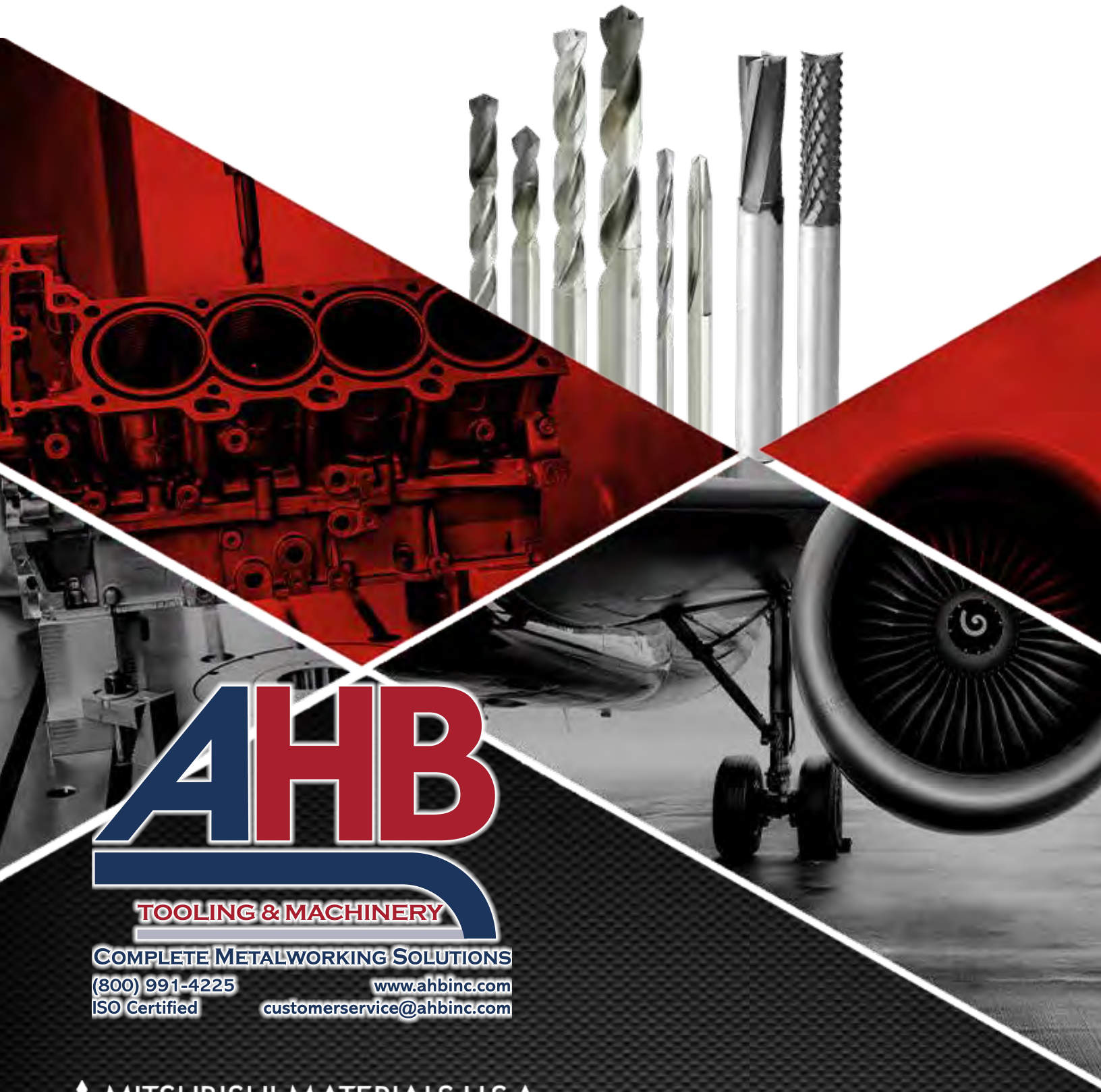
DIA EDGE

SOLUTIONS FOR COMPOSITE



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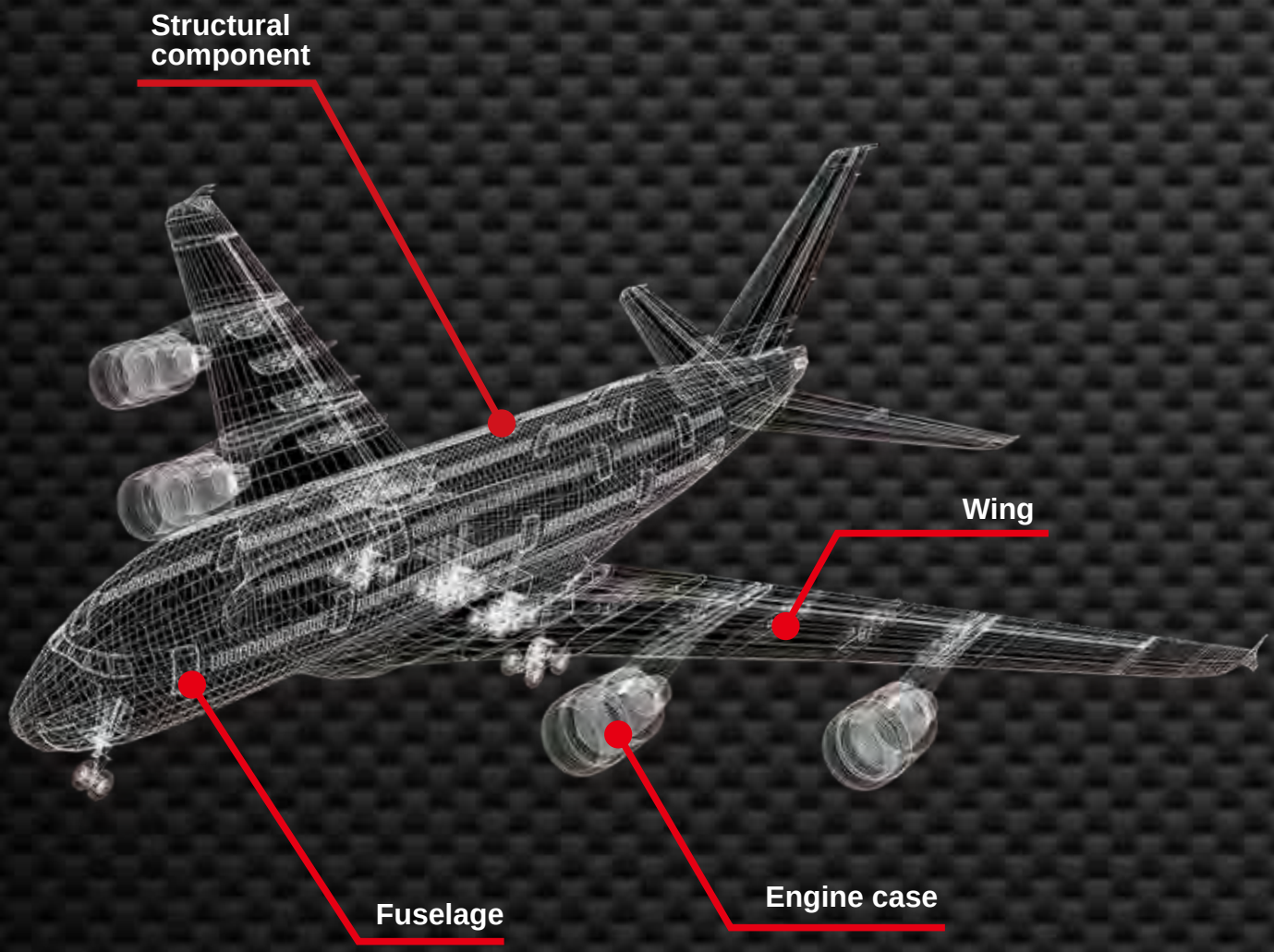
MITSUBISHI MATERIALS U.S.A.

SOLUTION

High strength carbon fiber is widely used in the aeronautic and au tomobile industries, as well as in wheelchairs, F1 chassis, bicycle frames and wind power generation blades for light structures that req uire strength. However, the life of such tools is extremely short

AEROSPACE



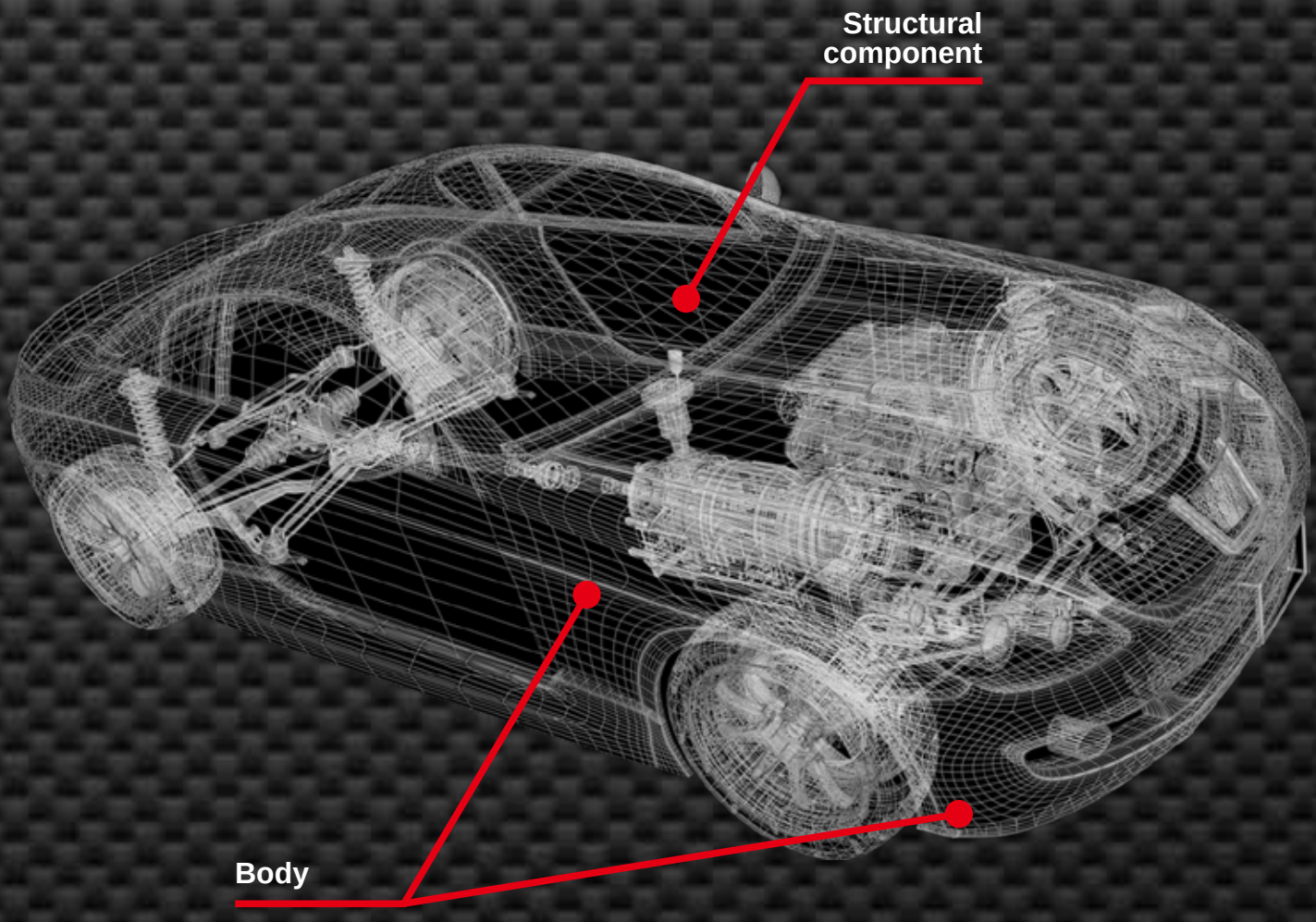
Drilling

The CVD diamond coating and cemented carbide drill equipped with an edge shape optimized by application and high abrasion resistance provide stability that minimizes burr and delamination.

FOR CFRP

due to the high strength. In addition, it is effective to use tools with a high abrasion resistance coating in composite material machining where delamination and burr is liable to occur du ring cutting due to the laminate structure.

AUTOMOTIVE

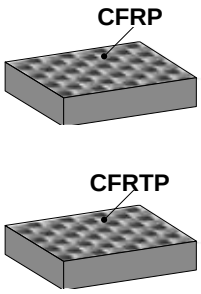
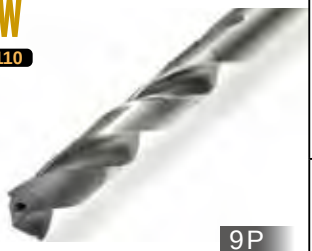
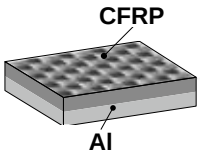
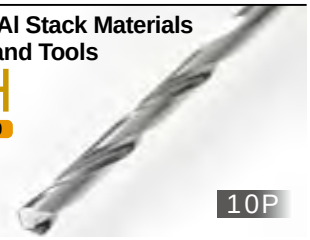
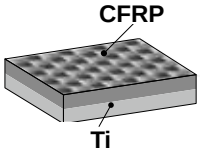
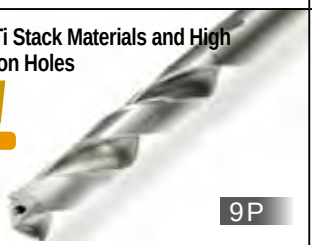


Trimming

The end mill that combines an optimized edge shape and high wear resistance CVD diamond coating maintains high quality.

DRILLING TOOLS

DRILL

	CNC Machine 		Hand Tool 
	**CFRP** **MCC** DD2105  5P The cutting edge angle = 90° setting minimizes cutting resistance in the thrust direction. This controls delamination and maintains good hole quality.	**For CFRP/CFRTP, CFRP/Al Stack Materials and High Precision Holes** **MCW** DD2110  9P The unique cutting edge shape with V-shaped grooves on the cutting edge controls the flow of chips generated at the outer circumference. Furthermore, this minimizes the hole diameter gaps in stack materials. Burr on the hole exit side is controlled by shifting the cutting load to the rotating shaft.	**Hand Tool (CFRP)** **MCCH** DT2030  10P The hand tool ultra-hard substrate with enhanced strength prevents sudden breakages and maintains high-quality holes. The double angle design controls the thrust and enables a stable cutting speed even in hand tool machining.
	**CFRP/Al Stack Materials** **MCA** DD2110  6P The groove design that wraps up chips also minimizes gaps of CFRP and aluminum hole diameter in addition to preventing contact between the chips and the CFRP hole wall surface.		**CFRP/Al Stack Materials and Hand Tools** **MCAH** DT2030  10P The hand tool ultra-hard substrate with enhanced strength prevents sudden breakages and produces highly reliable hole machining. The combination of the groove shape and optimal twisting ensures compatibility of the aluminum chip dividing and discharging. This leads to stable hole machining even in CFRP and aluminum stack material machining.
	**CFRP/Ti Stack Materials** **MCT** TF15  8P The sharp cutting edge in titanium machining which requires good CFRP hole quality and machining that minimizes the generation of cutting heat with low thermal conductivity achieves high-quality CFRP and titanium stack material hole machining.	**CFRP/Ti Stack Materials and High Precision Holes** **MCW** HTi10  9P The unique cutting edge shape with V-shaped grooves on the cutting edge controls the flow of chips generated at the outer circumference. Furthermore, this minimizes the hole diameter gaps in stack materials. Burr on the hole exit side is controlled by shifting the cutting load to the rotating shaft.	

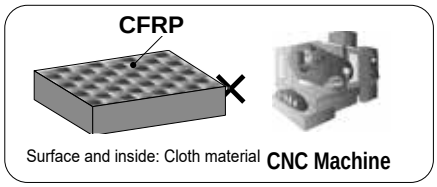
⁎CFRTP=Carbon Fiber Reinforced Thermoplastic Resin

END MILLS

Four Flutes

DFCAJC

The low resistance cutting edge with low helix angle reduces delamination and burrs when machining CFRP.

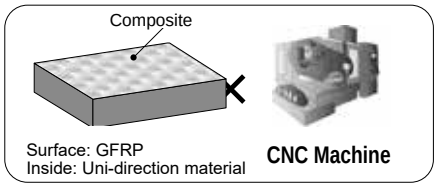


13P

Performance

DFCJRT

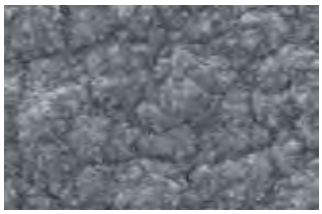
The cross-nick type cutting edge allows high efficiency machining due to lower cutting resistance and reduced temperatures.



14P

Features

Proprietary CVD diamond coating

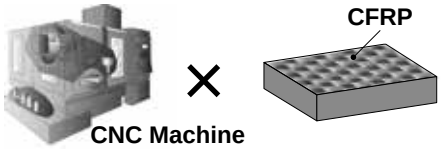


New coating

Conventional

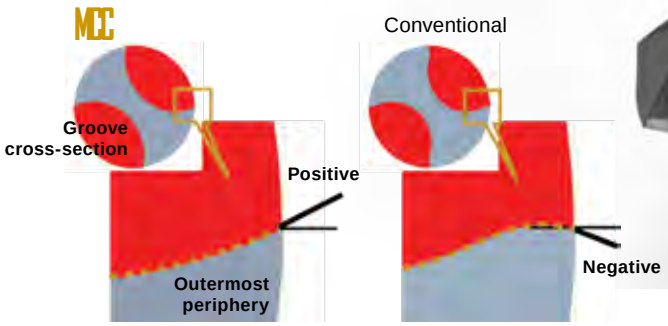
The newly developed CVD diamond coated coating achieves outstanding abrasion resistance and smoothness due to a proprietary fine multilayer diamond crystal control technology.

DRILLING TOOLS
MCC



90° Cutting Edge Angle

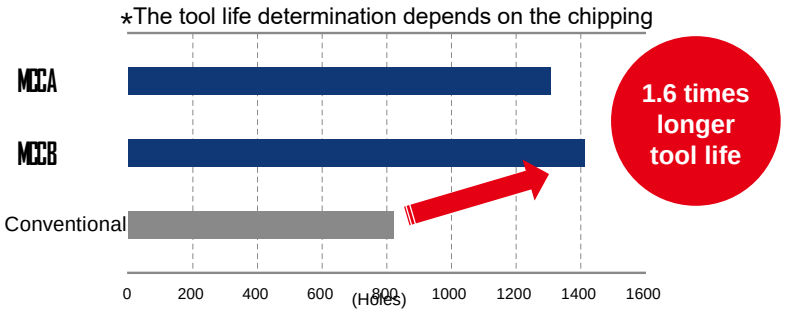
The acute cutting angle thoroughly reduces thrust and minimizes delamination.

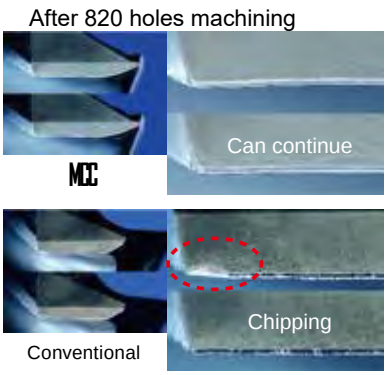


Strong Rake Grooves

The cutting edge rake angle has been strengthened in the vertical direction on the axis of rotation. As a result, it is possible to minimize un-cutting and delamination on sharp cutting edges.

Comparison of Tool Life and Hole (Entrance/Exit)



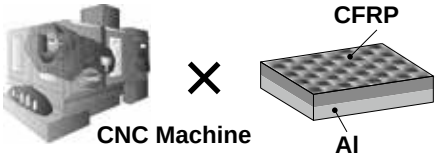


<Cutting condition>
Tool : ø6.55
Work material : CFRP□
For tool life (10mm)
For hole quality
(12.5mm)Cutting speed : 120m/min
Feed : 0.10mm/rev
Cutting mode : Dry cutting

	306 holes		588 holes		MCC (1192 holes)
	MCC	Conventional	MCC	Conventional	
Entrance					
Exit					

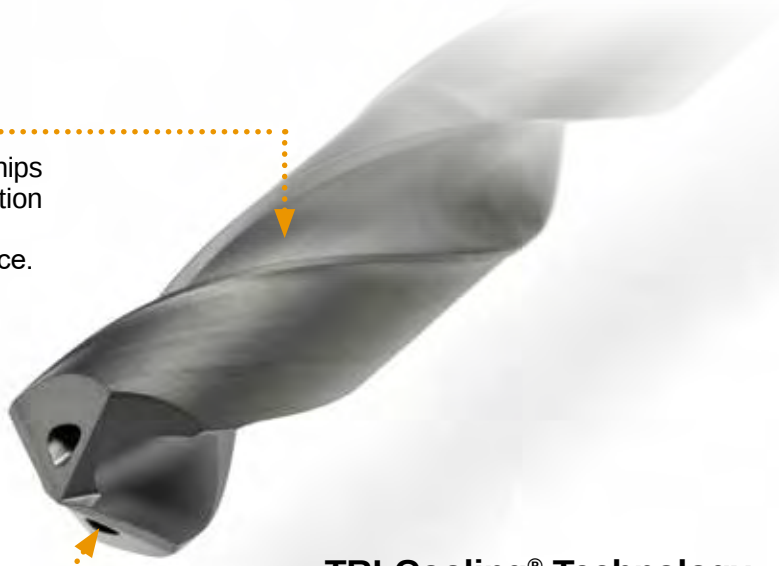
DRILLING TOOLS

MCA



New Groove Structure

The groove design that covers up chips also minimizes back counter in addition to minimizing contact between the chips and the CFRP hole wall surface.

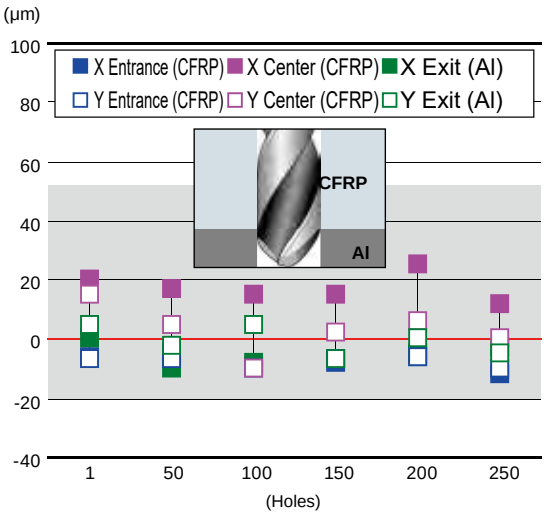


TRI-Cooling® Technology

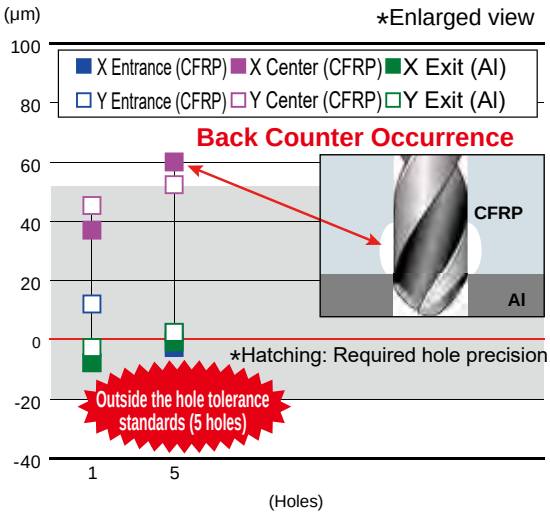
Controlling the cutting heat reduces deterioration of the CFRP hole precision caused by heat (improves the internal air effectiveness).

Groove Shape Effect

MCA



Conventional



<Cutting condition>

Tool	: 0.251"(ø6.38)	CFRP		Al	
Work material	: CFRP(11mm)+Al(5mm)	Cutting speed	: 100m/min	Cutting speed	: 100m/min
		Feed	: 0.15mm/rev	Feed	: 0.15mm/rev
				Cutting mode	: Internal air

DRILLING TOOLS

MCC

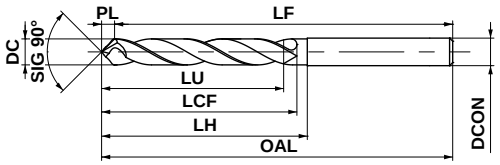
CNC Machine / CFRP

CNC Machine

×

CFRP

3<DC≦6	6<DC≦10	10<DC≦18	18<DC≦20
0 –0.018	0 –0.022	0 –0.027	0 –0.033
0 –0.008	0 –0.009	0 –0.011	0 –0.013



Hole Dia.		Drill Dia.		Hole Depth	Order Number	Grade	Dimensions (mm)						
AWG*	inch	DC (mm)	inch	(L/D)		DD2105	LU	LCF	LH	OAL	LF	PL	DCON
—	3/16	4.76	.1875	3	**MCC0476X03S060**	●	16.7	40	40	80	77.6	2.4	6
—	1/4	6.38	.251	3	**MCC0638X03S080**	●	22.3	50	50	90	86.8	3.2	8
—	5/16	7.96	.3125	3	**MCC0796X03S080**	●	27.9	50	50	90	86.0	4.0	8
—	3/8	9.55	.375	3	**MCC0955X03S100**	●	33.5	50	50	100	95.2	4.8	10
—	7/16	11.14	.4375	3	**MCC1114X03S120**	●	39.0	60	60	110	104.4	5.6	12

✱**AWG :** American Wire Gage

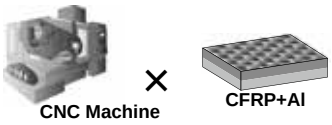
RECOMMENDED CUTTING CONDITIONS

Work Material		CFRP			
Dia. **DC** (inch)	Dia. **DC** (mm)	Cutting speed (m/min)	Revolution (min^{-1})	Feed (Min.—Max.) (mm/rev)	Feed rate (mm/min)
.1875	4.76	100	6700	0.08 (0.05—0.12)	540
.251	6.38	100	5000	0.1 (0.05—0.12)	500
.3125	7.96	100	4000	0.1 (0.05—0.12)	400
.375	9.55	100	3400	0.1 (0.05—0.12)	340
.4375	11.14	100	2900	0.1 (0.05—0.12)	290

● **: Inventory maintained in Japan.** □ **: Non stock, produced to order only.**

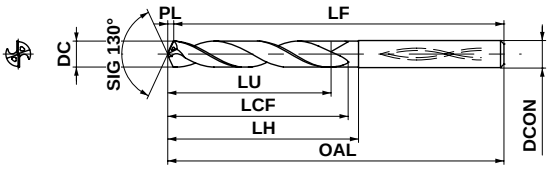
MCA

CNC Machine / CFRP + Al



3<DC≤6	6<DC≤10	10<DC≤18	18<DC≤20
0 / −0.018	0 / −0.022	0 / −0.027	0 / −0.033
0 / −0.008	0 / −0.009	0 / −0.011	0 / −0.013

h6



Hole Dia.		Drill Dia.		Hole Depth	Order Number	Grade	Dimensions (mm)						
AWG*	inch	DC (mm)	inch	(L/D)		DD2110	LU	LCF	LH	OAL	LF	PL	DCON
—	1/4	6.38	.251	5	**MCA0638X05S070**	□	33.4	51	51	91	89.5	1.5	7
—	3/8	9.55	.375	5	**MCA0955X05S100**	□	50.0	77	77	118	115.8	2.2	10

✱**AWG :** American Wire Gage

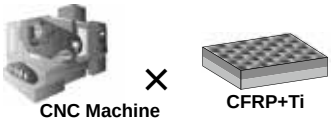
RECOMMENDED CUTTING CONDITIONS

Work Material		CFRP				Aluminum Alloy (Si<5%) A6061, A7075 etc.			
Dia. DC (inch)	Dia. DC (mm)	Cutting speed (m/min)	Revolution (min^{-1})	Feed (Min.—Max.) (mm/rev)	Feed rate (mm/min)	Cutting speed (m/min)	Revolution (min^{-1})	Feed (Min.—Max.) (mm/rev)	Feed rate (mm/min)
.251	6.38	100	5000	0.15 (0.10—0.20)	750	100	5000	0.03 (0.02—0.04)	150
.375	9.55	100	3400	0.15 (0.10—0.20)	680	100	3400	0.03 (0.02—0.04)	100

1) We recommend to divide cutting conditions in each work materials.

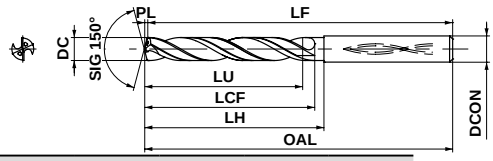
MCT

CNC Machine / CFRP + Ti



3<DC≤6	6<DC≤10	10<DC≤18	18<DC≤20
0 / −0.018	0 / −0.022	0 / −0.027	0 / −0.033
0 / −0.008	0 / −0.009	0 / −0.011	0 / −0.013

h6



Hole Dia.		Drill Dia.		Hole Depth	Order Number	Grade	Dimensions (mm)						
AWG*	inch	DC (mm)	inch	(L/D)		TF15	LU	LCF	LH	OAL	LF	PL	DCON
—	1/4	6.38	.251	5	**MCT0638X05S070**	□	32.8	47	47	96	95.1	0.9	7
—	3/8	9.55	.375	5	**MCT0955X05S100**	□	49.1	71	71	122	120.7	1.3	10

✱**AWG :** American Wire Gage

RECOMMENDED CUTTING CONDITIONS

Work Material		CFRP				Titanium Alloy Ti-6Al-4V etc.				
Dia. DC (inch)	Dia. DC (mm)	Cutting speed (m/min)	Revolution (min^{-1})	Feed (Min.—Max.) (mm/rev)	Feed rate (mm/min)	Cutting speed (m/min)	Revolution (min^{-1})	Feed (Min.—Max.) (mm/rev)	Feed rate (mm/min)	Peck machining (mm)
.251	6.38	100	5000	0.15 (0.10—0.20)	750	15	750	0.02 (0.01—0.03)	15	1
.375	9.55	100	3400	0.15 (0.10—0.20)	680	15	500	0.02 (0.01—0.03)	10	1

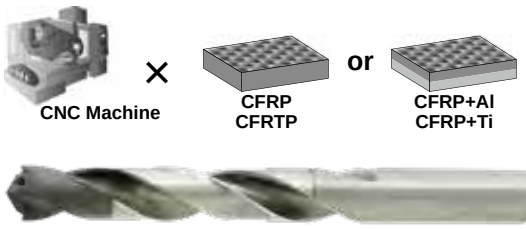
1) This condition is for when internal air or mist is used.
2) We recommend to divide cutting conditions in each work materials.

● **: Inventory maintained in Japan.** □ **: Non stock, produced to order only.**

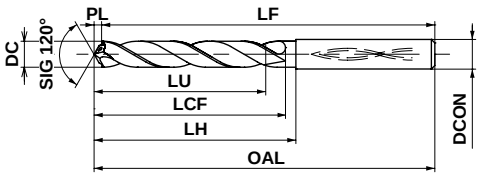
DRILLING TOOLS

MCW

CNC Machine / CFRP and stack material high precision



3<DC≦6	6<DC≦10	10<DC≦18	18<DC≦20
0 / −0.018	0 / −0.022	0 / −0.027	0 / −0.033
0 / −0.008	0 / −0.009	0 / −0.011	0 / −0.013



Hole Dia.		Drill Dia.		Hole Depth	Order Number	Grade		Dimensions (mm)						
AWG *	inch	DC (mm)	inch	(L/D)		HTi10	DD2110	LU	LCF	LH	OAL	LF	PL	DCON
—	1/4	6.38	.251	5	**MCW0638X05S070**	□	□	33.7	52	52	92	90.2	1.8	7
—	3/8	9.55	.375	5	**MCW0955X05S100**	□	□	50.6	73	73	119	116.2	2.8	10

✱**AWG :** American Wire Gage

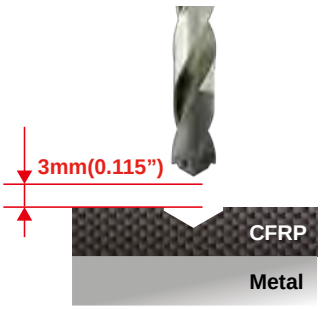
RECOMMENDED CUTTING CONDITIONS

Work Material		CFRP			
Dia. DC (inch)	Dia. DC (mm)	Cutting speed (m/min)	Revolution (min^{-1})	Feed (Min.—Max.) (mm/rev)	Feed rate (mm/min)
.251	6.38	100	5000	0.15 (0.10—0.20)	750
.375	9.55	100	3400	0.15 (0.10—0.20)	680

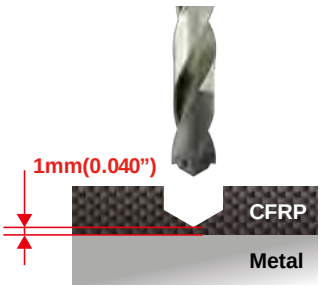
Work Material		Aluminum Alloy (Si<5%) A6061, A7075 etc.					Titanium Alloy Ti-6Al-4V etc.				
Dia. DC (inch)	Dia. DC (mm)	Cutting speed (m/min)	Revolution (min^{-1})	Feed (Min.—Max.) (mm/rev)	Feed rate (mm/min)	Peck machining (mm)	Cutting speed (m/min)	Revolution (min^{-1})	Feed (Min.—Max.) (mm/rev)	Feed rate (mm/min)	Peck machining (mm)
.251	6.38	100	5000	0.15 (0.10—0.20)	750	3	15	750	0.02 (0.01—0.03)	15	1
.375	9.55	100	3400	0.15 (0.10—0.20)	500	3	15	500	0.02 (0.01—0.03)	10	1

1) This condition is for when internal air or mist is used.
2) We recommend to divide cutting conditions in each work materials.

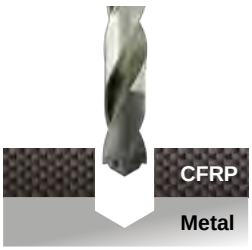
Peck Machining Method (Applicable for MCT and MCW)



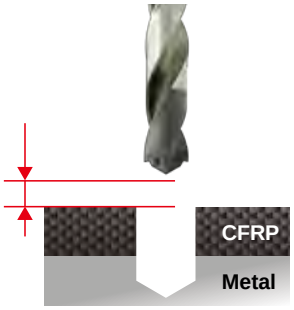
Set the machining start position to 3 mm above normal.



Refer to the recommend conditions for CFRP. Machine the cutting edge of the drill to at least 1 mm (0.040") before the metal.



Peck machine 3 mm (0.115") for aluminum and 1 mm (0.040") for titanium for the metal machining area.



Set it so that it returns to its start position during peck machining.

● **: Inventory maintained in Japan.** □ **: Non stock, produced to order only.**

MCCH

Hand tool / CFRP

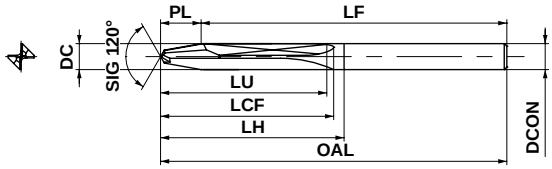

Hand Tool

×


CFRP

h6

1≤DC≤3	3<DC≤6	6<DC≤10	10<DC≤18	18<DC≤20
0 / −0.014	0 / −0.018	0 / −0.022	0 / −0.027	0 / −0.033
0 / −0.006	0 / −0.008	0 / −0.009	0 / −0.011	0 / −0.013



Hole Dia.		Drill Dia.		Hole Depth	Order Number	Grade	Dimensions (mm)						
AWG*	inch	DC (mm)	inch	(L/D)		DT2030	LU	LCF	LH	OAL	LF	PL	DCON
#40	—	2.5	.0985	15	**MCCH0250X15S030**	●	42.1	48	50	100	95.4	4.6	3
#30	—	3.26	.1285	10	**MCCH0326X10S040**	●	38.6	48	50	100	94.0	6.0	4
#20	—	4.1	.1615	8	**MCCH0410X08S050**	●	40.3	48	50	100	92.5	7.5	5
#11	—	4.86	.1915	5	**MCCH0486X05S050**	●	33.2	48	50	100	91.1	8.9	5
—	1/4	6.38	.251	3	**MCCH0638X03S070**	●	30.8	48	50	100	88.3	11.7	7
—	3/8	9.55	.375	2	**MCCH0955X02S100**	●	36.6	48	50	100	82.5	17.5	10

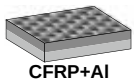
*AWG : American Wire Gage

MCAH

Hand tool / CFRP + Al

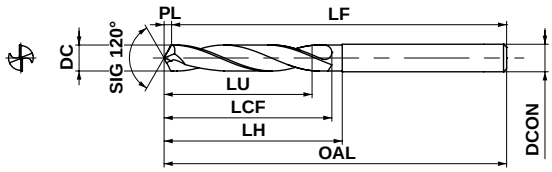

Hand Tool

×


CFRP+Al

h6

1≤DC≤3	3<DC≤6	6<DC≤10	10<DC≤18	18<DC≤20
0 / −0.014	0 / −0.018	0 / −0.022	0 / −0.027	0 / −0.033
0 / −0.006	0 / −0.008	0 / −0.009	0 / −0.011	0 / −0.013



Hole Dia.		Drill Dia.		Hole Depth	Order Number	Grade	Dimensions (mm)						
AWG*	inch	DC (mm)	inch	(L/D)		DT2030	LU	LCF	LH	OAL	LF	PL	DCON
#40	—	2.5	.0985	15	**MCAH0250X15S030**	●	38.2	50	50	100	99.3	0.7	3
#30	—	3.26	.1285	15	**MCAH0326X15S040**	●	49.8	50	50	100	99.1	0.9	4
#20	—	4.1	.1615	10	**MCAH0410X10S050**	●	42.2	50	50	100	98.8	1.2	5
#11	—	4.86	.1915	8	**MCAH0486X08S050**	●	40.3	50	50	100	98.6	1.4	5
—	1/4	6.38	.251	5	**MCAH0638X05S070**	●	33.7	50	50	100	98.2	1.8	7
—	3/8	9.55	.375	3	**MCAH0955X03S100**	●	31.5	50	50	100	97.2	2.8	10

*AWG : American Wire Gage

● : Inventory maintained in Japan. □ : Non stock, produced to order only.

DRILLING TOOLS

Request sizes other than those in the inventory by inserting the code and numerical value in the □ of the following model numbers. Contact our sales department for details on the dimensions.

Order number

MC□ □□□□ X□□ S□□□

- MC□: Applications
- □□□□: Drill Dia. DC
- X□□: Hole Depth (L/D)
- S□□□: Shank Dia. DCON

*Minimum diameter with internal coolant is ϕ4mm (ϕ.1575").

Applications
C : CNC Machine / CFRP
A : CNC Machine / CFRP + Al
T : CNC Machine / CFRP + Ti
W : CNC Machine / CFRP and stack material high precision
CH : Hand tool / CFRP
AH : Hand tool / CFRP + Al

< Example >

Hole Depth (L/D)

□ L/D2 → X02
□ L/D10 → X10

Shank Dia. DCON

□ ø3mm → S030
□ ø10mm → S100

*For inch sizes please convert to metric (1"= 25.4mm)

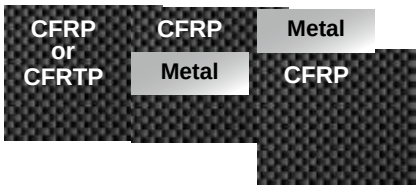
Work material

Type

- CFRP: Thermosetting and thermoplasticity
- Type of reinforcing fiber
- Metal: Aluminum or titanium, etc.

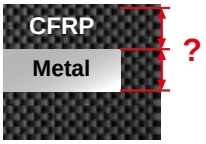
Combination

- CFRP or CFRTP
- CFRP + stack materials (aluminum or titanium)
- Lap joint method



Other

- Thickness for each work material
- Affixture of film



Equipment

Type

- CNC Machine
- Hand Tool
- Power feeders etc.

Coolant

- Internal through
- Air, MQL and dry, etc.

Hole Quality

- Required hole diameter (upper and lower limit of tolerance)
- Surface roughness of the hole inner wall
- Metal burr height
- CFRP and metal hole diameter gap

MILLING TOOLS

CVD diamond coating with outstanding abrasion resistance and superior sharpness for high quality CFRP machining.

DFC Series

CVD diamond coated end mill for CFRP machining

Geometry for CFRP machining

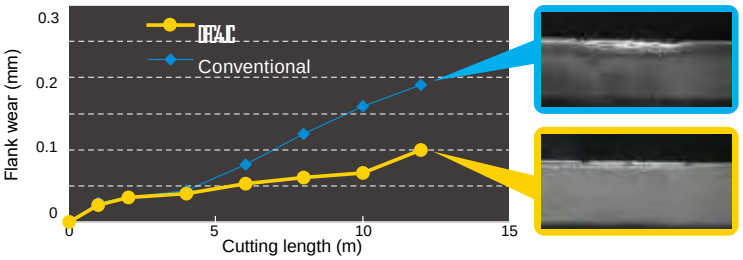
DFC4JC
For finishing

DFCJRT
For efficient machining

The low resistance cutting edge with low helix angle reduces delamination and burrs when machining CFRP.

The cross-nick type cutting edge allows high efficiency machining due to lower cutting resistance and reduced temperatures.

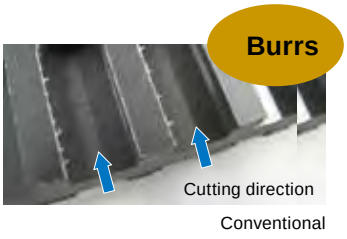
■Long tool life



End mill	DFC4JCD1000 (ø10)
Work material	CFRP (Thick: 5.3mm)
Revolution	6400min^{-1} (200m/min)
Feed rate	800mm/min (0.03mm/tooth)
Coolant mode	Air blow

■Excellent surface finish

DFC4JC



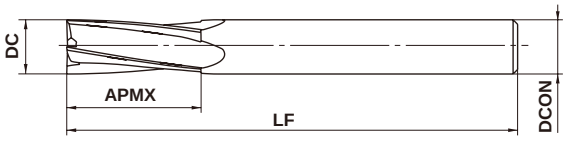
Conventional

End mill	DFC4JCD1000 (ø10)
Work material	CFRP (Thick: 6mm)
Revolution	6000min^{-1} (188m/min)
Feed rate	750mm/min (0.03mm/tooth)
Coolant mode	Air blow

MILLING TOOLS

DFC4JC

End mill, Semi long cut length, 4 flute, for CFRP



6≤DC≤12		
0 - 0.03		
DCON=6	8≤DCON≤10	DCON=12
0 - 0.008	0 - 0.009	0 - 0.011

Order Number	DC	APMX	LF	DCON	No.of Flutes	Stock
DFC4JCD0600	6	20	70	6	4	●
DFC4JCD0800	8	30	80	8	4	●
DFC4JCD1000	10	30	90	10	4	●
DFC4JCD1200	12	30	100	12	4	●

Please contact Mitsubishi Materials for geometries and through coolant types other than standard.

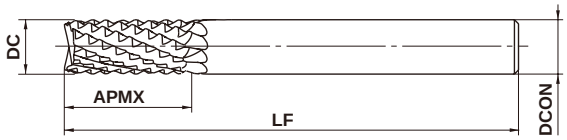
RECOMMENDED CUTTING CONDITIONS

Work material	CFRP	
Dia. DC (mm)	Revolution (min^{-1})	Feed rate (mm/min)
6	11000	950
8	8000	780
10	6400	700
12	5300	650

1) Cutting conditions may differ considerably due to the kind of CFRP, the rigidity of the machine, or the clamping and geometry of the workpiece. Please use the left table as a standard starting point.
2) When high machining accuracy is needed, or large burrs or delamination occurs, we recommend reducing the feed rate.
3) When the depth of cut is greater than 0.8DC, we recommend reducing the feed rate.
4) Please take precautions against dust.

DFCJRT

Cross-nick type end mill, Semi long cut length, for CFRP



DCON=6	8≤DCON≤10	DCON=12
0 - 0.008	0 - 0.009	0 - 0.011

Order Number	DC	APMX	LF	DCON	No.of Flutes	Stock
DFCJRTD0600	6	20	70	6	10	●
DFCJRTD0800	8	30	80	8	10	●
DFCJRTD1000	10	30	90	10	12	●
DFCJRTD1200	12	30	100	12	12	●

Please contact Mitsubishi Materials for geometries and through coolant types other than standard.

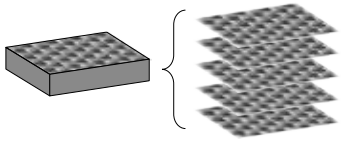
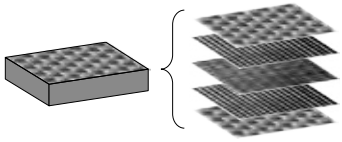
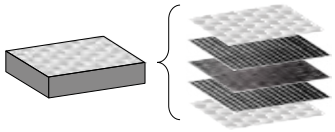
RECOMMENDED CUTTING CONDITIONS

Work material	CFRP	
Dia. DC (mm)	Revolution (min^{-1})	Feed rate (mm/min)
6	11000	1200
8	8000	1000
10	6400	900
12	5300	850

1) Cutting conditions may differ considerably due to the kind of CFRP, the rigidity of the machine, or the clamping and geometry of the workpiece. Please use the left table as a standard starting point.
2) When high machining accuracy is needed, or large burrs or delamination occurs, we recommend reducing the feed rate.
3) When the depth of cut is greater than 0.8DC, we recommend reducing the feed rate.
4) Please take precautions against dust.

● : Inventory maintained in Japan. ○ : Inventory maintained in Japan. (Available Autumn 2017)

Recommended Tools According to Type of CFRP

Type / End mill	Surface and inside: Cloth material	Surface → Cloth material Inside → Uni-direction material	Surface → Glass fiber material Inside → Uni-direction material
			
DFC4JC	◎	○	○
DFC6JC	◎	◎	○
DFCJRT	○	○	◎
Burr	Liable to occur →		

● : Inventory maintained in Japan. ○ : Inventory maintained in Japan. (Available Autumn 2017)

DIA EDGE

For Your Safety

- Don't handle inserts and chips without gloves.
- Please machine within the recommended application range and exchange expired tools with new ones in advance of breakage.
- Please use safety covers and wear safety glasses.
- When using compounded cutting oils, please take fire precautions.
- When attaching inserts or spare parts, please use only the correct wrench or driver.
- When using rotating tools, please make a trial run to check run-out, vibration and abnormal sounds etc.

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DIA EDGE
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