

NS TOOL

CORE LINE

For Crafting Tomorrow

PCD

PCD END MILL SERIES Vol.3

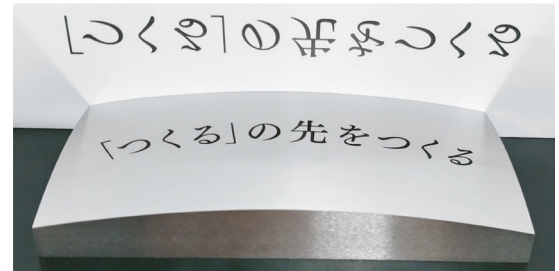


Achieve a higher level finishing surface by machining centers

PCD Ball End Mill

PCDRB

R0.05 ~ R3
Total 13 sizes



PCD Square End Mill

PCDSE

ϕ 0.1 ~ ϕ 1
Total 8 sizes



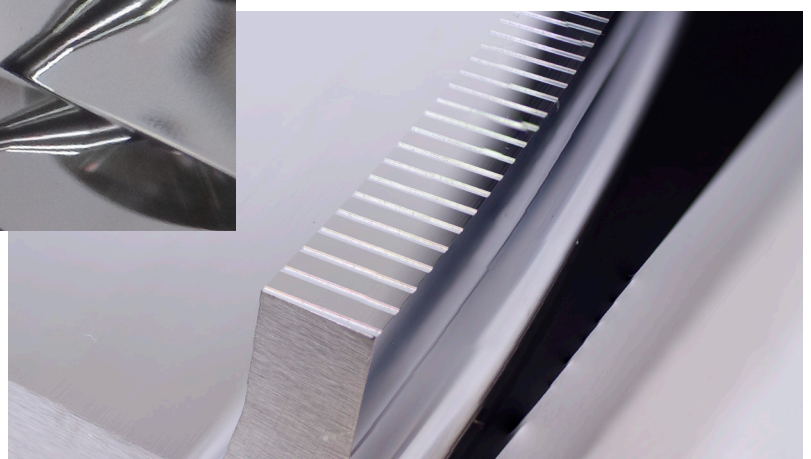
PCD Corner Radius End Mill

PCDRS

ϕ 0.3xR0.05 ~ ϕ 1xR0.1
Total 10 sizes



Reduce polishing time by machine centers for various shapes



Mirror surface machining

PCD end mill realizes excellent mirror-like surface

PCD ball end mills and radius end mills further improve mirror-like surface and surface roughness



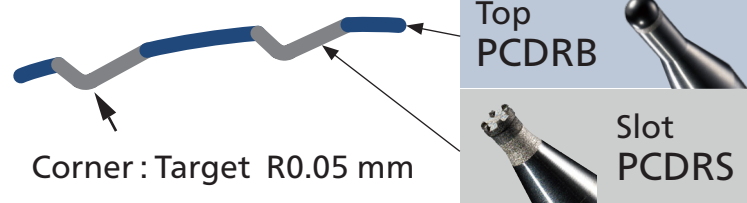
Work material: STAVAX (52HRC)
 Work size : 150x50x40 mm
 Coolant: Oil-mist

Water-insoluble fluid
 (PCDRB PCDRS)

Total machining time: 64hr 50min
 ※Machined by 5-axis

	Reflection on the surface	Measuring position	Surface roughness Ra [μm]	Corner: Target R0.05 [mm]
Beginning		Top	0.016	R0.052
		Slot	0.019	
End		Top	0.014	R0.051
		Slot	0.018	

Cross section



Machining Position								
Process	Roughing	Semi-Roughing	Roughing	Semi-Finishing	Finishing	Semi-Finishing	Finishing	Finishing
Tool	MRBSH230SF R1.5 x 6	MRBSH230SF R1.5 x 6	MHRSH430SF φ1xR0.05x2	SSPB220 R1.5 x 6		SHPR400 φ1xR0.05x1	PCDRB R1.5 x 7.5	PCDRS φ1xR0.05x1
Spindle speed [min ⁻¹]	20,000	20,000	20,000	24,000	24,000	40,000	30,000	40,000
Feed [mm/min]	3,000	1,600	1,000	1,400	1,400	600	700	300
Depth of cut ap x ae [mm]	0.2 x 0.8	0.06 x 0.06	0.15 x 0.01	ae 0.03	0.03x0.03	0.003x0.005	ae 0.006	0.001x0.003
Stock [mm]	0.08	0.035	0.01	0.005	-	0.004	-	0.002 → 0 Two sides
Machining time	6hr 5min	2hr 30min	2hr 40min	50 min	5hr 10min	5hr 45min	6hr 10min	35hr 40min

Achieve a higher level finishing surface by machining centers

PCD Ball End Mill

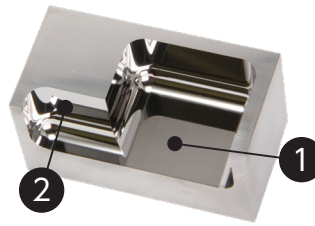
PCDRB

Size R0.05 ~ R3



Work material : HAP40 (64HRC)
 Work size : 50x25mm
 (Machining depth : 15mm)
 Coolant : Water-insoluble fluid
 Total machining time : 8hr 15min

High-quality mirror machining is achieved by exposing diamond particles to the surface and setting the R accuracy of the ball radius to ± 0.003 mm

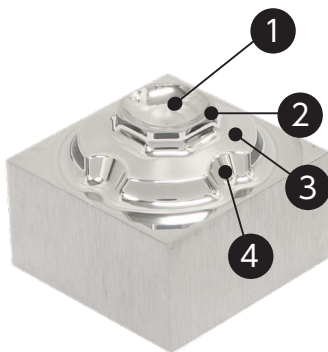


Surface Roughness		Unit [μm]
Measuring position		Ra
① Bottom		0.023
② Side		0.004



Mirror surface that also reflects the NS TOOL logo

Process	Roughing	Semi-Finishing ①	Semi-Finishing ②	Semi-Finishing ③	Finishing
Tool	MRBSH230SF R3 x 15	MRBSH230SF R3 x 15	MRBSH230SF R3 x 15	SSPB220 R3 x 18	PCDRB R3 x 15
Spindle speed [min^{-1}]	7,000	7,000	7,000	10,000	16,000
Feed [mm/min]	2,000	1,500	1,000	600	700
Depth of cut $a_p \times a_e$ [mm]	0.2 x 0.3	pf 0.1 Cutting depth 0.15	pf 0.06 Cutting depth 0.065	pf 0.04 Cutting depth 0.03	pf 0.009 Cutting depth 0.005
Stock [mm]	0.25	0.1	0.035	0.005	-
Machining time	1 hr	20 min	50 min	1hr 25min	4hr 40min



PCDRB R0.5

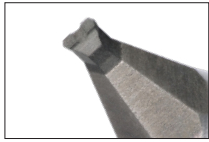
Surface Roughness		Unit [μm]
Measuring position		Ra
① Lens part		0.038
② Incline 0°		0.014
③ Incline 15°		0.022
④ Incline 60°		0.009

Work material :
 Cemented Carbide (92.5HRA)
 Work size : 10x10mm
 (Machining depth 2.5mm)
 Coolant : Water-insoluble fluid
 Total machining time : 5hr 9min

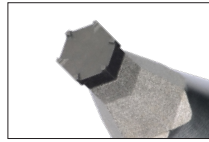
Process	Roughing	Semi-Finishing	Finishing
Tool	DCMB R0.75	DCMB R0.5	PCDRB R0.5 x 2.5
Spindle speed [min^{-1}]	30,000	30,000	40,000
Feed [mm/min]	300	300	300
Depth of cut $a_p \times a_e$ [mm]	0.03 x 0.15	0.01 x 0.01	0.003 x 0.005
Stock [mm]	0.013	0.003	-
Machining time	1hr 40min	1hr 17min	2hr 12min

PCD Square End Mill

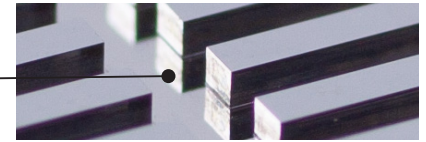
PCDSE Size ϕ 0.1 ~ ϕ 1



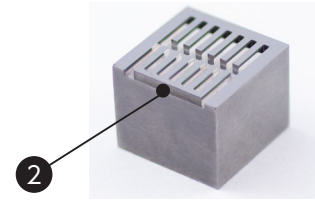
Cutting edge shape
2-Flute



Cutting edge shape
6-Flute



PCDSE ϕ 0.5



Surface Roughness

Unit [μ m]

Measuring position	Ra	Rz
① Bottom	0.0007	0.008
② Side	0.017	0.096

Work material :
Cemented Carbide(92.5HRA)
Work size : 10x10mm
(Machining depth 0.5mm)
Coolant : Water-insoluble fluid
Total machining time : 21hr 59min

Process	Roughing	Contour line Finishing	Bottom Finishing
Tool	DCMS ϕ 0.3	PCDSE ϕ 0.5	
Spindle speed [min ⁻¹]	120,000	120,000	120,000
Feed [mm/min]	150	100	50
Depth of cut ap x ae [mm]	0.0015 x 0.1	0.002 x 0.001	0.0005 x 0.002
Stock [mm]	Side 0.001 Bottom 0.0005	-	-
Machining time	10hr 57min	11hr 2min	

PCD Corner Radius End Mill

PCDRS Size ϕ 0.3xR0.05 ~ ϕ 1xR0.1



Cutting edge shape
2-Flute



Cutting edge shape
4-Flute



Cutting edge shape
6-Flute



PCDRS ϕ 0.5xR0.1xUnder neck length0.5

Work material : Cemented Carbide(92.5HRA)
Work size : 10x10mm
(Machining depth 0.864mm)
Coolant : Water-insoluble fluid
Total machining time : 5hr 12min



Surface Roughness

Unit [μ m]

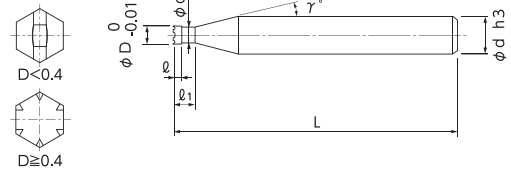
Measuring position	Ra	Rz
① Bottom	0.0027	0.0192

Process	Roughing		Semi-Finishing			Finishing	
	Contour line	Scanning line	Contour line	Contour line	Scanning line	Contour line	Scanning line
Tool	DCMB R1		DCMB R0.5	DCMS ϕ 1 x 2		PCDRS ϕ 0.5 x R0.1 x 0.5	
Spindle speed [min ⁻¹]	30,000		40,000	20,000		40,000	
Feed [mm/min]	350	200	200	120		120	
Depth of cut ap x ae [mm]	0.04 x 0.15	ae 0.1	ap 0.02	ap 0.002	0.002 x 0.05~0.1	ap 0.008	ae 0.02
Stock [mm]	0.005	0.005	0.001	0.001	0.001	-	-
Machining time	45 min		36 min	1hr 6min		1hr 40min	

PCD Square End Mill

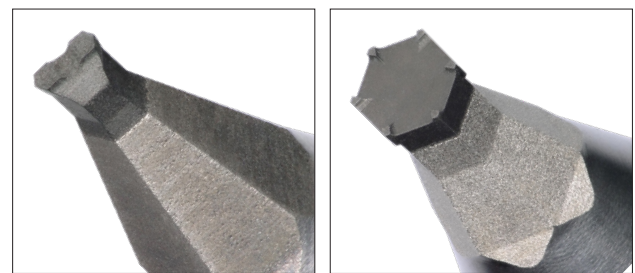
Total 8 sizes

PCD square end mill
Realized nano level finished surface roughness on hard brittle materials



- Fine and stable milling surface realized on cemented carbide material.
- Possible to get the nano-level surface roughness required on ultra-high precision machining.
- NS original flute design of cutting edge enabled a strong resistance against wear and chipping.

Work Material



Cutting edge shape 2-Flute

Cutting edge shape 6-Flute

ϕ 0.498



Actual diameter is indicated in 1 micron units on product label, and enables high precision machining.
※Micron units dimensions cannot be specified.

Unit [Size : mm]

Code No.	Dia. (D)	Under Neck Length (ℓ1)	Length of Cut (ℓ)	Neck Dia. (d2)	Neck Taper Angle (γ)	Shank Dia. (d)	Overall Length (L)	Number of Flute
04-00300-00100	0.1	0.1	0.02	0.09	15°	4	48	2
04-00300-00200	0.2	0.2	0.04	0.18	15°	4	48	2
04-00300-00300	0.3	0.3	0.06	0.27	15°	4	48	2
04-00300-00400	0.4	0.4	0.08	0.36	15°	4	48	6
04-00300-00500	0.5	0.5	0.1	0.45	15°	4	48	6
04-00300-00600	0.6	0.6	0.12	0.54	15°	4	48	6
04-00300-00800	0.8	0.8	0.16	0.72	15°	4	48	6
04-00300-01000	1	1	0.2	0.9	15°	4	48	6

How to Order

When you order, indicate PCDSE (D).

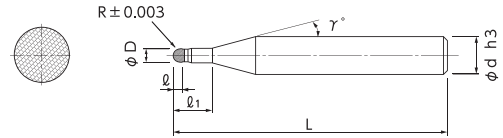
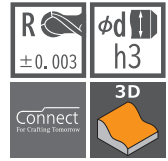
※(γ) is reference value.

Work Material	Cemented Carbide (~92.5HRA)		
	Depth of Cut	Spindle Speed	Feed
Dia.	a_p mm	min^{-1}	mm/min
0.1	0.0002	40,000	25
0.2	0.0002	40,000	25
0.3	0.0002	40,000	25
0.4	0.0005	40,000	50
0.5	0.0005	40,000	50
0.6	0.0005	40,000	50
0.8	0.0005	40,000	50
1	0.0005	40,000	50
Notes	<p>※1 Minimum tool runout is required to avoid the tool breakage and to increase the work accuracy. ※2 Due to infinitesimal Depth of Cut (a_p), recommend to assess the machine characters, such as expansion of the spindle and others before using the tool. ※3 Water-insoluble fluid is recommended. ※4 a_p : Axial Depth of Cut.</p>		

PCD Ball End Mill

Total 13 sizes

Capable to machine nano level surface roughness, and mirror finishing



- Unique tool geometry makes stable surface.
- Polish-less machining become reality by nano-level roughness on profiling finish.

Work Material

Hardened Steel (~70HRC) H	Hard Brittle Material O
◎	◎



Cutting edge shape



Actual diameter is indicated in 1 micron units on product label, and enables high precision machining.

※Micron units dimensions cannot be specified.

Unit [Size : mm]

Code No.	Radius (R)	Under Neck Length (l ₁)	Length of Cut (l)	Dia. (D)	Neck Taper Angle (γ)	Shank Dia. (d)	Overall Length (L)
04-00500-00501	R0.05	0.15	0.05	0.1	15°	4	48
04-00500-00502		0.25	0.05	0.1	15°	4	48
04-00500-00751	R0.075	0.23	0.075	0.15	15°	4	48
04-00500-00752		0.38	0.075	0.15	15°	4	48
04-00500-01001	R0.1	0.5	0.1	0.2	15°	4	48
04-00500-02001	R0.2	1	0.2	0.4	15°	4	48
04-00500-03001	R0.3	1.5	0.3	0.6	15°	4	48
04-00500-05001	R0.5	2.5	0.5	1	15°	4	50
04-00500-07501	R0.75	3.8	0.75	1.5	15°	4	48
04-00500-10001	R1	5	1	2	15°	4	48
04-00500-15001	R1.5	7.5	1.5	3	15°	6	59
04-00500-20001	R2	10	2	4	15°	6	60
04-00500-30001	R3	15	3	6	-	6	62

How to Order

When you order, indicate PCDRB (R)×(l₁).

※ (γ) is reference Value.

Work Material		Hardened Steels・High Speed Tool Steels (~70HRC)					Cemented Carbide (~92.5HRA)				
Radius	Under Neck Length	Stock	Depth of Cut		Spindle Speed	Feed	Stock	Depth of Cut		Spindle Speed	Feed
		mm	a _p mm	a _e mm	min ⁻¹	mm/min	mm	a _p mm	a _e mm	min ⁻¹	mm/min
0.05	0.15	0.001	0.001	0.001	40,000	50	0.001	0.001	0.001	40,000	50
	0.25	0.001	0.001	0.001	40,000	25	0.001	0.001	0.001	40,000	25
0.075	0.23	0.001	0.001	0.001	40,000	100	0.001	0.001	0.001	40,000	100
	0.38	0.001	0.001	0.001	40,000	50	0.001	0.001	0.001	40,000	50
0.1	0.5	0.001	0.001	0.001	40,000	100	0.001	0.001	0.001	40,000	100
0.2	1	0.002	0.002	0.002	40,000	200	0.002	0.001	0.002	40,000	150
0.3	1.5	0.003	0.003	0.003	40,000	400	0.002	0.002	0.002	40,000	200
0.5	2.5	0.005	0.005	0.005	40,000	500	0.003	0.003	0.003	40,000	300
0.75	3.8	0.005	0.005	0.005	40,000	600	0.004	0.004	0.004	40,000	400
1	5	0.005	0.005	0.005	40,000	800	0.005	0.005	0.005	40,000	500
1.5	7.5	0.005	0.006	0.006	30,000	800	0.005	0.005	0.005	30,000	500
2	10	0.005	0.007	0.007	22,000	800	0.005	0.006	0.006	20,000	500
3	15	0.005	0.009	0.009	16,000	800	0.005	0.007	0.007	12,000	500

Notes

※1 a_p: Axial Depth of Cut, a_e: Radial Depth of Cut.
 ※2 Described Depth of Cut is max value. Adjust it depending on machine rigidity, main spindle rigidity, and required precision.
 ※3 Obtain uniform stock amount on the cutting surface in the pre-stage cutting (semi-finishing).
 ※4 In order to perform lubricity and chip flow well, coolant must be always reached cutting points.
 ※5 Careful set up for milling condition and tool path are required especially when operate with high cutting load such as corner area and slotting.
 ※6 Water-insoluble fluid is recommended.
 ※7 Using water-insoluble fluid could lead to fires due to sparks generated during machining or heat caused by breakage. Ensure that you take proper fire-prevention measures.

NS
TOOL

Connect
For Crafting Tomorrow

Connect to information

Leads to various tool information

From 2D barcode on back of product case



Features



Size and Milling conditions

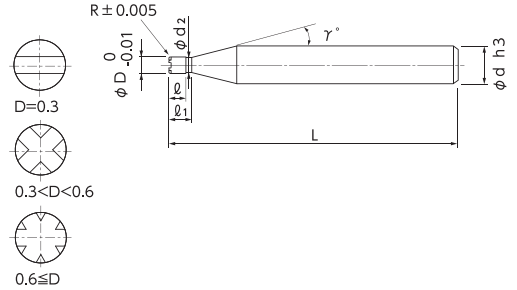
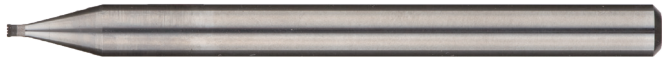
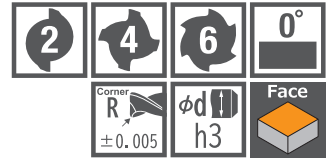
Video etc



PCD Corner Radius End Mill

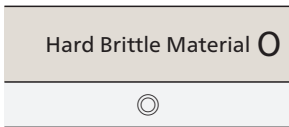
Total 10 sizes

PCD corner radius end mill
Realized nano level finished surface roughness on hard brittle materials



- Adopt high rigid tool design and specialized flat shape with optimized end tooth to realize nano-level surface roughness.

Work Material



Cutting edge shape 2-Flute



Cutting edge shape 4-Flute



Cutting edge shape 6-Flute



Actual diameter is indicated in 1 micron units on product label, and enables high precision machining.
※Micron units dimensions cannot be specified.

Unit [Size : mm]

Code No.	Dia. (D)	Corner Radius (R)	Under Neck Length (l1)	Length of Cut (l)	Neck Dia. (d2)	Neck Taper Angle (γ)	Shank Dia. (d)	Overall Length (L)	Number of Flute
04-00700-03050	0.3	R0.05	0.3	0.09	0.27	15°	4	48	2
04-00700-04050	0.4	R0.05	0.4	0.12	0.36	15°	4	48	4
04-00700-05050	0.5	R0.05	0.5	0.15	0.45	15°	4	48	4
04-00700-05100		R0.1	0.5	0.15	0.45	15°	4	48	4
04-00700-06050	0.6	R0.05	0.6	0.18	0.54	15°	4	48	6
04-00700-06100		R0.1	0.6	0.18	0.54	15°	4	48	6
04-00700-08050	0.8	R0.05	0.8	0.24	0.72	15°	4	48	6
04-00700-08100		R0.1	0.8	0.24	0.72	15°	4	48	6
04-00700-10050	1	R0.05	1	0.3	0.9	15°	4	48	6
04-00700-10100		R0.1	1	0.3	0.9	15°	4	48	6

How to Order

When you order, indicate PCDRS (D)×(R×l).

※(γ) is reference value.

Work Material		Cemented Carbide (~92.5HRA)			
Dia.	Corner Radius	Depth of cut for Finishing		Spindle Speed	Feed
		a_p mm	a_e mm	min^{-1}	mm/min
0.3	R0.05	0.001	0.005	50,000	50
0.4	R0.05	0.001	0.01	50,000	100
0.5	R0.05	0.001	0.01	50,000	100
	R0.1	0.001	0.015	50,000	150
0.6	R0.05	0.001	0.01	50,000	100
	R0.1	0.001	0.015	50,000	150
0.8	R0.05	0.001	0.015	50,000	150
	R0.1	0.001	0.03	50,000	200
1	R0.05	0.001	0.015	50,000	150
	R0.1	0.001	0.03	50,000	200
Notes		※1 Minimal tool runout is required to avoid the tool breakage and to increase the work accuracy. ※2 Due to infinitesimal Depth of Cut (a_p), recommend to assess the machine characters, such as expansion of the spindle and others before using the tool. ※3 Water-insoluble fluid is recommended.			

Machining case 1

SD Card model Cemented carbide (92.5HRA)

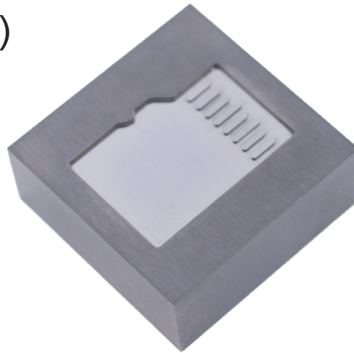
In the finishing of cemented carbide, PCDSE realizes surface roughness nano-level machining

Work material : Cemented carbide(92.5HRA)

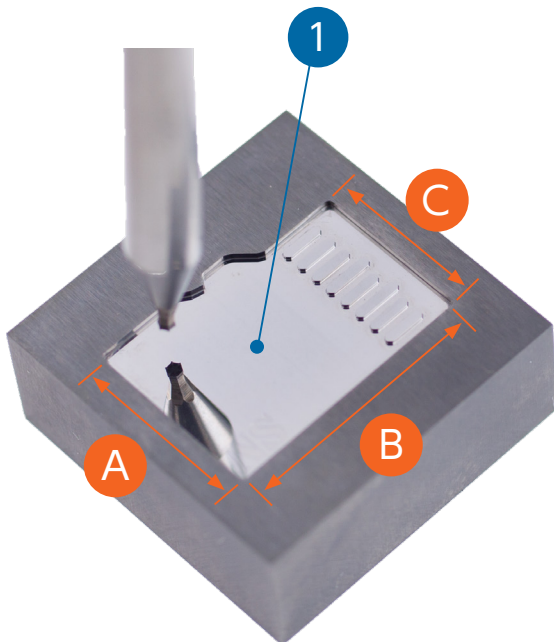
Work size : 20 x 20 mm
(Machining depth 0.415 mm)

Coolant : Water-insoluble fluid

Total machining time : 24hr 30min



PCDSE



Surface Roughness

Unit [μm]

Measuring position	Ra	Rz
1	0.002	0.02

Accuracy

Unit [mm]

Measuring position	Target	Actual	Error
A	10.769	10.768	- 0.001
B	15.000	15.003	+ 0.003
C	9.423	9.425	+ 0.002

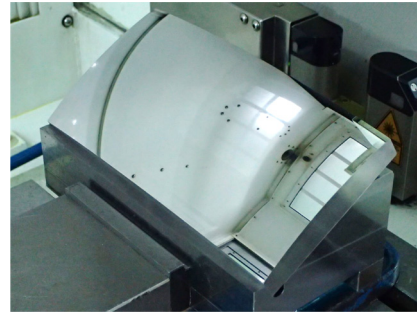
Process	Roughing	Semi-Finishing	Finishing
Tool	DCMS $\phi 0.5$	DCMS $\phi 0.5$	PCDSE $\phi 0.5$
Spindle speed [min^{-1}]	20,000	20,000	40,000
Feed [mm/min]	150	150 ~ 300	100 ~ 200
Depth of cut $a_p \times a_e$ [mm]	0.002×0.3	$0.002 \times$ $0.002 \sim 0.05$	$0.0005 \sim 0.002 \times$ $0.001 \sim 0.025$
Stock [mm]	0.003	$0.0005 \sim 0.002$	-
Machining time	14 hr	2hr 30min	8 hr

Machining case 2

Head up display STAVAX (52HRC)

Finished surface looks “smooth, even and shiny”
 such as the mirror surface realized by milling process
 Achieves surface roughness Ra 0.011 μm or less

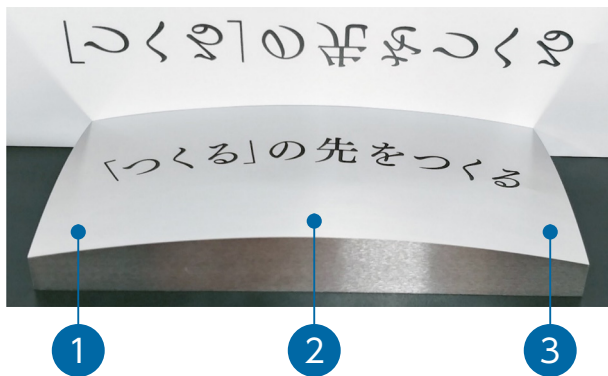
Work material : STAVAX (52HRC)
 Work size : 200 × 100 × 30 mm
 Coolant : Water-insoluble fluid
 ※Uses oil mist except for the semi-finishing and finishing process
 Total machining time : 66hr 50min



PCDRB




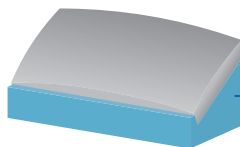
Mirror surface that also reflects the letter



Surface Roughness

Unit [μm]

Measuring position	Ra
1	0.010
2	0.010
3	0.011

Process	Roughing	Semi-Roughing	Semi-Finishing	Finishing
Process set up	Horizontal to X-Y Plane 	Machining without using the center of the tool tip Set up with inclined 30° 		
Tool	MRB5H230SF R3 × 10	MRB5H230SF R3 × 10	SSPB220 R3 × 12	PCDRB R3 × 15
Spindle speed [min ⁻¹]	16,000	10,000	16,000	16,000
Feed [mm/min]	3,000	2,000	1,400	700
Depth of cut ap × ae [mm]	0.3 × 2	ae 0.15	ae 0.05	ae 0.009
Stock [mm]	0.1	0.04	0.005	-
Machining time	2 hr	1hr 35min	5hr 40min	57hr 35min

Machining case 3

Cone model ELMAX (57HRC)

Unique cutting edge and high accuracy R of $\pm 0.003\text{mm}$ realize high quality mirror surface machining

Work material : ELMAX (57HRC)
 Work size : 40 × 35 mm
 (Machining depth 28 mm)
 Coolant : Water –insoluble fluid
 ※ Uses oil mist except for the finishing process
 Total machining time : 12hr 5min

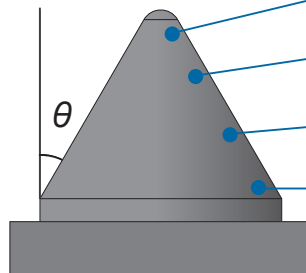


PCDRB



Accuracy (Inclined angle θ)

Target	Actual	Error
30°	29°59'28"	0°0'32"



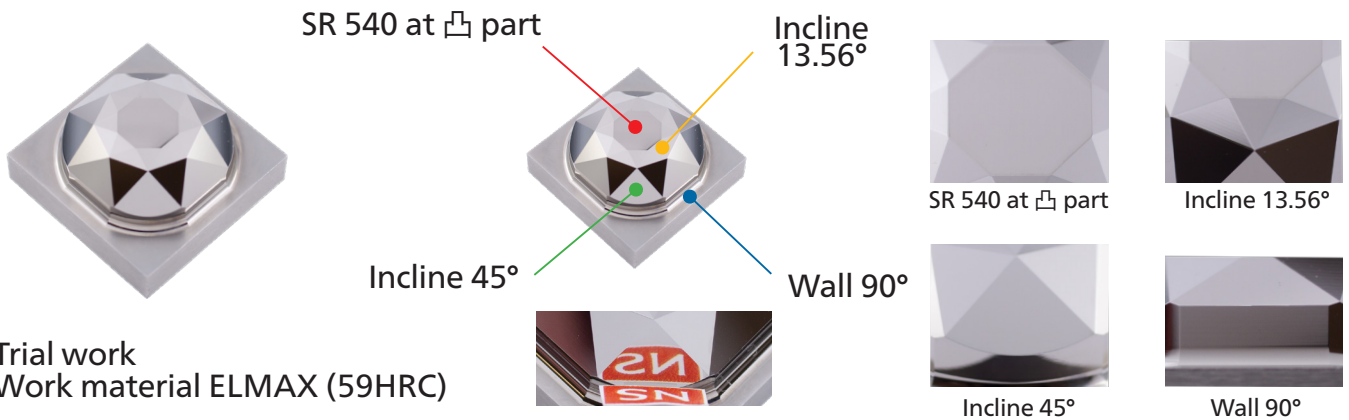
Surface Roughness

Measuring position	Unit [μm]	
	Ra	Rz
1	0.017	0.114
2	0.015	0.108
3	0.013	0.091
4	0.011	0.079

Mirror surface that also reflects the NS TOOL logo

Process	Roughing ①	Roughing ②	Semi-Finishing ①	Semi-Finishing ②	Finishing
Tool	MHDH645R $\phi 6 \times R0.5$	MSBH345 R3	MSBH230 R1.5		PCDRB R1.5
Spindle speed [min ⁻¹]	6,000	7,000	30,000	30,000	30,000
Feed [mm/min]	1,200	1,400	1,300	800	800
Depth of cut ap × ae [mm]	4.5 × 0.6	0.15 × 1.2	ap 0.1	ap 0.05	pf 0.006
Stock [mm]	-	0.05	0.02	0.005	-
Machining time	3hr 15min	1hr 57min	15 min	49 min	5hr 49min

NS TOOL provides a trial kit included tools, work material and NC program for whom begin to use PCD end mill



Trial work
Work material ELMAX (59HRC)

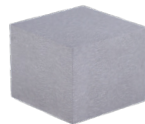
Process	Roughing	Semi-Finishing	Finishing
Tool	MRBH230 R1 x 4	SSPB220 R1 x 4	PCDRB R0.75 x 3.8
Spindle speed [min ⁻¹]	31,000	31,000	31,000
Feed [mm/min]	2,500	1,000	450
Depth of cut ap x ae [mm]	0.2 x 0.5	pf 0.03 Cutting depth 0.025 (SR540 Part 0.028)	pf 0.005 Cutting depth 0.005 (SR540 Part 0.002)
Stock [mm]	0.03	0.005 (SR540part 0.002)	-
Machining time	48 min	1hr 33min	9hr 43min

PCD Trial Kit

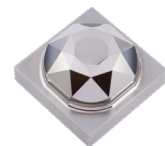


Set Contents

PCD Ball End Mill PCDRB R0.75 x 3.8
CBN Ball End Mill SSPB220 R1 x 4
2-flute carbide end mill MRBH230 R1 x 4



Work material of trail
ELMAX (59HRC)
25x25x20mm

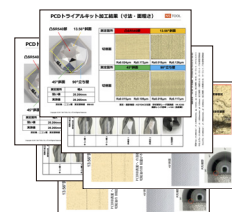
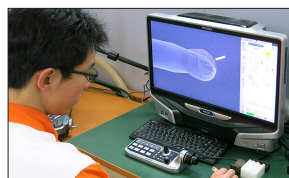
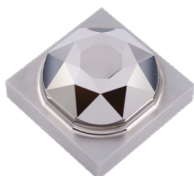


After machining



NC program data

※ Available for download from our official website.



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Attention on Safety

- 1) When removing tools from cases, be careful of getting-out of tools and don't touch directly the cutting edges.
- 2) Never touch the cutting edges directly with bare hand.
- 3) Use safety covers and eye protection, as tools may be broken.
- 4) Use holders, etc. that match the tools and nature of the machining operations.
The tool should be firmly attached to the holder to prevent shaking.
- 5) The work materials clamp firmly.
- 6) Make sure of dimensions of tools and work pieces before starting operation.
- 7) It is necessary to adjust conditions according to the dimensions of work materials and the machine.
- 8) Select a cutting fluid appropriate to the particular usage. Using water-insoluble fluid could lead to fires due to sparks generated during machining or heat caused by breakage.
Ensure that you take proper fire-prevention measures.
- 9) If abnormal sound, etc. occurs during machining, stop the machine immediately.
- 10) Don't modify tools.