



PLASTIC
MOULD STEEL



POWDER
METALLURGY

PLASTIC MOULD STEEL

塑膠模具鋼

BÖHLER M368

為您帶來的效益

YOUR BENEFIT



百樂鋼 M368 MICROCLEAN 是一種使用粉末冶金技術生產之麻田散鐵含鉻不銹鋼。其合金設計使該鋼種得以提供高耐磨耗性、高韌性與高耐腐蝕性- 是可以最有效適用於各式應用之完美組合。

- » 高耐磨耗性
- » 高韌性
- » 高耐腐蝕性
- » 優異之研磨性
- » 良好之拋光性
- » 高尺寸穩定性

使您能夠:

- » 製作大型模具
- » 擁有較長且穩定之模具壽命
- » 重複生產過程
- » 生產高精度之零件

帶來之助益:

- » 提升生產效率
- » 降低單位成本

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:

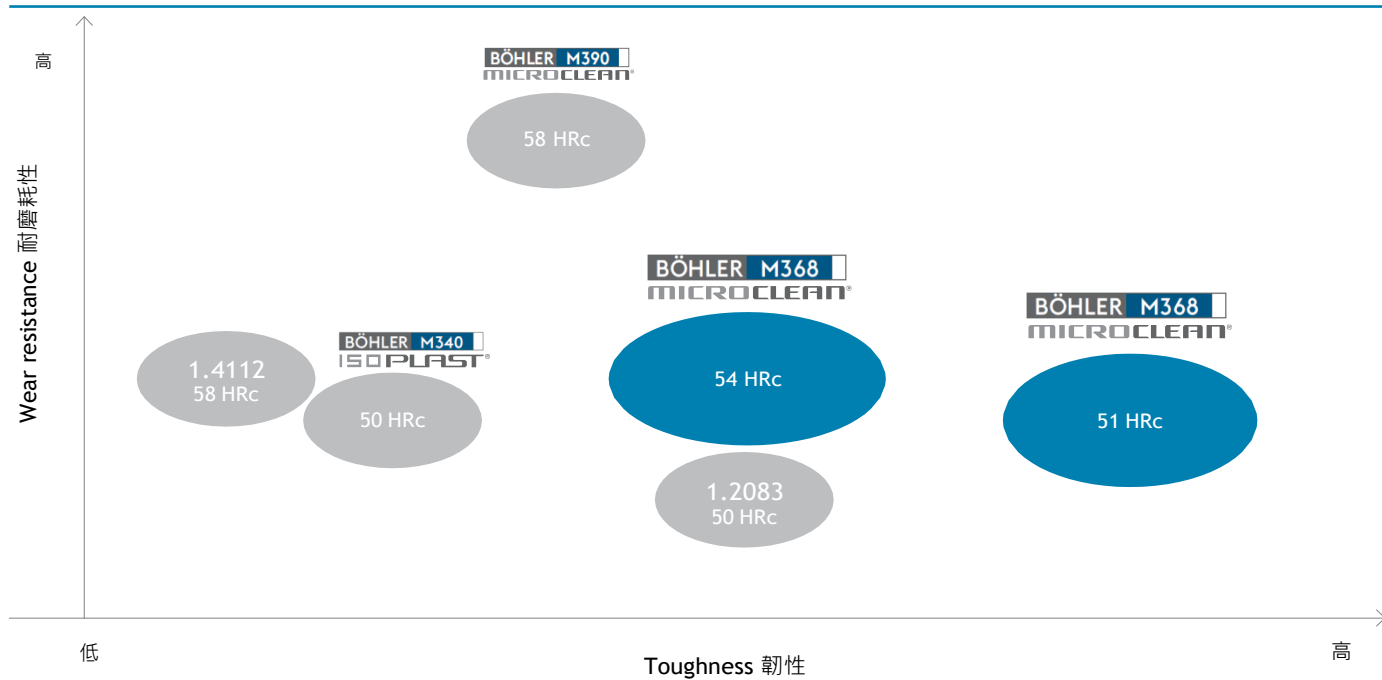
- » Production of big tools
- » Long and constant tool life
- » Reproducibility of production processes
- » High precision components

Benefit:

- » Increased productivity
- » Reduced unit costs



Product positioning 產品特性定位表



Chemical composition (average %) 合金成分

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

patented 專利鋼種



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

可使用之 最高品質

可應用於:

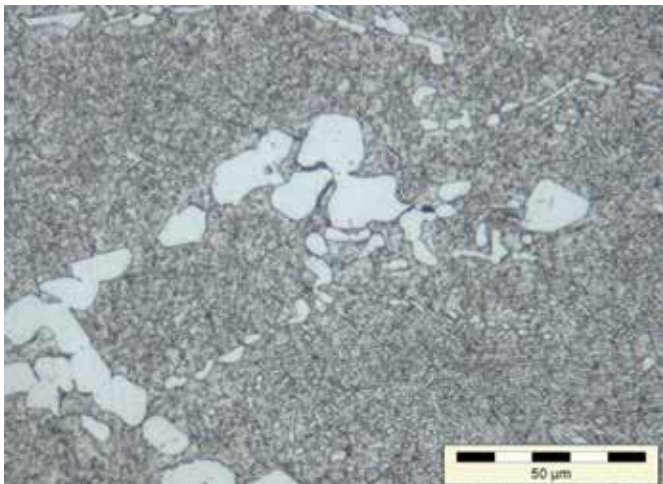
- » 模具鑲件
- » 用於處理含高磨耗性纖維(如玻璃纖維)之高腐蝕性塑膠料之模具
- » 食品加工業所使用之模具或刀具
- » 電子產業之模具
- » 塑膠射出機所用之螺桿
- » 塑膠射出機所用之襯套

IMPRESSIVE HOMOGENEITY

令人讚嘆之 均質性

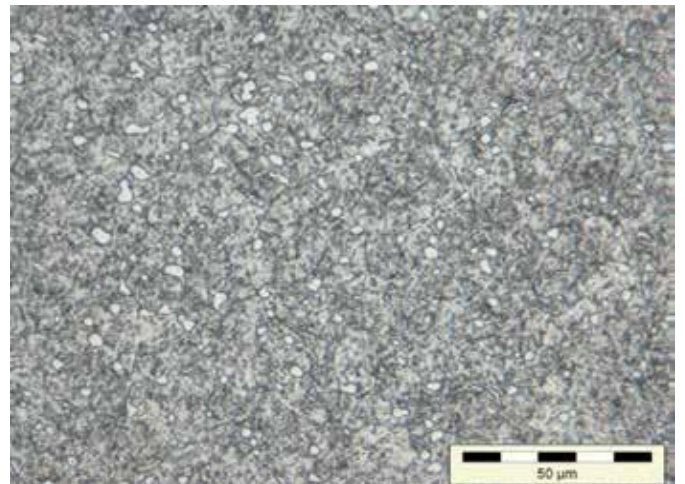
Due to powder metallurgical production of BÖHLER M368 MICROCLEAN a segregation-free microstructure with significantly improved homogeneity in comparison to conventional and ESR-produced standard products like e.g. 1.4112 could be achieved.

由於採用了百樂先進之粉末冶金製程，BÖHLER M368 MICROCLEAN之微觀組織並無偏析，和ESR電渣重熔製程之標準產品(如1.4112)相比，均質性有顯著地提升。



Microstructure 1.4112

1.4112 之微觀組織



Microstructure BÖHLER M368 MICROCLEAN

BÖHLER M368 MICROCLEAN 之微觀組織

熱處理

鋼廠供貨狀態

軟退火狀態 · 最高至280HB

應力消除

- » 650 至 700 °C
- » 透熱後 · 在中性氣體中持溫 1 至 2 小時
- » 緩慢地在爐中冷卻

淬火

- » 980 至 1000 °C, N₂
- » 內外溫度一致後 · 持溫 15 - 30 分鐘
- » 若模具尺寸較大 · 建議使用 980 °C 之較低淬火溫度和 505 to 520 °C 之較高回火溫度

回火

- » 淬火後立即緩慢加熱至回火溫度
- » 爐中持溫時間計算方法: 每20mm厚度加一小時 · 但至少需回火兩小時
- » 於空氣中冷卻
- » 建議回火三次
- » 為了獲得良好抗腐蝕性、最高抗磨耗性和韌性之平衡 · 建議回火溫度在 505 - 520 °C 之間。此條件下所獲得之抗腐蝕性將能適用於多數塑膠模具應用。
- » 若是為了獲得最高的硬度 · 建議回火溫度在 490 - 505 °C 之間 · 也可在淬火後立即進行深冷處理。
- » 若是為了獲得最高的耐蝕性 · 可以使用之回火溫度約為 300 °C · 如果另外也有最高尺寸穩定性之需求 · 則建議進行額外的深冷處理。
- » 可達到之硬度: 50 - 55 HRc

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

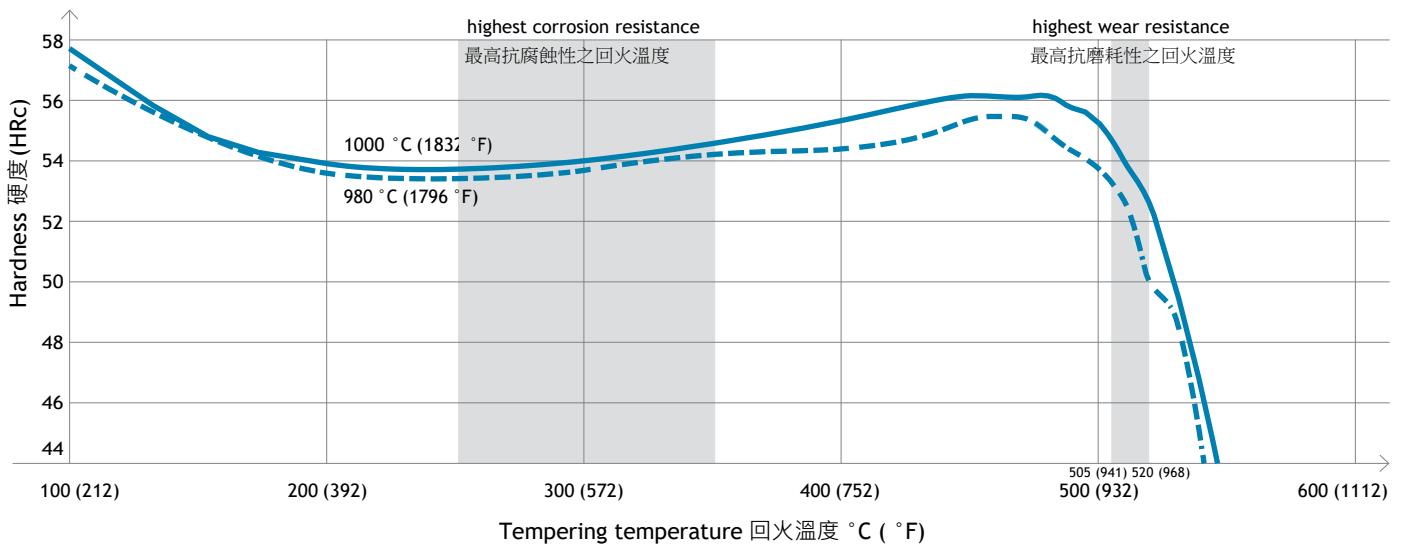
HARDENING

- » 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]).

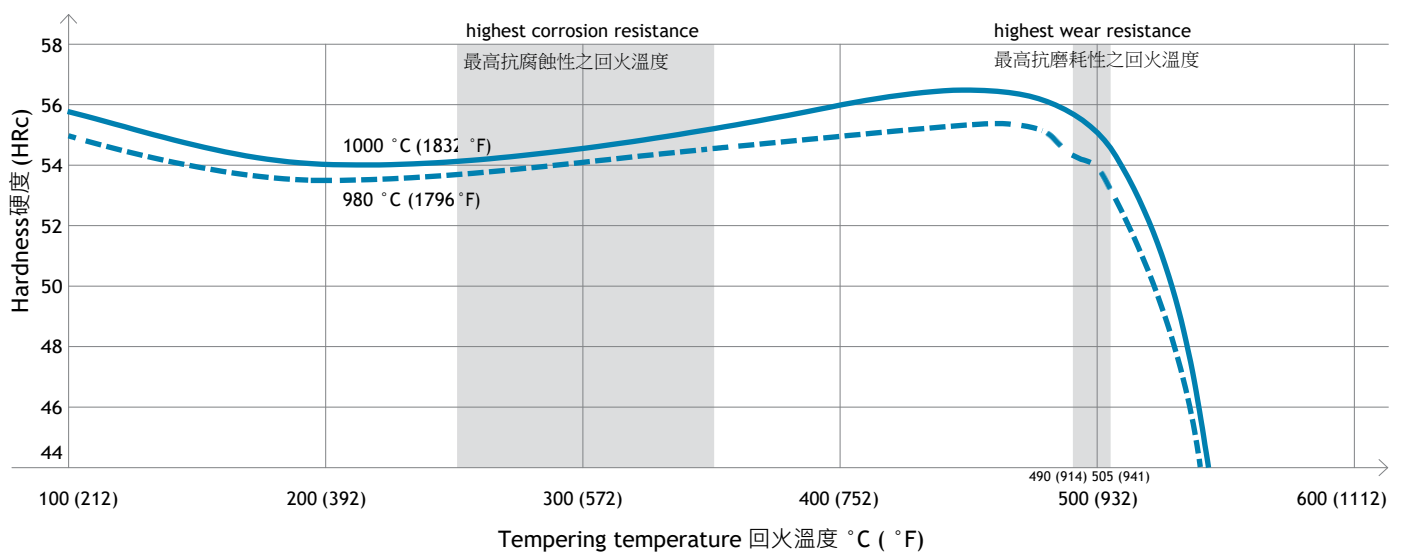
TEMPERING

- » 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) 回火曲線圖 (未做深冷處理)



Tempering chart (with subzero treatment) 回火曲線圖 (做過深冷處理)





熱處理建議

HEAT TREATMENT RECOMMENDATIONS

Continuous cooling CCT curves 持續冷卻CCT曲線圖

Austenitizing temperature: 1000 °C (1830 °F)

Holding time: 15 minutes

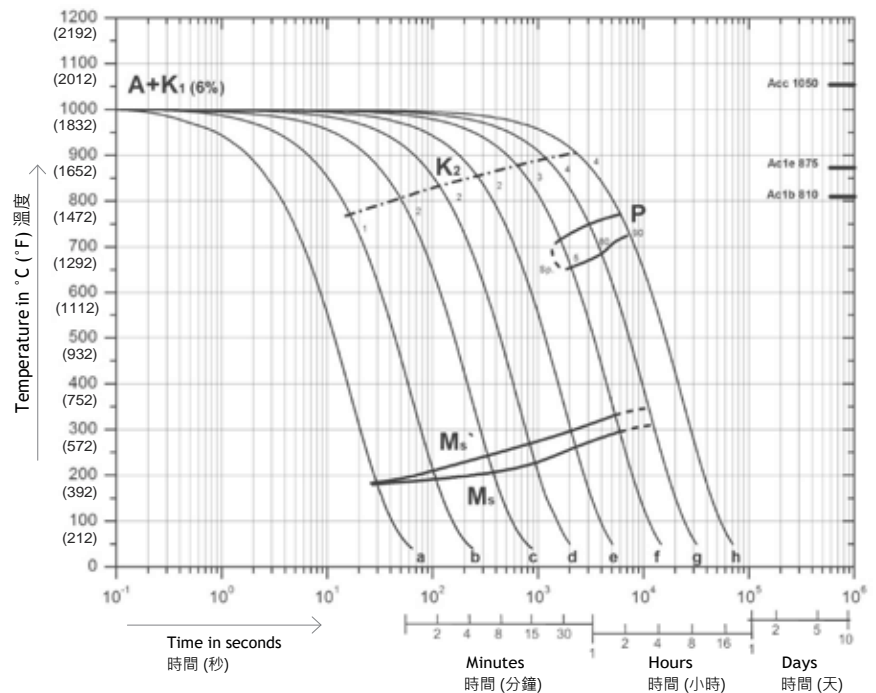
沃斯田鐵化溫度: 1000 °C

持溫時間: 15 分鐘

7 ... 60 phase percentages
相百分比

0.08 ... 110 cooling parameter,
i.e. duration of cooling from
800 - 500° C (1470 - 930 °F)
in $s \times 10^{-2}$
冷卻參數，例如800-500°C
之冷卻時間，以 $s \times 10^{-2}$ 為單位

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

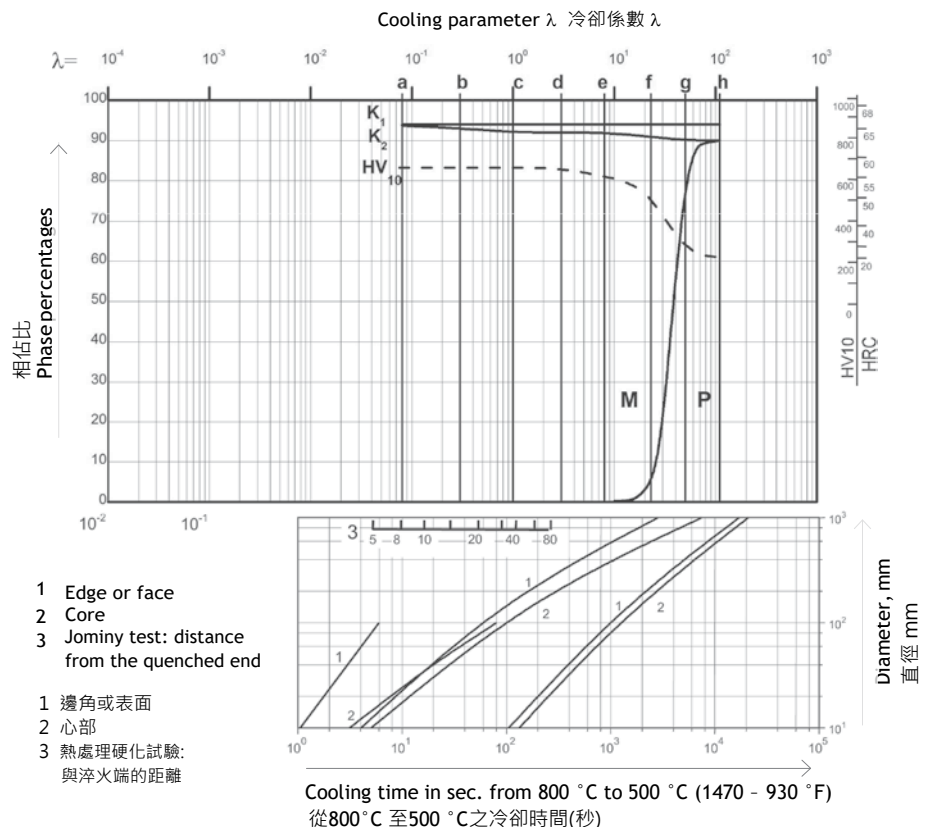




Quantitative phase diagram 定量相圖

- 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 Pearlite

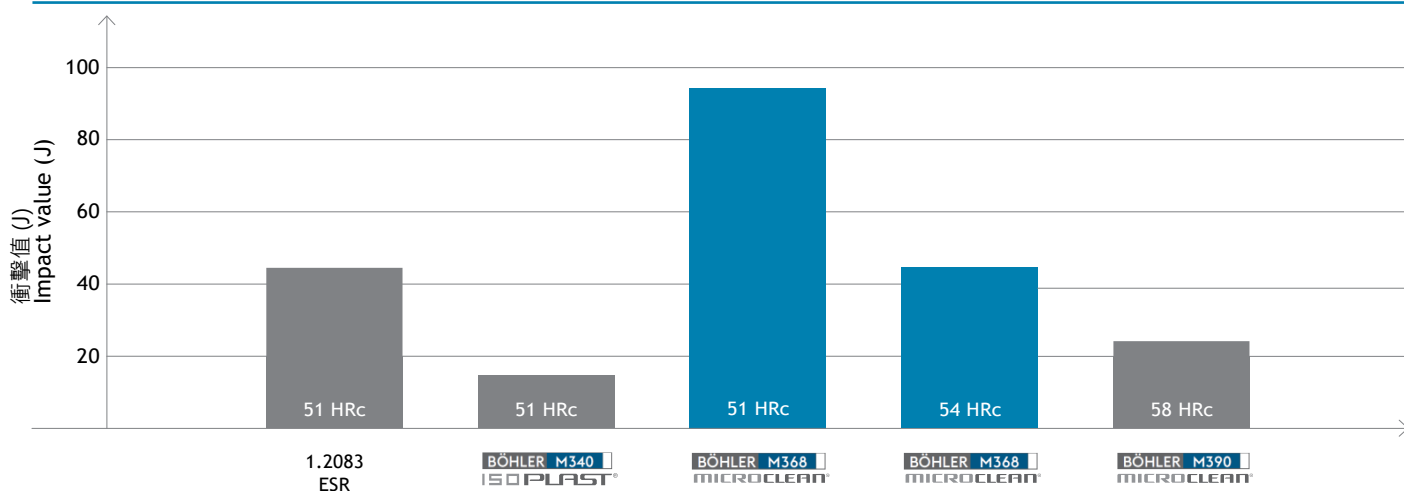
- K1 沃斯田鐵化過程中未溶解的碳化物 (6%)
- K2 碳化物開始從沃斯田鐵化溫度淬火中析出
- Ms-Ms' 麻田散鐵晶界範圍
- A 沃斯田鐵
- M 麻田散鐵
- P 波來鐵



卓越的性能

EXCEPTIONAL PROPERTIES

Toughness 韌性



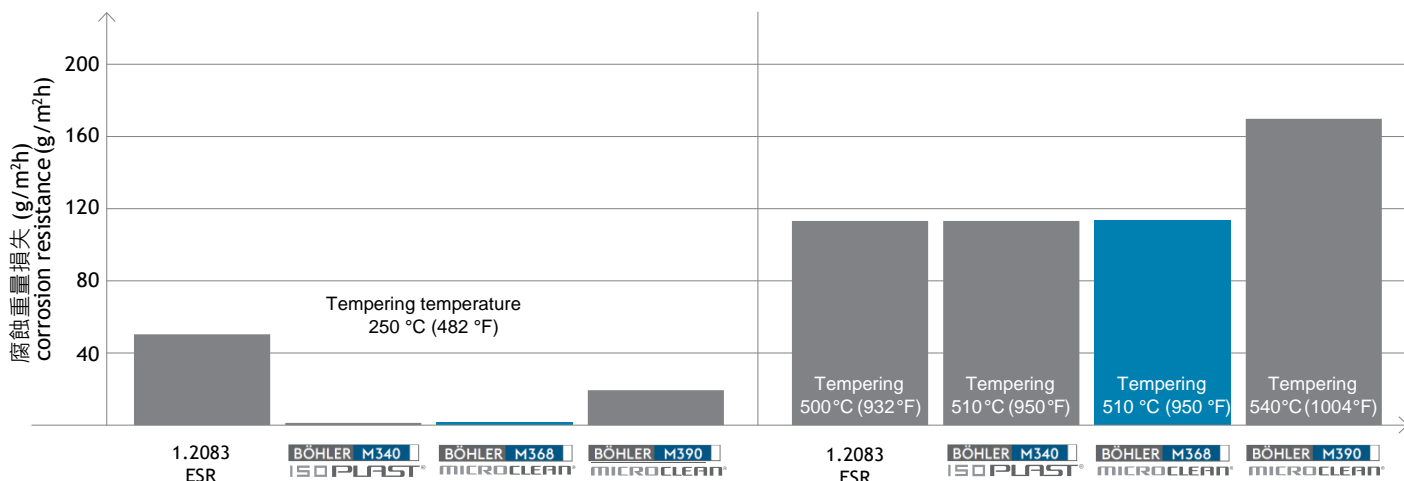
Samples from motherblock 403 x 303 mm, high tempered

Sample size: 10 x 7 x 55 mm (unnotched)

樣品取自 403 x 303 mm 之母塊 · 高溫回火

樣品大小: 10 x 7 x 55 mm (無缺口)

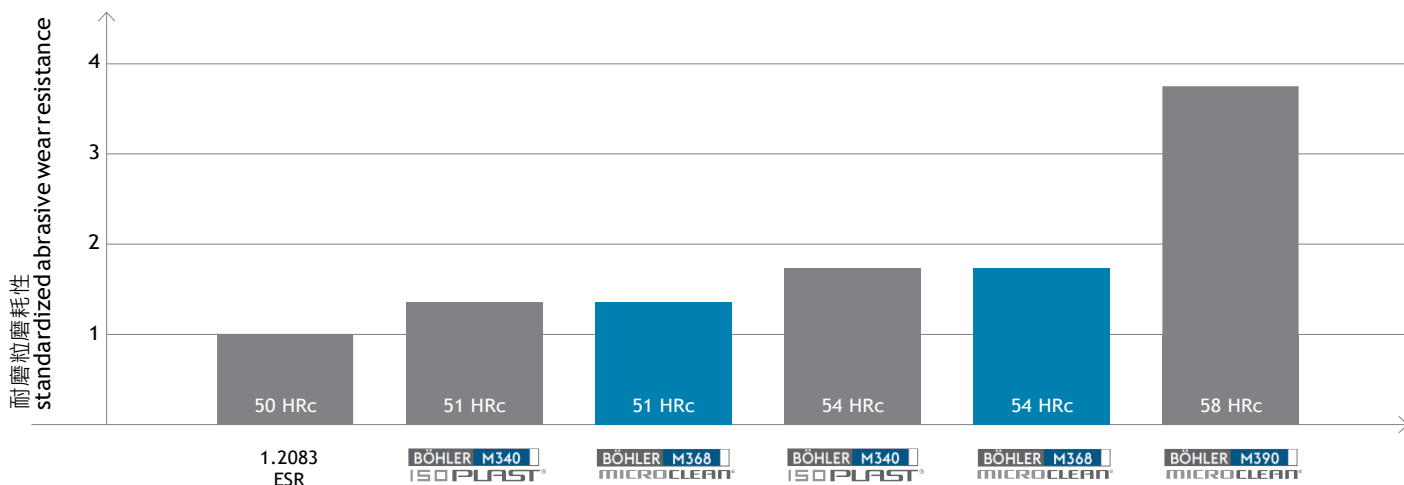
Corrosion resistance (weight loss - test according DIN 50905-2) 抗腐蝕性 (腐蝕重量損失測試 - 遵照 DIN 50905-2)



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

若追求最佳抗腐蝕性，建議使用低溫回火
熱處理：不含深冷製程
重量損失測試：回火處理後，採用沸騰20%醋酸溶液浸泡24小時。

Wear resistance 耐磨耗性



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

母塊403 x 303mm的樣品 · 高溫回火小樣本磨損試驗
塑膠：聚酰胺66 (PA66) · 玻璃纖維含量：50 wt% ·
溫度：300°C (570°F)

樣品尺寸：12 x 15mm



數據與事實

NUMBERS, FACTS AND DATA

Physical properties 物理特性

Density at 密度	20 °C 68 °F	7.70 kg/dm ³ 0.278 lbs/i ³
Specific heat capacity at 比熱容度	20 °C 68 °F	460 J/(kg.K) 0.110 Btu/lb °F
Magnetic properties existing	有磁化可能	



Thermal conductivity 熱傳導係數

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)

20°C與各目標溫度間之熱膨脹係數

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)

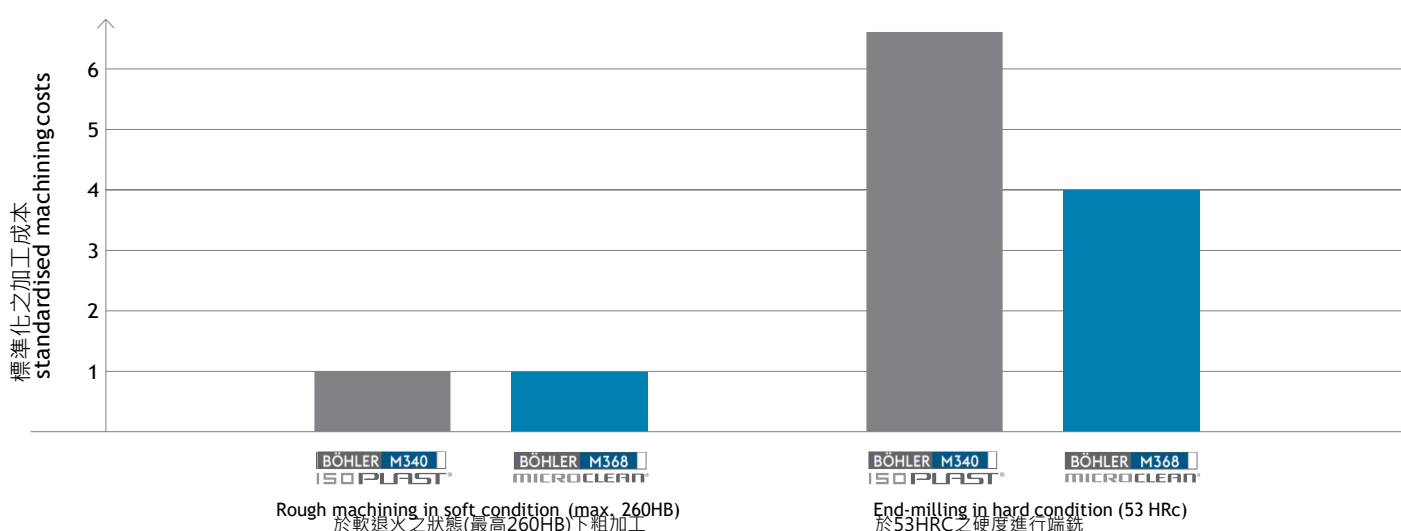
Modulus of elasticity 彈性係數

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

為您節省 加工成本

YOUR COST ADVANTAGE DURING MACHINING

Cost comparison 成本比較



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

Used tools:

Rough machining: Torus cutter V101-05 Depo; vc = 180 - 220 m/min., 1000 cm³
End-milling: CC-ball cutter V201-05 Emuge; vc = 1000 m/min., 1000 cm²

本數據於加工實驗室以真實加工條件測試 · company: PROFACITOR

使用加工工具:

粗加工: Torus cutter V101-05 Depo; vc = 180 - 220 m/min., 1000 cm³
端銑: CC-ball cutter V201-05 Emuge; vc = 1000 m/min., 1000 cm²

MACHINING RECOMMENDATIONS 加工建議

Condition: annealed, figures given are guidelines only

Turning with sintered carbide 碳化鎢切削

Depth of cut (inches) 切削深度 mm	0.5 - 1 (.02 - .04)	1 - 4 (.04 - .16)	4 - 8 (.16 - .31)
Feed (inches/rev.) 進給速度 mm/轉速	0.1 - 0.2 (.004 - .008)	0.2 - 0.4 (.008 - .016)	0.3 - 0.6 (.012 - .024)
BÖHLERIT grade BÖHLERIT 牌號	SB10, SB20, EB10	SB20, EB10, EB20	SB30, EB20, HB10
ISO grade ISO 牌號	P10, P20, M10	P20, M10, M20	P30, M20, K10
Cutting speed v_c (m/min) (f.p.m) 切削速度 v_c (公尺/分鐘)			
Indexable inserts 捨棄式刀片 Tool life: 15 min. 刀具壽命: 15分鐘	260 - 200 (850 - 655)	200 - 150 (655 - 490)	150 - 110 (490 - 360)
Brazed tools 硬鍍刀具 Tool life: 30min. 刀具壽命: 30分鐘	210 - 170 (690 - 560)	170 - 130 (560 - 425)	140 - 90 (460 - 295)
Coated indexable inserts 鍍膜捨棄式刀片			
BÖHLERIT LC 225 C	bis 260 (850)	bis 220 (720)	bis 150 (490)
BÖHLERIT LC 235 C	bis 230 (750)	bis 180 (590)	bis 130 (425)
Rake angle 法前角	12° - 15°	12° - 15°	12° - 15°
Clearance angle 法後角	6° - 8°	6° - 8°	6° - 8°
Inclination angle 斜角	0°	0°	-4°

Turning with high speed steel 高速鋼切削

Depth of cut (inches) 切削深度 mm	0.5 (.02)	3 (.12)	6 (.24)
Feed (inches/rev.) 進給速度 mm/轉速	0.1 (.004)	0.5 (.02)	1.0 (.04)
HSS-grade BÖHLERIT/DIN 牌號	S700 / DIN S10-4-3-10		
Cutting speed v_c (m/min) (f.p.m) 切削速度 v_c (公尺/分鐘)			
Tool life: 60 min. 刀具壽命: 60分鐘	55 - 45 (180 - 150)	45 - 35 (150 - 115)	35 - 25 (115 - 80)
Rake angle 法前角	14° - 18°	14° - 18°	14° - 18°
Clearance angle 法後角	8° - 10°	8° - 10°	8° - 10°
Inclination angle 斜角	0°	0°	0°

Milling with inserted tooth cutter 碳化鎢插入式銑刀銑削

Feed (inches/tooth) 進給量mm/每齒	up to 0.2 (.008)	0.2 - 0.3 (.008 - .012)
Cutting speed v_c (m/min) (f.p.m) 切削速度 v_c (公尺/分鐘)		
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 碳化鎢鑽孔

Drill diameter (inches) 孔徑 mm	3 - 8 (.12 - .31)	8 - 20 (.31 - .80)	20 - 40 (.80 - 1.6)
Feed (inches/rev.) 進給量 mm/轉速	0.02-0.05 (.001 - .002)	0.05-0.12 (.002 - .005)	0.12-0.18 (.005 - .007)
BÖHLERIT/ISO grade 牌號	HB10 / K10		
Cutting speed v_c (m/min)(f.p.m) 加工速度 公尺/分鐘			
Point angle 尖角	115° - 120°	115° - 120°	115° - 120°
Clearance angle 法後角	5°	5°	5°

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ONE STEP AHEAD.