FMD QFD系列 QFD Series ENGINEERING DRILL®

工程微钻头 ® 的特点与用途
ENGINEERING DRILL®

工程微钻头 ® 的主要应用领域：半导体晶圆检测探针卡等的高端微钻孔；
半导体封测插座探针插入层孔等的钻孔。

工程微钻头 ® 满足了对于精度要求极高制品加工的需求，
除了在半导体检查部品的制作领域发挥了其超微细孔加工的特长，
同时在医疗设备用超微细喷嘴・超微细套管等的微钻孔方面也得到了一定的应用。

This is a specialized tool for drilling probe insertion guide plates such as micro jigs for probe cards used in semiconductor wafer tests and IC sockets used in semiconductor package tests.

Engineering Drill ®, which able to process products that require high precision, drill and manufacture ultra-fine medical metal nozzles and pipes by taking advantage of the features that are specialized for the processing of ultra-fine holes.

主要面向的被切削材料

铝、铜、不锈钢、可加工陶瓷、高性能工程塑料 等

Work Material
Aluminum, Brass, Stainless Steel, Machinable Ceramics, Super Engineering Plastics, etc.

特点

从钻头母材选取，钻头刃部形状设计到钻头制造均在日本进行，采用了最新的设计以及最尖端的技术。仅以钻头母材合金钢中钴的含有量为例，即可根据客户的不同需求按 (5%～8%) 进行客制化配比。
根据被加工物的材质以及各种层孔的形状之不同，对于各细部进行了最优化的钻头设计，可按客户要求生产最小刃径为φ20μm 的微钻头，钻径指定可以做到以 1μm 为单位※选定。

为达到所钻微孔漂亮美观的目的，工程微钻头 ® 在设计上对孔径・位置精度・正圆度・层孔同轴度・同心度・层孔深度・孔壁光滑度・毛刺・崩孔等所有要素均有所考量，可以做到为客户的不同加工部件提供最恰当的微钻头。

※XQFD(客制化规格) 系列的钻径公差保证值最小可为 ±1μm

Product Features
Since all of the drill base metal and flutes are manufactured in Japan with the most advanced technology, it is also possible to manufacture custom drills with a high cobalt content (5-8%).
The drill specifications can be customized in detail according to the shape and material of the work piece, and the drill diameter can be ordered from φ20 μm to 1 μm increments※.

We are committed to the design of drills for beautiful and precise processing, and clear all the affected condition such as hole diameter, position, roundness, concentricity, concentricity, hole depth, inner wall roughness, etc.

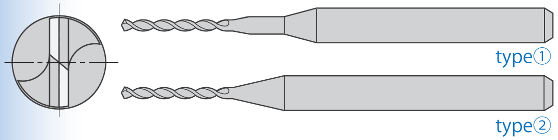
※XQFD (custom specification) guaranteed minimum tolerance value is ±1μm.

工程微钻头 ® 的规格
ENGINEERING DRILL® basic specification

鲁玛型全钢钻头
钻柄直径：Φ3.175 h4
全　　长　：38.1
素　　材　：超微粒子超硬合金
（碳化钨和钴 :5～8%）

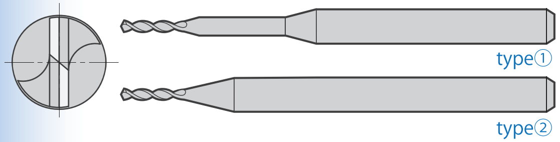
Carbide one-piece pivot drills
Shank Diameter：Φ3.175 h4
Overall Length：38.1
Carbide Grade：Micro-grain carbide
(Tungsten carbide and Cobalt :5～8%)

标准刃长微钻头 Regular Flute Length Drills QFD



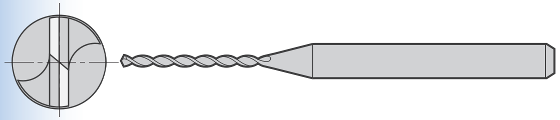
- 双刃 Double flute type
- DR 12 Diameter Ratio : 12
- 顶角 120° Point angle : 120°

短刃长微钻头 Short Flute Length Drills SQFD



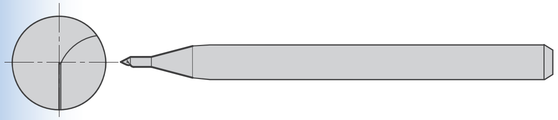
- 双刃 Double flute type
- DR 6 Diameter Ratio : 6
- 顶角 120° Point angle : 120°

中长刃长微钻头 Semi-long Flute Length Drills MQFD



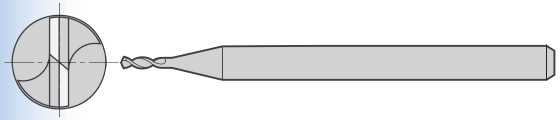
- 双刃 Double flute type
- DR 18 Diameter Ratio : 18
- 顶角 120° Point angle : 120°

单刃 中心钻头 Center Drills CQFD



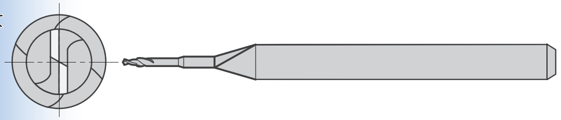
- 1 枚刃 Single flute type
- 顶角 55° Point angle : 55°

可应用于下沉台阶面的定位钻头 Digging depth Point Drill PQFD



- 2 枚刃 Double flute type
- DR 3 Diameter Ratio : 3
- 先端角 120° Point angle : 120°

层孔内打点定位钻头 Pointing Drill for Stepped Shape Holes QFDS

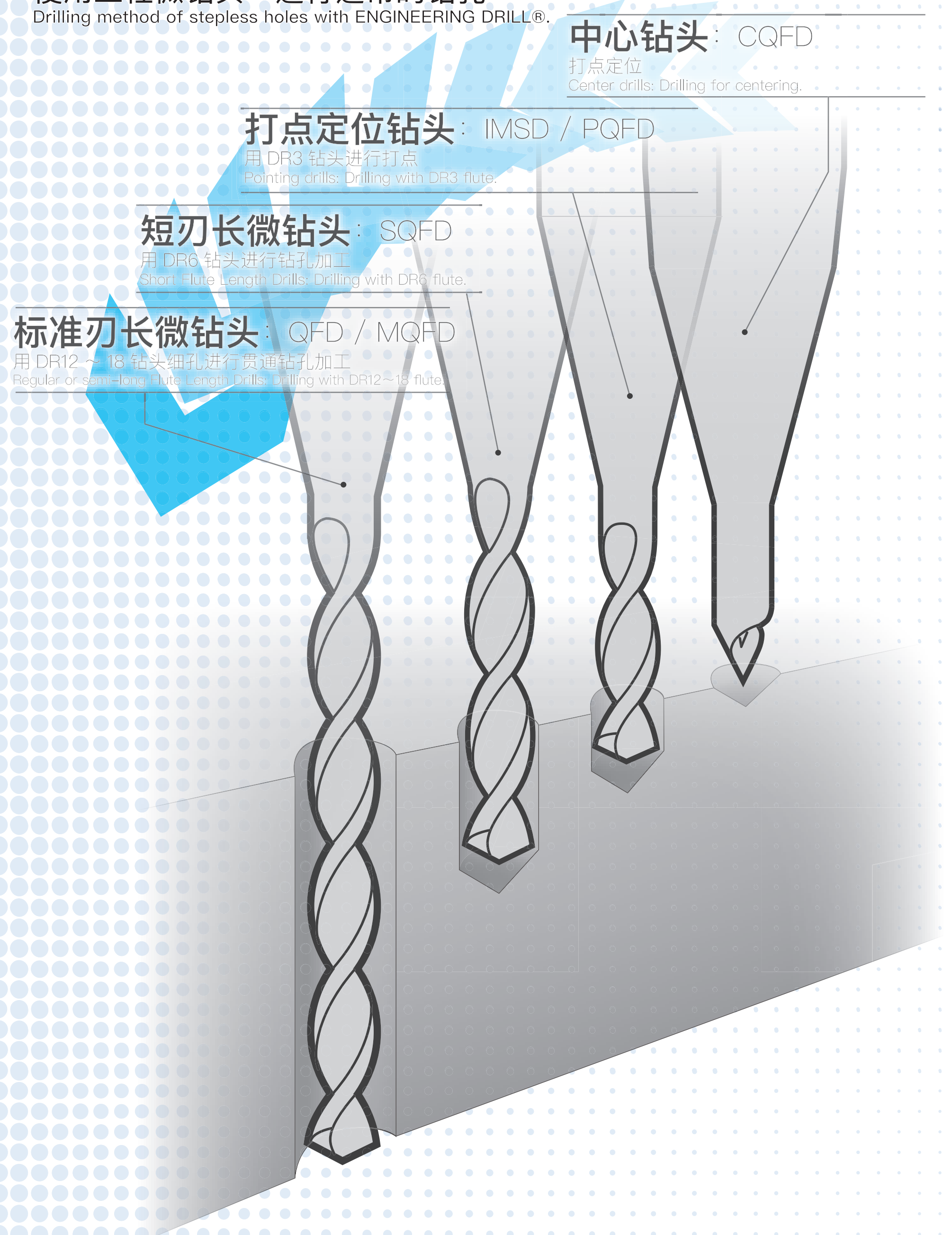


- 阶梯钻头 Stepped shape flute
- 2 枚刃 Double flute type
- DR 3 Diameter Ratio : 3
- 顶角 120° Point angle : 120°

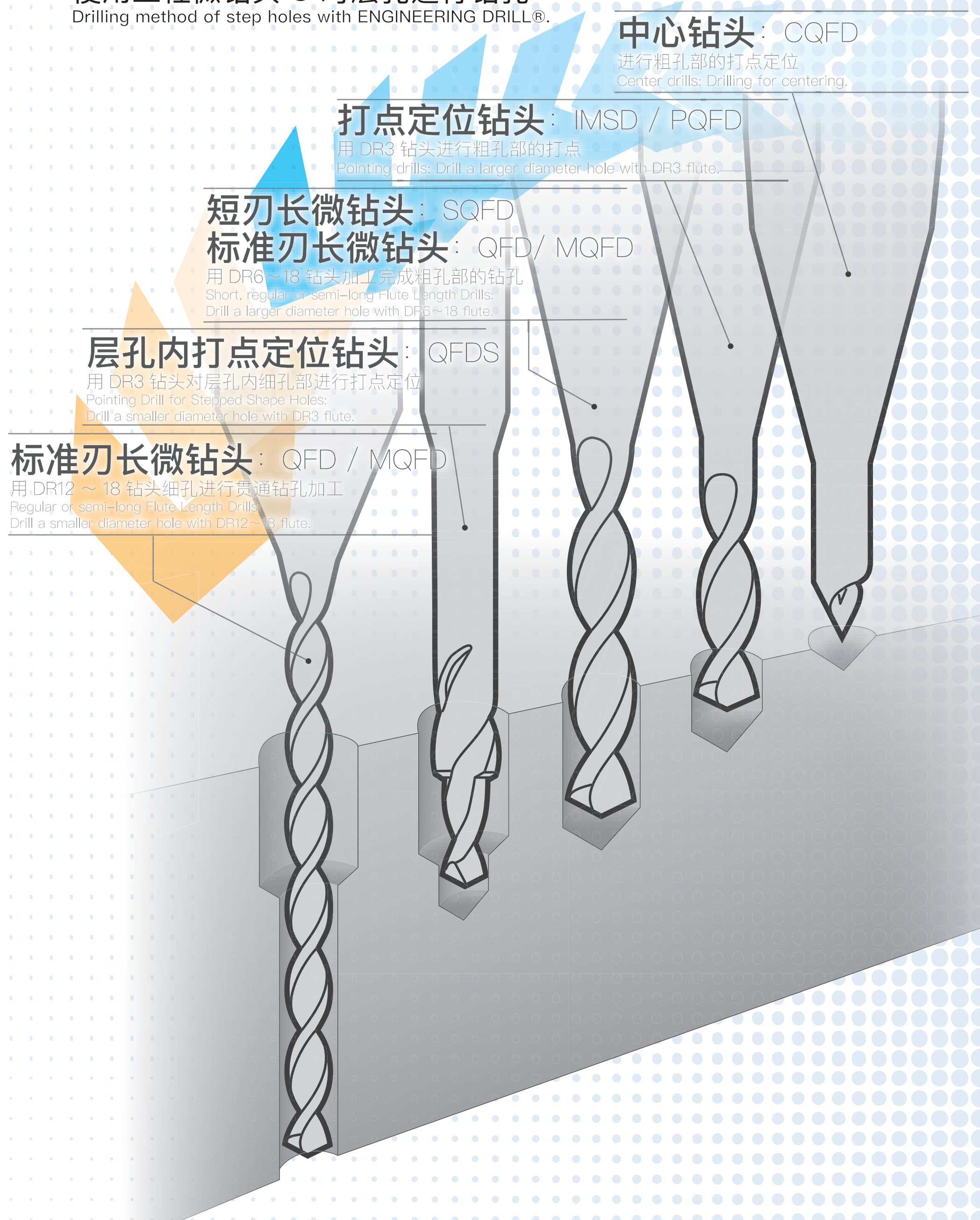
技术资料 DRILLING DATA

使用工程微钻头 ® 进行加工的例子
The order of drilling with ENGINEERING DRILL®

使用工程微钻头 ® 进行通常的钻孔
Drilling method of stepless holes with ENGINEERING DRILL®.



使用工程微钻头 ® 对层孔进行钻孔
Drilling method of step holes with ENGINEERING DRILL®.



技术资料
DRILLING DATA

FMD QFD系列 QFD Series ENGINEERING DRILL®

钻头制造过程中的极小公差设定是为了实现对高精度加工的追求
High accuracy with small tolerance

实现各类探针导孔精密加工一定离不开选用精密的钻孔工具。
工程微钻头 ®QFD 系列以高精度为主要特征，设立了严格的公差管控标准。

Processing probe-guide holes require accuracy tools.
QFD series set the criteria with small tolerance as high accuracy.

钻径公差范围在 3 μm 之内※
Diameter tolerance : range 3μm※

※无镀膜钻头
※ Non-Coated Drill

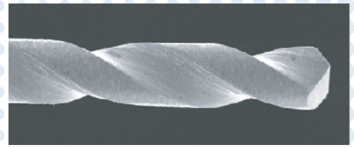
FMD 客制化钻头 Custom Drill ENGINEERING DRILL®

可对应高精度钻头的客制化
High accuracy drills for Custom made

根据客户制品的用途・材料等，
QFD 系列钻头可调整规格满足客户的客制化要求。

●最小钻径ф20μm～，以 1 μm 为单位
可生产最小直径到Φ20μm 的微钻头，钻径指定可以做到以 1μm 为单位选定。

照片：ф0.025 无镀膜钻头
Φ0.025 Non-Coated Drill



●最小公差 2μm※
钻径公差范围最小可指定到 2μm。
钻径指定的微细化意味着公差也必须越发严格。
※无镀膜钻头

●长刃长也可对应
长刃长（D Ratio～20 倍）也可对应。

●其它可指定规格如下：
顶角・螺旋角・钻芯厚度・横刃修磨・镀膜的有无等。

Can customize QFD Drills depending on materials and the use of products.

●The minimum diameter : 20μm～, in increment of 1μm
The minimum diameter : 20μm～, specify the diameter in increments of 1μm.

●The minimum tolerance : 2μm～※
The minimum range : 2μm～
Less tolerance is essential to fine custom diameter. ※Non- coated drills

●Produce a long flute length
Long flute length (D ratio:～20times) available upon request.

●Other specifications available

长寿命镀膜钻头
Long life coated drills

除通常钻头之外
如果有量镀膜钻头也可生产

QFD 系列可对应镀膜制作要求。

FMD 公司制镀膜钻头表面光滑，且有三大特点：

(1) 由于提高了耐磨性，可防止钻径随加工进行而变细的问题；

(2) 可使切削屑更易排出；

(3) 提高切削锐利度。

利用以上镀膜钻头之特长可提高对于金属类或可加工陶瓷类材料之钻孔能力，延长钻头使用寿命。

Produce normal drills and coated drills as well

Coated drills available on QFD series.

The coating of our drills are excellent in smooth surface. They feature“a clear cutting performance”, “continuous flow of chips” and “prevent drill diameter from thinning”.

Long life time drill bits for use in processing metal and machinable ceramics.

客制化钻头规格要求
Custom-made drills

- **钻径**・・・ϕ20μm～ϕ500μm　可按 1μm 单位指定钻头直径
  Diameter・・・・・・・Φ20μm～Φ500μm　in increments of 1μm
- **公差**・・・刃径公差范围最小可指定为 2μm
  Tolerance・・・・・・・Lemgth 2μm
- **刃长**・・・D Ratio 最大可做到 20 倍
  Flute Length・・・・D ratio ～20
- **顶角**・・・可对应各种角度
  Point Angle・・・・・various angle
- **镀膜**
  Coated Drill or Nomarl Drill
- **钻芯厚度（芯厚）**
  Web thickness

客制钻头订单格式
Custom-made Orders

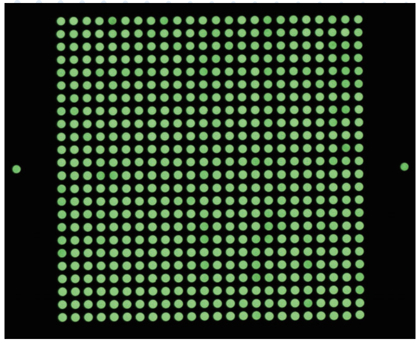
*最小批量 100 支
*Min：100pcs～

钻径 Diameter Φ(mm)	公差 Tolerance ±(mm)	刃长 Flute Length L(mm)	顶角 Point Angle (°)	镀膜 Coating	芯厚 Web thickness	备注 Notes
	+ −					
	+ −					
	+ −					
	+ −					
	+ −					

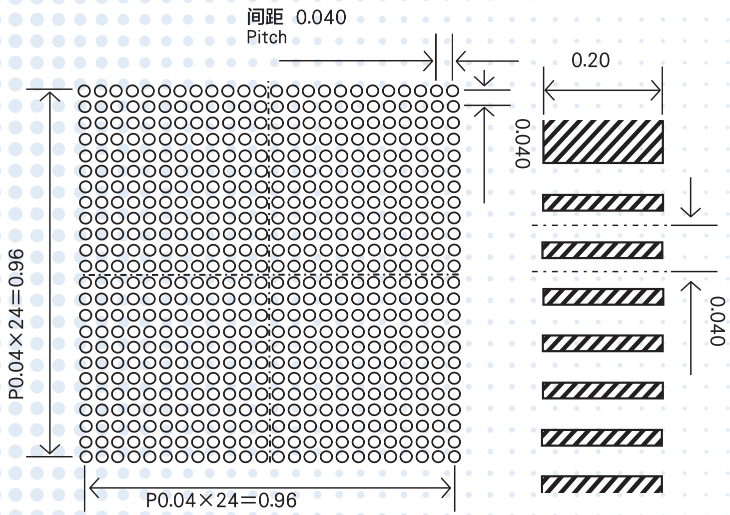
技术资料 DRILLING DATA

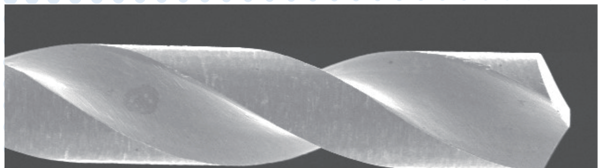
钻孔加工实例　加工内容
Case example, processing content

- 钻径（实测值）/ ϕ0.027
- 材质 / 可加工陶瓷 (Photoveel Ⅱ)
- 孔深 / 0.20mm
- 孔深：钻径 / 8:1
- 孔数 / 576 孔 (24×24 矩阵排列)
- 孔间距 / 0.040mm



- Diameter(actual measurement value)／Φ0.027
- Material／Machinable Ceramics (Photoveel Ⅱ)
- Material Thickness／0.2mm
- Material Thickness：Hole Diameter／8：1
- Number of Holes／576 Holes (24×24Matrix arrangement)
- Pitch／0.040mm





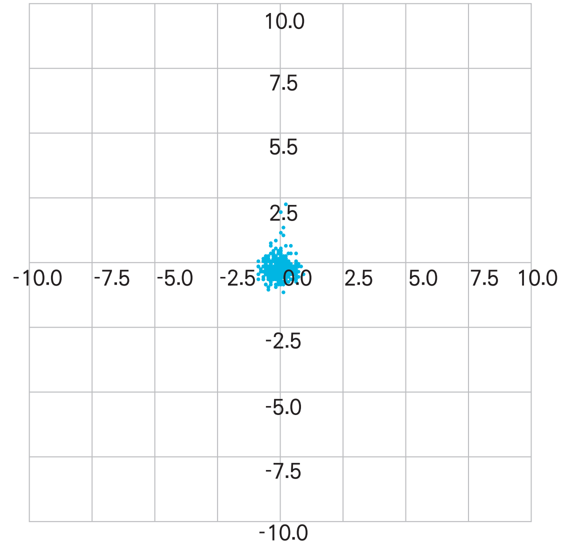
摄影放大倍数：900倍
Photographic magnification：×900

钻孔加工实例　结果
Results of case example as drilling

●孔位置精度 (mm)
Hole Position Accuracy

偏移量 Deviation Amount	X	Y
最大值 Max	0.0009	0.0027
最小值 Min	−0.0009	−0.0013
平均值 Ave	0.0000	−0.0003

孔位置分布图 (μm)
Distribution Chart for Hole Positions



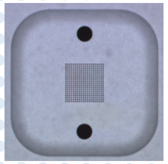
●孔径精度 (mm) 钻径 :ϕ0.027mm
Hole Diameter Accuracy

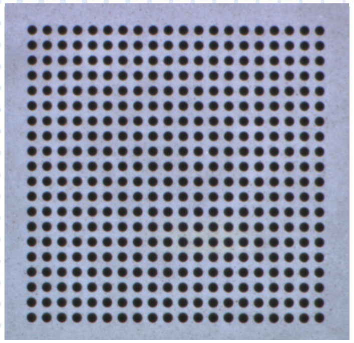
最大值 Max	0.0274
最小值 Min	0.0265
平均值 Ave	0.0270

技术资料 DRILLING DATA

精密钻孔案例 加工结果
Case examples and results

- 钻径 / ϕ0.025
- 材质 / 可加工陶瓷
- 孔深 / 0.15mm
- 孔数 / 400 孔 (20×20 矩阵排列)





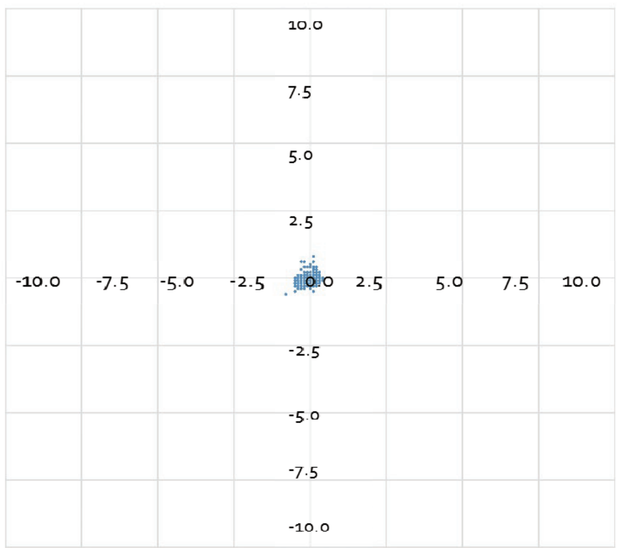
ϕ0.025 探针导孔
孔位置精度 (mm)

	X	Y
最大值	0.0004	0.0008
最小值	-0.0008	0.0006
平均值	-0.0002	0.0007

ϕ0.025 探针导孔
孔径精度 (mm)

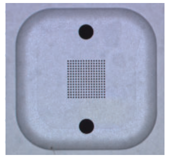
	X
最大值	0.0261
最小值	0.0250
平均值	0.0256

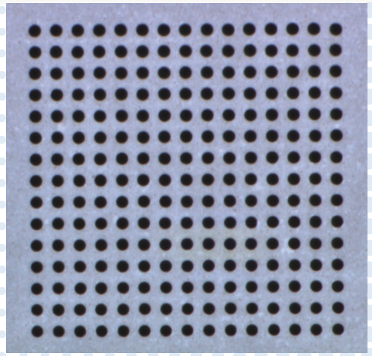
孔位置精度分布图 (ϕ0.025)



测定仪器： Nikon CNC 图像测量系统

- 钻径 / ϕ0.030
- 材质 / 可加工陶瓷
- 孔深 / 0.20mm
- 孔数 / 225 孔 (15×15 矩阵排列)





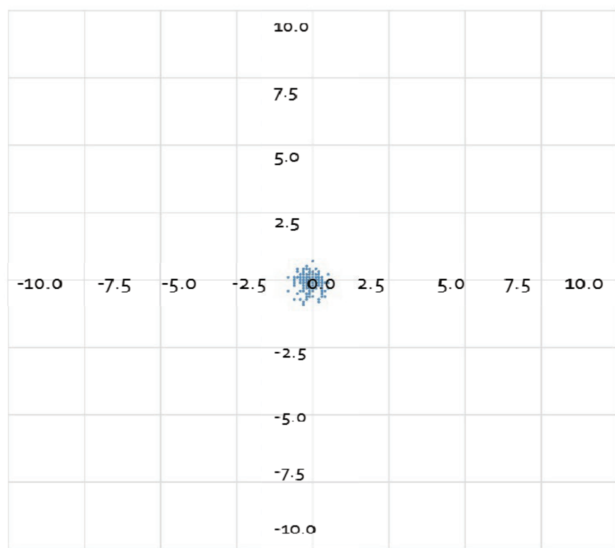
ϕ0.030 探针导孔
孔位置精度 (mm)

	X	Y
最大值	0.0005	0.0007
最小值	-0.0008	-0.0009
平均值	-0.0002	-0.0001

ϕ0.030 探针导孔
孔径精度 (mm)

	X
最大值	0.0328
最小值	0.0318
平均值	0.0323

孔位置精度分布图 (ϕ0.030)

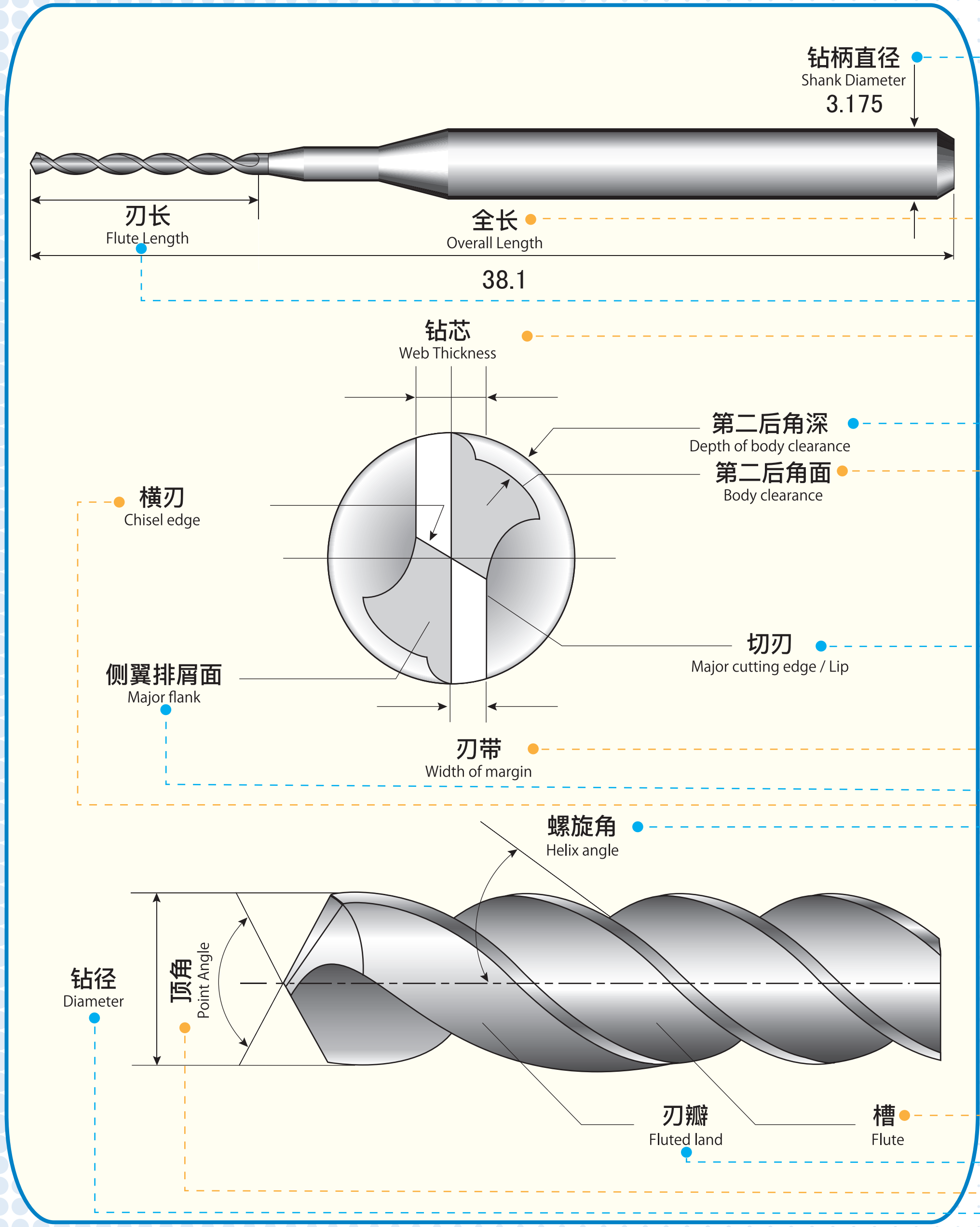


测定仪器： Nikon CNC 图像测量系统

技术资料
DRILLING DATA

钻头各部分名称
Name of each parts

(JISB 0171 :2014)



■ **钻柄直径** Shank Diameter

钻柄外径。
Outer diameter of straight shank.

■ **全长** Overall Length

钻头长轴方向，从刃尖到钻柄尾部的长度。
The distance between two planes normal to the drill axis through the chisell edge and the end of the shank.

■ **刃长** Flute Length

钻头长轴方向，从刃尖到刃槽最上部的长度。
The distance between two planes normal to the drill axis through the outer corner of the cutting lips at the point and the extreme back end of the flutes(included groove length).

■ **钻芯** Web Thickness

刃槽最先端部的刃宽。
The extreme end of the web forms the chisel edge on a two–flute drill.

■ **第二后角深** Depth of body clearance

从钻头外周到第二后角面的深度。
The depth from the outer circumference of the cutting edge to the body clearance surface.

■ **第二后角面** Body clearance

钻削中为减少钻头外周与工作面的摩擦而设计的间隙面。
A surface with a gap to reduce friction between the outer circumference of the drill and the processing surface during drilling.

■ **切刃** Major cutting edge / Lip

前刃面与后刃面的交线。
The line of intersection between the flank and flute surfaces.

■ **刃带** Width of margin

轴直角断面上的刃宽。
The width of the margin between the short portion of the land not cut away for clearance to the drill axis.

■ **侧翼排屑面** Major flank

切削时，为避免与工作面发生不必要的摩擦而设计的排屑面。
此面与切削面的交线便为切刃
注记　排屑面的形状，既有锥面又有平面。
When cutting, the surface that was released to avoid unnecessary friction with the processing surface.
The line of intersection between this face and the rake face constitutes the cutting edge.
NOTE:There are two types of flank shapes: conical surface and flat surface.

■ **横刃** Chisel edge

两排屑面的交线。
The intersection of the two flanks.

■ **螺旋角** Helix angle

刃槽斜线与轴心线之夹角。
The acute angle between the tangent to the helical leading edge and a plane containing the drill axis and the point in question.

■ **槽** Flute

钻头排屑部的凹陷螺旋沟槽部分。
A body part of the drill groove which are in the between of major cutting edge and hill in order to permit removal of the chips.

■ **刃瓣** Fluted land

从顶角刃部到刃尾部的堤状部分。
A part with a cylindrical or conical leading surface to the heel.

■ **顶角** Point Angle

钻头顶端的尖角。
Twice the angle formed by the drill axis and the projection of a major cutting edge in a plane through the drill axis and parallel ti this cutting edge.

■ **钻径** Diameter

钻刃部的外径尺寸。
The measurement across the lands at the outer corners of the drill.

为实现高精度钻孔加工…
To get highly precise hole drilling

(JISB 0621 :1984)

■ 钻径 Diameter

加工出正确的孔径
It is processed with the correct hole diameter.

GOOD

如果孔径小了…
・则探针无法插入
If the hole diameter is too small:
・The probe pin cannot be inserted.

FAILURE

如果孔径大了…
・则会与周围的孔发生干涉
・甚至有可能与周围的孔联通，造成探针间短路
If the hole diameter is large:
・It will interfere with other holes
・Probe pin cannot be inserted because it is connected to other holes.

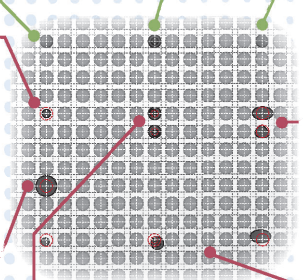
FAILURE

■ 同心度 Concentricity

两种直径的孔以同一点为中心完成加工
Holes with two different diameters are processed around the same point.

同轴两圆柱体的断面圆心投影到同一平面时，两圆心偏移的大小即称为同心度。
In a plane figure, the toleration of the positions of the centers of one circle to the center of the datum circle is called concentricity.

GOOD



如果同心度差的话…
・则探针无法插入
・无法使探针正确触到待检查对象的电极
If the concentricity is low:
・Probe pin cannot be inserted
・The probe pin cannot be applied to the electrode for inspection.

FAILURE

■ 真圆度 Roundness

加工出无限接近真圆的形状
It is processed in a shape that is as close to a perfect circle as possible.

亦即相对于同一圆心之最大半径与最小半径的差值来表示。
Roundness means the measure of how closely the shape of a hole approaches that of a perfect in geometric dimensioning and tolerancing.

GOOD

真圆度差时，如偏椭圆或三角…
・则会与周围的孔发生干涉
・甚至有可能与周围的孔联通，造成探针短路
If the roundness is low and the holes will be in elliptical or rice ball-shaped
・It may interfere with other holes
・The probe pin cannot be inserted because it may connected to another hole.

FAILURE

■ 位置度 Position degree

所谓位置度，是衡量被测要素的实际位置对理想位置变动量的指标。位置度包括点的位置度、线的位置度和面的位置度。
Position is a point from a theoretically exact position defined in relation to a datum or other feature. The size of the deviation of a straight line shape or a plane shape.

如果位置精度差的话…
・则会与周围的孔发生干涉
・则探针无法插入
If the position accuracy is low:
・It will interfere with other holes
・Probe pin can't be inserted.

FAILURE

■ 同轴度 Coaxiality

两种孔径的孔可按照同轴心来加工
Holes of two different diameters are processed in the same axis.

同轴两圆柱体的轴线重合程度，即代表了同轴度的好坏。
Coaxiality refers to the magnitude of deviation from the datum axis line of the axis line that should be on the same line as the datum axis line.

同轴度差时，层孔的粗细孔轴心偏差大…
・则探针无法插入
・探针偏位而无法正确触碰到检查对象
If the coaxiality is low and the holes of two different diameters will be misaligned,
・Probe pin cannot be inserted
・The probe pin is displaced and causes the inspection loss.

■ 孔内壁粗糙度 Inner surface roughness

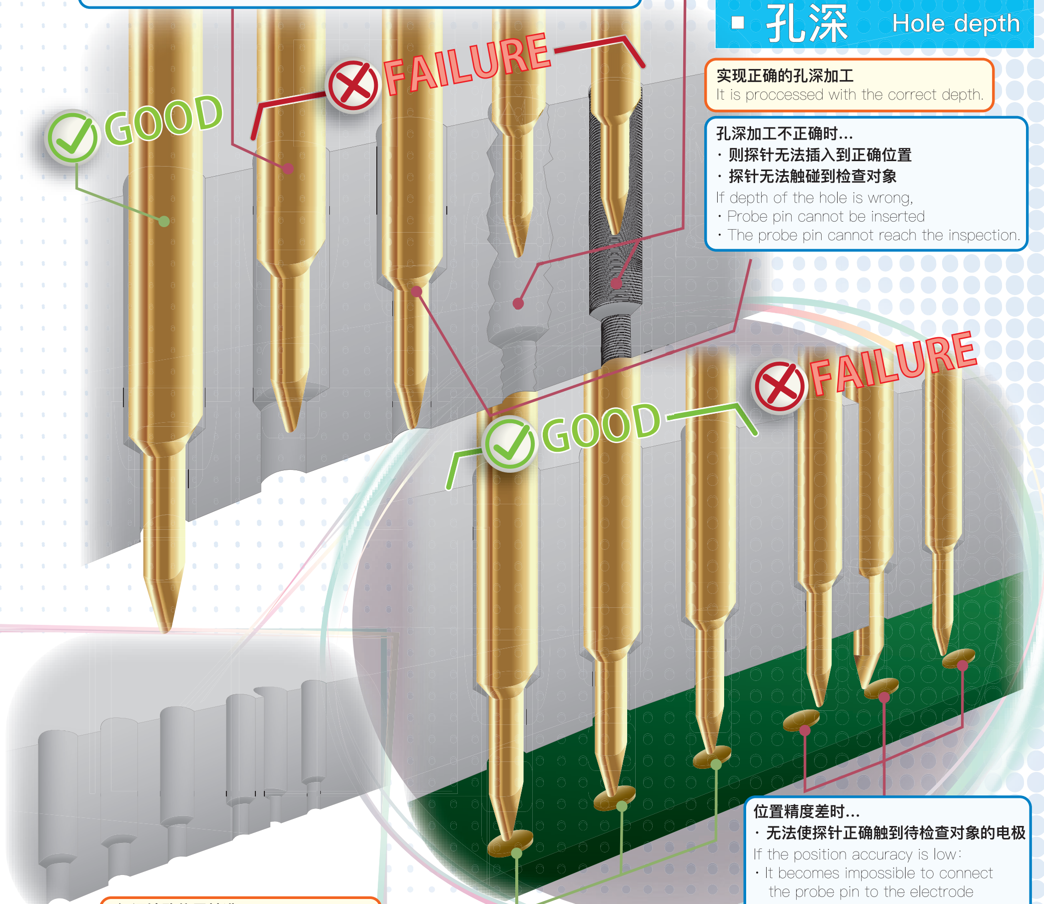
钻孔加工内面光滑
The inner surface of the processed hole is smooth.

孔内面粗糙时…
・则探针无法正常插入
・探针与孔内壁过度摩擦造成破损的可能
If the inner surface roughness is low:
・Probe pin cannot be inserted
・The probe pin may rub against the inner surface of the hole and be damaged.

■ 孔深 Hole depth

实现正确的孔深加工
It is proccessed with the correct depth.

孔深加工不正确时…
・则探针无法插入到正确位置
・探针无法触碰到检查对象
If depth of the hole is wrong,
・Probe pin cannot be inserted
・The probe pin cannot reach the inspection.



保证钻孔位置精准
It is processed in the correct position.

位置精度差时…
・无法使探针正确触碰到待检查对象的电极
If the position accuracy is low:
・It becomes impossible to connect the probe pin to the electrode for inspection.

技术资料 DRILLING DATA

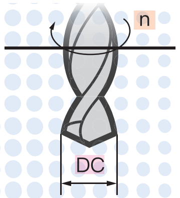
加工条件的计算公式
Formura for Drilling

■ 切削速度（周速）= vc　　Cutting Speed = vc

$$vc = \frac{\pi \cdot DC \cdot n}{1000} \quad (m/min)$$

※单位mm改为m时，除以1,000来表示

- vc (m/min)：切削速度　Cutting Speed
- π (3.14)　：圆周率　Pi
- DC (mm)　：钻径　Drill Diameter
- n $(min)^{-1}$：主轴转速　Main Axis Spindle Speed



(例) 主轴转速20,000min–1、钻头直径Φ0.300mm进行加工时。
求此时的切削速度。

$$vc = \frac{\pi \cdot DC \cdot n}{1000} = \frac{3.14 \cdot 0.300 \cdot 20000}{1000} = 18.84m/min$$

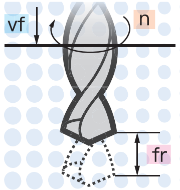
由此，算出切削速度为**18.84m/min**。

(Example) Drill holes with a spindle rotation of 20,000 min–1 and a hole diameter of ϕ0.300 mm.
The cutting speed at this time is calculated.
The cutting speed is 18.84 m/min.

■ 主轴进刀（进刀速度）= vf　　Feed of the main spindle = vf

$$vf = fr \cdot n \quad (mm/min)$$

- vf (mm/min)：主轴(Z轴)进刀速度　Feed Speed of the Main Spindle (Z axis)
- fr (mm/rev)：每转的进刀量　Feed amount per Revolution
- n $(min)^{-1}$：主轴转速　Main Axis Spindle Speed



(例) 每转进刀量0.005mm/rev、转速20,000min–1时求主轴进刀速度。

$$vf = fr \times n = 0.005 \times 20000 = 100mm/min$$

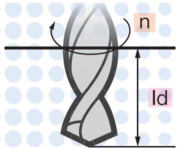
由此，求得主轴进刀速度为**100mm/min**。

(Example) The spindle feed rate when the feed rate per revolution is 0.005 mm/rev
and the rotation speed is 20,000 min–1.
The spindle feed is 100 mm/min.

■ 钻孔时间 = Tc　　Drilling time = Tc

$$Tc = \frac{ld \cdot i}{n \cdot fr} \quad (min)$$

- Tc (min)　：钻孔时间　Drilling Time
- n $(min)^{-1}$：主轴转速　Main Axis Spindle Speed
- ld (mm)　：孔深　Hole Depth
- fr (mm/rev)：每转的进刀量　Feed per Revolution
- i　：孔数　Number of Holes



(例) 如果用钻径Φ0.300mm的钻头、钻2.0mm深的孔，且
孔数200孔、切削速度18.84m/min、每转进刀量0.005mm/rev时、求此时的切削时间。

$$n = \frac{18.84 \cdot 1000}{0.300 \cdot 3.14} = 20000min^{-1} \rightarrow Tc = \frac{2.0 \times 200}{20000 \cdot 0.005} = 4min$$

由此，切削时间为 4 × 60 ≒ **240sec(1.2sec/hole)**。

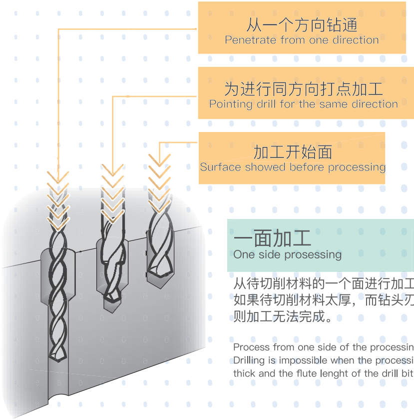
(Example) Make a hole of ϕ0.300 mm and depth of 2.0 mm in the processing material.
The number of holes is 200 holes, the cutting speed is 18.84 m/min,
and the feed rate is 0.005 mm/rev, and the cutting time at this time is calculated.
The cutting time is 4 x 60 ≈ 240 sec (1.2 sec/hole).

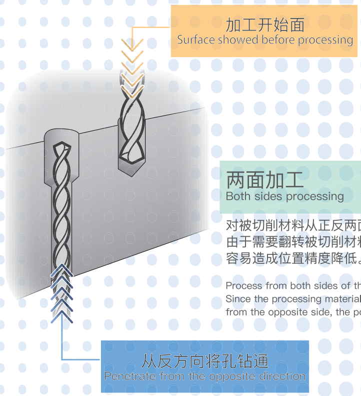
有关条件设定的专用词语
Technical terms for drilling condition

■ 转速 [rpm]　　The number of Rotations

每分钟主轴所转圈数
Rotation number per minute of spindle

■ 一面加工 · 两面加工　　One side prosessing · Both sides processing





一面加工
One side prosessing

从待切削材料的一个面进行加工。
如果待切削材料太厚，而钻头刃长不够长时
则加工无法完成。

Process from one side of the processing material.
Drilling is impossible when the processing material is
thick and the flute lenght of the drill bit is insufficient.

两面加工
Both sides processing

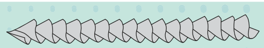
对被切削材料从正反两面进行加工。
由于需要翻转被切削材料从背面进行加工、
容易造成位置精度降低。

Process from both sides of the processing material.
Since the processing material is turned over and processed
from the opposite side, the position accuracy tends to be low.

■ 切屑（切粉）　　Excavated chips

切削加工时产生的无用屑末
Discharged chips

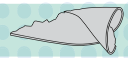
圆锥螺线型
Conical helical chips



当材料具有延展性且进刀较慢时会发生。
如果切屑可在数圈后折断则认为排屑性良好。

Fan– shaped chips cut by the cutting edge are curved by the flute. Chips of this type are produced when the feeding rate of ductile material is small.
If the chip breaks after several turns, the chip raking performance is satisfactory.

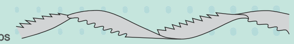
偏移折断形
Cutting off chips



在切屑由圆锥螺线形要变成长距形之前
由于被切削材料的延性不足而在孔内壁和钻头之间发生断裂的切屑。
切屑排出性、切屑处理均较好。

A conical spiral chip that is broken before the chip grows into the long– pich shape by the restraint caused by the wall of the drilled hole due to the insufficiency of ductility.
Exellent chip disposal and chip discharge.

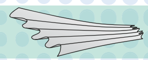
长距形
Long pitch helical chips



切屑直接排出而不形成螺旋状、
排出后易缠在钻头上。

The generated chip comes out without coiling. It will easily coil around the drill.

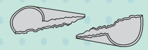
锯齿形
Folded ribon chips



根据刃槽形状以及被切削材的特性而弯曲并折叠的切屑。
易堆积于刃槽内。

A chip that is buckled and folded because of the shape of flute and the characteristics of the material.
It easily causes chip packing at the flute.

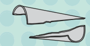
扇形
Fan chips



在孔内壁和钻头间发生断裂、进刀较快时易出现此种形状的切屑。
切屑处理良好。

This is a chip broken by the restraint caused by the drill flute and the wall of a drilled hole.
It is generated when the feed rate is high.

针状形
Acicular chips



加工硬脆材料、或有小半径弯曲发生时由于震动而断裂的切屑。
排出性比较好、但有时在刃槽内会有切屑堆积。

Chips broken by vibration or broken when brittle material is curled with a small radius.
The raking performance is satisfactory, but these chips can pack closely creating.

有关条件设定的专用词语
Technical terms for drilling condition

■ 上升速度 [m/min, mm/sec, Inch/min(IPM)] Retract rate

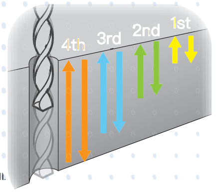
钻头上升时的速度
Retract speed after drilling

■ 主轴进刀（进刀速度）[m/min, mm/sec, Inch/min(IPM)] Feed rate

单位时间内的进刀距离
Vertical speed of drilling

■ 步进式加工（叨啄） Peck drilling

钻孔时，钻头所进行的切削与排屑的反复动作
To make a hole by repeating the movement of cutting and chip discharge



步进式钻孔的优点
Advantages of step drilling

- 放出孔内壁的摩擦热、进而防止被切削材料的变形。
  · The heat of the inner wall of the hole is released to prevent deformation of the processing material.
- 便于深孔加工时排出切屑。
  · Excellent chip discharge even in deep hole drilling.

步进式钻孔的缺点
Disadvantages of step drilling

- 因有不在切削的时间、所以与非步进式钻孔相比，加工时间会更长。
  · There is a time when without drilling is performed, and the processing time is longer than that in non-step processing.
- 因钻头尖端需反复钻击，钻头寿命会受一定的影响。
  · The tip drill has hit the processing material many times, might cause the breaking of the drill.

■ 进给量 [μm/rev, Mil/rev] Chipload

钻头每转一圈的进刀量
Feed amount per Revolution

■ 毛刺 Burr

被切削材料加工孔口处所出现的多余突起
An unwanted piece of material that occurs on the processed surface of a processing material

■ 击数 Number of Hits

钻头因钻击而接触被切削材的次数，反映钻头寿命的指数
Life of drill bit indicated by number of hits to material

单位换算 Unit Conversion

1m = 1000mm	1mm = 1000μm	1Feet = 304.8mm
=3.28Feet	=39.37mil	1Inch = 25.4mm
=39.37Inch		1mil = 25.4μm

MEMO

已发表于杂志上
Posted on magazine

登载于日刊工业新闻社【机械技术】2015 年 9 月号(2015 Vol.63 No.9)。第 47 页介绍到了工程微钻头 ®。
【特集】工作机械篇介绍了
小型精密加工机μV1 的特长与加工案例，
其中提到了所用工具即为先进的工程微钻头 ®，
并介绍了此钻头系列的规格与特长及加工效果。

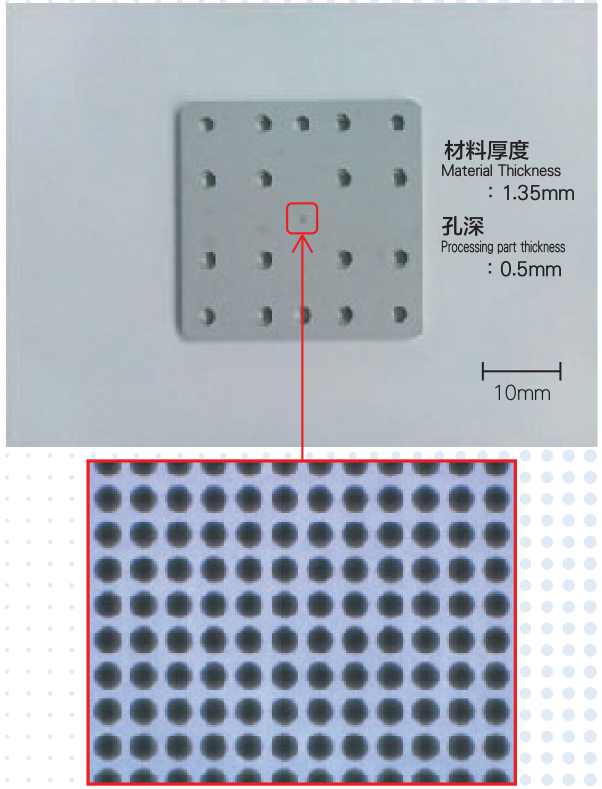
ENGINEERING DRILL® was posted on "Machine Technology" of NIKKAN KOGYO SHIMBUN, LTD on Sep, 2015. (2015 vol.63 No.9, Page47)
【Special Topic】Ultra precision and fine processing technology supporting the development of advanced products. Editing machine tools with the latest trend of machinery and tools, the article called "The features and processing examples of small precision processing machine μV1", it has been published about the features and processing examples of μV1 from MITSUBISHI HEAVY INDUSTRIES MACHINE TOOL in the article and also, the results of the processing experiment used ENGINEERING DRILL®s.

概　要

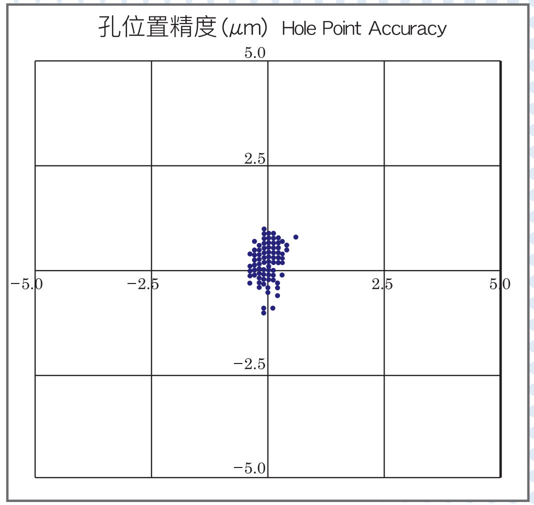
近年、随着电子产品的小型化不断进步，元部件也变得更加的精细化。
文章主要介绍了三菱重工μV1 机台为挑战不断进化的微细加工而具有的四大特长：主轴的安定性、高速追随性（HGP 控制）、机械刚性、CCD 摄像式工具测定系统。
文章还介绍了利用 FMD 公司的 QFD 系列的Φ0.025mm 微钻头，
μV1 机台的超高精度得到了具体的验证。请参照下页的加工实例说明。

Summary

Lately, electronic miniaturization has been a process of making parts more downsized. "Main spindle stability" by original technology, "High speed following capability" using HGP control, "Mechanical stiffness" enable to work both precision and rough process with one unit and, "optical image type tool measurement system" using CCD camera which measures thermal displacement of the main spindle and tools precisely. The article shows these festures of μV1 from MITSUBISHI and shows what they have been challenging to microfabrication. It is published about processing which used QFD series φ0.025 drill of FMD and verified the effect of the HGP control and "optical image type tool measurement system" using end mill.The next page is a processing example using QFD drills and μV1 similarly.



孔位置精度测量结果　Measurement result of Hole Point Accuracy



测定仪器：Nikon CNC 图像测量系统 NEXIV
Measuring Instrument：NICON NEXIV (CNC Image measurement system)