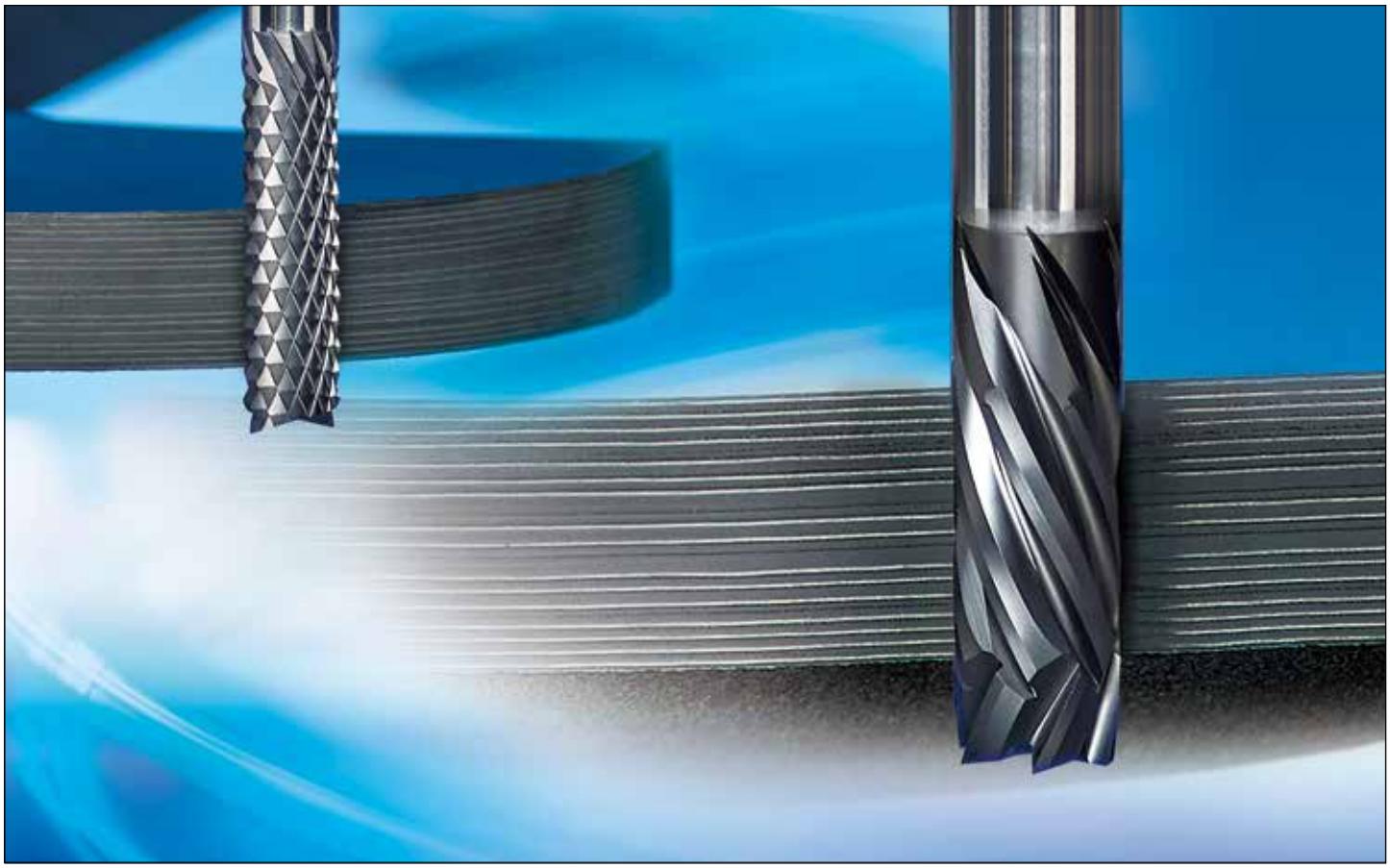
KORLOY
TECH-NEWS

Composite Router Endmill

Router Endmill Series for Machining Composite Materials

- **High Quality Machining**
  Minimized machining troubles with our new design, inhibiting delamination, splintering and burrs
- **Excellent Tool Life**
  The nano-crystalline diamond coating provides exceptional resistance to wear and flaking
- **Composite Materials: CFRP/GFRP**

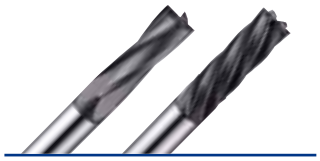


KORLOY

Composite Router Endmills for Machining Composite Materials (CFRP/GFRP)

Composite Router Endmill

CCDR/CCR



CCLR/CCRR

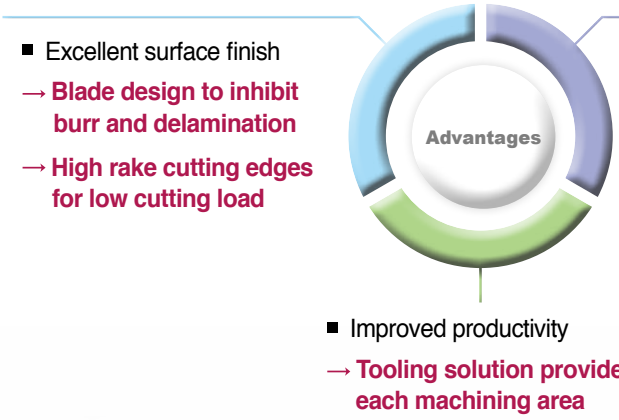
With a growing number of environmental regulations and the increasing demands for higher efficiency and lighter weight, more and more composite materials have been used in various industrial fields such as automotive, aerospace, wind power and energy industries.

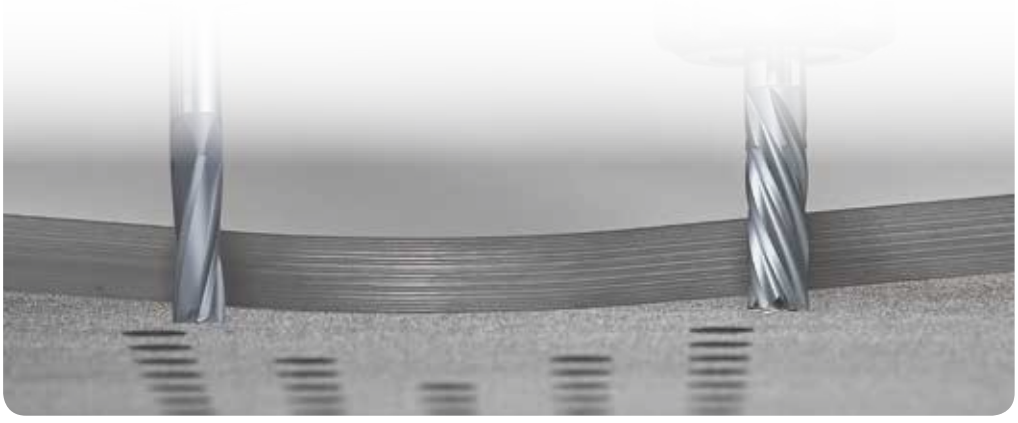
A composite material is combined materials of two or more kinds for better machining properties. Typical examples are **CFRP**(1) consisting of carbon fiber and resin, and **GFRP**(2) consisting of glass fiber and resin. They are light and have excellent mechanical properties featuring strong resistance to corrosion and fatigue.

Unlike general metals, CFRP and GFRP generate large amounts of chips in the form of scraps. Due to the high hardness and low thermal conductivity of the fiber-reinforced materials, high-temp cutting heat is generated during machining and tools wear out rapidly. In addition, their high strength, high elastic modulus, and inhomogeneity between dissimilar materials cause excessive vibrations, and the composite structures cause machining troubles such as delamination, splintering and burrs.

KORLOY's diamond-coated grade **ND2100** features a nano-crystalline diamond coating that has strong resistance to wear and friction, resulting in outstanding tool life.

CCDR is a dual-helix-type finishing endmill, which is designed to inhibit flaking from upper and lower faces of workpieces in compression cutting, so that high quality contouring and slotting can be achieved with excellent surface finish.
CCR is a roughing endmill with down-cut blade design of low vibrations and low cutting resistance, which is suitable for contouring, slotting and parting off thin sheet metals.
CCLR/CCRR are low-helix-type finishing endmills with low axial cutting resistance that inhibits fiber tears and burrs, excelling in contouring and slotting with superior surface finish.





(1) **CFRP**
: Carbon Fiber Reinforced Plastic

(2) **GFRP**
: Glass Fiber Reinforced Plastic

ND2100 (Diamond-coated grade for machining composite materials)

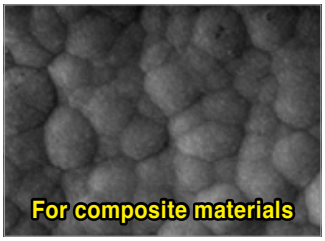
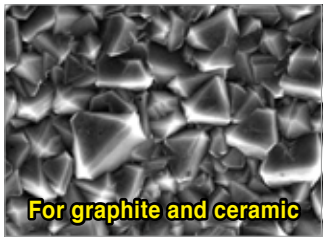
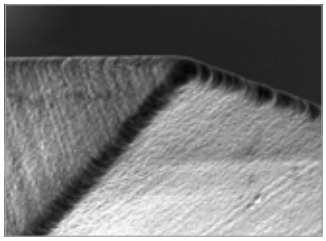
Problems When Machining Carbon Fiber Composite Materials

- Relief surface is quickly worn out due to carbon fiber reinforcing agents.
- Coating films flake off due to impact on cutting edges caused by cut carbon fiber chips.
- Machining troubles are caused by worn-out and dulled cutting edges.

1. Wear on relief surface	2. Coating flaking	3. Machining troubles
		

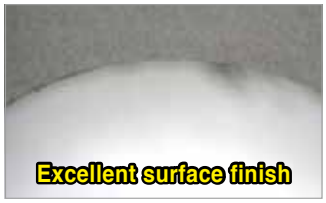
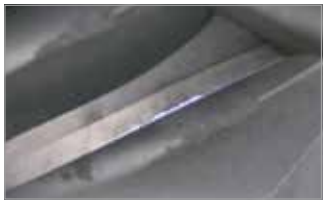
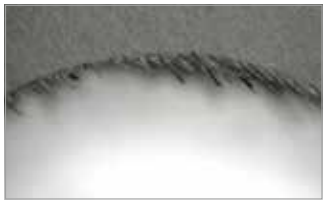
Development of ND2100
(Diamond-coated grade for machining composite materials)

- High-hardness nano-crystalline diamond coating ideally suited for machining composite materials
- Stable tool life due to excellent resistance to wear and flaking

Coating surface of ND2100	Coating surface of ND3000	Cutting edges of ND2100
		
• Nano-crystalline structure • Excellent friction resistance • Excellent wear resistance and surface finish	• Substrate specialized for diamond coating • Excellent flaking resistance	• Cutting edges stay sharp • Excellent cutting performance

Development Effect

- Nano-crystalline structure
  → **strong wear resistance**
- Substrate specialized for diamond coating
  → **Improved flaking resistance**
- Cutting edges remain in high rake
  → **Exceptional surface finish**

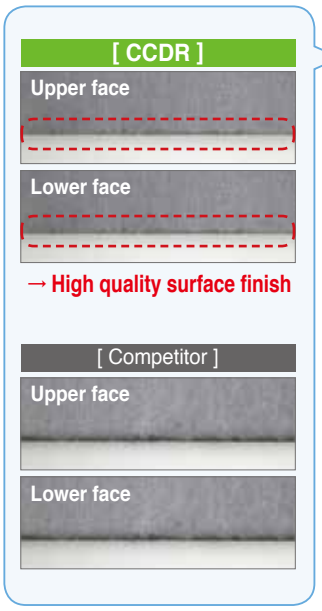
1. Inhibited wear on relief surface	2. Inhibited flaking	3. Inhibited machining troubles
		
[ND2100]	[ND2100]	[ND2100]
		
[Competitor]	[Competitor]	[Competitor]

Router Endmills for Machining Composite Materials

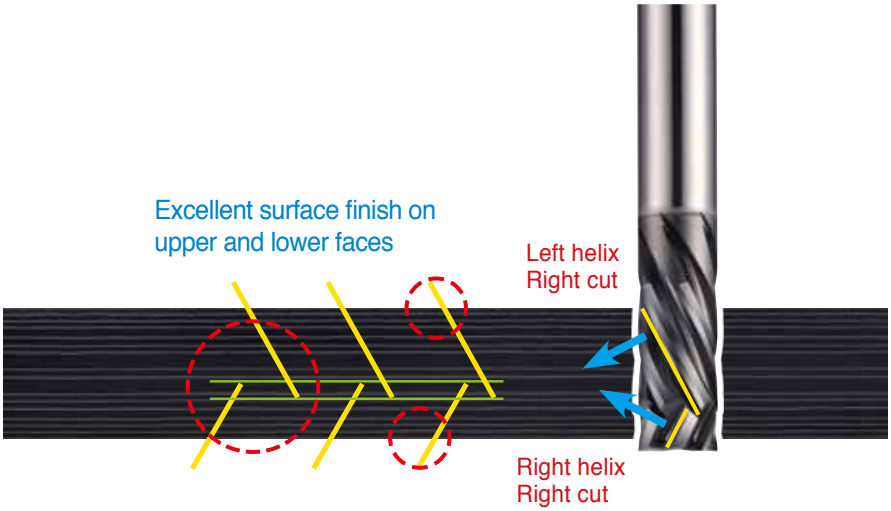
Features

- Router endmills optimized for machining composite materials (CFRP/GFRP)
- High-hardness nano-crystalline diamond coating for excellent tool life
- Blade design to inhibit delamination, burr and splintering

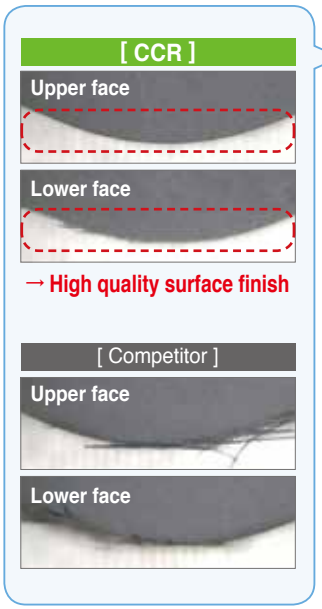
CCDR (Dual Helix Router Endmill)



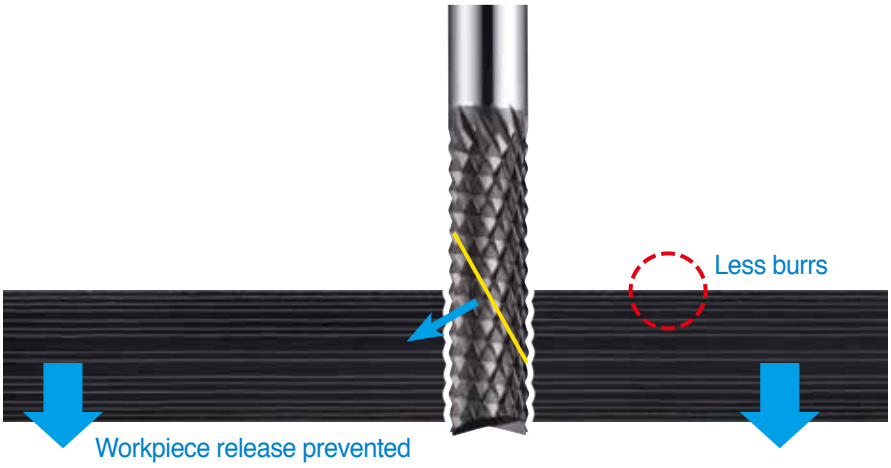
- Cutting force is directed toward the center of workpieces
- Burr and delamination around upper and lower faces of workpieces are inhibited



CCR (Router Endmill)



- Diamond-cut edges for low cutting load
- Down-cut blade design prevents workpiece release and strengthens the vaccuum clamping force.



[CCLR]

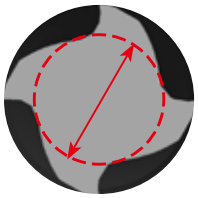
→ Excellent adhesion of coating, Excellent surface finish

[Competitor]

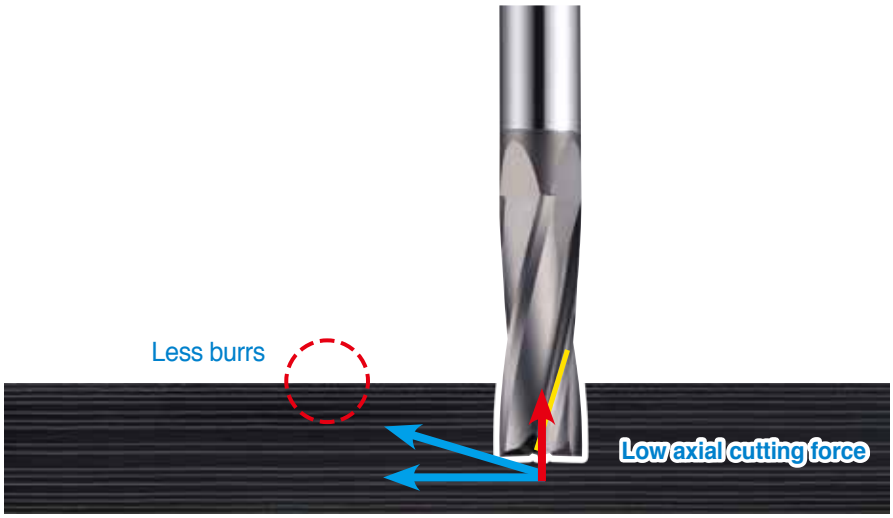
→ **Less burrs**

CCLR (Low Helix Router Endmill)

- Exellent machinability and high rigidity due to high rake cutting edges and large core web
- Low helix design to reduce the axial force and inhibit burr creation
- Large core web - High rigidity

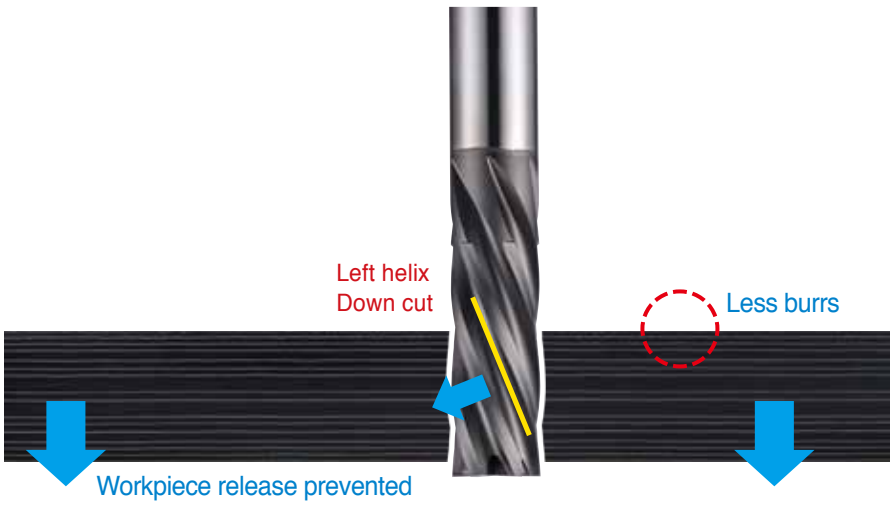


[Large core web]



CCRR (Reverse Helix Router Endmill)

- Multi-flute design (6F, 8F) enables highly efficient finishing.
- Down-cut blade design prevents workpiece release and strengthens the vaccuum clamping force.



Application Examples

CFRP Beam

- Cutting conditions: vc (m/min) = 200, fz (mm/t) = 0.05, ap (mm) = 6, ae (mm) = 2, dry
- Tool: CCR2080-075

CCR (Router): Over 20M machining

Competitor: 8.5M machining

100% longer

➔ 100% longer cutting time compared to the competitor

CFRP Plate

- Cutting conditions: vc (m/min) = 200, fz (mm/t) = 0.08, ap (mm) = 20, ae (mm) = 0.3, dry
- Tool: CCRR805000

CCRR (Reverse helix): 40M machining

Competitor: 20M machining

100% longer

➔ 100% longer cutting time compared to the competitor

CFRP Plate

- Cutting conditions: vc (m/min) = 200, fz (mm/t) = 0.08, ap (mm) = 20, ae (mm) = 0.3, dry
- Tool: CCDR605000

CCDR (Dual helix): 150M machining

Competitor: 125M machining

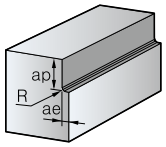
20% longer

➔ 20% longer cutting time compared to the competitor

Recommended Cutting Conditions (CCDR)

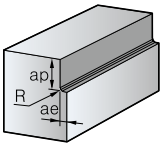
Division	CCDR (Shoulder roughing)				CCDR (Shoulder finishing)			
Workpiece	CFRP		GFRP		CFRP		GFRP	
Cutting conditions / Tool diameter (Ø)	RPM n (min^{-1})	Feed vf (mm/min)	RPM n (min^{-1})	Feed vf (mm/min)	RPM n (min^{-1})	Feed vf (mm/min)	RPM n (min^{-1})	Feed vf (mm/min)
6	7,960	1,114	3,980	557	10,610	1,910	5,310	743
8	5,970	1,075	2,980	536	7,960	1,910	3,980	716
10	4,770	1,717	2,390	860	6,370	3,058	3,180	1,145
12	3,980	1,672	1,990	836	5,310	3,027	2,650	1,113

■ **Application tip (shoulder roughing)**



- ap = 1D
- ae = 0.4D

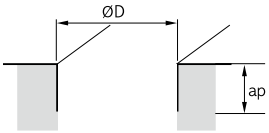
■ **Application tip (shoulder finishing)**



- ap = 1D
- ae = 0.02D

Division	CCDR (Slotting)			
Workpiece	CFRP		GFRP	
Cutting conditions / Tool diameter (Ø)	RPM n (min^{-1})	Feed vf (mm/min)	RPM n (min^{-1})	Feed vf (mm/min)
6	5,310	531	3,710	371
8	3,980	478	2,790	335
10	3,180	763	2,230	535
12	2,650	716	1,860	502

■ **Application tip (slotting)**



- CFRP, ap = 1D
- GFRP, ap = 0.8D

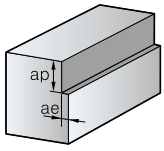
∗ Notice

- Please adjust the recommended cutting conditions properly, according to the types of CFRP or GFRP, the workpiece shapes, clamping conditions, and the rigidity of your machines.
- In case of machining troubles such as peeling, burrs and flaking, reduce feed rate by the same ratio.
- It is highly recommended to use purified water for high-pressure wet machining because cutting heat may cause troubles.
- Please provide against dust before machining begins.

Recommended Cutting Conditions (CCR)

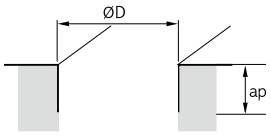
Division	CCR (Shoulder roughing)				CCR (Slotting)			
Workpiece	CFRP		GFRP		CFRP		GFRP	
Cutting conditions / Tool diameter (Ø)	RPM n (min^{-1})	Feed vf (mm/min)	RPM n (min^{-1})	Feed vf (mm/min)	RPM n (min^{-1})	Feed vf (mm/min)	RPM n (min^{-1})	Feed vf (mm/min)
4	15,920	1,020	7,960	510	7,960	340	3,980	170
5	12,730	1,270	6,370	640	6,370	430	3,180	210
6	10,610	1,270	5,310	640	5,310	430	2,650	210
8	7,960	1,340	3,980	670	3,980	450	1,990	230
10	6,370	1,530	3,180	760	3,180	510	1,590	260
12	5,310	1,720	2,650	860	2,650	580	1,330	290

■ **Application tip (Shoulder roughing)**



• ap = 2D
• ae = 0.35D

■ **Application tip (Slotting)**



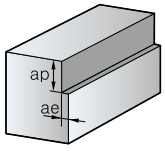
• CFRP, ap = 1D
ae = 1D

Recommended Cutting Conditions (CCLR/CCRR)

Division	CCLR/CCRR (Shoulder roughing)				CCLR/CCRR (Shoulder finishing)			
Workpiece	CFRP		GFRP		CFRP		GFRP	
Cutting conditions / Tool diameter (Ø)	RPM n (min^{-1})	Feed vf (mm/min)	RPM n (min^{-1})	Feed vf (mm/min)	RPM n (min^{-1})	Feed vf (mm/min)	RPM n (min^{-1})	Feed vf (mm/min)
4	15,920	1,530	7,960	510	15,920	1,275	7,960	380
5	12,730	1,530	6,370	510	12,730	1,275	6,370	380
6	10,610	1,530	5,310	510	10,610	1,275	5,310	380
8	7,960	1,530	3,980	510	7,960	1,275	3,980	380
10	6,370	1,530	3,180	510	6,370	1,275	3,180	380
12	5,310	1,530	2,650	510	5,310	1,275	2,650	380

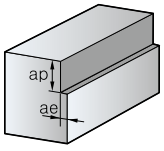
* In case of CCRR, increase feed rate, vf (mm/min) by 30%.

■ **Application tip (Shoulder roughing)**



• CFRP, ap = 2D, ae = 0.4
• GFRP, ap = 2D, ae = 0.3

■ **Application tip (Shoulder finishing)**



• ap = 2D
• ae = 0.1D

* Notice

- Please adjust the recommended cutting conditions properly, according to the types of CFRP or GFRP, the workpiece shapes, clamping conditions, and the rigidity of your machines.
- In case of machining troubles such as peeling, burrs and flaking, reduce feed rate by the same ratio.
- It is highly recommended to use purified water for high-pressure wet machining because cutting heat may cause troubles.
- Please provide against dust before machining begins.

CCDR4000/6000 (Flat)

Shouldering Ramping Helical milling

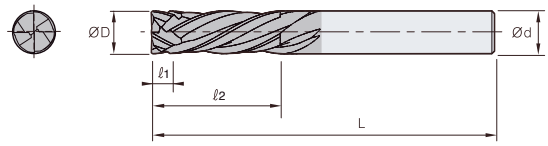


Fig.1

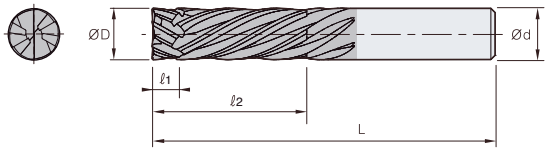


Fig.2

4	6	Helix Angle 30°/-30°	Grade ND2100	h5 shank	ØD	Tolerance
					Ø6~Ø12	0.00~ -0.03 mm

Workpiece			
CFRP	GFRP	CFRP/ Metal stacks	Honey-combs
◎	◎		

※ Metal: Aluminum or titanium, etc.

(mm)

Designation		ØD	Ød	ℓ1	ℓ2	L	Fig
CCDR 4	4060-065	6	6	3	18	65	1
	4080-075	8	8	4	24	75	1
CCDR 6	6100-085	10	10	5	30	85	2
	6120-100	12	12	6	36	100	2

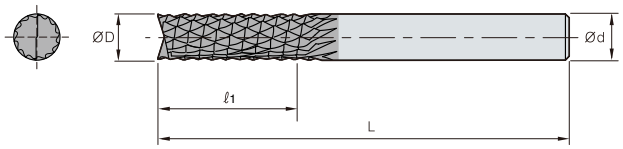
4	6	Helix Angle 30°/-30°	Grade ND2100	h5 shank	ØD	Tolerance
					Ø0.250~Ø0.500	0.0000 ~ -0.0012 inch

(inch)

Designation		ØD	Ød	ℓ1	ℓ2	L	Fig
CCDR 4	402500	1/4 0.250	0.250	0.125	0.750	2.500	1
	402500L	1/4 0.250	0.250	0.125	1.500	4.000	1
CCDR 6	603750	3/8 0.375	0.375	0.125	1.000	3.250	2
	603750L	3/8 0.375	0.375	0.125	1.500	4.000	2
	605000	1/2 0.500	0.500	0.125	1.000	3.250	2
	605000L	1/2 0.500	0.500	0.125	1.500	4.000	2

CCR2000 (Flat)

Shouldering | Slotting | Ramping | Helical milling



2	Helix Angle -27°	Grade ND2100	h5 shank

ØD	Tolerance
Ø4~Ø12	-0.02~ -0.08 mm

Workpiece			
CFRP	GFRP	CFRP/ Metal stacks	Honey-combs
◎	◎		

※ Metal: Aluminum or titanium, etc.

(mm)

Designation		ØD	Ød	ℓ1	L
CCR 2	2040-050	4	4	12	50
	2050-050	5	5	15	50
	2060-065	6	6	18	65
	2080-075	8	8	24	75
	2100-085	10	10	30	85
	2120-100	12	12	36	100

2	Helix Angle -27°	Grade ND2100	h5 shank

ØD	Tolerance
Ø0.250~Ø0.500	-0.0008~ -0.0032 inch

(inch)

Designation		ØD	Ød	ℓ1	L
CCR 2	202500	1/4 0.250	0.250	0.750	2.500
	202500L	1/4 0.250	0.250	1.500	4.000
	203750	3/8 0.375	0.375	1.000	3.250
	203750L	3/8 0.375	0.375	1.500	4.000
	205000	1/2 0.500	0.500	1.000	3.250
	205000L	1/2 0.500	0.500	1.500	4.000

[Endface Tooth]


2F,
Standard type

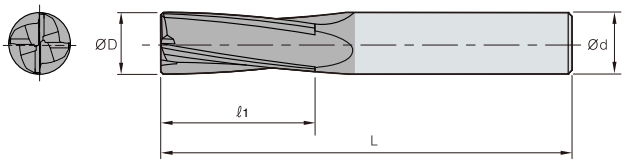

Without an endface tooth
(For shouldering)*


With 4~6F endface teeth
(For facing and Blind-hole machining)*

※ Inserts marked with an asterisk (*) are available for a custom-made order.

CCLR4000 (Flat)

Shouldering | Slotting | Ramping | Helical milling



4	Helix Angle 15°	Grade ND2100	h5 shank

ØD	Tolerance
Ø4~Ø12	0.00~ -0.03 mm

Workpiece			
CFRP	GFRP	CFRP/ Metal stacks	Honey-combs
◎	◎		

※ Metal: Aluminum or titanium, etc.

(mm)

Designation		ØD	Ød	ℓ1	L
CCLR 4	4040-050	4	4	12	50
	4050-050	5	5	15	50
	4060-065	6	6	18	65
	4080-075	8	8	24	75
	4100-085	10	10	30	85
	4120-100	12	12	36	100

4	Helix Angle 15°	Grade ND2100	h5 shank

ØD	Tolerance
Ø0.250~Ø0.500	0.0000~ -0.0012 inch

(inch)

Designation		ØD	Ød	ℓ1	L
CCLR 4	402500	1/4 0.250	0.250	0.750	2.500
	402500L	1/4 0.250	0.250	1.500	4.000
	403750	3/8 0.375	0.375	1.000	3.250
	403750L	3/8 0.375	0.375	1.500	4.000
	405000	1/2 0.500	0.500	1.000	3.250
	405000L	1/2 0.500	0.500	1.500	4.000

CCRR6000/8000 (Flat)

Shouldering | Ramping | Helical milling

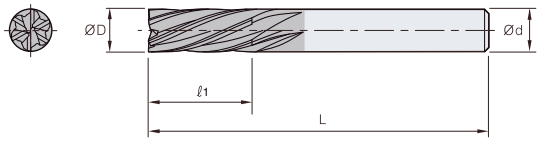


Fig.1

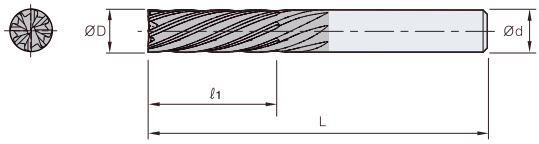


Fig.2

6 | 8 | Helix Angle -25° | Grade ND2100 | h5 shank

ØD	Tolerance
Ø6~Ø12	0.00~ -0.03 mm

Workpiece			
CFRP	GFRP	CFRP/ Metal stacks	Honey-combs
◎	◎		

※ Metal: Aluminum or titanium, etc.

(mm)

Designation		ØD	Ød	ℓ1	L	Fig
CCRR 6	6060-065	6	6	18	65	1
	6080-075	8	8	24	75	1
CCRR 8	8100-085	10	10	30	85	2
	8120-100	12	12	36	100	2

6 | 8 | Helix Angle -25° | Grade ND2100 | h5 shank

ØD	Tolerance
Ø0.250~Ø0.500	0.0000~ -0.0012 inch

(inch)

Designation		ØD	Ød	ℓ1	L	Fig
CCRR 6	602500	1/4 0.250	0.250	0.750	2.500	1
	602500L	1/4 0.250	0.250	1.500	4.000	1
CCRR 8	803750	3/8 0.375	0.375	1.000	3.250	2
	803750L	3/8 0.375	0.375	1.500	4.000	2
	805000	1/2 0.500	0.500	1.000	3.250	2
	805000L	1/2 0.500	0.500	1.500	4.000	2

KORLOY

Holystar B/D, 1350, Nambusunhwan-ro, Geumcheon-gu, Seoul, 08536, Korea
Tel: +82-2-522-3181 Fax: +82-2-522-3184, +82-2-3474-4744 Web: www.korloy.com E-mail: export@korloy.com

KORLOY AMERICA
620 Maple Avenue, Torrance, CA 90503, USA
Tel: +1-310-782-3800 Toll Free: +1-888-711-0001 Fax: +1-310-782-3885
www.korloyamerica.com E-mail: sales@korloy.us

KORLOY INDIA
Plot NO.415, Sector 8, IMT Manesar, Gurgaon 122051, Haryana, INDIA
Tel: +91-124-4391790 Fax: +91-124-4050032
www.korloyindia.com E-mail: sales.kip@korloy.com

KORLOY EUROPE
Gablonzer Str. 25-27, 61440 Oberursel, Germany
Tel: +49-6171-277-83-0 Fax: +49-6171-277-83-59
www.korloyeurope.com E-mail: sales@korloyeurope.com

KORLOY BRASIL
Av. Aruana 280, conj.12, WLC, Alphaville, Barueri,
CEP06460-010, SP, Brasil
Tel: +55-11-4193-3810 E-mail: vendas@korloy.com