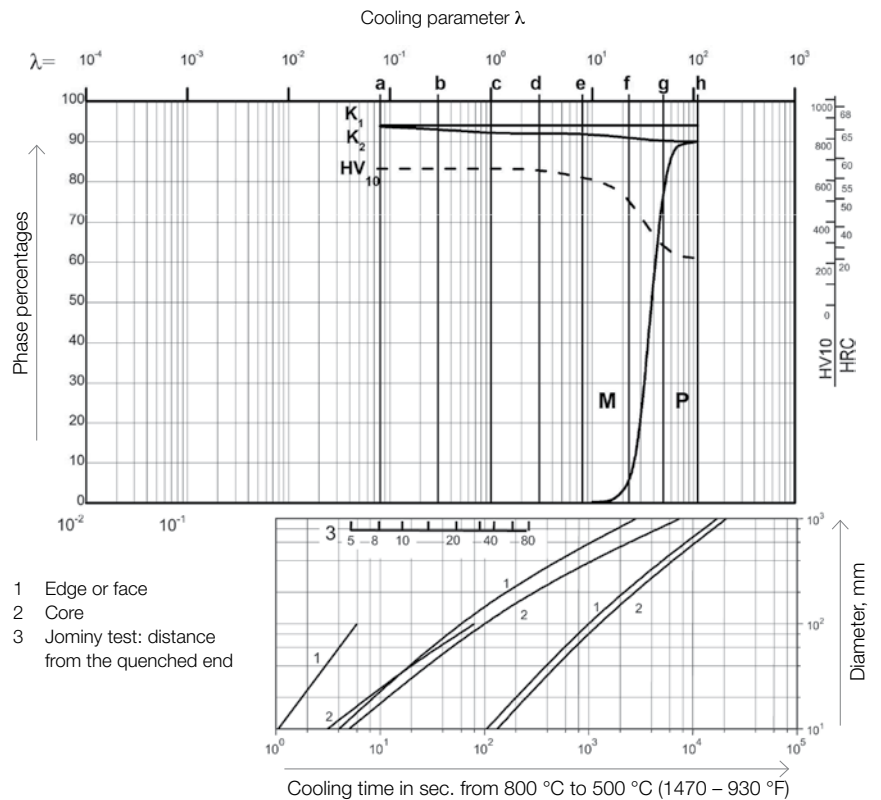
Sample	λ	HV10
a	0.08	660
b	0.30	660
c	1.10	660
d	3.00	660
e	8.00	620
f	23.00	570
g	50.00	235
h	110.00	215





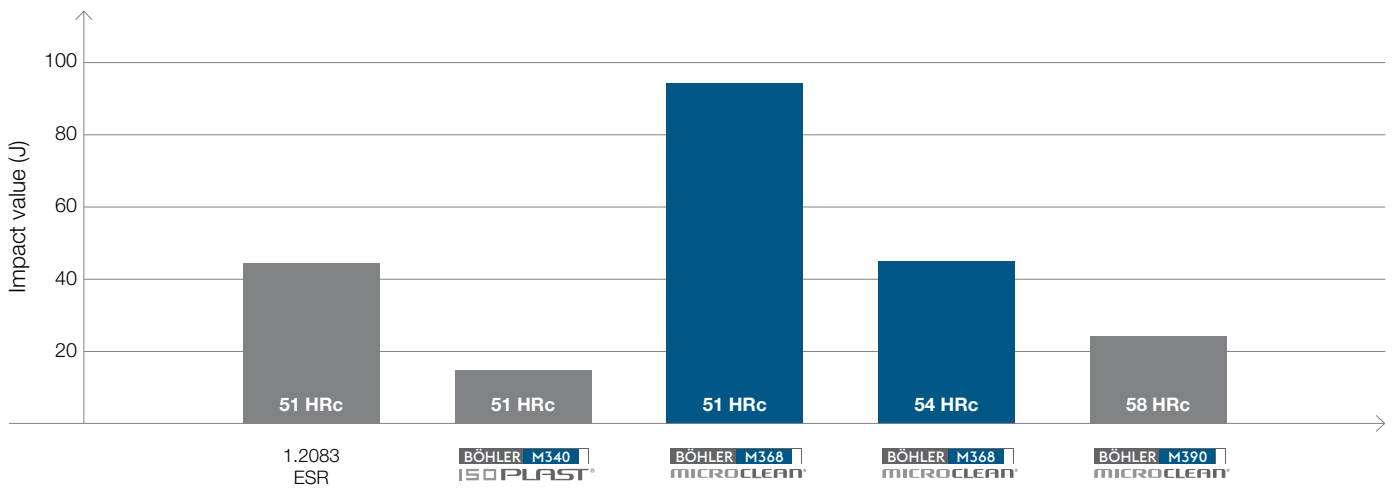
Quantitative phase diagram

- K1 carbides which are not dissolved during austenitization (6%)
- K2 start of carbide precipitation during quenching from austenitizing temperature
- Ms-Ms' range of grain boundary martensite
- A Austenite
- M Martensite
- P Perlite



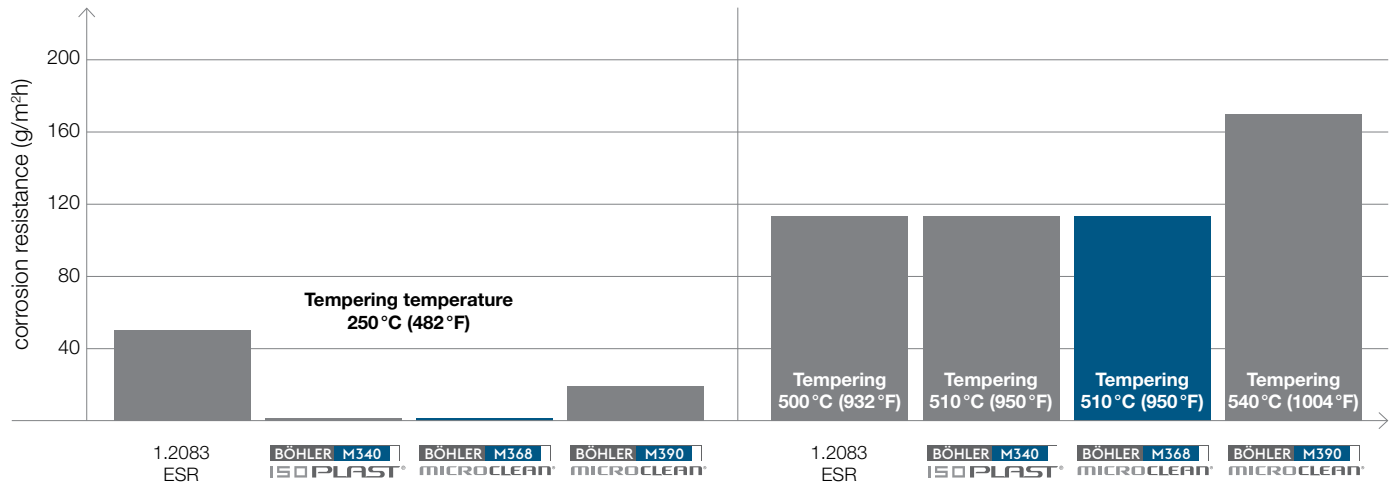
EXCEPTIONAL PROPERTIES

Toughness



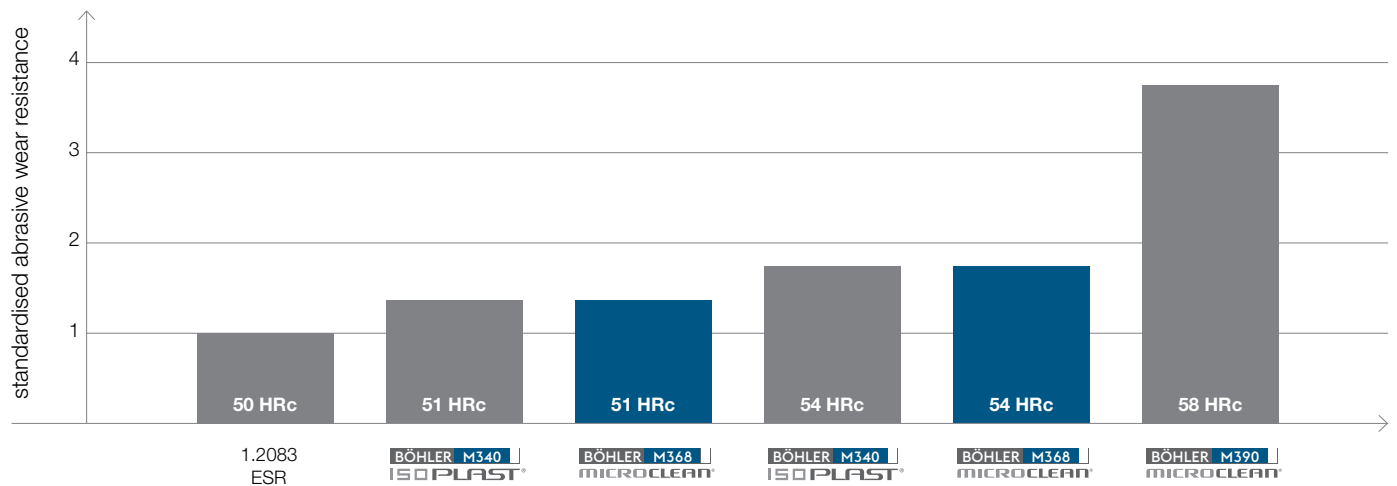
Samples from motherblock 403 x 303 mm, high tempered
Sample size: 10 x 7 x 55 mm (unnotched)

Corrosion resistance (weight loss – test according DIN 50905-2)



For highest corrosion resistance use lower tempering temperatures.
 Heat treatment: without subzero-cooling
 Weight loss test: measured after 24 h with 20 % boiling acetic acid

Wear resistance



Samples from motherblock 403 x 303 mm, high tempered
 Small-plate-wear-test
 Plastic: Polyamide 66 (PA66), Glass fibre content: 50 wt.%,
 Temperature: 300 °C (570 °F)

Sample size: 12 x 15 mm



NUMBERS, FACTS AND DATA

Physical properties

Density at	20 °C	7.70 kg/dm ³
	68 °F	0.278 lbs/in ³
Specific heat capacity at	20 °C	460 J/(kg.K)
	68 °F	0.110 Btu/lb °F

Magnetic properties existing



Thermal conductivity

20 °C	100 °C	200 °C	300 °C	400 °C	500 °C	
22.30	22.80	23.80	24.30	25.0	25.60	W/(m.K)
68 °F	210 °F	390 °F	570 °F	750 °F	930 °F	
12.92	13.17	13.75	14.08	14.50	14.83	Btu/(ft h °F)

Thermal expansion between 20 °C (68 °F) and ... °C (°F)

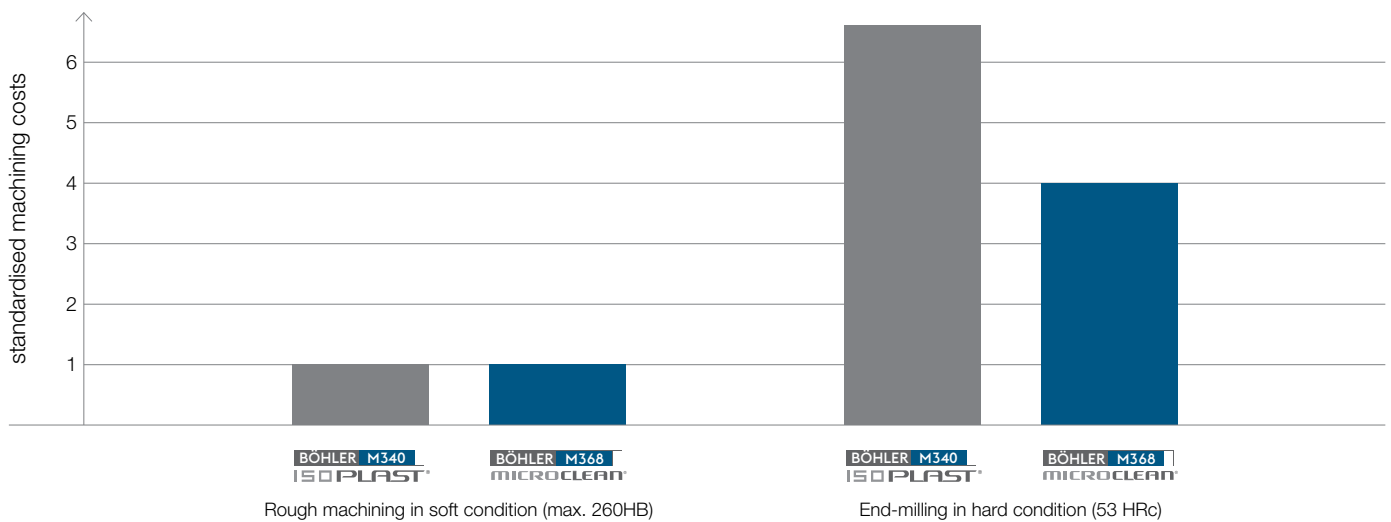
100 °C	200 °C	300 °C	400 °C	500 °C	
10.30	10.82	11.20	11.56	11.87	10 ⁻⁶ m/(m.K)
210 °F	390 °F	570 °F	750 °F	930 °F	
5.72	6.01	6.22	6.42	6.59	10 ⁻⁶ in/(in °F)

Modulus of elasticity

20 °C	100 °C	200 °C	300 °C	400 °C	500 °C	
219	215	209	201	193	183	10 ³ N/mm ²
68 °F	210 °F	390 °F	570 °F	750 °F	930 °F	
31.80	31.20	30.30	29.10	28.00	26.50	10 ³ KSI

YOUR COST ADVANTAGE DURING MACHINING

Cost comparison



Tested under real conditions in the machining laboratory, company: PROFACTOR.

Used tools:

Rough machining: Torus cutter V101-05 Depo; $v_c = 180 - 220$ m/min., 1000 cm³

End-milling: CC-ball cutter V201-05 Emuge; $v_c = 1000$ m/min., 1000 cm²

MACHINING RECOMMENDATIONS

Condition: annealed, figures given are guidelines only

Turning with sintered carbide

Depth of cut (inches)	0.5–1 (.02 – .04)	1–4 (.04 – .16)	4–8 (.16 – .31)
Feed (inches/rev.)	0.1–0.2 (.004 – .008)	0.2–0.4 (.008 – .016)	0.3–0.6 (.012 – .024)
BÖHLERIT grade	SB10, SB20, EB10	SB20, EB10, EB20	SB30, EB20, HB10
ISO grade	P10, P20, M10	P20, M10, M20	P30, M20, K10
Cutting speed v_c (m/min) (f.p.m)			
Indexable inserts Tool life: 15 min.	260–200 (850 – 655)	200–150 (655 – 490)	150–110 (490 – 360)
Brazed tools Tool life: 30 min.	210–170 (690 – 560)	170–130 (560 – 425)	140–90 (460 – 295)
Coated indexable inserts BÖHLERIT LC 225 C BÖHLERIT LC 235 C	bis 260 (850) bis 230 (750)	bis 220 (720) bis 180 (590)	bis 150 (490) bis 130 (425)
Rake angle	12°–15°	12°–15°	12°–15°
Clearance angle	6°–8°	6°–8°	6°–8°
Inclination angle	0°	0°	-4°

Turning with high speed steel

Depth of cut (inches)	0.5 (.02)	3 (.12)	6 (.24)
Feed (inches/rev.)	0.1 (.004)	0.5 (.02)	1.0 (.04)
HSS-grade BÖHLERIT/DIN	S700 / DIN S10-4-3-10		
Cutting speed v_c (m/min) (f.p.m)			
Tool life: 60 min.	55–45 (180 – 150)	45–35 (150 – 115)	35–25 (115 – 80)
Rake angle	14°–18°	14°–18°	14°–18°
Clearance angle	8°–10°	8°–10°	8°–10°
Inclination angle	0°	0°	0°

Milling with inserted tooth cutter

Feed (inches/tooth)	up to 0.2 (.008)	0.2 – 0.3 (.008 – .012)
Cutting speed v_c (m/min) (f.p.m)		
BÖHLERIT LW 225	220–200 (720 – 655)	140–60 (460 – 195)
BÖHLERIT SB40 / ISO P40	100–60 (330 – 195)	70–40 (230 – 130)
BÖHLERIT LC 444 W	140–110 (460 – 360)	–

Drilling with sintered carbide

Drill diameter (inches)	3–8 (.12 – .31)	8–20 (.31 – .80)	20–40 (.80 – 1.6)
Feed (inches/rev.)	0.02–0.05 (.001 – .002)	0.05–0.12 (.002 – .005)	0.12–0.18 (.005 – .007)
BÖHLERIT/ISO grade	HB10 / K10		
Cutting speed v_c (m/min) (f.p.m)			
Point angle	115°–120°	115°–120°	115°–120°
Clearance angle	5°	5°	5°

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. Measurement data are laboratory values and can deviate from practical analyses. The manufacture of our products does not involve the use of substances detrimental to health or to the ozone layer.

MATERIALS | MOLD BASES | PVD COATINGS | ADDITIVE

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