拋光-模具製造的重要製程
POLISHING IN MOLD MAKING

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模具製程中的拋光

POLISHING IN MOLD MAKING

THE SURFACE AS A MIRROR OF TIME

But what do they look like, the modern, future-oriented surfaces? Aesthetic, high-quality, robust, easy-care, with top-finish? The requirements to the perfect outer skin are varied. Likewise the fields of application.

The polishing ability of steel for certain application fields is of high importance. Especially in the plastics processing industry very high expectations are often placed on the surfaces of the tools.

The highest surface quality of the tools offers many advantages:

» **Highest quality surfaces** of plastic parts
» **Good release properties** (easy ejection) of plastic parts »
Improved optical properties (e.g. for glasses, lenses, flat screens, headlights in the automotive industry)

Highly polished surfaces also offer technological advantages:

» **Improved corrosion resistance**
Polished surfaces tend to have much smaller corrosive attack than ground surfaces
» **Improved security against breaks or cracks**
A polished surface has a higher endurance strength and has lower notch effects than ground surfaces. This results in an increased tool life.

表面如鏡，映照出長時間的努力

現代化、未來取向的鏡面看起來應該是什麼樣子?
是美觀、高品質、堅固、容易保養? 完美表面的需求與其應用範圍一樣均為多樣性的。
在特定的產業領域中，鋼材的拋光能力極其重要。尤其在塑膠射出業中模具的表面時常被以高標準檢視

最高品質的模具表面有以下幾項優勢:

» 製造出**最高表面品質**的塑膠部件
» **良好的脫模性能**(易於頂出)
» **提高光學性能**(針對如: 眼鏡、鏡片、液晶螢幕、車燈等應用)

高拋光的表面也提供技術上的優勢

» **提高抗腐蝕性**
拋光表面一般來說比研磨表面更不易受到腐蝕攻擊
» **提高抗斷裂或抗破裂的能力**
拋光表面有較高的耐久性，相較於研磨表面有較低的缺口效應(較小的面粗度 Ra)，因此**有較好的模具壽命**

良好拋光性鋼材之條件
REQUIREMENTS FOR STEELS REGARDING GOOD POLISHABILITY

Important parameters for the polishability of steels are the level of purity, the homogeneity of the microstructure and the size or respectively the distribution of carbides and other hard constituents in the steel matrix. Especially inhomogeneities can cause significant problems in polishing.

The homogeneity and purity of steel is significantly influenced by the manufacturing process. Primarily the melting technology as the first step of the production is crucial.

With open melting, oxide inclusions, with larger blocks, cannot be completely ruled out. But not only the size and quantity of inclusion are important for the polishing result, but above all the type of inclusion, which depends on the deoxidation process in steelmaking. Disadvantageous are larger, hard and brittle oxides, as they are „polished out" during the polishing process and thus pores can be left behind.

影響鋼材拋光性的重要因素包含鋼材清淨度，微組織均質性以及碳化物及基地中其他硬質成分之顆粒大小及分佈等，尤其是微組織若不均勻會在拋光過程引起嚴重的問題。
鋼材的均質性及清淨度受製造過程影響很大，特別是製程中第一步的煉鋼技術尤其重要。

A modern steelworks technology with corresponding secondary metallurgy reduces the oxygen content and thus the oxide content in the steel so far that critical inclusion sizes can be minimized. Block formats adapted to the final dimensions and a heat treatment appropriate to the material reduce segregations, and therefore compensate the differences in hardness, so that homogeneity differences hardly influence the polishing result.

In principle, the segregation state and thus the homogeneity of the steel can be improved by remelting processes such as vacuum arc remelting (VAR) or electroslag remelting (ESR / PESR). At the same time, non-metallic inclusions are minimized in these processes. The best level of purity is achieved by melting in the vacuum induction furnace (VIM) or remelting under vacuum (VAR).

在開放式的熔煉過程中，較大塊的鋼錠無法完全排除氧化物的夾雜物。除了夾雜物的尺寸及數量外，夾雜物的種類也會影響拋光效果，而這些都取決於煉鋼過程中的除氧程序。大顆、堅硬及脆質的氧化物在拋光過程中易被拔出，留下細孔。

現代化的煉鋼技術和相應的二次精煉技術可降低鋼中的氧含量，從而降低鋼材中的氧化物含量，使有害夾雜物之尺寸最小化，採用與最終成材尺寸相近的鋼錠以及適當的熱處理能夠減少偏析以及硬度落差，使組織均勻性的差異不至於影響拋光的結果。

可以通過諸如真空重熔（VAR）或電渣重熔（ESR / PESR）的重熔工藝來改善鋼材的偏析，從而改善均勻性。同時，在重熔過程中能將非金屬介在物減至最少。通過在真空感應爐（VIM）中熔煉或在真空下重熔（VAR）可以達到最佳清淨度。

影響拋光性之因素
INFLUENCING FACTORS ON POLISHABILITY

鋼材品質

» 熔煉過程對鋼材的清淨度影響重大
» 鋼材中的介在物可能比周圍的材料軟，從而導致組織不均勻
» 通常介在物的尺寸為幾微米，並具有細長的形狀

合金組成

» 在組織中形成硬度差異
» 導致組織不均勻
» 晶體形態導致表面剝離

How the alloying design influences the polishability shows the following example:

In the case of steel 1.2316, the hard carbide phases embedded in the soft delta ferrite zone give a more irregular polishing result. In return, BÖHLER M303 EXTRA offers a uniform polishing pattern and thus a clear advantage compared to the standard.

以下範例顯示合金設計如何影響拋光性:

觀察 1.2316，嵌入在較軟 δ 肥粒鐵區域的硬質碳化物使得拋光結果較不均勻，另一方面，百樂鋼的 M303 EXTRA 能夠提供更為均勻的拋光結果，與標準 1.2316 產品相比明顯較為優勢。

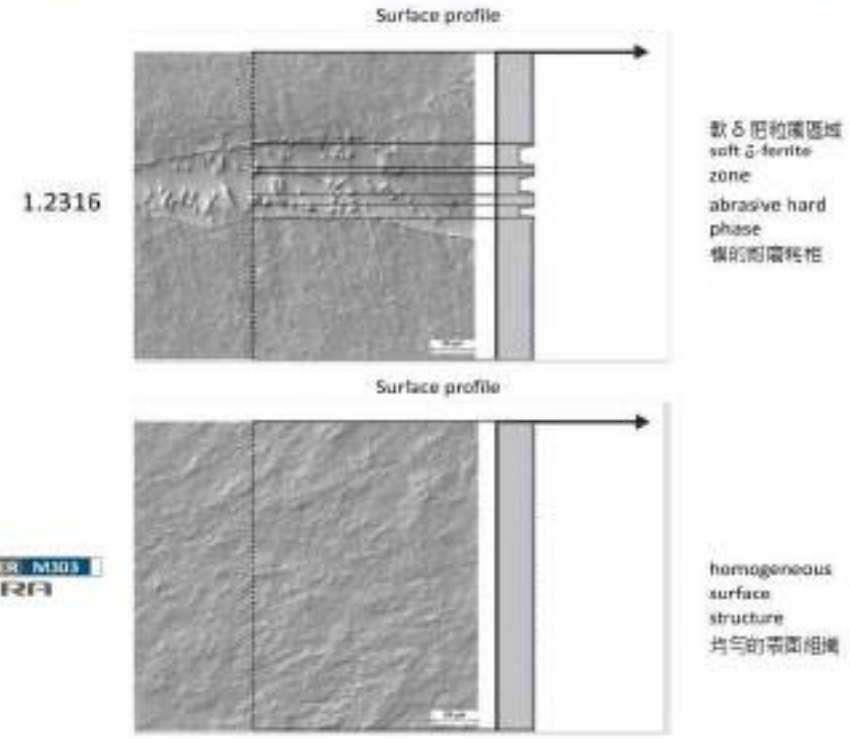
STEEL QUALITY

» The melting process is decisive for the purity of steel
» Inclusions in steel, mostly sulphidic, can be harder than the surrounding material and thus lead to elutriation
» Often, inclusions are several microns in size and have elongated shapes

ALLOYING COMPONENTS

» Form hardness differences in the structure
» Lead to elutriation
» in crystal form lead to breakouts of the surface

Surface comparison　表面比較



MANUFACTURING PROCESSES

Remelted steels

have the following advantages compared to conventionally produced steels:

» Uniform primary structure and extensive absence from block segregation and internal defects due to solidification

» Low crystal segregations and thus more uniform microscopic microstructure

» Reduced quantity and size as well as better distribution of non-metallic inclusions (better level of purity)

Powder metallurgically produced steels

are mostly high-alloy tool steels and have isotropic properties as well as a fine structure. The carbides are homogeneously distributed in the size of a few microns in the matrix, which has a positive effect on the polishability.

製造過程

重熔鋼材 (ESR/ PESR/ VAR)

與非重熔鋼材相比有以下幾個優勢

» 均勻的初析組織，且大幅避免鋼錠回化時產生的偏析及內部缺陷

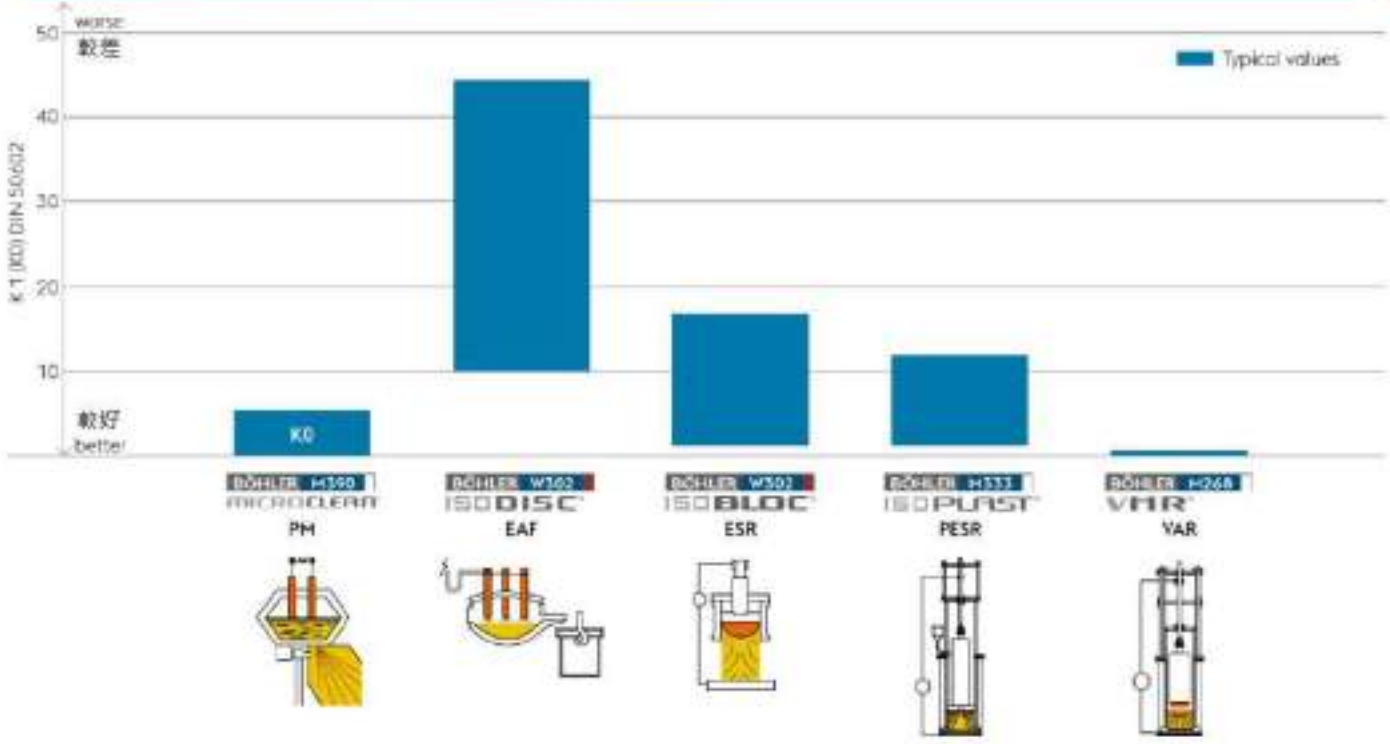
» 結晶偏析低，顯微組織更加均勻

» 非金屬介在物不但在數量及尺寸上有所降低，在分布上也較不會聚集(較好的清淨度)

粉末冶金鋼材

多數為高合金工具鋼，具有等向性和細緻的組織。碳化物以幾微米之大小均勻分佈在基地中，這對拋光性有正面的影響。

Purity depending on the melting process 各種熔煉方式的清淨度



熱處理

為了獲得最佳的拋光性能，應非常仔細地進行熱處理，最好在真空或保護氣體爐中進行。 在熱處理過程中滲碳或脫碳作用，會造成工具表面的硬度不均勻，因此有可能會產生較差的拋光性能。不適合的沃斯田鐵化溫度、持溫時間或過慢的冷卻速率均會造成晶界析出以及晶粒的粗大，對拋光性有不良的影響。

HEAT TREATMENT

For best polishing properties the heat treatment should be performed very carefully and preferably in vacuum or protected gas furnaces. Due to carburization or decarburization effects in course of the heat treatment uneven hardness at the tool surface and so worse polishing behavior can arise. Either precipitations at the grain boundaries or grain growth due to unfavorable austenitizing temperatures, holding times as well as slow cooling rates can influence the polishability negatively.

ERODE

Eroded surfaces should be given special attention during polishing. The erosion process causes a structural change on the surface. It can lead to an enrichment of the steel surface with carbon, which in turn leads to the formation of carbides. Furthermore, the rapid local solidification leads to a very brittle martensite. This so generated carbides increase the risk of pinholing, breakouts and orange peel. For a good mirror finish polish, the material must be removed to below the eroding skin.

放電加工

放電過之表面在拋光時需要特別的注意，由於放電過程會導致表面結構發生變化，放電加工可能使鋼材表面含碳量增加，進而導致碳化物的形成。 此外，快速的局部凝固產生硬脆之麻田散鐵(放電白層)，這樣生成的碳化物會增加出現針孔、剝離和橘皮的風險。因此為了獲得良好的鏡面拋光效果，必須將材料去除到放電表層以下。

3 種品質等級
3 種煉鋼技術
3 QUALITY LEVELS
3 TECHNOLOGIES

BASIC　基礎級

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

常規煉鋼方式

常規煉鋼材質為使用電弧工藝生產的產品，是一般用途通常使用的"基本材質"(EAF)，有以下幾種主要特性:

» 帶狀碳化物分布
» 可接受之清淨度

含鉻 12%之常規鋼種微金相組織
Micro structure of conventional 12% chromium steel

PREMIUM 優良級

ESR / PESR or VAR Manufacture

Products with improved properties can be produced using the ESR / PESR or VAR 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

ESR/PESR 或 VAR 煉鋼

使用 ESR/ PESR 以及 VAR 的方式可以生產擁有更佳性能的鋼材，使用重熔鋼能延長模具壽命的原因:

- 高等級之清淨度
- 低偏析
- 即使是產出較大的尺寸也擁有同等級的碳化物分布
- 均勻的尺寸變化
- 較好的韌性

含鉻 8%之 ESR 鋼
種微金相組織

Microstructure of 8% chromium steel in ESR grade

SUPERIOR 特優級

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

粉末冶金煉鋼

使用粉末冶金所製造的鋼材越來越常用在最嚴苛的條件，因為它能滿足以下最嚴格的要求:

- 無偏析
- 極細微之碳化物分布
- 高尺寸穩定性
- 均質化之組織
- 高抗壓強度
- 高耐磨耗性
- 高韌性及高硬度

粉末冶金鋼種
微金相組織

Microstructure of PM materials

正確之拋光技術
至關重要
THE RIGHT POLISHING TECHNOLOGY IS DECISIVE

TYPES OF POLISHING

The requirements for the surface of a workpiece arise from the intended application areas. It is roughly divided into 4 qualities:

Stroke polish
» Simple surfaces - finishing mostly with abrasive cloths, polishing bench stones or files
» Used to facilitate demoulding of molded or die cast parts
» Applying with non-visible surfaces, e.g. inside of a housing
» As a preparation for nitrating and graining
» Tools used have a grain size between 320 – 400

Gloss polish
» Smaller processing marks are often still visible
» Surfaces and recesses are shiny
» Especially for visible parts, which should be visually appealing (household items, transparent parts...)
» Clean shiny surface, controllable with the eye
» Final polish with felt and diamond pastes between 3 – 6 µm achievable

Mirror finish
» No visible scratches or cords (crack-free mirror finish)
» Especially used when products are chrome-plated

Dimensionally accurate and form-true mirror finish
» Highest demands on the surface
» In addition to the crack-free high gloss also the adherence with the macrostructure is required, i.e. flatness, sharp edges and angularity

拋光的類型

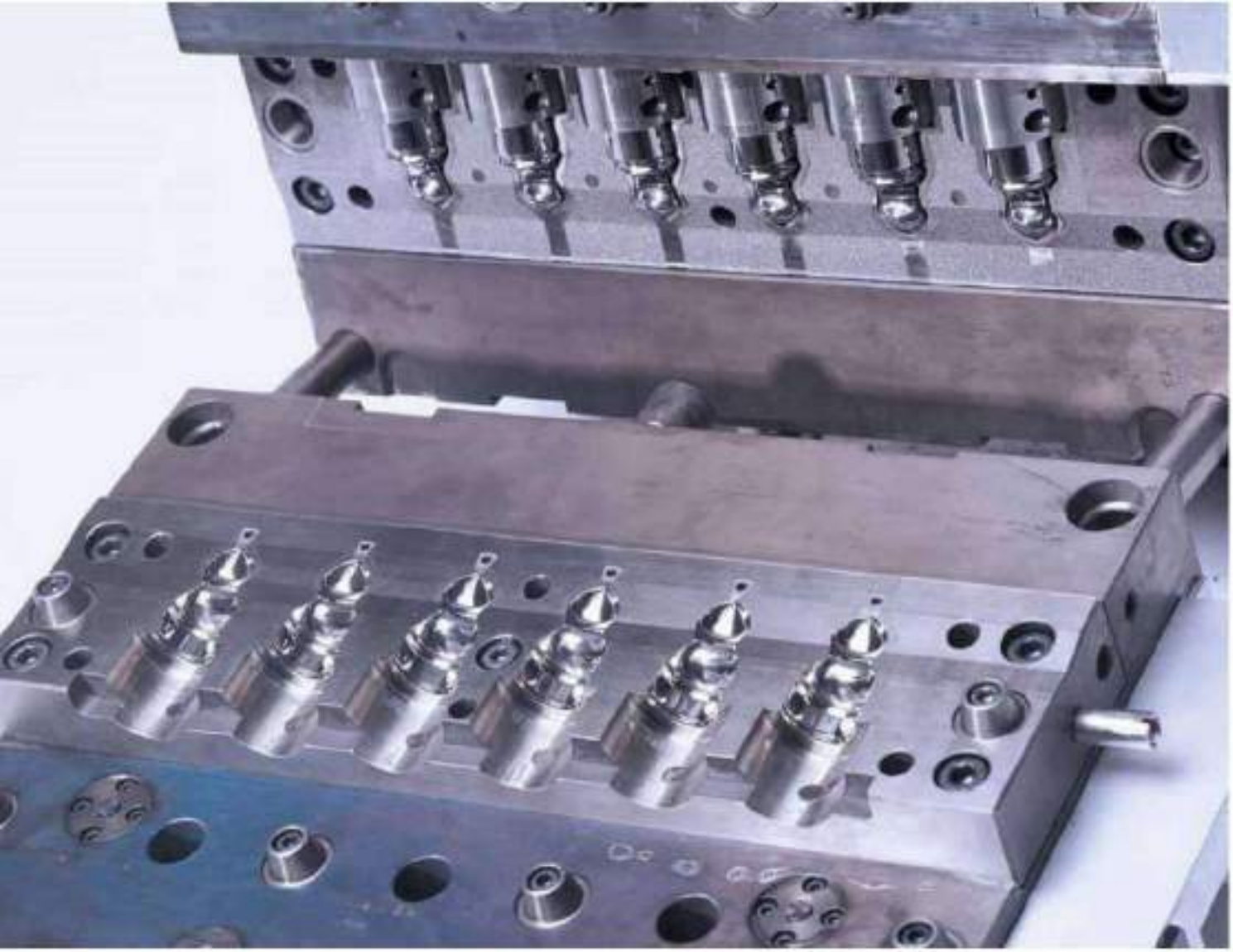
不同的應用領域對於工件的拋光表面要求也有所不同，大致上可以分成 4 種等級

打底拋光
» 簡單表面- 主要用砂布，拋光台石或銼刀進行拋光
» 用於輔助模製或壓鑄零件的脫模
» 使用於不可見的表面，例如外罩的內面
» 作為氮化及咬花的前置準備
» 拋光工具的晶粒度在 320 – 400 之間

光澤拋光
» 較小的加工痕跡仍然可見
» 表面和凹槽有光澤
» 用於可見部分，需要視覺上吸引人，例如家庭用品，透明件
» 乾淨發亮的表面，眼睛可識別
» 最終拋光使用毛氈和鑽石膏可達到 3 至 6µm

鏡面拋光
» 沒有可見的刮痕或線條（無裂紋的鏡面拋光）
» 特別用在鍍鉻產品

尺寸及形狀精確的鏡面拋光
» 對表面的最高標準要求
» 除了無裂紋的高光澤度外，還需要與宏觀結構保持一致，例如平整度，尖銳的邊角和棱角



載體材料/拋光工具之影響
INFLUENCE OF CARRIER MATERIAL / POLISHING TOOL

The hardness of the carrier material and the size of the polishing grain can be decisive for the roughness depth of the surface to be processed. The greater the penetration depth into the polishing tool at same grain size, the lower the penetration depth into the workpiece surface or the cutting performance of the polishing agent. The adhesion of the grains in the polish carrier is crucial for the polishing result. If the grains adhere firmly to the polishing agent carrier, the cutting process is favored and rolling of the polishing agent on the workpiece surface is avoided. The stickiness of the grains can in turn be influenced by the processing pressure or the liquid used.

Requirements for a successful polishing are:

- Proper rough grinding and finishing
- Selection of suitable polishing tools and polishing pastes
- Avoidance of overpolishing
- Avoidance of high contact pressures
- Careful care and cleaning of the polishing tools
- Cleanliness (best cleanroom-like conditions)

載體材料的硬度和拋光顆粒的大小對於工件表面的粗糙度的深度有決定性的影響。在相同粒度下進入拋光工具的滲透深度越大，刻入工件表面的深度或拋光劑的切削性能越低。顆粒是否可以黏附在拋光載體關鍵性地影響拋光結果。如果顆粒牢固地黏附在載體上，則有利於切割過程，並且避免了拋光劑在工件表面上的滾動。顆粒的黏性又會受到加工壓力或所用液體的影響。

成功拋光的條件:

- 適當的研磨以及精加工
- 選擇合適的拋光工具和拋光膏
- 避免過度拋光
- 避免過大的接觸壓力
- 仔細保養和清潔拋光工具
- 清潔度（最好為無塵室）

相信
您的眼睛
LISTEN TO
YOUR EYES

POLISHING PROCEDURE

Due to the mutual influence of the many influencing factors, it is not possible to draw up general guidelines for the creation of a polished surface. The selection of the individual work steps and the respective polishing agents and tools is primarily determined by experiments and experiences. The following polishing guide represents a common sequence of operations from machining to polishing.

Depending on the quality and processing of the starting surface (eroded, milled or ground), an abrasive wheel with a grain size of 320, 400 or 600 is chosen to completely remove the traces of prefabrication. An optimized polishing result is achieved by sandblasting after the finishing, whereby the surface is compacted.

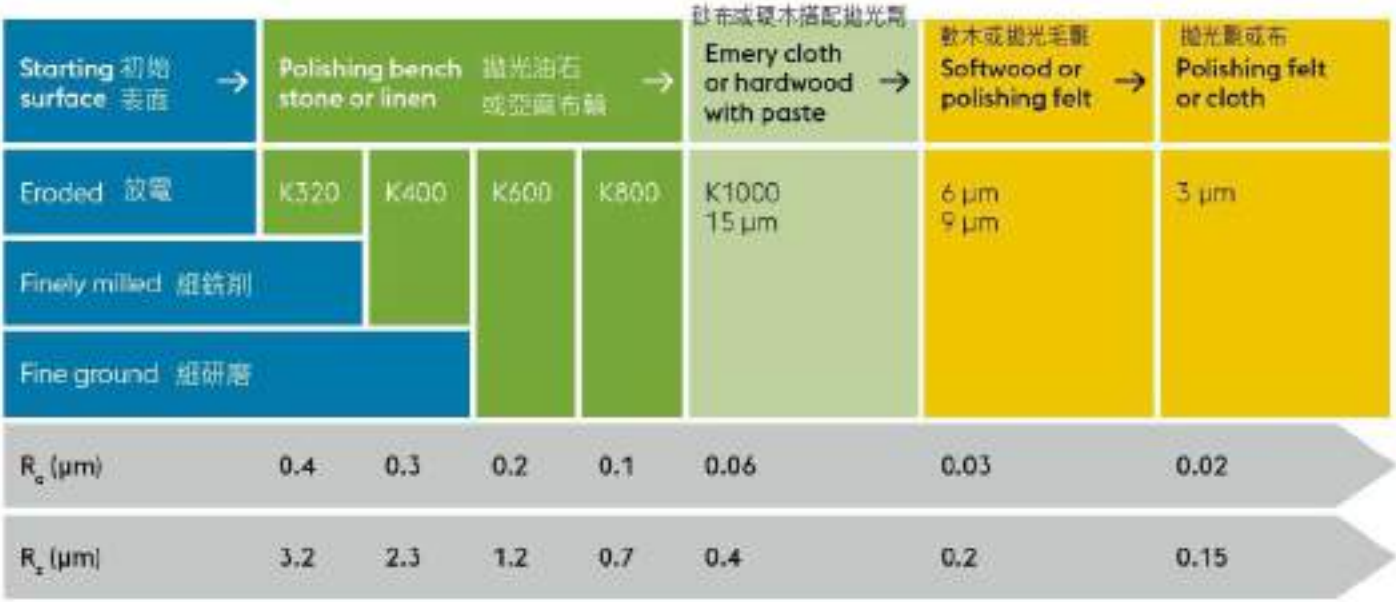
The polishing process follows in several steps. Starting with a harder carrier such as hardwood, brass or plastic with a paste of about 15 microns (roughly corresponds to an abrasive grain of 1000 – 1200). All traces from the previous step should be removed. Subsequently, the hardness of the carrier / tool is maintained but the grain of the paste is reduced e.g. 9 µm. After this step, the carrier can be changed to a softer medium such as e.g. felt or softwood. This scheme is repeated until finally the grain size 1 – 3 microns with felt or a flocced cloth is used

拋光的程序:

由於拋光結果會受許多因素的交互影響，因此無法建立一個拋光程序的萬用通則，各工序以及使用的拋光劑和工具仍需取決於實驗結果與經驗。以下拋光建議為機加工到拋光之常見操作順序。

根據初始表面（放電加工、銑削或研磨）的品質和加工，選擇顆粒為 320、400 或 600 之砂輪去完全消除粗加工痕跡。完成後再通過噴砂處理可達到最佳拋光效果，從而使表面緻密。

拋光過程原則上有以下階段。先以較硬的載體(例如:硬木、黃銅或塑膠)開始，搭配約 15 微米的拋光劑(大約等同 1000-1200 磨粒顆粒)，前一步驟所造成的痕跡必須完全消除。隨後載體可以繼續使用，但拋光顆粒需變小(如至 9 微米)。接下來可將載體改變為較軟的介質，例如毛氈或軟木。重複這個模式，直到最後使用毛氈或絨布並且顆粒尺寸為 1-3 微米為止。



CLASSIFICATION OF POLISH DEFECTS 拋光缺陷之分類

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Source: PROCESSSTRATEGIES FOR DEFECTFREE POLISHED STEEL SURFACES, pages 9 – 15, Fraunhofer Institute for Production Technology IPT

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LAMINARY DEFECTS 片狀缺陷

Scratches

Non-directional flat recesses, mostly caused by the cutting edges of the polishing particles or foreign particles (depth ~ roughness Rt).

Tips

» Depending on the requirements of the surface fine scratches can persist
» Pay attention to the cleanliness of the environment, that no foreign particles cause scratches
» Final polishing with small abrasive particles

刮痕

無方向性之平凹，主要是由拋光顆粒或異物的尖銳邊緣引起的(深度～粗糙度 Rt)。

秘訣

» 根據表面的要求，細小划痕可能可被接受
» 注意環境的清潔，不要有異物引起刮痕
» 用小磨料顆粒進行最終拋光

Orange peel

Fine valleys and hills give the appearance of an orange peel. Excessive pressure or too long polishing time can cause such a defect.

Tips

» Work with low pressures
» Do not polish too long (» overpolish «)

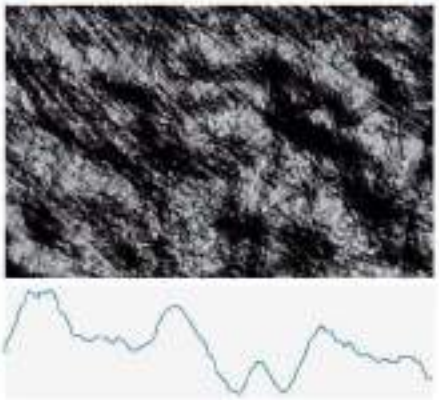
橘皮

細小的凹凸呈現出橘皮，力道過大或拋光時間過長都會導致此類缺陷。

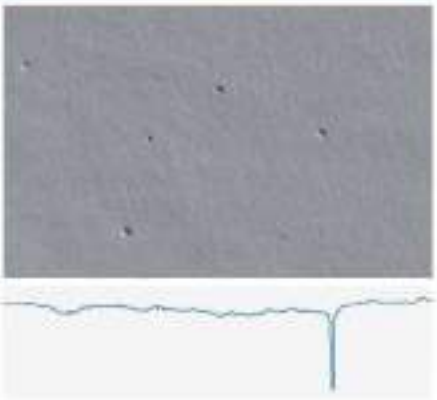
秘訣

» 使用較小的力道
» 不要過拋

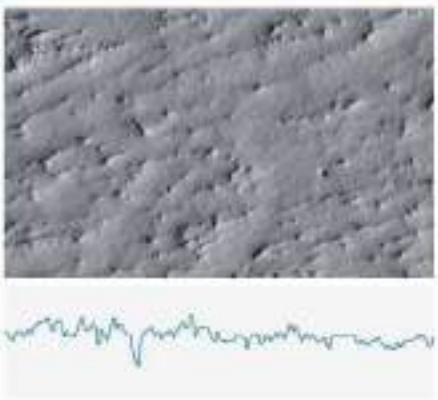
Orange Peel 橘皮



Pitting 點蝕



Relief 起伏缺陷



Mist
Less shiny surfaces. Mist may result from deposits of the polish.

Tips
» Use pH-neutral polishes that do not cause a chemical reaction
» Work with low pressures to prevent the polishing grains from being pushed in

霧面
較不光滑的表面，拋光劑的沉積可能導致霧面

秘訣
» 使用酸鹼值中性的拋光劑，避免化學反應
» 使用較小的力道避免拋光顆粒過度擠壓進拋光表面

Pitting
Surface pitting means many small holes that are spread over the entire surface.

Tips
» Keep pressure constant
» Short polishing steps, cleaning in between and good dry to avoid corrosion

點蝕
許多小點遍佈整個表面

秘訣
» 使用固定不變的力道拋光
» 縮短拋光步驟，每步驟之間要清潔並維持乾燥避免腐蝕

Relief
Differences in the removal of individual phases due to different material phases (hard / soft).

Tips
» Before polishing, make sure that the material structure is as homogeneous as possible in order to keep the different material phases low
» When polishing, choose a tool that is as hard as possible, so that the material phases are removed evenly despite different hardnesses

起伏缺陷
模具材質有不同硬度相，導致不同相的組織在拋光後被移除的程度不一

秘訣
» 拋光前請確認材質組織是否均勻，確保減低相間之表面落差
» 拋光時，請盡可能選擇最硬的工具，即使材料硬度不均仍能平均的移除表面

形狀偏差
FORM DEVIATIONS

Edge radiusing
Undesired material removal on workpiece edges.

Tips
» Use suitable polishing tool: hard polishing cloth with low impact resilience
» Reduce pressure

邊角圓弧
邊角遭非計畫性的去除

秘訣
» 使用適合的拋光工具: 抗衝擊力低的硬質拋光布
» 減少拋光力道

Ripple
According to DIN EN ISO 8785, the ripple is a deviation of the actual geometry in the millimeter to centimeter range. It mainly occurs during manual polishing.

Tip
» Homogeneous pressure distribution during the polishing process to achieve a uniform removal

波紋
根據 DIN EN ISO 8785 的定義，波紋是 mm 到 cm 左右大小幾何形狀的偏差，通常發生在手工拋光

秘訣
» 使用均一的力道進行拋光，以期達到一致的去除效果

CLASSIFICATION OF POLISH DEFECTS 拋光缺陷之分類

LOCAL DEFECTS 局部瑕疵

Cracks

Very deep scratches, sharp edges, mostly due to high material stress.

Tip

» Avoidance during the polishing process is not possible, because it is more a material error. For this reason, the workpiece should be examined in advance for invisible cracks / material defects.

裂痕

非常深的刮痕，有銳利的邊緣，主要是較大的材料應力所致。

秘訣

» 由於這是一個材質本身的問題，因此在拋光過程中無法避免，應事先檢查是否有不可見的瑕疵或材質問題

Holes / Breakouts

Unevenly shaped holes. They are formed where non-metallic inclusions and carbides are present in the microstructure.

Tips

» Work with low pressures to avoid tearing

» Use the most homogeneous steel structure as possible in advance, if the surface quality requirements are very high (purity level)

» Use a napless polishing cloth, as this promotes tearing out of carbides and inclusions

» Low pressures already during pre-grinding and fine grinding

孔洞/剝離

不規則的孔洞，產生在非金屬介在物或碳化物的位置

秘訣

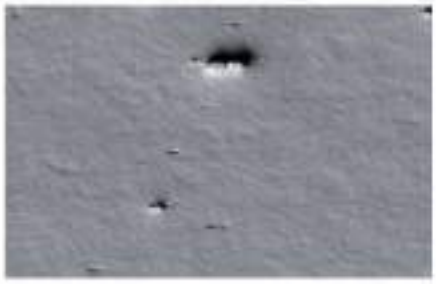
» 使用較低的力道，減少拔扯的可能

» 如果對表面要求很高，請盡可能使用組織最均勻，淨潔度最好的鋼材

» 使用無絨毛的拋光布，因為絨毛會加強碳化物和夾雜物的拔扯

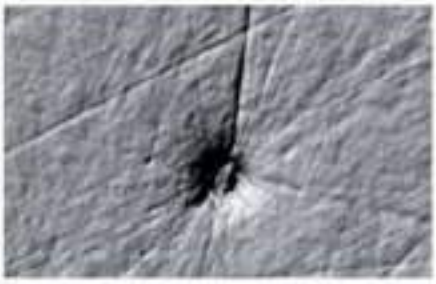
» 研磨或精修時使用低壓/較小力道

Holes / Breakouts 孔洞/剝離



Scoring 刮痕

Impurities 雜質



Scoring
Deep, directional tracks (depth >> roughness Rt). They arise when the processing traces of the previous step (usually the pre-processing) were not completely eliminated.

Tip
» Always remove pre-processing marks thoroughly

刮痕
深並有方向性的刮痕(深度>粗糙度 Rt)，上一步(通常在前加工)的處理痕跡沒有完全消除而導致

秘訣
» 徹底去除粗加工痕跡

Peak
Uneven elevations. These are either workpiece material that has been unevenly removed during the polishing process, or polishing particles that have pressed into the surface during the polishing process.

Tips
» Homogeneous pressure distribution
» Use high viscosity polish

突起
表面凹凸不平，有可能是加工力道不均，或拋光顆粒押入表面所致

秘訣
» 加工力道維持一致
» 使用高黏度拋光劑

Comet tails
Inclusions that have a "tail" and therefore the appearance of a comet.

Tips
» In the metallographic sample preparation, it should not be possible to polish in synchronism when comets appear
» When polishing manually, a higher speed can prevent comet formation

彗星痕
可見的介在物，有尾巴並且外觀如彗星一般

秘訣
» 準備金相標本時，當彗星出現時不應該同步做拋光
» 手動拋光時，快一點的速度可以預防彗星痕的出現

Impurities
A hole filled with foreign material (dirt particles or material removal products).

Tips
» Working clean
» Use low pressures to prevent the particles from getting into the hole

雜質
出現孔洞並有異物在其中(髒污的顆粒或刨除的碎屑)

秘訣
» 工作環境保持清潔
» 加工使用較小力道防止碎屑進入孔洞中

其他瑕疵
FURTHER DEFECTS

Corrosion
Reaction of machined workpieces with substances from the environment. Corrosion often results from poor drying after cleaning.

Tips
» Clean and dry samples immediately after processing
» Store samples dry

腐蝕
加工過的工件與環境物質的反應，腐蝕通常是清潔過後工件不夠乾燥所造成的。

秘訣
» 拋光處理後立即清潔並乾燥工件
» 將工件儲存在乾燥環境中

Burn mark
Fire pattern on the workpiece surface. Caused by too much heat during the polishing process and often causes damage to the surface structure (microcracks).

Tip
» Use sufficient coolant / lubricant during the process

燒焦痕
工件表面有燒焦紋，在拋光過程中由於過熱而引起，並經常損壞表面結構（微裂紋）。

秘訣
» 在過程中使用足夠的冷卻液/潤滑劑

Discoloration
Area that appears differently (in most cases dull) to the actual surface. Topographically, there is usually no difference.

Tips
» Use neutral polishes to avoid damage to the surface
» For soft material, work with low pressures to prevent polishing grains from settling in the surface

變色
表面有部分區域看起來不同(多數看起來較黯淡)，但就型貌測量上，高低平整並無不同

秘訣
» 使用中性拋光劑，避免損壞表面
» 對於柔軟的材料，請在使用較小力道加工以防止拋光顆粒沉澱在表面上

For post-processing of BÖHLER tool steels joke recommends:

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On-off-switch directly at the motor

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拋光性評估
ASSESSMENT OF POLISHABILITY

The surface quality of forming parts of compression or injection molds is often defined by indications such as „polished" or „mirror polished", without these terms being defined in standards by measurable variables. Although a good reproducibility can be achieved by specifying the processing steps required for a certain surface quality, however, no guarantee of the predefined polishing quality can be given by the before mentioned influences.

The visual impression of a smooth, shiny surface is composed of a variety of optical and physiological effects. As a result, the correlation of the visual impression with quantitatively measurable variables is difficult. Therefore, the subjective assessment of the surface finish by experts is widespread.

壓縮或射出模具成型零件的表面品質通常由 "拋光" 或 "鏡面拋光" 等名詞定義，而這些術語並沒有通用的可測量標準。即使透過制訂標準加工程序可以良好地再現相當程度的表面品質，但仍無法保證拋光結果不受上述因素的不良影響。

光滑，有光澤的表面視覺印象是由多種光學及物理效應而構成，因此視覺印象無法作為可測量的標準，導致拋光表面的品質判斷通常流於主觀標準。

百樂鋼種之拋光性
POLISHING OF BÖHLER GRADES

The following assessment of polishability was conducted with experienced polish specialists at **Joke-Technologies**. The assessment is based on the basic suitability of the material for **mirror polishing** and the time required for polishing.

The assessment refers to small round dimensions (50-80 mm) and polishing transverse to the grain direction and represents a principal comparison of the polishability of the grades. In actual work-pieces, deviations from the polishability due to the dimension, the removal position and the structural coherency between the fiber direction and surface of the workpiece to be polished may occur. In addition, the polishability depends on the type of polishing process and the sequence of polishing steps

以下是 Joke-Technologies 經驗豐富的拋光專家針對拋光性的測試評估，以鏡面拋光材料的基本適用性以及拋光所需的時間作為標準

該測試使用較小的圓形樣本(50-80 毫米)，以垂直於晶粒方向進行拋光，做不同鋼種之間拋光性能的比較。在實際的工件中，由於尺寸、拋光位置和纖維方向與工件表面之間的相互影響，可能會引起拋光性能的偏差。另外，拋光性取決於拋光製程的類型和拋光步驟的順序

抗磨耗，非耐腐蝕鋼種
Wear-resistant, non-corrosion resistant steels

BÖHLER K110	★
BÖHLER K340 ISODUR	★★
BÖHLER K360 ISODUR	★★
BÖHLER K390 MICROCLEAN	★★★★
BÖHLER K490 MICROCLEAN	★★★★½
BÖHLER K600	★★★★★
BÖHLER K890 MICROCLEAN	★★★★½
BÖHLER S390 MICROCLEAN	★★★★

熱作鋼種
Hot work tool steels

BÖHLER W300 ISOBLOC	★★★
BÖHLER W302 ISOBLOC	★★
BÖHLER W350 ISOBLOC	★★★½
BÖHLER W360 ISOBLOC	★★★½
BÖHLER W400 VMR	★★★★★
BÖHLER W403 VMR	★★★★½

可硬化之耐腐蝕不銹鋼
Hardenable, corrosion resistant steels

BÖHLER M310 ISOPLAST	★★½
BÖHLER M333 ISOPLAST	★★★★★
BÖHLER M340 ISOPLAST	★★
BÖHLER M368 MICROCLEAN	★★★★
BÖHLER M390 MICROCLEAN	★★★
BÖHLER N685	★

非耐腐蝕之預硬鋼種
Prehardened steels, non-corrosion resistant

BÖHLER M200	★★
BÖHLER M261 EXTRA	★★½
BÖHLER M238	★★★
BÖHLER M238 EXTRA HIGH SPEED	★★★★
BÖHLER M268 VMR	★★★★★

耐腐蝕之預硬不銹鋼種
Prehardened steels, corrosion resistant

BÖHLER M303 EXTRA	★★★★
BÖHLER M303 EXTRA HIGH SPEED	★★★★★
BÖHLER M314 EXTRA	★½
BÖHLER M315 EXTRA	★
BÖHLER N700	★★½

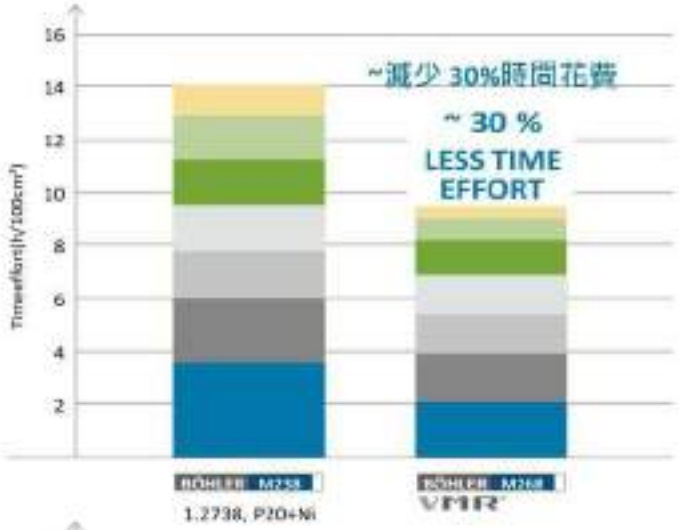
The comparative assessment of polishability takes place within material groups.
A comparison of the evaluation of grades of different groups does not make sense.

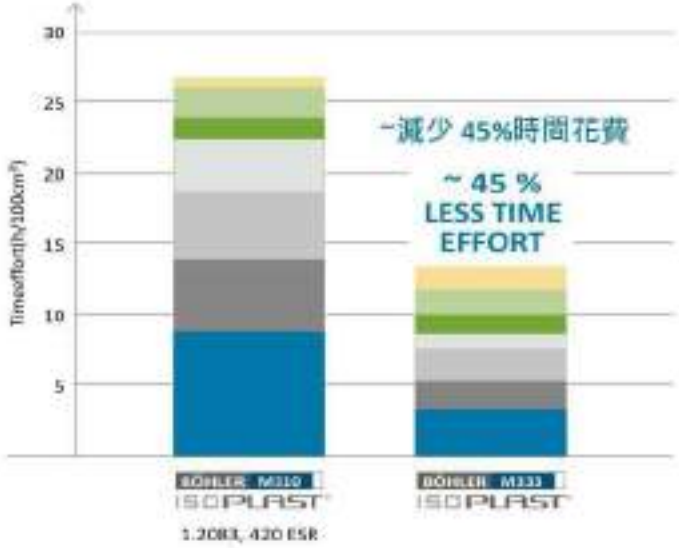
可拋光性的比較評估是在各鋼種分類內進行。
比較不同分類的評估結果是沒有意義的。

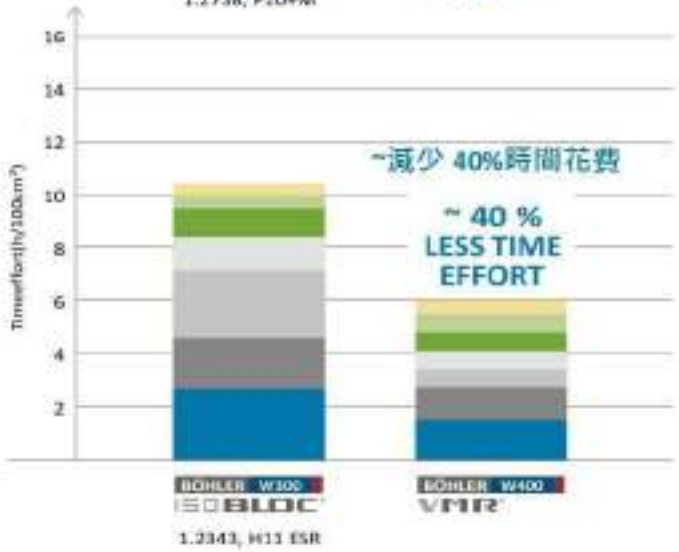
案例分析
CASE STUDIES

The following comparison illustrates exemplarily the **time effort reaching a mirror-polished surface** starting from a pre-ground surface.

下表為各鋼種從粗研磨到**鏡面拋光完成所花費的時間**比較







拋光步驟
Polishing steps

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