

信昌精密模具(上海)有限公司

高效能高質量
汽車塑膠模具鋼條件與應用



許憲斌 資歷：henry@wujii.com.tw)

- *1982-1984 瑞典Uddeholm鋼廠HAGFÖS培訓
- *1984-1996 Uddeholm/ASSAB 亞洲地區技術支持
- *1997-2000 ASSAB北京分公司 總經理
- *2001-NOW BÖHLER-梧濟公司行銷技術副總迄今
- *中原大學機械系業界科專講師
- *國立第一科大模具材料與熱處理教科書編輯委員

■ 新合金設計概念：

冶金工藝：清淨度

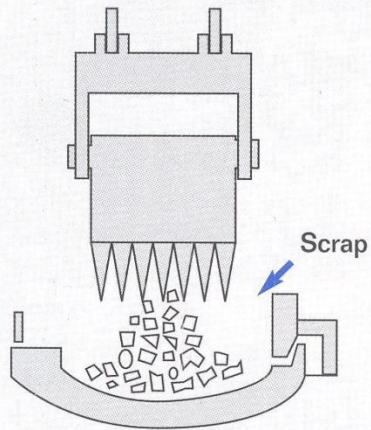
機械特性：硬度，熱傳導性

■ 德國Buderus模具材料的選用

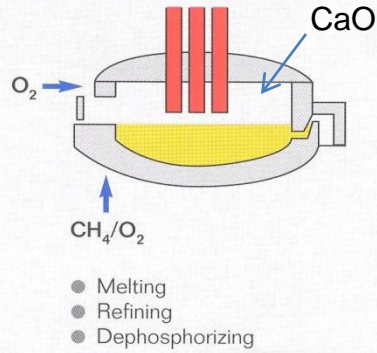
CNC，拋光，蝕刻，咬花，鋼材顯微組織

■ 歐洲汽車模具鋼案例

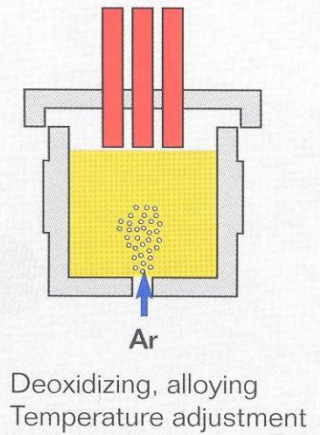
1. Loading the scrap



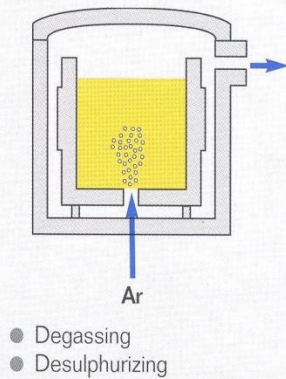
2. Electric arc furnace



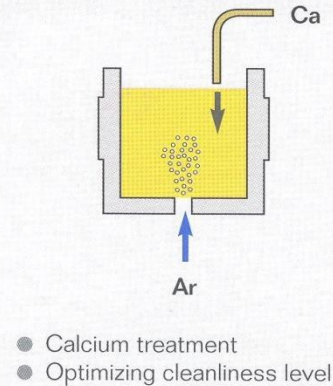
3. Ladle furnace



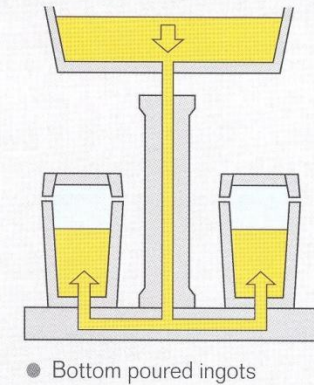
4. Vacuum treatment



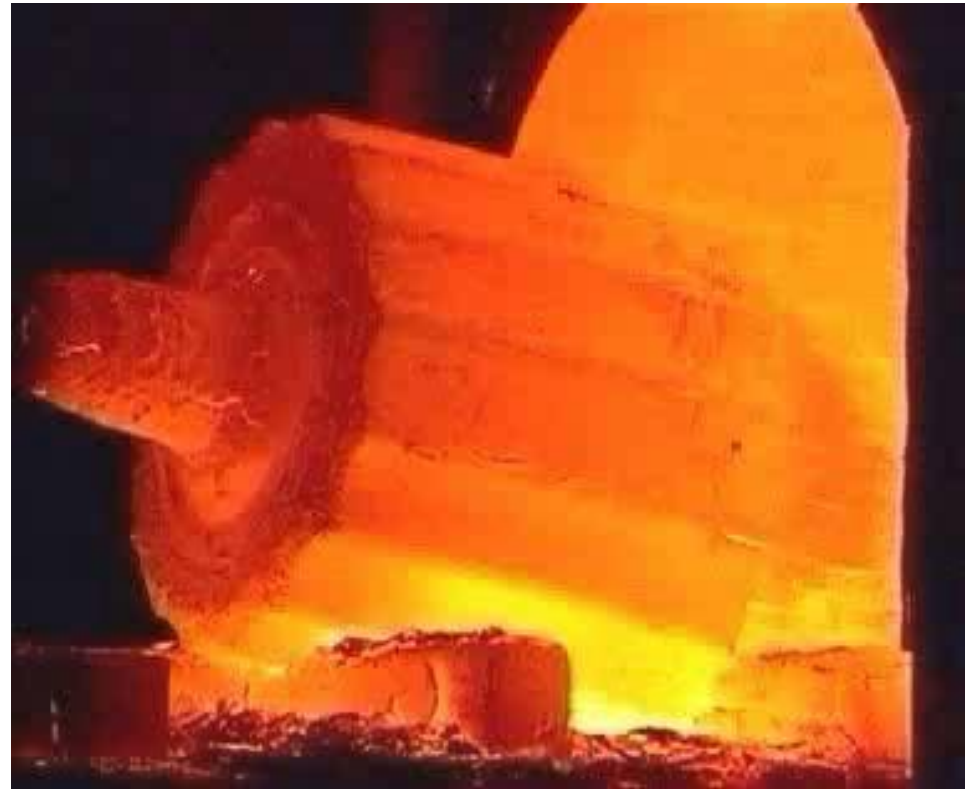
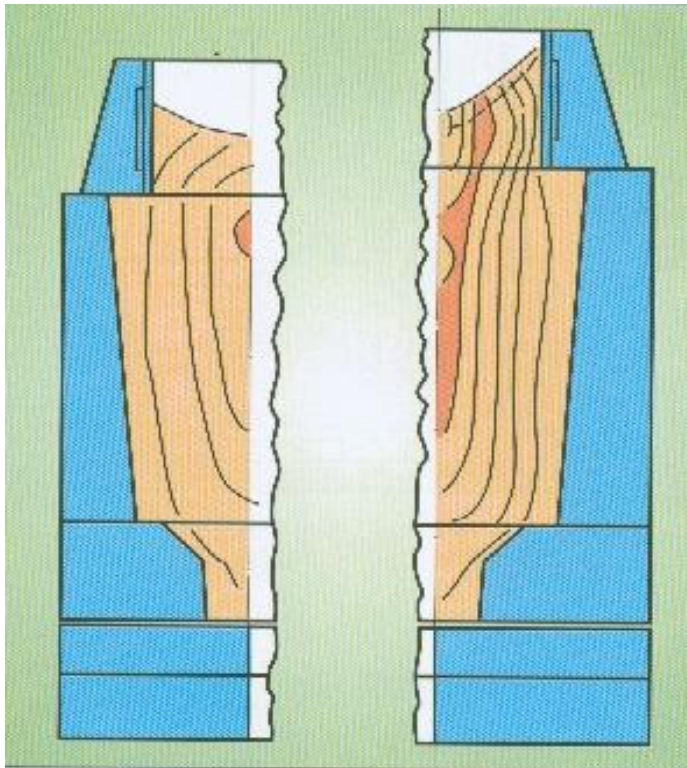
5. Calcium-argon treatment



6. Casting

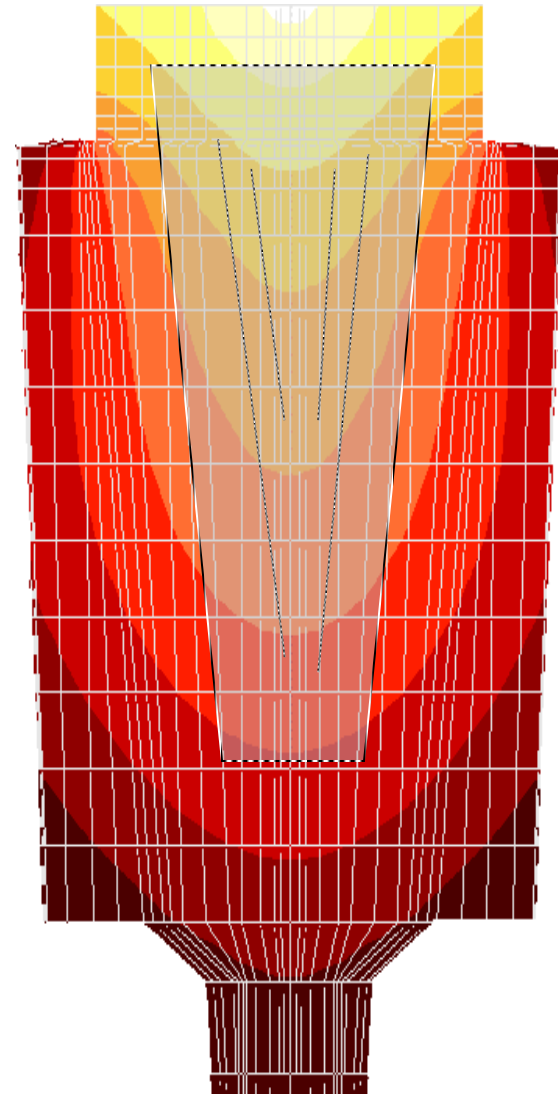
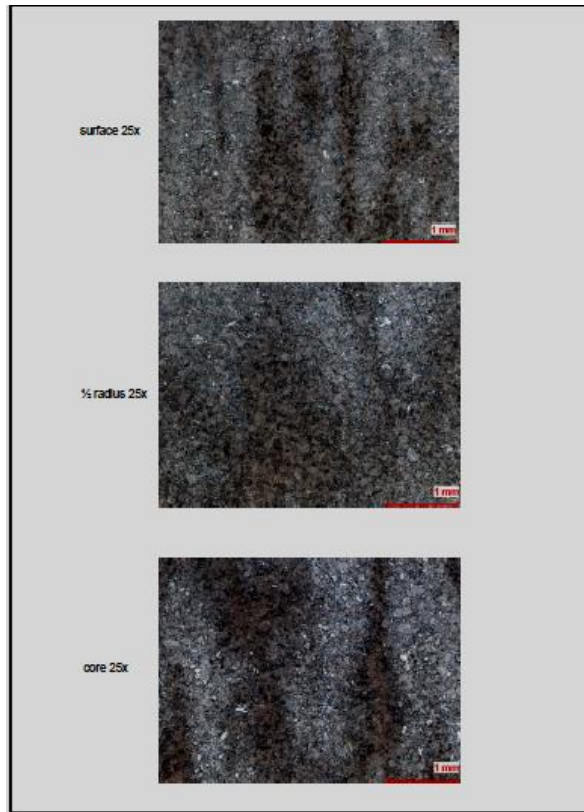


冶金工藝



冶金工藝

偏析(segregation), 合金碳(C)量愈高, 碳化物偏析愈嚴重



Buderus 模具鋼 鍛造工藝

鍛造工藝



8000T 鍛造機

鍛造工藝

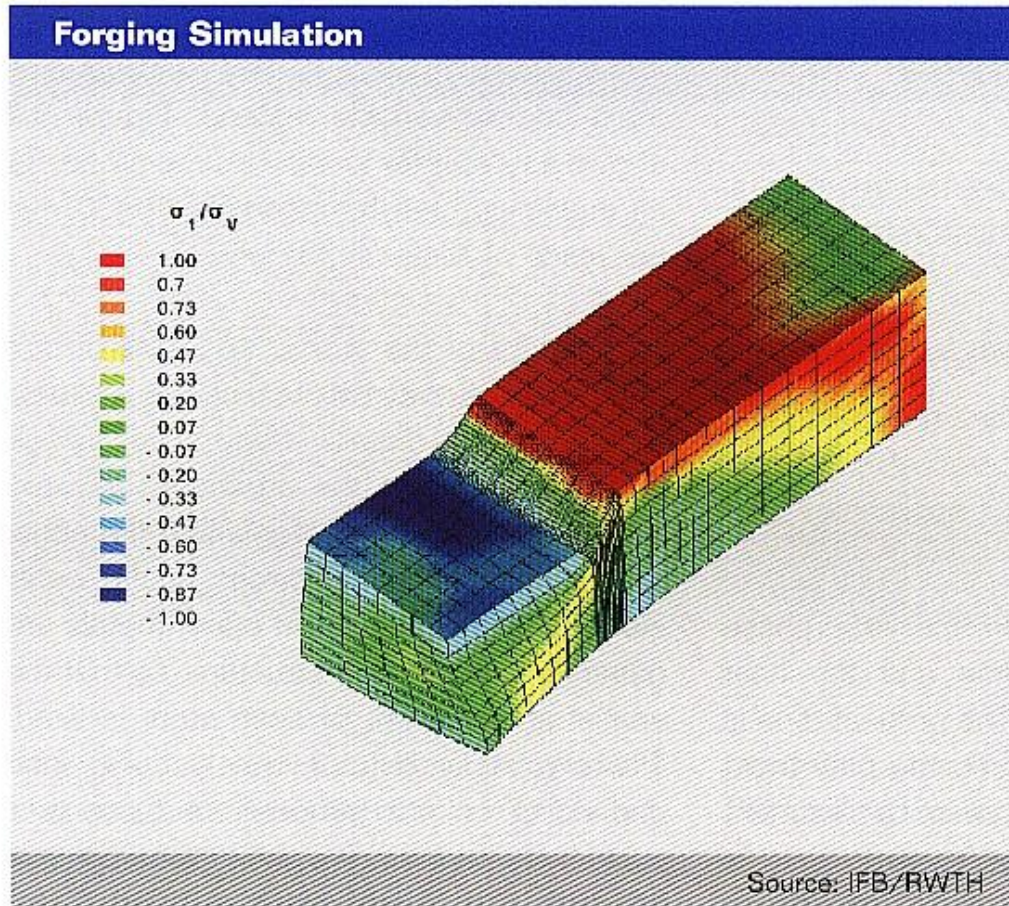
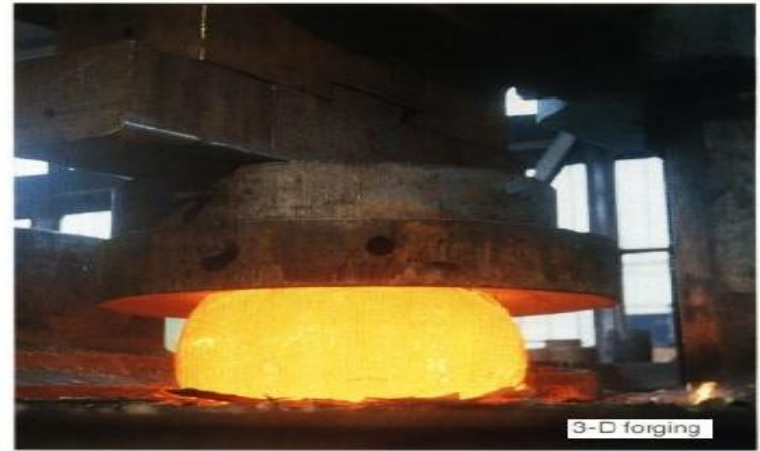


Figure 5.8: FEM simulation of forming an ingot to refine to the forging parameters

Source :Buderus Handbook of plastic Mould steels

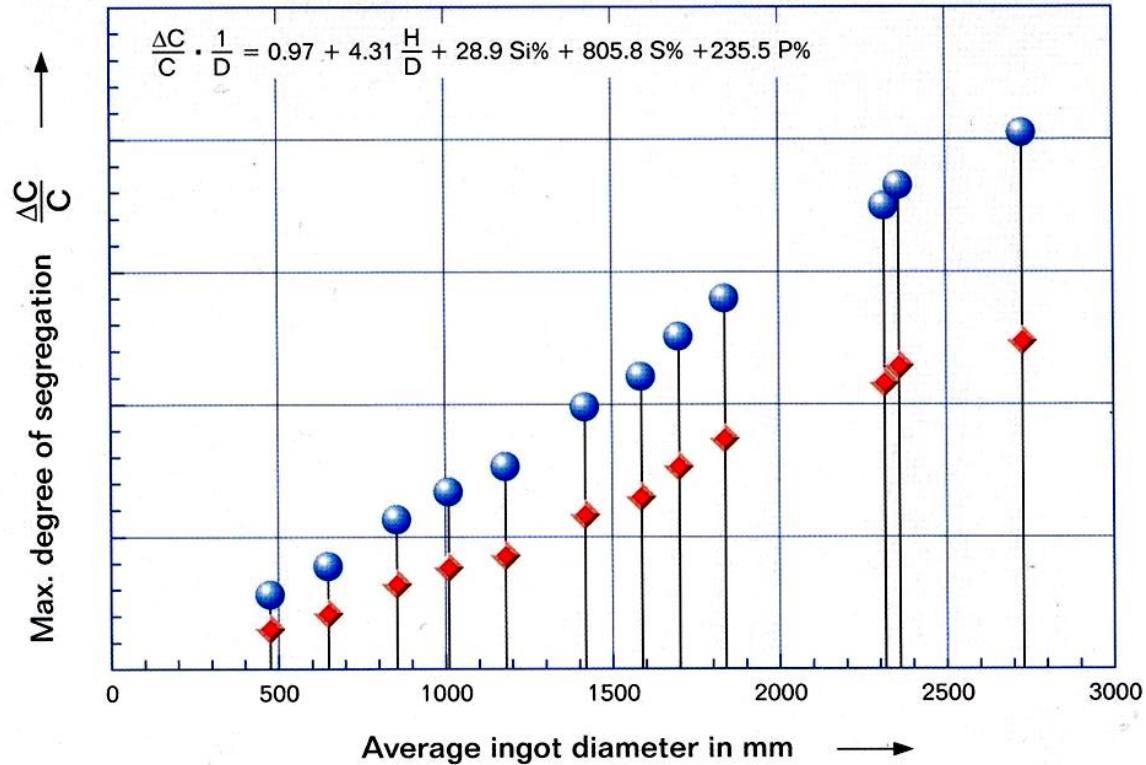
锻造工艺



模具鋼 清淨度

模具鋼偏析度與清淨度

Maximum carbon segregation



5t - 140t ingot weight ● Material 2311 / 2738 ◆ THRUHARD SUPREME®

模具鋼合金成分

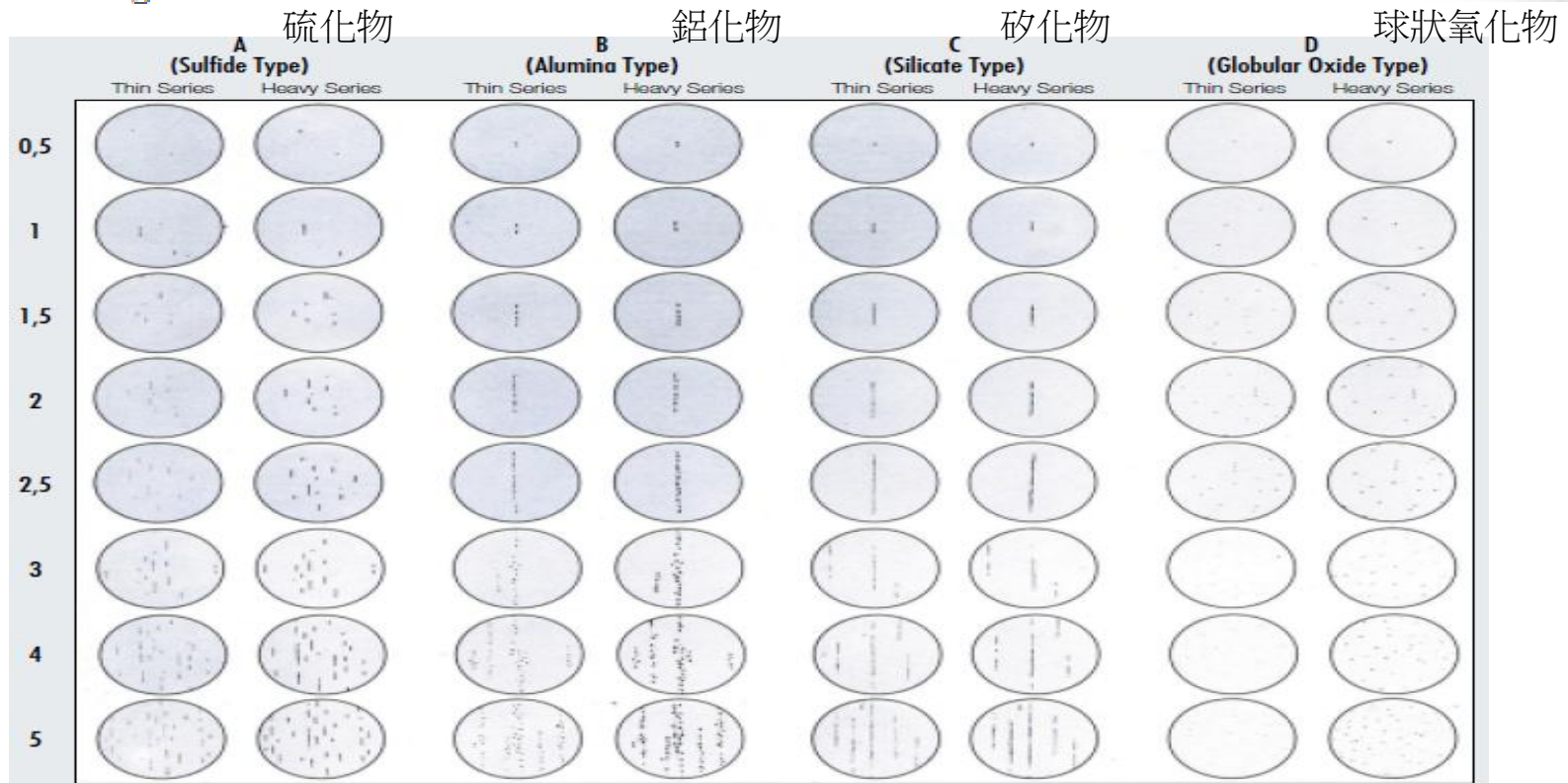
材質 DIN	C	Si	Mn	Cr	Mo	V	Ni	S	使用硬度 HRC
1.2311	0.38	0.3	1.5	2.0	0.2	-	-	≤0.003	28-31
1.2738	0.38	0.3	1.5	2.0	0.2	-	1.0	≤0.003	29-33
BPM-HH (2738mod_TS-HH)	0.26	0.10	1.45	1.25	0.60	0.12	1.05	≤0.003	34-38

Non-metallic inclusions impair the steel's toughness owing to their notch effect. The special melting measures employed for ISODISC, ISOBLOC and VMR allow non-metallic inclusions to be virtually eliminated. The unavoidable inclusions remaining in the steel are of extremely small size and uniform distribution, which improves the steel toughness.

Reinheitsgrad von **ISODISC**,
ISOBLOC und **VMR**
(Beurteilung nach ASTM E45, Plate I – r, „Mikroskopische Prüfung auf nichtmetallische Einschlüsse“)

Inclusion level of **ISODISC**,
ISOBLOC and **VMR**
(Evaluation to ASTM E45, Plate I – r, „Microscopic examination for non-metallic inclusions“)

Einschlusstyp / Type of inclusion	ISODISC	ISOBLOC	VMR
A dünn/dick, thin/heavy	max. 2/1,5	max. 1/-	max. 1/-
B dünn/dick, thin/heavy	max. 2,5/1,5	max. 1,5/-	max. 1/1
C dünn/dick, thin/heavy	max. 2/1,5	max. -/-	max. -/-
D dünn/dick, thin/heavy	max. 2/1,5	max. 1,5/1	max. 1/0,5



低硫(S)，清淨度，韌性

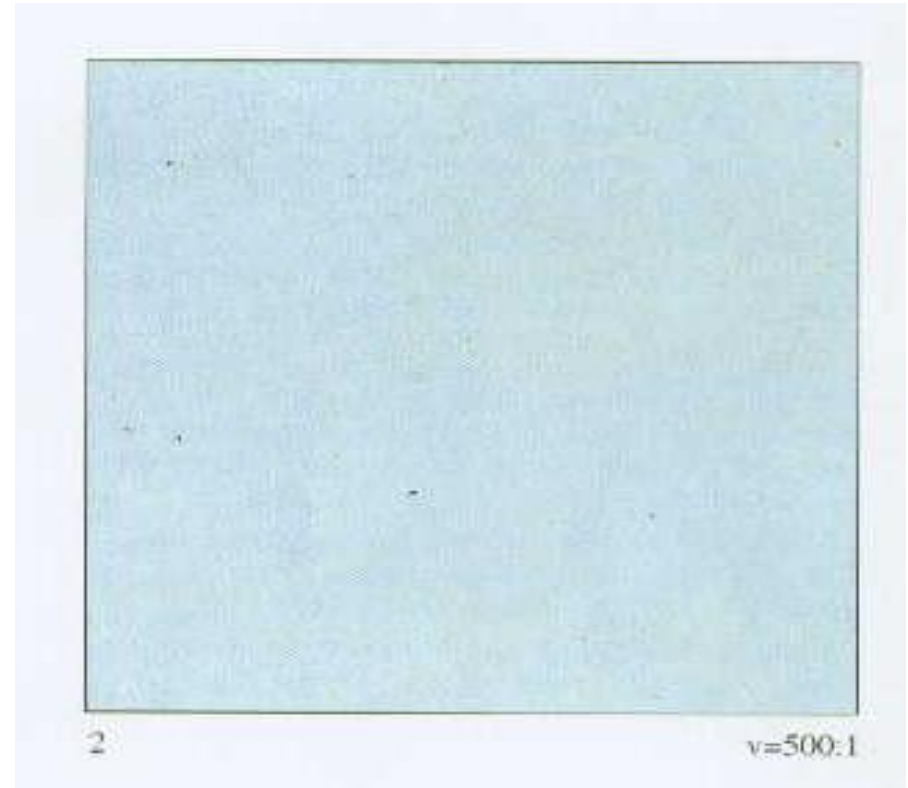
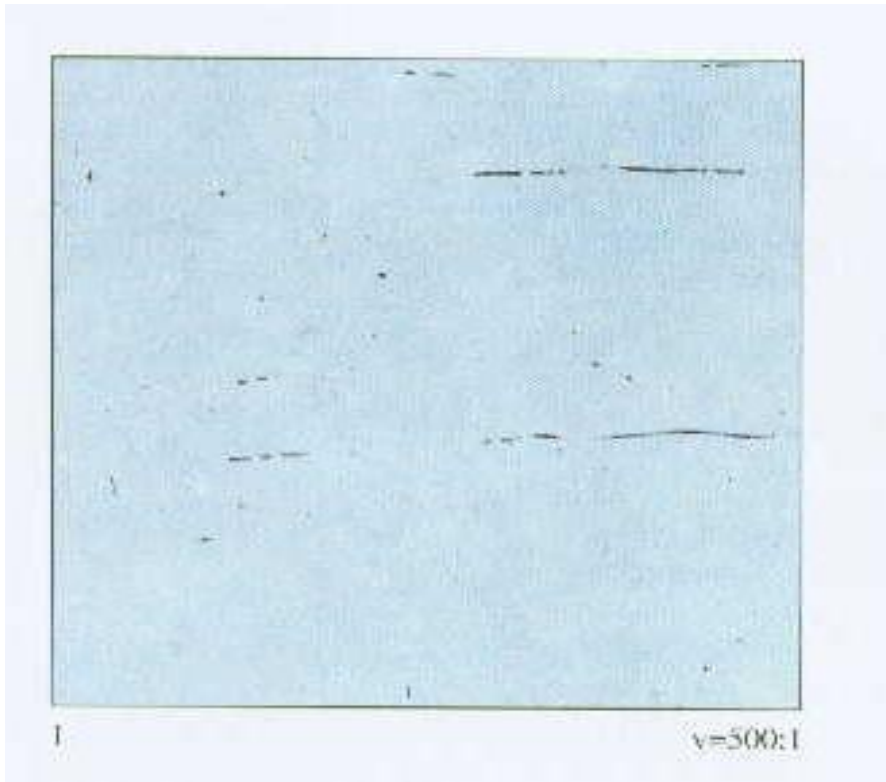
硫與鋼內的錳會結合成硫化錳 (MnS) 顆粒。軋延或鍛造時MnS顆粒沿著軋延方向被拉伸而變得細長，此物系咬花不均或材料強度有方向性之最主要『罪魁禍首』



低硫(S)，清淨度，熱傳導性

高硫S - MnS

低硫S



Source :Buderus Handbook of plastic Mould steels

模具鋼

皮紋，幾何咬花

Quality advantages of THRUHARD SUPREME®(HH) due to it's more homogeneous micro structure

- Uniform hardness distribution through to the core zone
- Improved toughness
- **High grain reliability**

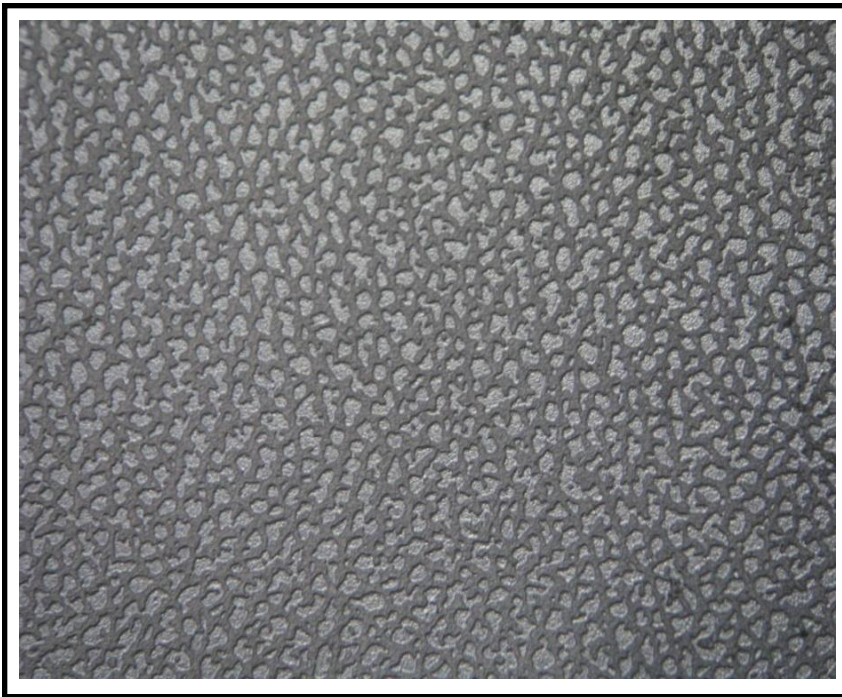
幾何咬花性佳
(多層次咬花)



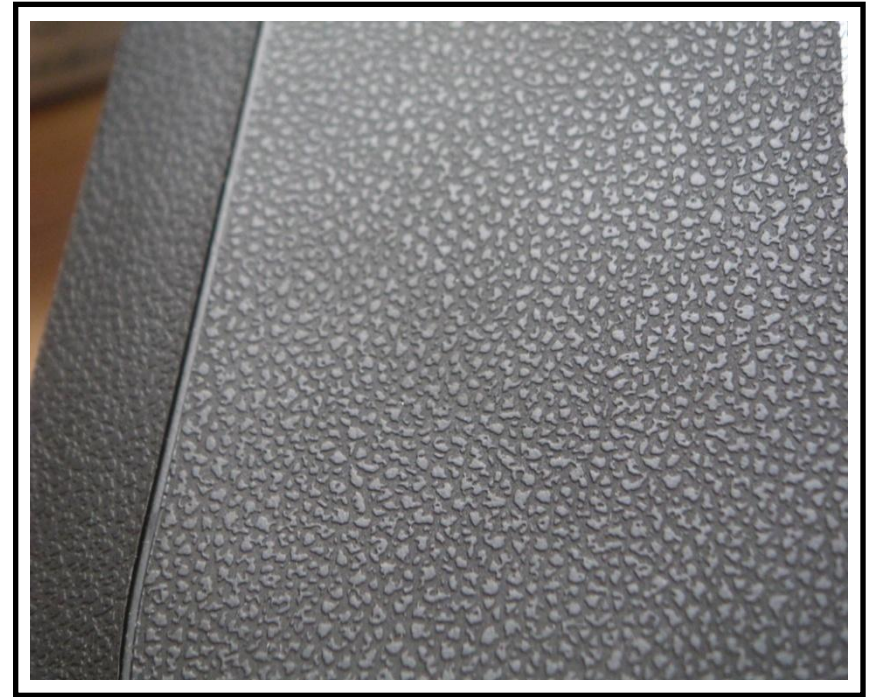
低硫(S)，高潔淨度，化學蝕刻咬花

Steel surface with etch graining pattern

Etch graining pattern on the plastic part



Grain root in steel glossy,
raised pattern matt



Depression in plastic part matt,
raised surfaces glossy

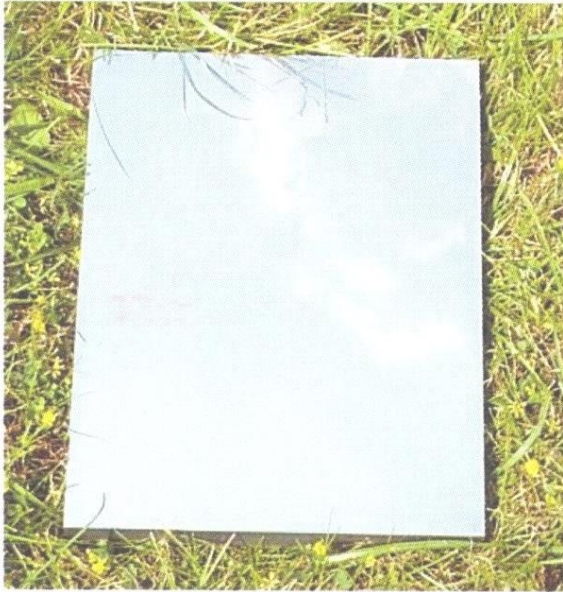
Source :Buderus Handbook of plastic Mould steels

- 近年來皮紋咬花要求開始偏向淺(20~30um)、細皮紋或幾何皮紋，對於淺並且細緻的皮紋要求，傳統2738已經無法滿足客戶要求，因鍛塊存在微偏析問題是無法避免的，而且越大的鍛塊可能存在的微偏析問題更為顯著，所以Buderus鋼廠開發新的鋼種BPM-HH，BPM-HHH新的合金設計理念是為改善偏析問題，提高產品外觀要求並且達到更高的壽命要求，是未來大型模具選用的主流。

模具鋼 拋光性

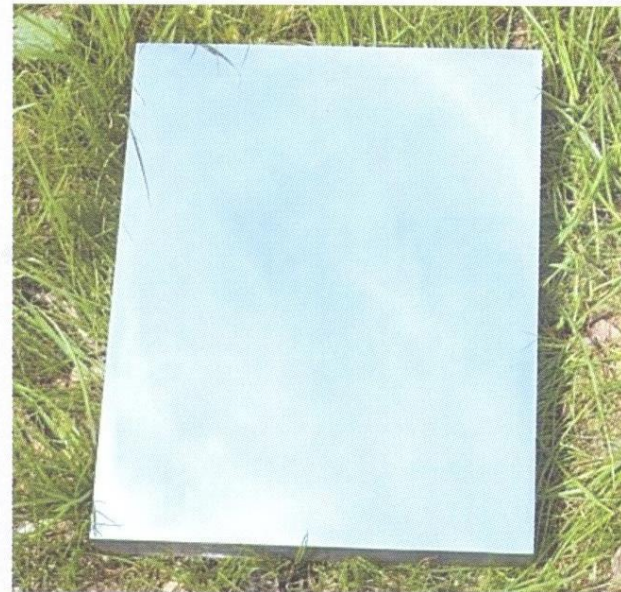
低硫(S)，低磷(P)，高清淨度，高拋光性

THRUHARD SUPREME®
appr. 1000 N/mm²



THRUHARD SUPREME® HighHard
appr. 1200 N/mm²

BPM-HH

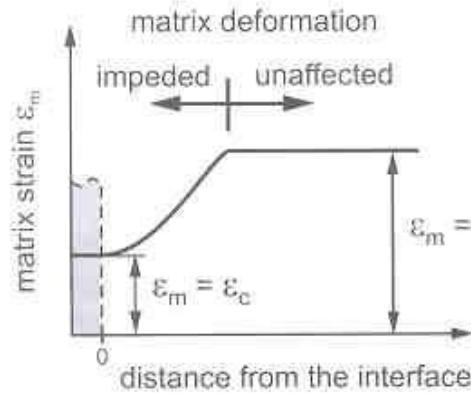
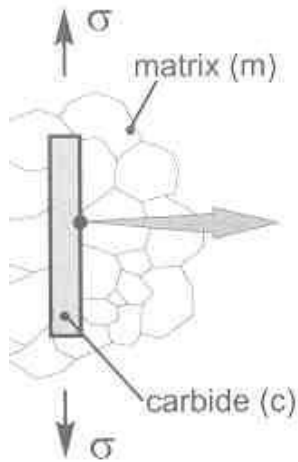


Hand polishing parameters:

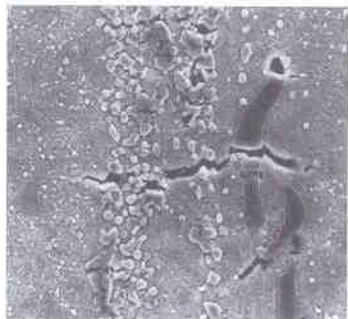
- Grinding with grades 320 / 400 / 600 / 1000,
- Rubbing with 1000 grade abrasive paper,
- High polish with 3 μ m diamond paste.

Figure 4.52: THRUHARD SUPREME® has excellent polish characteristics.

正確的拋光觀念

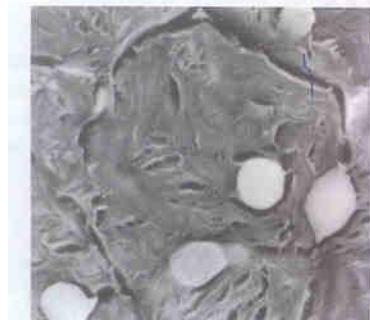


- 左圖為碳化物於基地中被牽引的行為，其中：
- matrix：微基地晶格
- Carbide：碳化物
- matrix deformation：微基地變形
- impeded：被擠壓
- unaffected：未擠壓



b)

5 μm

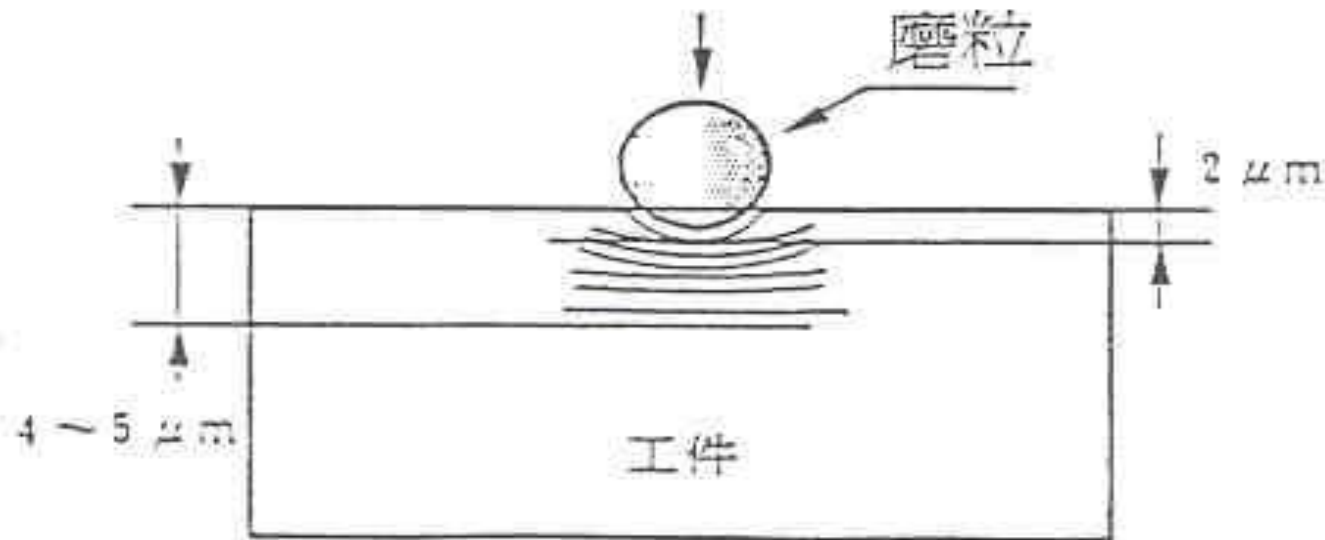


c)

1 μm

加工質變：

由於研磨或油石打磨不當而影響加工質變，深度 2μ ，影響區為 $3\sim 5\mu$ ，所以其延性質變區其為 $5\sim 7\mu$ ，即是金屬微組織產生延性質變。

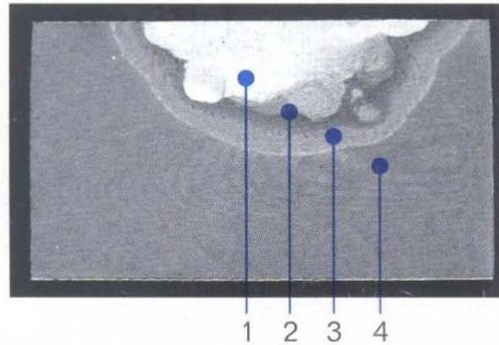


模具鋼

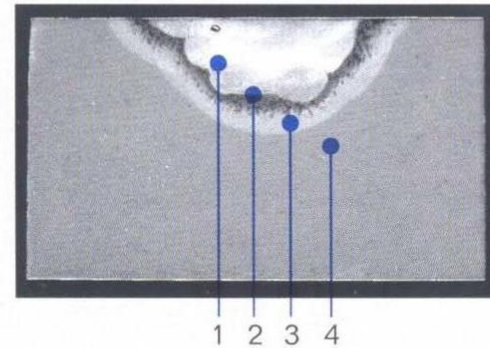
焊補性，火焰硬化性

Results of welding trials

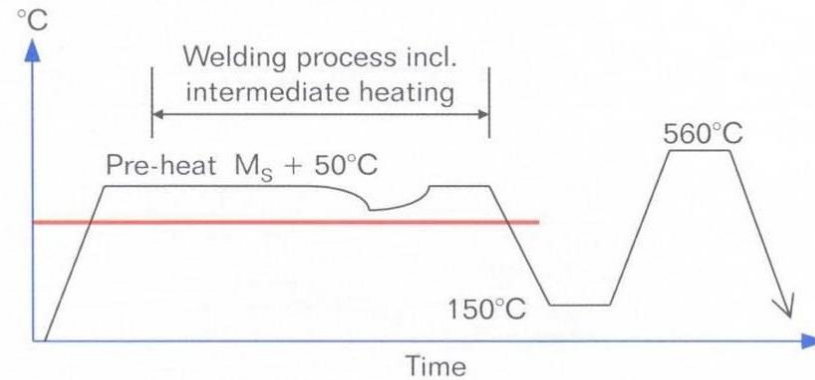
Welded without pre-heating



Hot welded



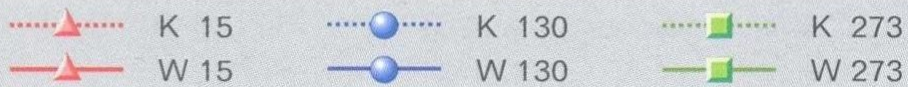
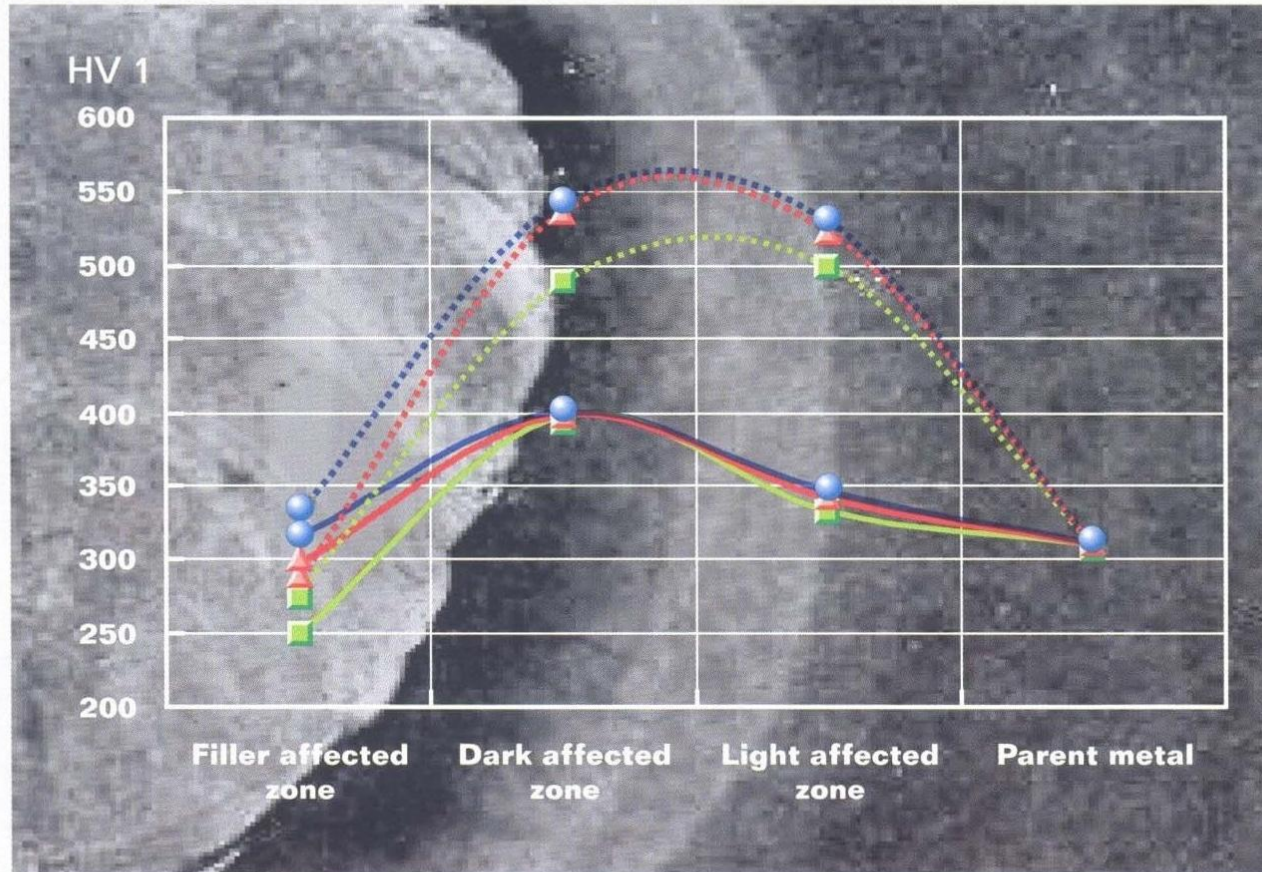
M_s = martensite starting temperature



- 1 Welding material
- 2 Re-hardening zone
- 3 Tempering zone
- 4 Parent metal

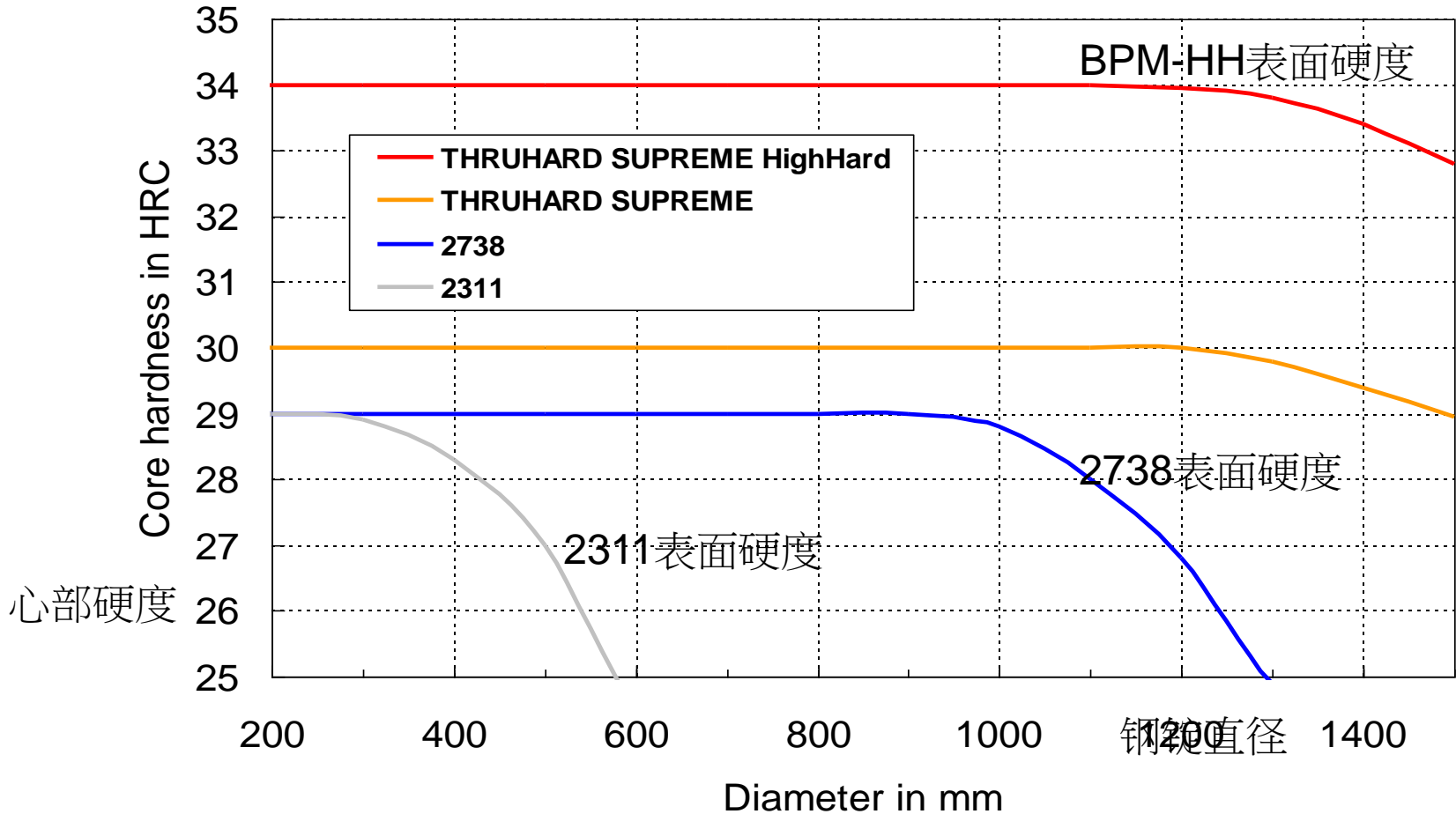


Microhardness pattern

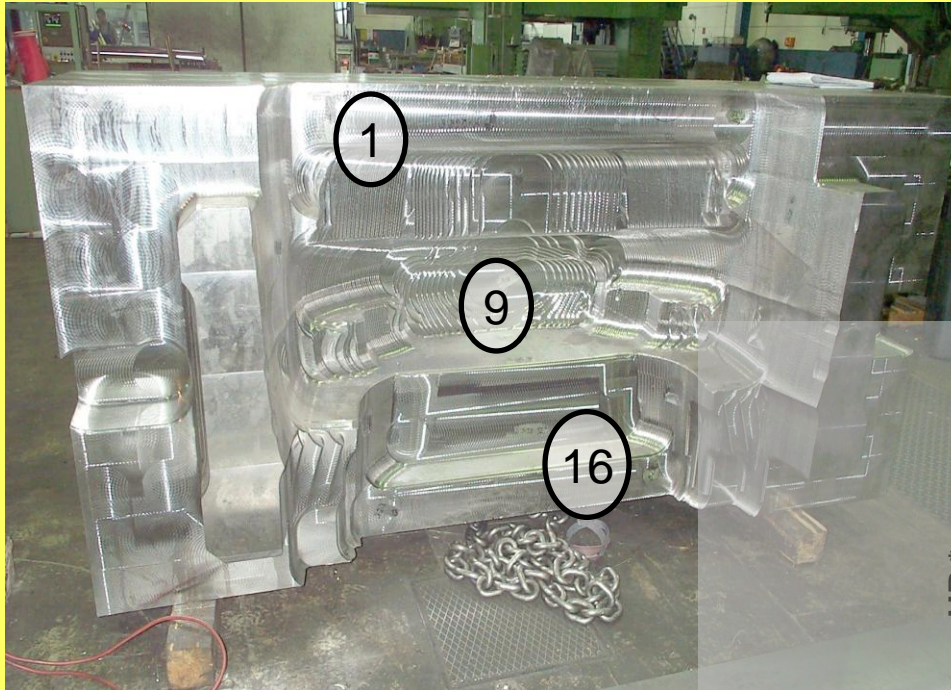


模具鋼 硬度及偏移量

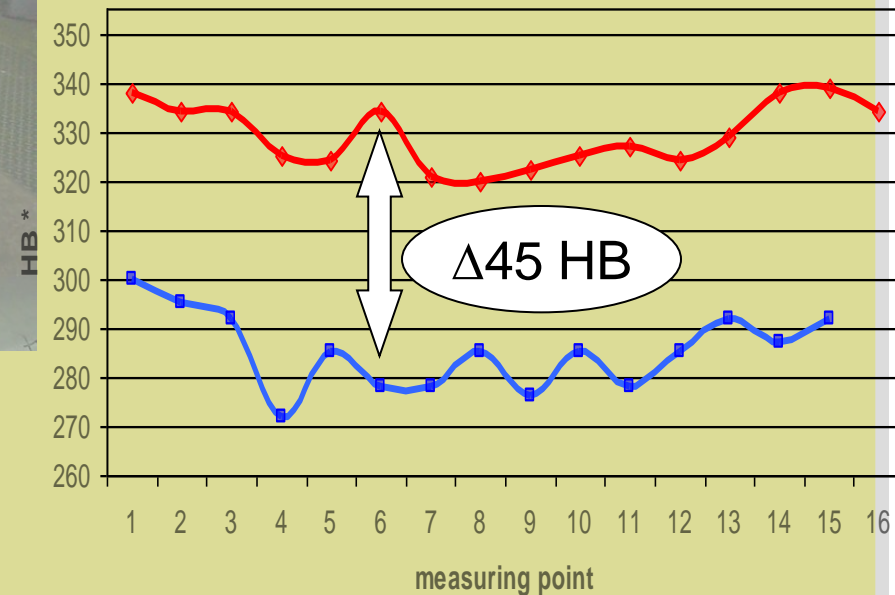
硬化能表現



硬化能表現



Example of hardness curve*
in mould contours -
comparison of similar cavities
in 2738 and BPM-HH



*Equo-Tip testing system

BPM-HH

模具鋼 韌性

Quality advantages of THRUHARD SUPREME®(HH) due to it's more homogeneous micro structure

- Uniform hardness distribution through to the core zone
- Improved toughness

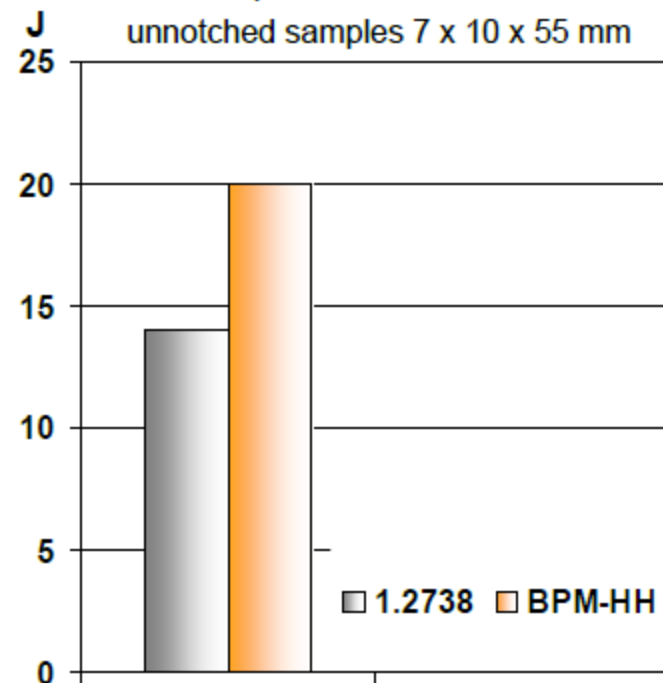
韌性佳

Toughness examination result

Bar diameter approx. rd 1150 mm

test position 0.5 x radius

unnotched samples 7 x 10 x 55 mm



Seminar
2011

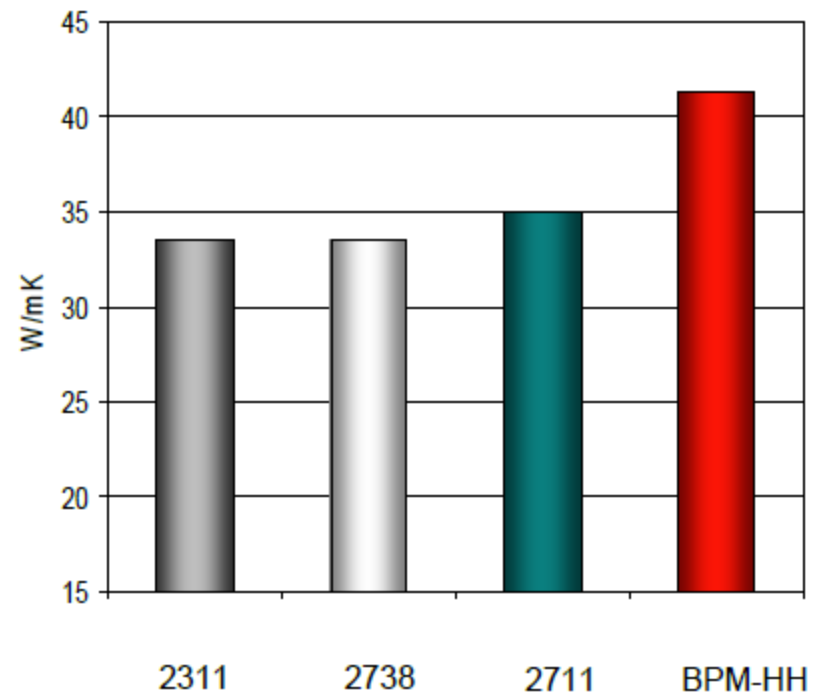
模具鋼 熱傳導性

Quality advantages of THRUHARD SUPREME®(HH) due to it's modified chemical composition

- Uniform hardness distribution through to the core zone
- Improved toughness
- High grain reliability
- Excellent polishability
- Increased stress-cracking resistance in welding and surface hardening.
- **Increased thermal conductivity**

熱傳導性佳

Comparison of thermal conductivity at 250°C



超音波檢查

熱處理

Buderus 預硬鋼-熱處理工藝



硬化-淬火制程

Figure 5.11: Steel ingot poised for quenching in the polymer pond at Edelstahlwerke Buderus AG

Source :Buderus Handbook of plastic Mould steels

回火溫度決定硬度進而影響材質性能

依據德國DIN EN 10052規範，P20系列鋼材，最佳回火溫度需達600°C為最佳(內應力小)，硬度落差較小。如鋼材回火溫度為550°C易造成模具鋼應力破裂，硬度落差大(，拋光易橘皮等問題。回火溫度是決定鋼材品質好壞的重要因素之一。回火溫度下降對鋼材有四大影響：

機械性質	S45C	P20	Buderus2738	Buderus-BPM-HH
回火溫度	560°C	540°C	600°C	600°C

A. 加工應力值增加

(回火溫度不足其材料會使內應力提高，鋼材心部與表面硬度落差大)。

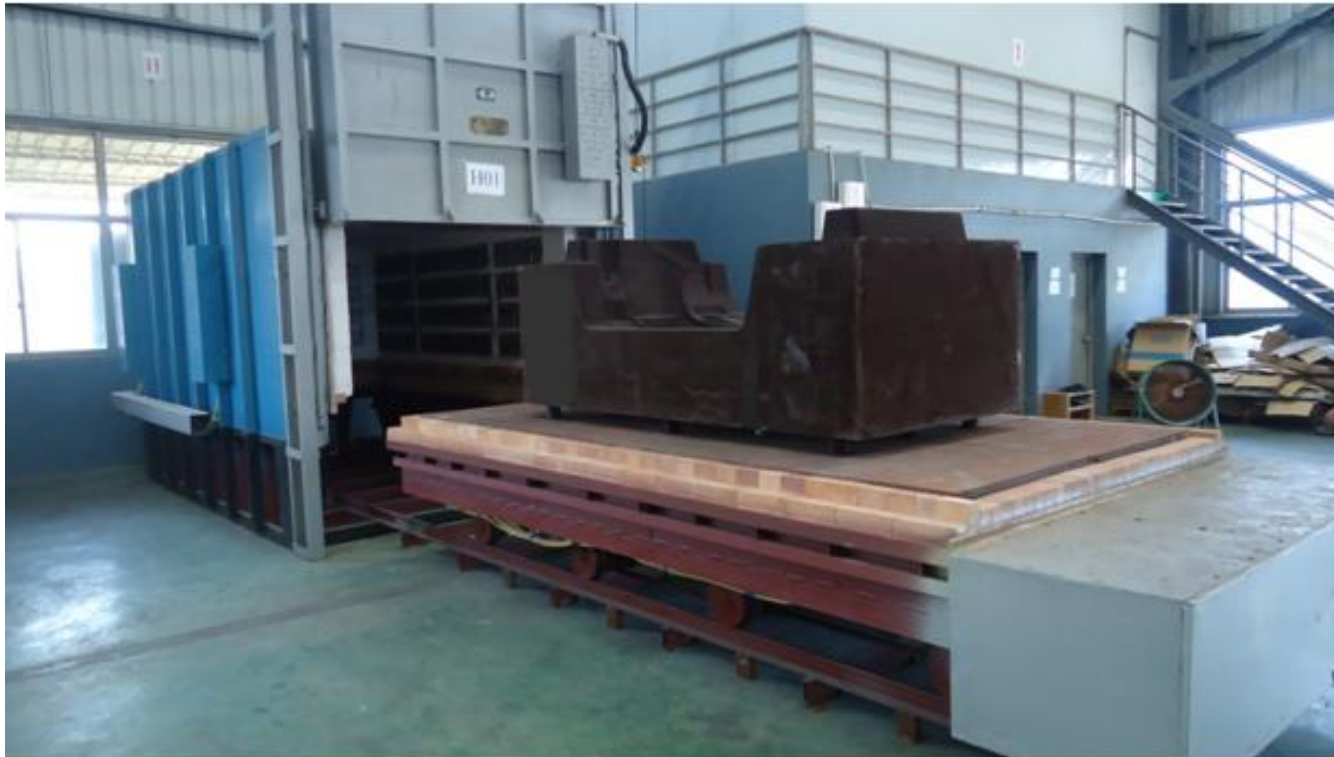
B. 焊補時易裂

(內應力高在焊補是與熱應力交叉影響下，應力釋放而造成裂痕產生)。

C. 加工性變差(內應力提高會使加工困難，而增加加工的成本)。

D. 容易變寸 (模具在內應力較高的情況下，CNC加工時會容易產生變形、翹曲，而且在公、母模具若有相嵌情形下射出成型制程時，模具會易變形而造成模具刮傷，損壞到模具)。

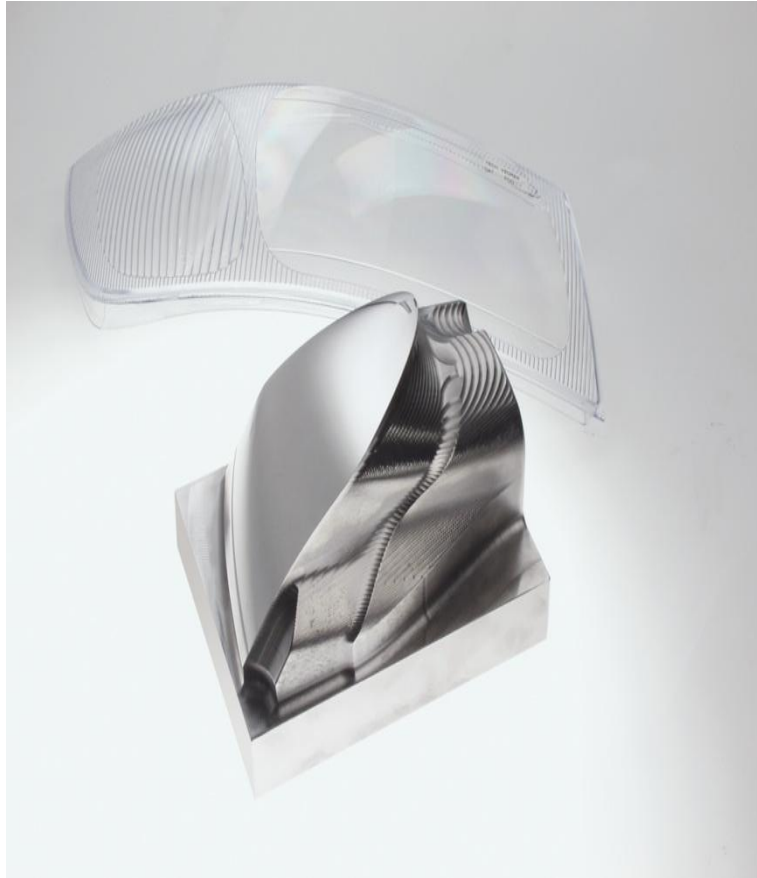
應力消除作業



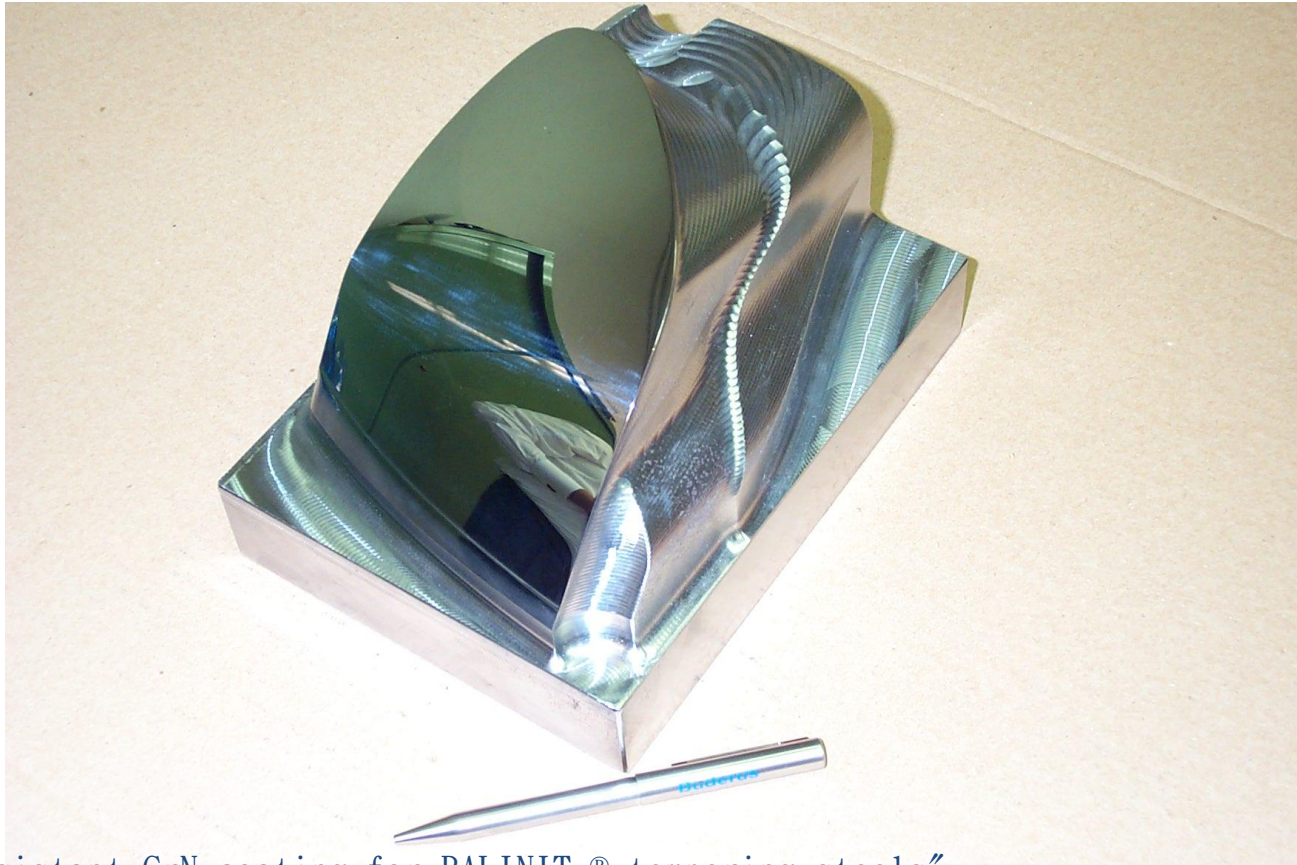
鋼材：BPM-HH

尺寸：905*1150*2400mm

Buderus - BPM-HH



HELLA 車燈 - BPM-HH + CrN



scratch-resistant CrN coating for BALINIT® tempering steels",
表面氮化鉻鍍層 8µm coat thickness approximately 8µm,
CrN 硬度 HV: 1750 hardness approximately 1750HV.



BPM-HH 汽車天窗



Buderus - BPM-HH



Buderus –BPM-HH





Plastic injection moulded part before coating



BPM-HH
BMW-7

Buderus 1.2343

HRC:50+TiN(HV-2300)

30% G/F(玻纖)



Thank you for your attention