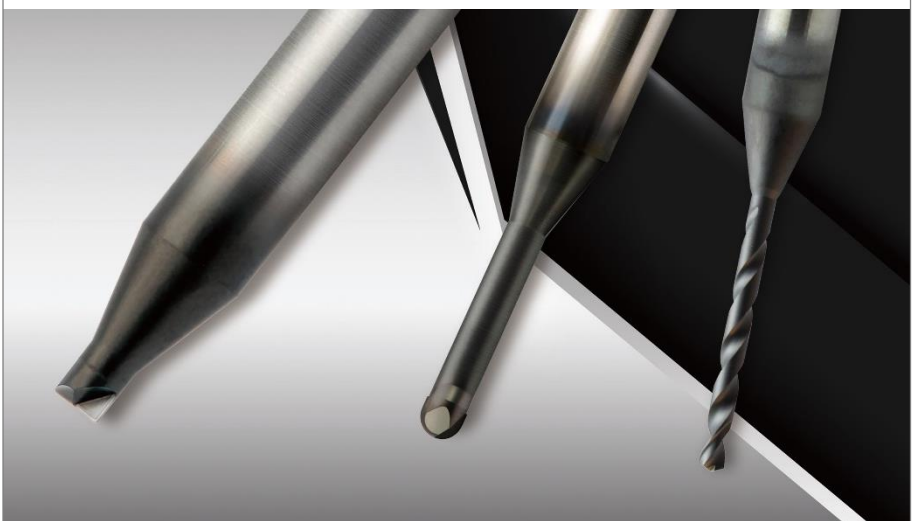
“For significant cost reduction and shortened cycle time”

UDC
ULTRA DIAMOND COAT



～ UDC Series ～

For direct milling WC（Hard brittle material）

We have summarized it as a “How to use”
so that you can use UDC series well

How to use

UNION TOOL CO.

Choose by application

～ Please choose the appropriate tools for your purposes ～

	For highly efficient roughing and semi-finishing	For better surface finishing	For cost saving purposes
	【H series】 (New edge treatment)	【F series】	
Ball	UDCBH UDCLBH	UDCBF UDCLBF	UDCB UDCLB
Radius	NEW UDCRRS	UDCLRSF	UDCLRS
	For drilling processes	For threading	
	UDCMX	UDCT	

Study case (Roughing – Semi-finishing – Finishing)

For efficient and high precision process,
It had better to choose the appropriate tools for each process.

～ Milling example for Bevel gear ～

Roughing ~ Semi-finishing : UDCLB
Finishing : UDCLBF

<Condition>
Work material : Cemented carbide VU-70（83HRA）
Size : Φ44 X 12.75 mm
Coolant : Air blow

工程名	工具形状	型番・サイズ	回転数 (min^{-1})	送り速度 (mm/min)	軸方向 a_p(mm)	径方向 a_e(mm)	仕上げ代 (mm)	工具本数	切削時間
荒	2枚刃ロングネックボール	UDCLB R2×L8	8,250	300	0.5	0.2	0.03	3	2:12:31
	〃	UDCLB R2×L10	8,250	300	0.5	0.2	0.03	2	0:29:24
中荒	〃	UDCLB R1.5×L6	11,000	280	0.38	0.15	0.03	1	0:22:33
	〃	UDCLB R1.5×L10	11,000	280	0.3	0.15	0.03	1	0:23:27
中仕上げ	〃	UDCLB R1.5×L10	11,000	280	(0.005)	–	0.015	1	1:08:35
	〃	UDCLB R1.5×L10	11,000	280	(0.002)	–	0.005	1	1:36:52
隅取り	〃	UDCLB R1×L6	16,500	420	0.12	0.05	0.015	1	0:52:28
	〃	UDCLB R1×L8	16,500	420	0.12	0.05	0.015	1	0:49:56
	〃	UDCLB R1×L8	16,500	420	0.09	–	0.005	1	1:09:32
仕上げ	2枚刃ハイグレードロングネックボール	UDCLBF R1×L8	20,000	200	–	0.12	0	1	0:41:20
	〃	UDCLBF R1×L8	20,000	200	(0.001)	–	0	2	3:39:54
	〃	UDCLBF R1×L8	20,000	200	0.09	–	0	1	0:34:00
	〃	UDCLBF R1×L8	20,000	200	–	0.08	0		1:04:00
							Total	16	15:04:32

16 pcs, completed in 15 hours

(First trial … 30 pcs, 35 hours. About 60% reduction !)

NEW

New released UDCRRS improves the roughing process efficiency dramatically.
Please consider it.
(Milling example in P16, 17)

Classification of Cemented carbide

Cemented carbide is classified by component, WC average particle size, hardness.

Classification of cemented carbide (TAS, Tool Association Standard)

TAS 7000 Excerpt from the grade selection criteria for cemented carbide and ultrafine particle cemented carbide for wear and impact resistant tools

Roughly classified into 3 types in the type of component, and then middlely classified into 4 types in WC average particle size and further classified into 8 types according to the hardness. No correlation with JIS B 4053.

E.g.) V M – 4 0

Symbol	Component
V	Co
R	Co ／ Ni
N	Ni

Symbol	WC average particle size (μm)
F	smaller than 1.0
M	1.0 to 2.5
C	2.5 to 5.0
U	5.0 or more

Symbol	Nominal hardness (HRA)
10	93 or more
20	92 to 93
30	91 to 92
40	89 to 91
50	87 to 89
60	85 to 87
70	82 to 85
80	Smaller than 82

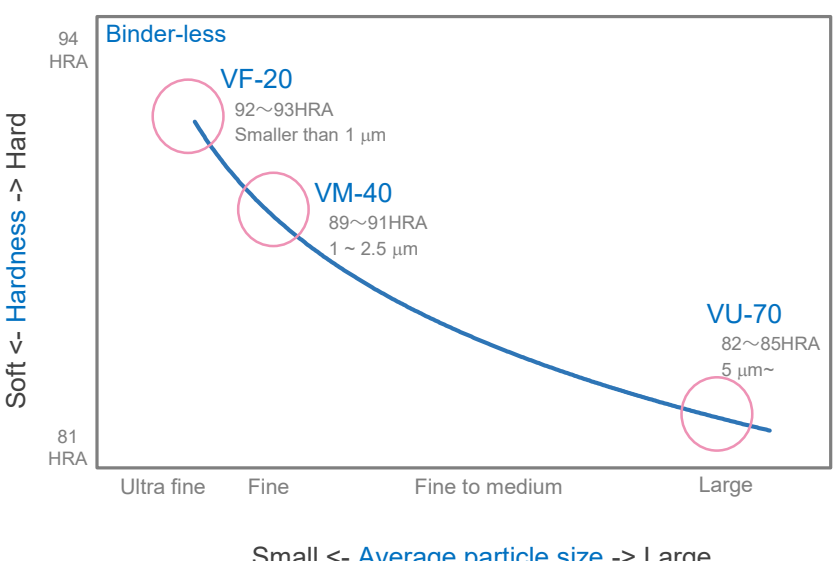
Characteristics of cemented carbide

Characteristics (= Processability) differ by the type of cemented carbide.

Example of grade classification symbol

Symbol	Component	WC average particle size (μm)	Nominal hardness (HRA)
VF-10	Co	Smaller than 1.0	93 or more
VF-20	Co	Smaller than 1.0	92 to 93
VF-30	Co	Smaller than 1.0	91 to 92
VM-40	Co	1.0 to 2.5	89 to 91
VU-70	Co	5.0 or more	82 to 85

Relationship between particle size and hardness



Removal volume of cemented carbide

We recommend that you select a material with workability while considering the required performance (Ex. Mold life)

～ Removal volume comparison ～

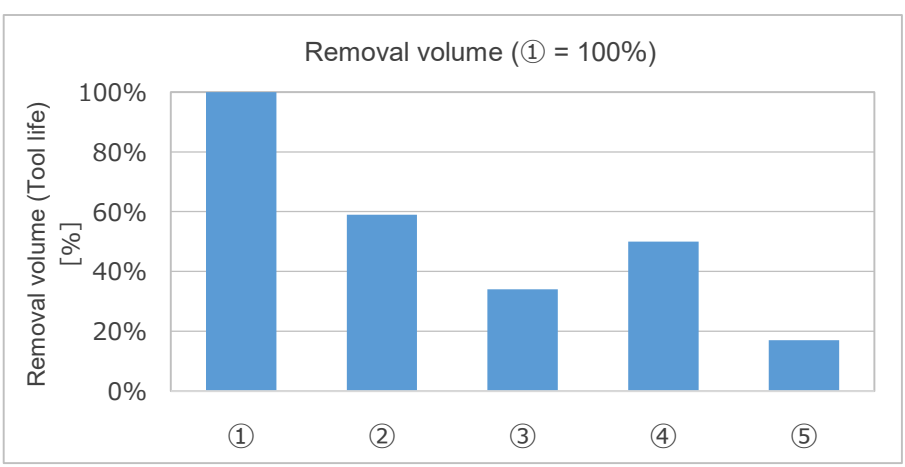
<Condition>

Tool : UDCB 2010-0070(R0.5)
Work material : Cemented carbide(Below)
Coolant : Oil mist
Milling method : Pocket milling

n : 30,000 min^{-1}
Vf : 300 mm/min
ap : 0.1 mm
ae : 0.05 mm

WC	Symbol	Density g/cm^3	Hardness HRA	Anti breaking force MPa	Compressive strength MPa	Co amount* %	Particle size μm
①	VF-20	14.1	92.5~ 93.0	4,500~ 5,000	–	12.0	0.5
②	VM-40	14.7	90.0	3,240	4,700	8.8	2~3
③	VM-40	14.3	89.0	3,400	–	13.6	–
④	VM-50	14.2	87.5	3,160	4,070	15.1	–
⑤	–	13.1	83.0	2,660	2,800	28.9	–

* In-house measurement



* The ratio depends on the series and tool shapes.

Difference by the MC

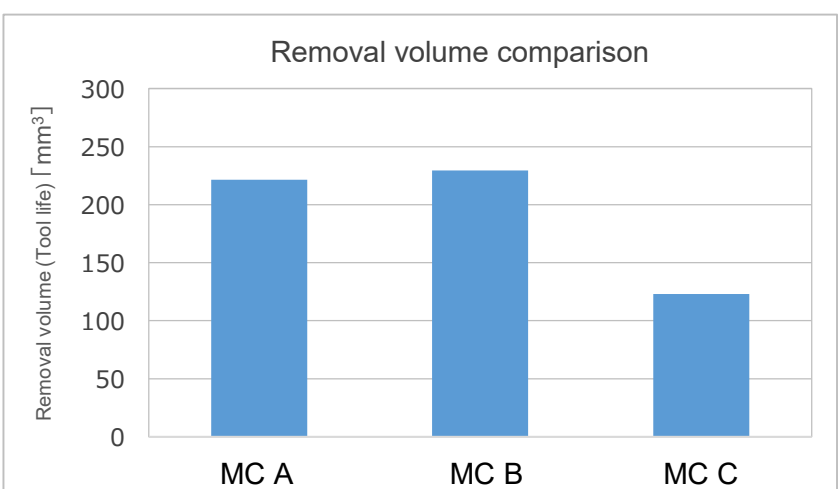
Depending on the difference of MC,
process quality and tool life might be difference.

～ Removal volume comparison ～

<Condition>

Tool : UDCB 2010-0070(R0.5)
Work material : Cemented carbide VM-40
Coolant : Air blow (Adjusted to be about the same on each machine)
Milling method : Pocket (8.2mm^3)

		MC A	MC B	MC C
Spindle Speed	min^{-1}	30,000		
Feed Rate	mm/min	300		
ap	mm	0.1		
ae	mm	0.25		
No. of Pockets	Pockets	27	28	15
Removal volume	mm^3	221.4	229.6	123.0



Difference by the MC (Supplement)

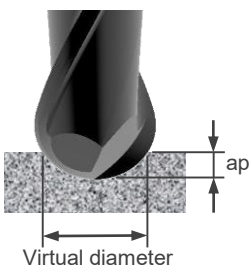
We recommend the high rigidity machine
Since the cemented carbide has high cutting resistance.

～ Cutting resistance comparison (Slotting) ～

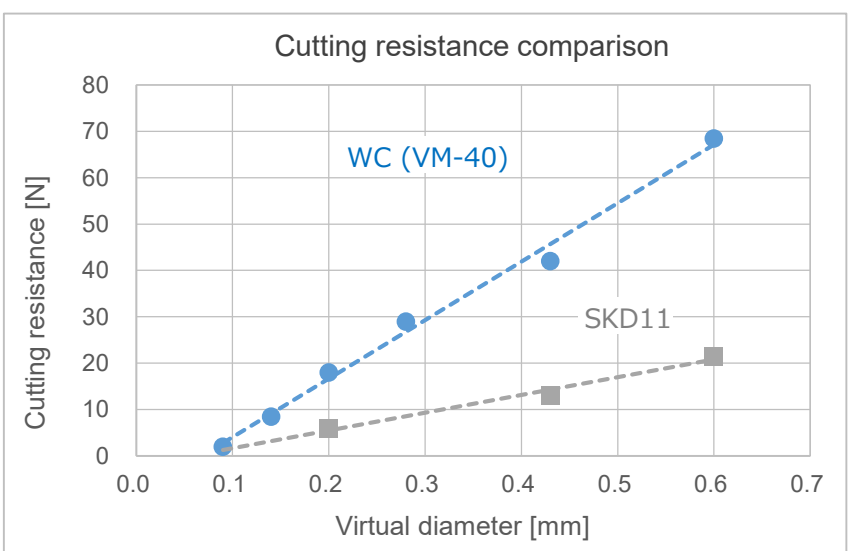
<Condition>

Tool	: UDCB 2010-0070(R0.5)	n : 30,000 min^{-1}
Work material	: Cemented carbide VM-40	Vf : 300 mm/min
	: SKD11	ap : 2、5、10、20、50、100 μm
Coolant	: Air blow	
Milling method	: Slotting(Straight)	

We measured the cutting resistance in the direction perpendicular to the tool axis



- Cutting resistance of WC = SKD 11 x 3.5
- Increases in proportion to the virtual diameter



Condition and environment 【Coolant】

Coolant affect the tool life significantly.

～ Removal volume comparison (Roughing) ～

<Condition>

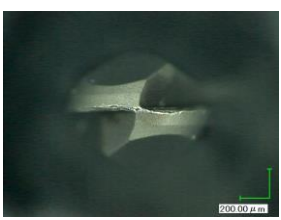
Tool	: UDCB 2010-0070(R0.5)
Work material	: Cemented carbide VM-40
Coolant	: Water soluble, oil mist, air blow
Milling method	: Pocket

n : 30,000 min^{-1}
Vf : 300 mm/min
ap : 0.1 mm
ae : 0.05 mm

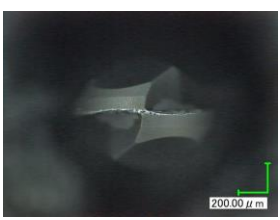
<Tool damage after 30mm^3 milling>

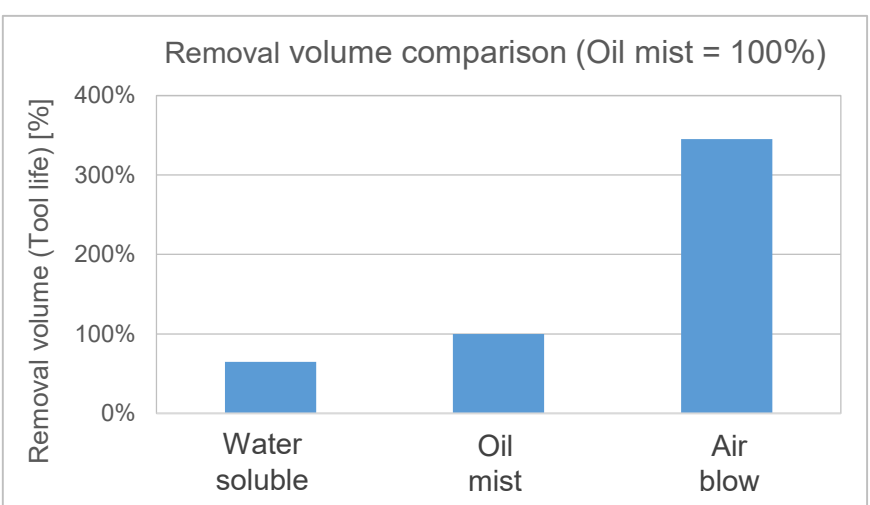
Water soluble

Oil mist



Air blow





Condition and environment 【Cutting depth】

Cutting depth ap & ae must be adjusted depending on WC materials.For high hardness WC, small ap and large ae will make the tool life longer. (In case of ball end mills)

～ Influence of different cutting depth (ap and ae) ～

<Condition>

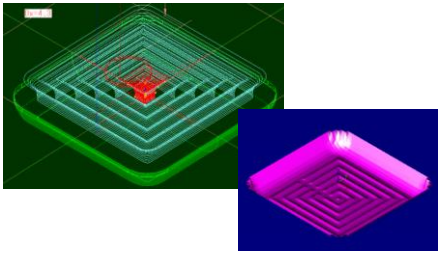
Tool	: UDCB 2010-0070(R0.5)	n	: 30,000 min^{-1}
Work material	: Cemented carbide VM-40	Vf	: 300 mm/min
Coolant	: Oil mist	ap	: See below
Milling method	: Pocket	ae	: See below

Cutting depth

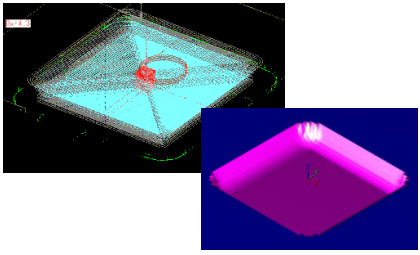
	ap	ae
Condition A	0.05	0.30
Condition B	0.10	0.05

(mm)

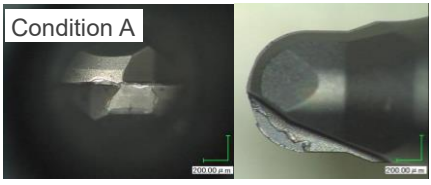
Condition A M.R.R : 1.88mm^3/min



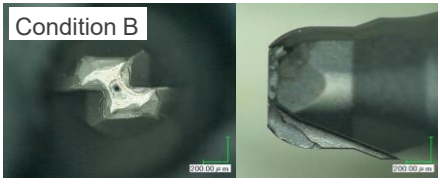
Condition B M.R.R : 1.21mm^3/min



<Tool damage at the end of tool life>



Tool life : 100%



Tool life : 42%
(When condition A = 100%)

Condition and environment 【Feed Rate 2】

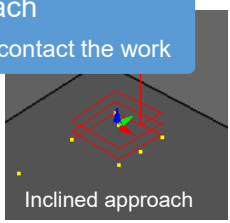
Tool life is improved when “Feed Rate 2” is used.

*Too slow “Feed Rate 2” will cause of short tool life. (Please refer to the catalog condition)

When “Feed Rate 2” is used ?

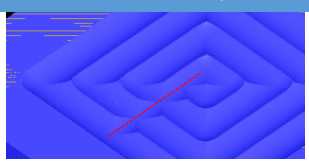
◆Approach

When tool contact the work



◆Connecting move

Movement when tool across the passed area



～ Different “Feed Rate 2” comparison ～

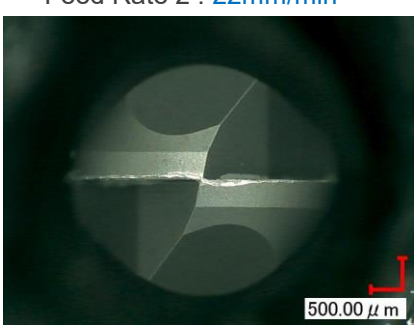
<Condition>

Tool	: UDCLB 2030-1400(R1.5)
Work material	: Cemented carbide VM-40
Coolant	: Air blow
Milling method	: Pocket

n : 27,500 min^{-1}
Vf : 220 mm/min
ap : 0.125mm
ae : 0.33mm

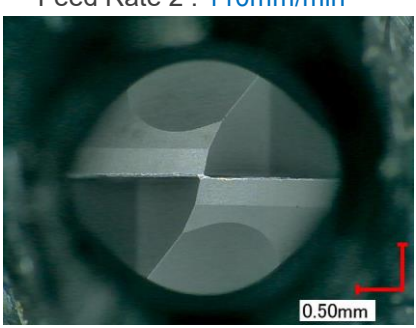
<Tool after 120mm^3 milling>

Feed Rate 2 : 22mm/min



Removal volume : 120mm^3

Feed Rate 2 : 110mm/min



Removal volume : 600mm^3

Tool life is dramatically improved ! (5 times)

Condition and environment 【Approach】

Difference of approach (starting of cutting) will affect the tool life.

～ Influence of difference approach ～

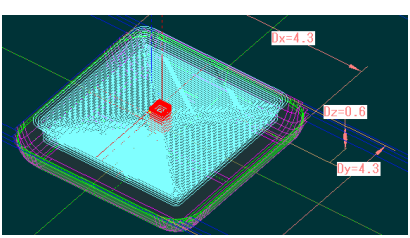
<Condition>

Tool	: UDCB 2010-0070(R0.5)	n	: 30,000 min^{-1}
Material	: Cemented carbide VM-40	Vf	: 300 mm/min
Coolant	: Oil mist	ap	: 0.1 mm
Methods	: Pocket (10mm^3)	ae	: 0.05 mm

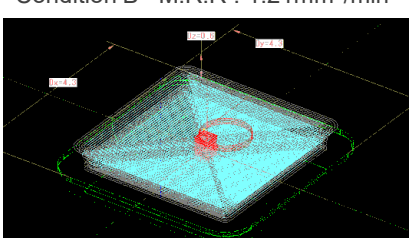
Condition of approach

	Contents
Condition A	・Inclined approach
Condition B	・Helical approach ・F = 30 when milling in radial direction

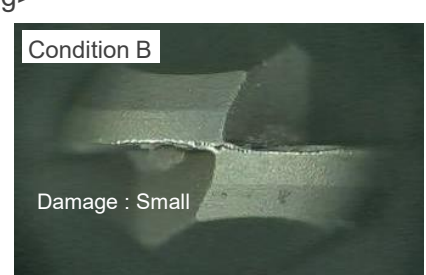
Condition A M.R.R : 1.81mm^3/min



Condition B M.R.R : 1.21mm^3/min



<Tool damage after 10mm^3 milling>

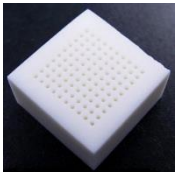


UDC series applications

Drilling by UDCMX
Threading by UDCT

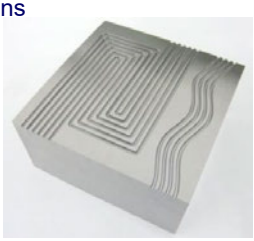
Chamfering and pilot hole
by SP tools

Ceramics parts

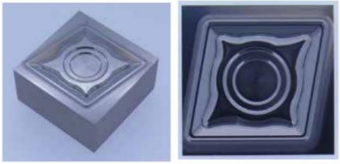


・Automobile parts
・Fuel cell separator

Lens



・WC insert chips
・Sintered ceramics

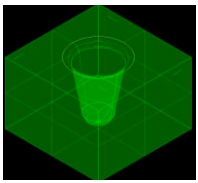


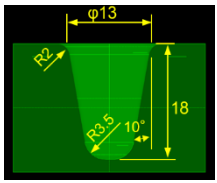
UDC is used for wide applications.

*Those photo includes the sample images.

Advantaged of “direct milling” (Comparison with EDM)

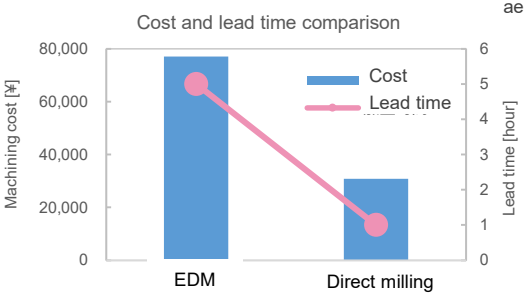
<Model>Tapered circular pocket
Size : Φ13 x depth 18mm x draft angle 10°, fillet R2, bottom R3.5





<Condition>

Tool	: UDCLB 2060-1500(R3)
Work material	: Cemented carbide VM-40
Coolant	: Air blow
n : 20,000 min^{-1}	
Vf : 200 mm/min	
ap : 0.2mm	
ae : 0.4mm	



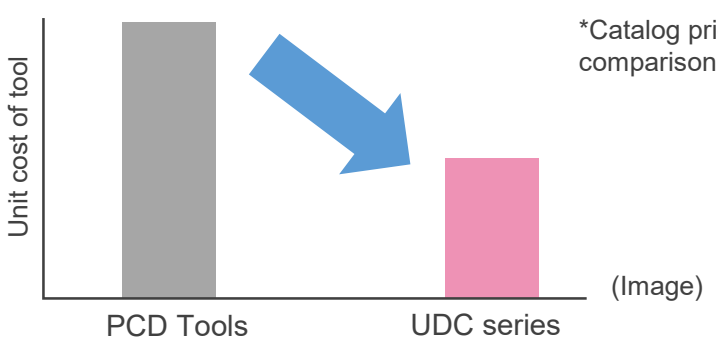
In this study case,
Direct milling offers

- ◆Machining cost : 60% reduction
- ◆Lead time : 80% shortened

Compare to EDM processing

Case of WC direct milling is increasing due to realization of Milling surface improvement and shortened lead time etc.

High cost-performance (Compare to PCD Tools)

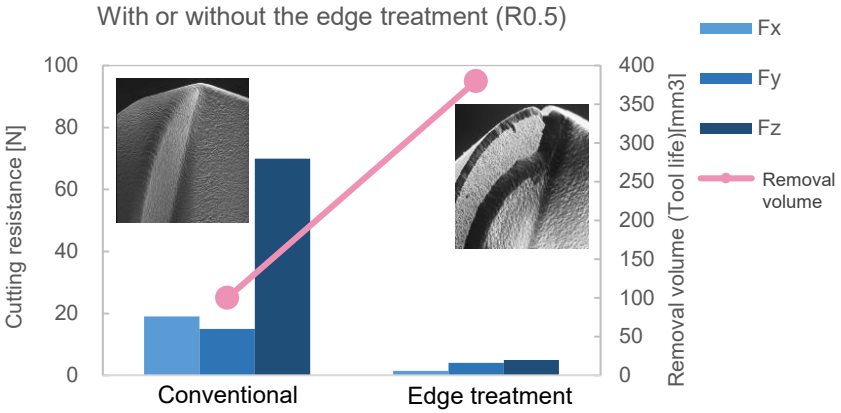


*Catalog price comparison

(Image)

UDC series are more affordable than PCD tools.
Please try when the cost reduction is necessary.

Advantage of edge treatment

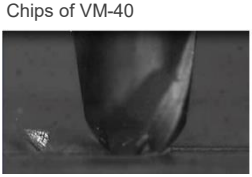


The edge treatment (For F series and H series)
reduces the cutting resistance by the sharp edges.
It offers longer tool life and improvement the process qualities.

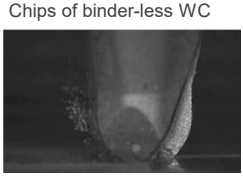
Accumulated reliable know-how

◆Chips (With different WC)*by high-speed camera

Chips of VM-40

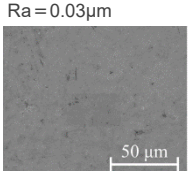


Chips of binder-less WC

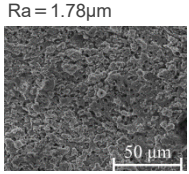


◆Roughness (Direct milling vs EDM)

Ra＝0.03μm



Ra＝1.78μm



◆SP tools of UDC

+

Examples of SP tools form

We are knowledgeable about UDC process. You can combine
UDC + SP tools forms. Please do not hesitate to contact us.

(To inquiries on the back cover)

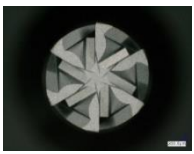
The latest product【UDCRRS Long neck radius for roughing】

Achieves higher efficiency !

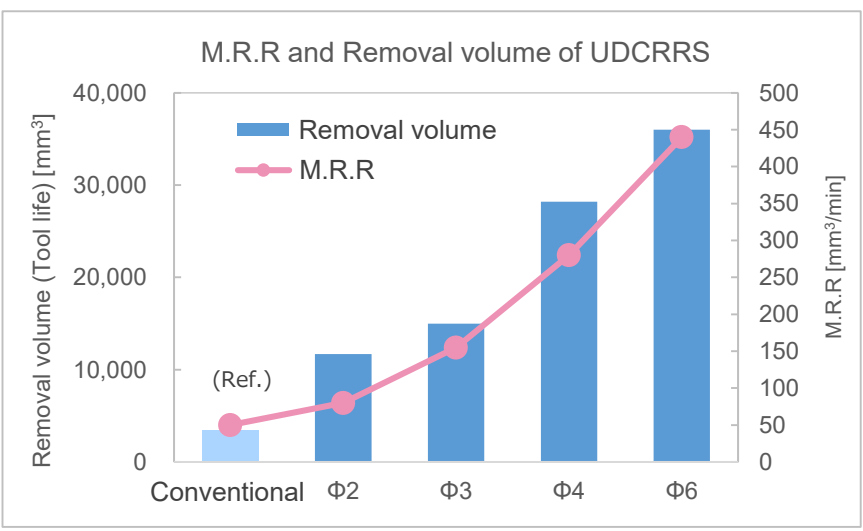
NEW

The Multi-flutes and
40 degree helix angle
achieves low cutting
resistance and offers
deep cutting depth milling !

Φ2~4 : 6 Flutes



Φ6 : 10 Flutes



*Conventional = R1 ball end mill (Pocket)

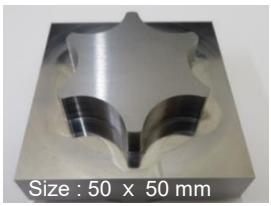
UDCRRS improves the efficiency and
removal volume for roughing process !

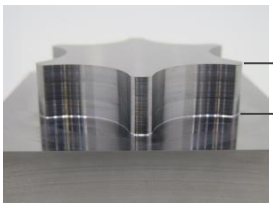
WC punching die milling example

<Condition>

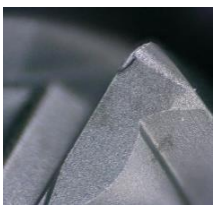
Tool	: UDCRRS 6040-020-100	n :	15,000 min^{-1}
Work material	: Cemented carbide VM-40	Vf :	375 mm/min
Coolant	: Air blow	ap :	3.0 mm
Cycle time	: 93 min	ae :	0.25 mm

<Appearance>



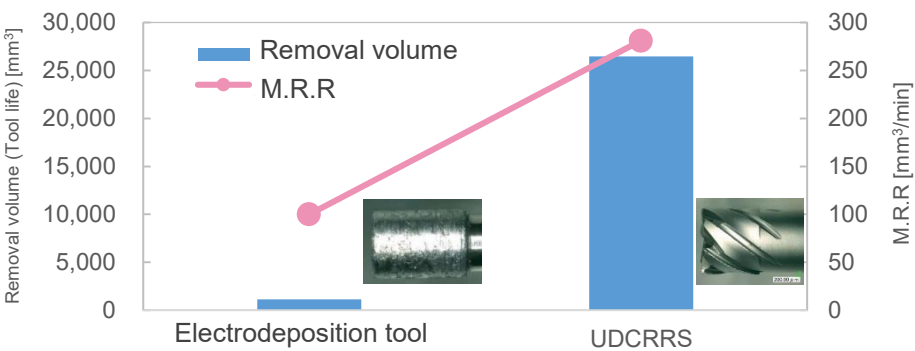


<Tool damage>



Tool damage is limited and continuous cutting is possible
Even after the process 15,953 mm^3

Tool (Φ4)	n min^{-1}	Vf mm/min	ap mm	ae mm	Coolant
UDCRRS (LOC 3.2 mm)	15,625	375	3	0.25	Air blow
Electrodeposition tool (LOE 5mm)	8,000	200	5	0.1	Water soluble



Compare to the electrodeposition tool,
Removal volume : 23 times, M.R.R : 2.8 times
UDCRRS offers high efficiency and long tool life.

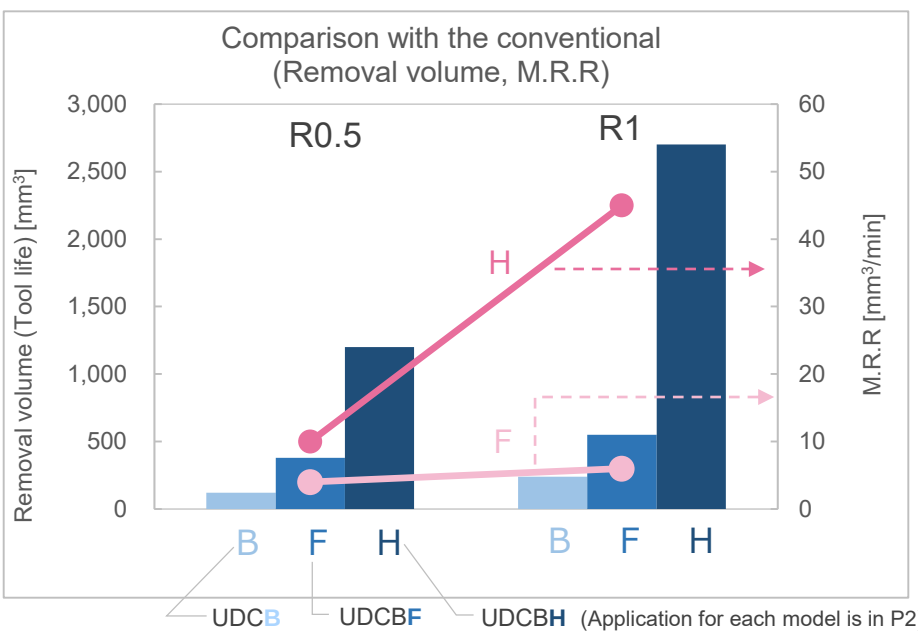
Introduction of UDC-H series

H series offers more efficient process than conventional.
It is the best suited for roughing to semi-finishing.

～ Features of H series ～

High-level Treatment | **H**igh Speed | **H**igh Material Removal Volume

Ball (UDCBH) 6 models, Long neck ball (UDCLBH) 22models
We are expanding the line-up for the future.



*UDC-H series shows the maximum tool performance under high-speed conditions.
Please try with appropriate coolant supply and high rigid MC.

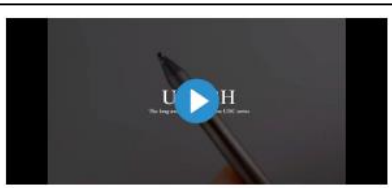
Information of our web site

You can see various milling examples / videos on our web site.

› **UDCBF Cemented Carbide (VU-70)**
Large Hexalobular

› **UDCB Quartz Glass Pocket Milling**

Scan for milling example →



› **Introduction of UDCBH**

Milling VM-40 (90HRA) grade tungsten carbide at ultra high speed!

› **UDCLB/UDCLBF**
Direct milling on Carbide Bevel Gear

Optimized cutting parameters for Low-hardness carbides has greatly reduced the cycle time and milling cost !

Scan for milling videos →