Proposal

**EDM**
- Long lead-time to prepare the electrode.
- Large consumption on electrode.
- Generate heat affected layer.

**Grinding with Diamond or Electroplated wheel**
- Electrodes wear easily.
- Poor accuracy. Difficult to form the 3D irregular shape.

**Milling with PCD tool**
- High tool cost
- Poor efficiency with small cutting depth.

Direct mill on carbide using our DIAMOND COATED tool.
= Shorten lead time & reduce cost
CONTENTS

◆ Features of UDC series
◆ Close study of milling “Cemented Carbide”
◆ NEW “F series”
◆ BONUS data
• Diamond coating made by Thermal CVD method
• Super high Adhesion and Wear resistance
• Controlled micro structure
• Improves both Hardness and Durability

Comparison of Adhesion / Wear resistance using shot-blast test

UT

Measure time until coating peeling off by shot blast.

Controlled Diamond coating micro structure

Improves Hardness & Durability
Toughness
Original coating process with excellent controlled micro-structure offers outstanding toughness.

Hardness
Our original SP3 structure has similar hardness to diamond.

Adherence
UNION TOOL original pre-treatment process and coating process offers extreme adherence.
UDC SERIES Variety

Standard Ball
Long Neck Ball
Long Neck Corner Radius
Drill
Thread Mill

Total: 8 series over 200 models
CONTENTS

◆ Features of UDC series

◆ Close study of milling “Cemented Carbide”

◆ NEW “F series”

◆ BONUS data
CARBIDE MILLING  Cutting Chips

Material: 90HRA (CIS VM-40)  
Cemented Carbide

UDCB Series

<table>
<thead>
<tr>
<th>Process</th>
<th>Tool</th>
<th>Spindle speed [min⁻¹]</th>
<th>XY Feed [mm/min]</th>
<th>ap [mm]</th>
<th>Coolant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roughing</td>
<td>UDCB2010-0070 (R0.5)</td>
<td>30,000</td>
<td>300</td>
<td>0.1</td>
<td>Air blow</td>
</tr>
</tbody>
</table>

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CARBIDE MILLING  Accuracy

Measuring data on each label

- Actual Outer Diameter
- Max/Min rate of Ball Radius tolerance
- Max/Min rate of Corner Radius tolerance
**CARBIDE MILLING**

**Coolant**

Material: 90HRA (CIS VM-40) Cemented Carbide

### Tools after milling 10hr 30min

<table>
<thead>
<tr>
<th>Tool</th>
<th>Spindle speed [min⁻¹]</th>
<th>XY Feed [mm/min]</th>
<th>ap [mm]</th>
<th>ae [mm]</th>
<th>Coolant</th>
<th>Milling Time [h: m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>UDCB 2010-0070 (R0.5 x 0.7)</td>
<td>20,000</td>
<td>100</td>
<td>0.05</td>
<td>0.02</td>
<td>Air blow / Water Soluble</td>
<td>10:30</td>
</tr>
</tbody>
</table>

*Bottom surface ae amount = 0.03mm

Use **Air Blow** for the best result!
Do NOT clamp the coated area on shank part into the tool holder. Tool might stuck inside.
CONTENTS

◆ Features of UDC series
◆ Close study of milling “Cemented Carbide”
◆ NEW “F series”
◆ BONUS data
UDCBF & UDCLBF  What’s new?

- Newly developed Coating
- New Tip Design
- Special Treatment on cutting edge
**UDCBF milling example**

**Tool:** UDCBF 2060-0420 (R3x4.2)
**Work material:** VU-70 (83HRA)
**MRV:** 3762mm³

<table>
<thead>
<tr>
<th>Milling mode</th>
<th>Roughing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spindle speed  min⁻¹</td>
<td>5,500</td>
</tr>
<tr>
<td>Feed rate mm/min</td>
<td>280</td>
</tr>
<tr>
<td>Axial depth(ap) mm</td>
<td>0.65</td>
</tr>
<tr>
<td>Radial depth(ae) mm</td>
<td>0.28</td>
</tr>
<tr>
<td>Coolant</td>
<td>Air blow</td>
</tr>
<tr>
<td>Cycle time</td>
<td>50min22sec</td>
</tr>
</tbody>
</table>

Work size: 40 x 20 x t40 mm
Model size: 32.3 x 32.2 (upper surface) depth 12.5 mm
CHARACTERISTIC Surface Finishing

**Tool: R0.5 Ball type - UDCB & UDCBF**
- Spindle speed: 30,000 min\(^{-1}\)
- Feed rate: 300 mm/min
- ap: 0.05mm
- ae: 0.02mm
- Coolant: Air Blow
- Tool Overhang: 20mm
- Work material: Cemented Carbide
- Milling time: 55 min 5 sec

Form Accuracy
- Ra 0.20um
- Rz 1.21um
- UDCB

Milling Direction

Form Accuracy
- Ra 0.19um
- Rz 1.44um
- UDCBF
# CHARACTERISTIC Surface Finishing

<table>
<thead>
<tr>
<th>Tool: R0.5 Ball type</th>
<th>UDCB &amp; UDCBF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spindle speed</td>
<td>30,000 min⁻¹</td>
</tr>
<tr>
<td>Feed rate</td>
<td>300 mm/min</td>
</tr>
<tr>
<td>ap:</td>
<td>0.02mm</td>
</tr>
<tr>
<td>ae:</td>
<td>0.05mm</td>
</tr>
<tr>
<td>Coolant:</td>
<td>Air Blow</td>
</tr>
<tr>
<td>Work material:</td>
<td>Cemented Carbide 90HRA(VM-40)</td>
</tr>
</tbody>
</table>

Comparison of Micro Edge chipping on material surface

**UDCB**

**UDCBF**

Micro edge chipping
** TOOL : UDCBF 2010-0070 (R0.5 x 0.7mm)  
Material : Cemented Carbide VM-40 (90HRA) 

<table>
<thead>
<tr>
<th>Item</th>
<th>Roughing</th>
<th>Finishing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spindle Speed</td>
<td>30,000</td>
<td></td>
</tr>
<tr>
<td>XY Feed [mm/min]</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Ap [mm]</td>
<td>0.05</td>
<td>0.028</td>
</tr>
<tr>
<td>Ae [mm]</td>
<td>0.25</td>
<td>0.02</td>
</tr>
<tr>
<td>Coolant</td>
<td>Airblow (Nozzle)</td>
<td></td>
</tr>
<tr>
<td>MRR [mm³]</td>
<td>86.3</td>
<td>12.0</td>
</tr>
<tr>
<td>Milling time</td>
<td>43 min</td>
<td>2 hrs 17 min</td>
</tr>
</tbody>
</table>

 ttl: 98.3mm³  
ttl: 3 hrs  

※Used 1 tool each for Roughing and Finishing process.
CARBIDE MILLING  CARBIDE INSERT

UDCBF excellent surface roughness

- Ra: 0.051 μm
- Rz: 0.399 μm

- Ra: 0.068 μm
- Rz: 0.520 μm

- Ra: 0.054 μm
- Rz: 0.408 μm

Excellent Surface  No Edge chipping

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**Specifications**
- Diameter: $\phi 0.3 \sim \phi 2$
- Total 30 models
- Upgraded version of UDCLRS
- Special cutting edge processing

**Features**
- Long tool life
- Prevent edge chipping
- Improved surface roughness
## UDCLRSF _ Work Edge chipping

### Entry Side

- Tool Size: φ2xR0.03x2
- Work Material: VM-40 (90HRA)
- Milling Method: Bottom surface milling
- Coolant: Oil mist
- Spindle min⁻¹: 20,000
- Feed mm/min: 100
- **ap mm**: 0.01
- **ae mm**: 0.01

### Exit Side

- **MAX Edge Chipping Width**
  - UDCLRS: 0.055
  - UDCLRSF: 0.027

### Diagram

- **Controls edge chipping!**
- **Entry Side**: 0.055
- **Exit Side**: 0.027

### Images

- **Entry Side**: 100μm
- **Exit Side**: 100μm

---

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**UDCLRSF _ Curve slotting**

<table>
<thead>
<tr>
<th>Tool</th>
<th>UDCLRS</th>
<th>UDCLRSF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool size</td>
<td>φ2xR0.1x2</td>
<td></td>
</tr>
<tr>
<td>Work material</td>
<td>VM-40 (90HRA)</td>
<td></td>
</tr>
<tr>
<td>Milling method</td>
<td>Curve Slotting</td>
<td></td>
</tr>
<tr>
<td>Depth mm</td>
<td>1.99</td>
<td></td>
</tr>
<tr>
<td>Coolant</td>
<td>Air blow</td>
<td></td>
</tr>
<tr>
<td>Spindle min⁻¹</td>
<td>20,000</td>
<td></td>
</tr>
<tr>
<td>Feed mm/min</td>
<td>375</td>
<td>190</td>
</tr>
<tr>
<td>Ap mm</td>
<td>0.02</td>
<td>0.06</td>
</tr>
<tr>
<td>Cycle time / slot</td>
<td>9min 4sec</td>
<td>5min 36sec</td>
</tr>
</tbody>
</table>

- **Work size:** 20 x 20 x t10 mm
- **Slot size:** W2 x depth 1.99 mm

Higher efficiency & Longer life with URCLRSF!
CONTENTS

◆ Features of UDC series

◆ Close study of milling “Cemented Carbide”

◆ NEW “F series”

◆ BONUS data
CARBIDE MILLING  

Zirconia - ZrO2

Coolant: Water Soluble  
Milling Time: 98min  
Work Size: φ9 mm x Depth 2.2mm

Material: Zirconia

UDCB Series

Material Removal Rate = 91.7mm³

<table>
<thead>
<tr>
<th>Process</th>
<th>Tool</th>
<th>Spindle speed [min⁻¹]</th>
<th>XY Feed [mm/min]</th>
<th>Approach Feed [mm/min]</th>
<th>ap [mm]</th>
<th>ae [mm]</th>
<th>Milling time [min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roughing</td>
<td>UDCB2010-0070 (R0.5)</td>
<td>30,000</td>
<td>300</td>
<td>40</td>
<td>0.05</td>
<td>0.05</td>
<td>98</td>
</tr>
</tbody>
</table>
CARBIDE MILLING  Alumina- Al2O3

Coolant:                   Water Soluble
Milling Time:             196min
Work Size:                 φ9 mm x Depth 2.2mm

Material: Alumina

UDCB Series

Material Removal Rate = 91.7mm³

<table>
<thead>
<tr>
<th>Process</th>
<th>Tool</th>
<th>Spindle speed [min⁻¹]</th>
<th>XY Feed [mm/min]</th>
<th>Approach Feed [mm/min]</th>
<th>ap [mm]</th>
<th>ae [mm]</th>
<th>Milling time [min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roughing</td>
<td>UDCB2010-0070 (R0.5)</td>
<td>30,000</td>
<td>300</td>
<td>40</td>
<td>0.05</td>
<td>0.05</td>
<td>196</td>
</tr>
</tbody>
</table>

*Used 2 tools. First tool could not finish and milled twice with same program/condition.
CARBIDE MILLING  Hexalobular

Coolant: Air Blow
Milling Time: 39min
Work Size: φ9 mm x Depth 2.2mm

Material: 92.5HRA (CIS VF20) Cemented Carbide

UDCB Series

Material Removal Rate = 91.7mm³

<table>
<thead>
<tr>
<th>Process</th>
<th>Tool</th>
<th>Spindle speed [min⁻¹]</th>
<th>XY Feed [mm/min]</th>
<th>Approach Feed [mm/min]</th>
<th>ap [mm]</th>
<th>ae [mm]</th>
<th>Milling time [min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roughing</td>
<td>UDCB2010-0070 (R0.5)</td>
<td>30,000</td>
<td>300</td>
<td>100</td>
<td>0.05</td>
<td>*0.30</td>
<td>39</td>
</tr>
</tbody>
</table>

*Bottom surface ae amount = 0.05mm
**CARBIDE MILLING**  Deep Milling

Material: 90HRA (CIS VM-40)  
Cemented Carbide

**UDCB Series**

Material Removal Rate = 1,400mm³

<table>
<thead>
<tr>
<th>Tool</th>
<th>Spindle speed [min⁻¹]</th>
<th>XY Feed [mm/min]</th>
<th>ap [mm]</th>
<th>ae [mm]</th>
<th>Coolant</th>
<th>Milling Time [min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>UDCB 2060-0420 (R3 x 4.2)</td>
<td>20,000</td>
<td>200</td>
<td>0.2</td>
<td>0.4</td>
<td>Air blow</td>
<td>52</td>
</tr>
</tbody>
</table>

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CARBIDE MILLING  Pin Holder

Material: 92.5HRA (CIS VF-20) Cemented Carbide

UDCLB Series

<table>
<thead>
<tr>
<th>Process</th>
<th>Tool</th>
<th>Spindle speed [min⁻¹]</th>
<th>XY Feed [mm/min]</th>
<th>ap [mm]</th>
<th>ae [mm]</th>
<th>Milling time [min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>First step</td>
<td>UDCLB2010-0500</td>
<td>30,000</td>
<td>300</td>
<td>0.1</td>
<td>0.05</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>(R0.5 x 5mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second step</td>
<td>UDCLB2010-0500</td>
<td></td>
<td></td>
<td></td>
<td>0.05</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>(R0.5 x 5mm)</td>
<td></td>
<td></td>
<td></td>
<td>(Bottom surface 0.02mm)</td>
<td></td>
</tr>
<tr>
<td>Wall opening</td>
<td>UDCLB2030-080</td>
<td>27,500</td>
<td>275</td>
<td>0.125</td>
<td>0.33</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>(R1.5 x 8mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Used UDCLB 2030-080 (R1.5 x 8mm) to open the wall.
### CARBIDE DRILLING φ0.4 Blind hole

**Material:** 90HRA (CIS VM40) Cemented Carbide

**Holes around on 100 hits**

- **Coolant:** Air Blow [nozzle]
- **Hole depth:** 2.8mm x 100 holes
- **Work size:** 20mm x 20mm x 3mm
- **Drilling Time:** 36 sec/hole

**100 holes drilling in 60 min!**

---

**Tool after 100 hits**

- More tool life left

---

<table>
<thead>
<tr>
<th>Process</th>
<th>Tool</th>
<th>Spindle speed [min⁻¹]</th>
<th>Feed [mm/min]</th>
<th>Peck Amount [mm]</th>
<th>Hole Depth [mm]</th>
<th>Drilling time [sec]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling</td>
<td>UDCMX 2040-040 (0.4mm x 4mm)</td>
<td>20,000</td>
<td>5</td>
<td>Non-Step</td>
<td>2.8mm</td>
<td>36/hole</td>
</tr>
</tbody>
</table>

*Bottom surface ae amount = 0.05mm*
CARBIDE DRILLING  φ1.0 x 10mm

Material: 90HRA (CIS VM40) Cemented Carbide

Total 50 holes drilling in 86 min!

Coolant: Air Blow [nozzle]
Work size: 20mm x 20mm x 10mm
Drilling Time: total 86 min

Cross Section

Depth: 2mm, 4mm, 6mm, 8mm, 10mm

Blind holes
Through hole

Material: 90HRA (CIS VM40) Cemented Carbide

Process | Tool | Spindle speed [min⁻¹] | Feed [mm/min] | Peck Amount [mm] | Hole Depth [mm]  
--- | --- | --- | --- | --- | ---  
Drilling | UDCMX 2100-100 (1.0mm x 10mm) | 20,000 | 7.5 | 0.1 | 2, 4, 6, 8, 10  

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### CARBIDE MILLING  
**Drilling + Thread milling**

<table>
<thead>
<tr>
<th>Note</th>
<th>Drilling (Spiral drilling)</th>
<th>Thread milling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spindle Speed</td>
<td>8,000 [min(^{-1})]</td>
<td>5,300 [min(^{-1})]</td>
</tr>
<tr>
<td>Feed</td>
<td>50 [mm/min]</td>
<td>30 [mm/min]</td>
</tr>
</tbody>
</table>
| Z Feed | Roughing : 0.1 [mm/rev]  
Finishing (Zero-cut) : 0.3 [mm/rev] | 1.25 [mm/rev] |
| Coolant | Air blow (Nozzle) | Air blow (Nozzle) |
| Hole | Through Hole φ6.8  
Depth 10 [mm] x 16 holes | Depth 10 [mm] x 16 holes |
| Milling Time | 16 holes \(\Rightarrow\) 152 min  
(9 min 30 sec/hole) | 16 holes \(\Rightarrow\) 48 min  
(3 min/ hole) |

※Used 2 drills for Roughing and 1 tool each for Chamfering & Finishing.  

**Work Size: 50x50x10 [mm]**
### CARBIDE MILLING

**Drilling**
- Tool: UDCMX 2250-100
- Material: Cemented Carbide VM-40
- Diameter: 2.5mm x 10mm

**Thread Milling**
- Tool: UDCT M3-0.5-6
- Material: M3
- Diameter: 90HRA

**Work Size**: 20x20x10 [mm]

<table>
<thead>
<tr>
<th>Note</th>
<th>Drilling</th>
<th>Thread milling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spindle Speed</td>
<td>2,000 [min⁻¹]</td>
<td>20,000 [min⁻¹]</td>
</tr>
<tr>
<td>Feed</td>
<td>5 [mm/min]</td>
<td>3 [mm/min]</td>
</tr>
<tr>
<td>Peck Amount</td>
<td>0.5mm</td>
<td>-</td>
</tr>
<tr>
<td>Coolant</td>
<td>Air blow (Nozzle)</td>
<td>Air blow (Nozzle)</td>
</tr>
<tr>
<td>Hole</td>
<td>Blind Hole φ2.5 Depth 8 [mm] x 16 holes</td>
<td>Blind Hole Depth 6 [mm] x 16 holes</td>
</tr>
<tr>
<td>Milling Time</td>
<td>2min 2sec / hole</td>
<td>9 min 15sec / hole</td>
</tr>
</tbody>
</table>

**Drilling Image**

**Threading Image**

**Image with screw**
### Conditions

<table>
<thead>
<tr>
<th></th>
<th>Process</th>
<th>One-shot Drilling</th>
<th>Threading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool</td>
<td>UDCMX 2680-250</td>
<td>UDCT M8-1.25-24</td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>Cemented Carbide</td>
<td>VM-40 - 90 HRA</td>
<td></td>
</tr>
<tr>
<td>Spindlemin⁻¹</td>
<td>4,000</td>
<td>3,500</td>
<td></td>
</tr>
<tr>
<td>Feed mm/min</td>
<td>12</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Tool Overhang</td>
<td>35 mm</td>
<td>30 mm</td>
<td></td>
</tr>
<tr>
<td>Coolant</td>
<td>Airblow _ Nozzle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hole</td>
<td>Blind hole 20 mm depth × 25 holes</td>
<td>17.5 mm depth × 1 hole</td>
<td></td>
</tr>
<tr>
<td>Cycle Time / hole</td>
<td>1 min 56 sec</td>
<td>5 min 36 sec</td>
<td></td>
</tr>
</tbody>
</table>

- 25 holes drilled with φ6.8 UDCMX and more tool life left.
- MRV=17,000 mm³ in 1 hour

**Size:** 50 x 50 x 25 mm
A single tool, for a solid future.

U.S. UNION TOOL, INC.

✓ Solid carbide End Mills & Drills
✓ Global leader in micro-diameter cutting tools
✓ Extensive application database for high-speed machining on various materials.
✓ Available throughout the USA.

www.usuniontool.com

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