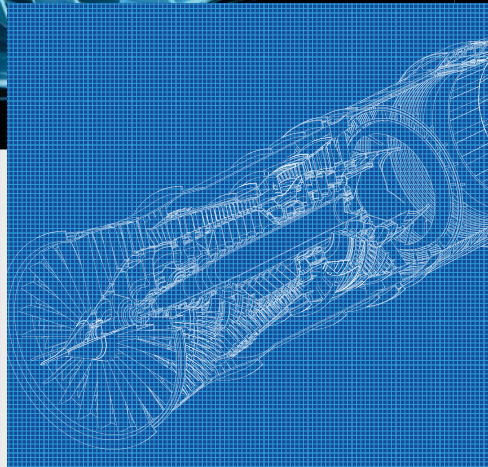
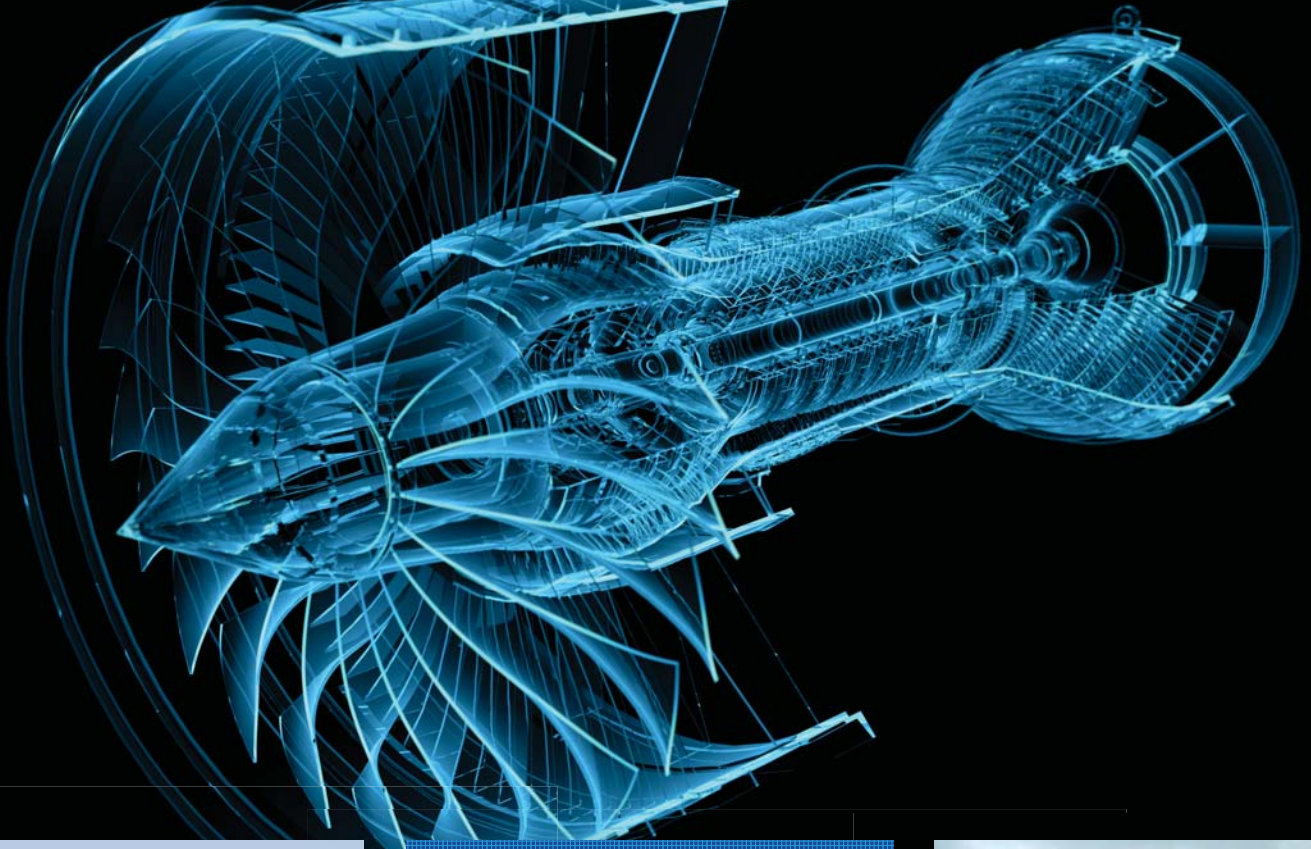


NACHI

AEROSPACE



High Performance Tools
for Aerospace Applications



Nachi Products for Aircraft Manufacturing Industry *“Adding Value Through Innovative Tooling Solutions”*

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Introduction to Nachi ~

Nachi — Your Full Service Tooling Partner:

Nachi offers a complete tooling program for machining aerospace metals and composites. As the choice of tools is always based on a cost-benefit assessment, the solution often includes standard as well as customized tools. This allows the customer to get the best solution from one source, thus reducing your supplier bases and overall cost of material procurement.

High Performance Tooling Solutions:

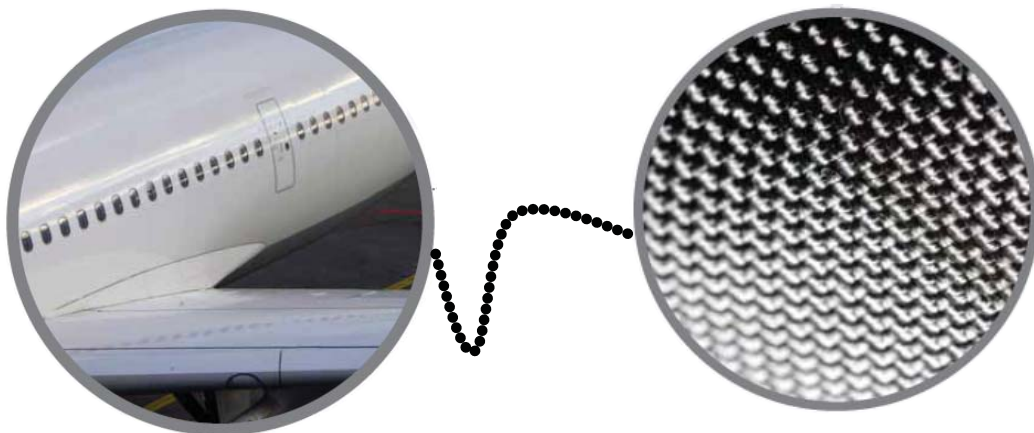
Obtaining lowest possible costs involves a combination of machinery, machining parameters and high performance tooling solutions. We at Nachi analyze all aspects of the production process involving cutting tools and systematically optimize them. Due to a wide range of requirements for machining aerospace components, Nachi works in partnership with each customer to ensure that every tooling solution offered is optimized for each individual application. The optimized tooling solution often includes unique geometries developed by Nachi and built to ensure extreme accuracy and tight tolerances.

Research & Development:

Nachi has established state-of-the-art testing and development facilities in Toyama, Japan and at our U.S. headquarters in Greenwood, Indiana. The R&D center helps Nachi stay ahead of the field by testing and re-testing our tools in various materials. For instance, tools are tested for function, tool life and wear under severe test conditions to establish and provide the optimum machining parameters for our customers. Hence, our major aerospace customers repeatedly rely on Nachi's extensively compiled test data obtained through testing on various materials.

Nachi — Your Partner in Manufacturing:

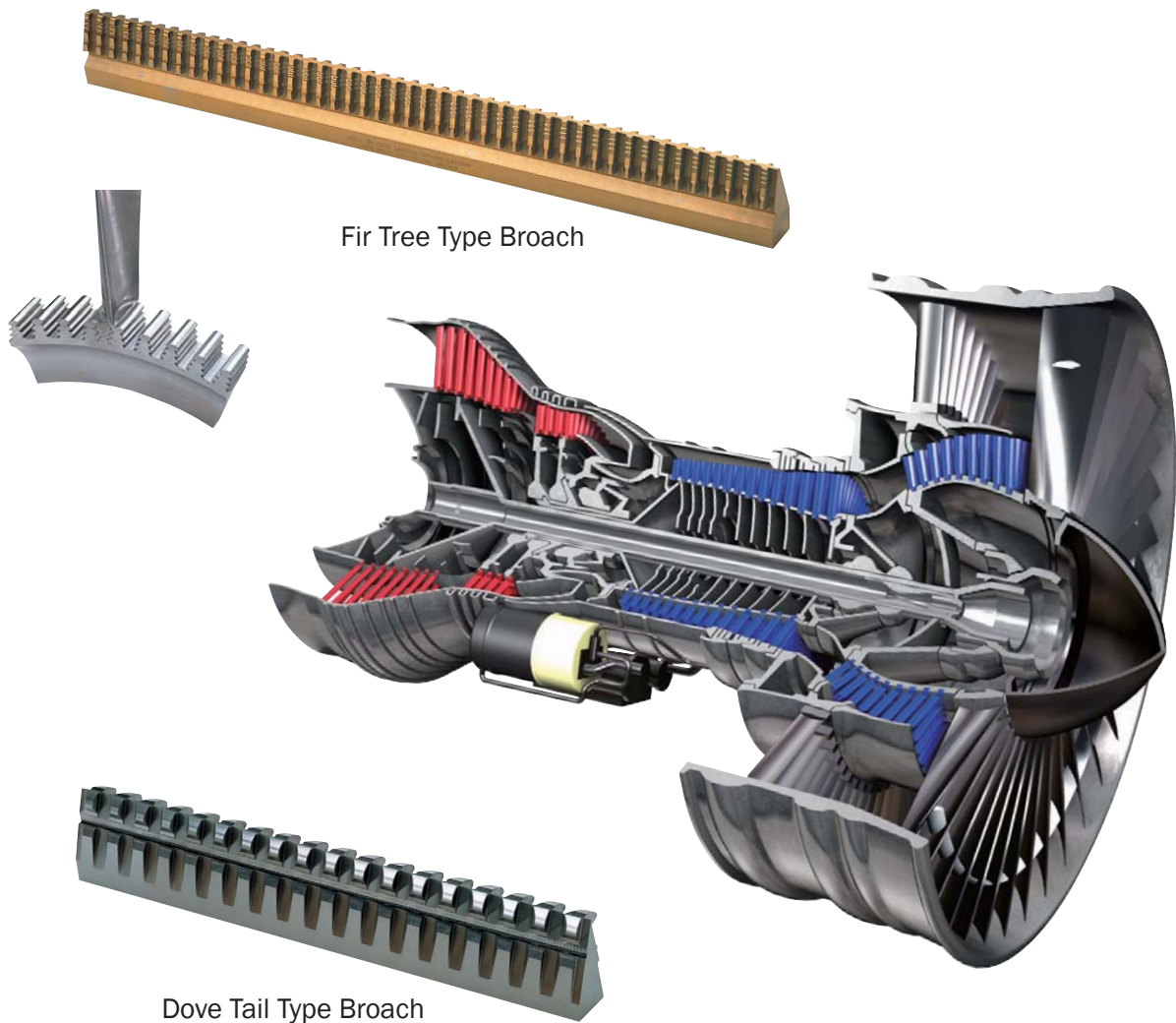
Today's competitive market demands a serious and permanent cooperation between both customer and manufacturer to improve productivity. Nachi today is in a unique position as manufacturer of both cutting tools and machining equipment to provide solutions that work to our customers advantage. That is why Nachi is the preferred tooling partner for the aerospace industry.





Fir Tree Broaches for Jet Engine Turbine Disks ~

Jet engines intake air, compress it with compressor disks, then combustible gas is compressed to drive the turbine disks. The grooves that are used to mate the blade to the disk are produced using a dovetail broach to create a dovetail shaped groove in the compressor disk. Fir tree broaches are used to cut fir tree shaped grooves in the turbine disk. The fir tree shape, with its superior stress distribution particularly in very hot high pressure environments, not only fills demands for shape accuracy, but also responds to the stringent demands for work surface characteristics such as surface roughness, and changes in the quality and ductility of the work surface layer. This has made Nachi the leading provider of Fir Tree broaches to companies like GE Turbines, Pratt & Whitney, Rolls Royce. Nachi Fujikoshi has developed broaches and broaching machines that support production of the heart of jet engines with sets of cutting tool and machining equipment.



Fir Tree Type Broach

Dove Tail Type Broach





Fir Tree Broach Design & Manufacturing Process ~

To produce a dovetail or fir tree shaped groove, a set of more than 10 broaches each with different cutting shapes are used. The best design involves taking into account the material to be cut and the length and shape of the cut, as well as the specifications of the broaching machine to be used. Nachi designers and tool engineers work hand in hand with customers like GE Turbine, Pratt & Whitney and Rolls Royce, to name a few, to produce the best design and form. Broaches are made from Nachi's own ultra-fine Powder Metal HSS that has superior wear-resistance characteristics. Broaches are manufactured at our state of the art broach manufacturing plant in Toyama, Japan, to the stingiest aerospace quality standards. Nachi thus can control all aspects of manufacturing from raw material to finished product.





Solid Carbide Drills for Heat Resistance Hi-Temp Alloys For Engine Components ~

The current set of materials used in the manufacture of aircraft engines can differ greatly according to their location within the engine. Due to the extreme forces and temperatures incurred during service, the materials involved are normally high strength and high temperature resistance alloys such as Inconel, Waspalloy and Titanium.

Due to the complex composition of these materials, it can be very difficult to machine with conventional tooling, calling for special tool geometries and specific machining techniques. Nachi has developed the AQUA EX solid carbide drill series, with proprietary geometries and coatings, to machine aerospace materials such as Inconel, Waspalloy and Titanium.

New USA Stock Items

NACHI

AQUA DRILL EX CARBIDE DRILL SERIES

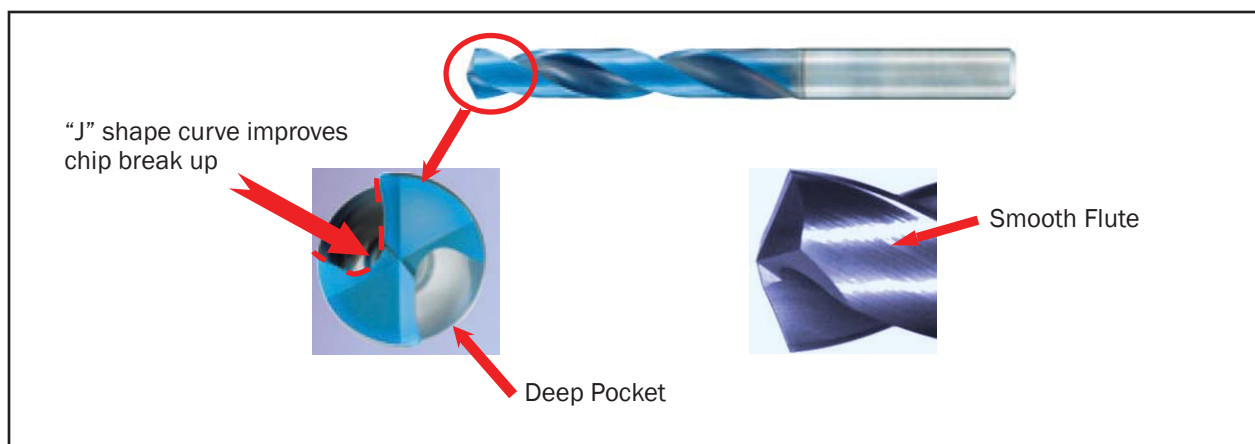
Aqua EX 2D, 4D
 Aqua EX Oil Hole 3D, 5D, 8D
 Aqua EX Deep Hole 10D, 15D, 20D, 25D, 30D, 40D
 Aqua EX Oil Hole Pilot
 Aqua EX Oil Hole Three Flute 3D, 5D
 Aqua Micro

Metric, Fractional, Wire & Letter Sizes Now Available



Nachi Aqua EX Series Features:

- The AQUA EX Drills are made with Ultra fine micro grain carbide and coated with Nachi's proprietary Aqua Ex coating (TiALN + AlTiCr based)
- Improved heat and wear resistance than regular TiALN coating. The Aqua Ex coating can withstand higher service temperatures up to 1200° C as compared to 900° for TiALN coating.
- A perfectly adapted TiALN based coating ensures excellent adhesion and affords great mechanical strength.
- The Nano crystalline Al-Ti-Cr based offers excellent hot hardness, resistance to oxidation and thermal insulation properties.
- Specially designed point angle and web thickness for drilling into Hi-temp alloys like Inconel, Titanium.
- "J" shape curve improves chip break up and smooth polished flutes offer excellent chip evacuation.





Case Story: Drilling Turbine Engine Component ~

NACHI answered the call of an aerospace customer whose requirement was to eliminate breakage of drills when drilling into a turbine engine component made out of Inconel 718 hi-temp alloy.

The current process of drilling 60 holes involved changing carbide drills after every 30 holes to avoid breakage of the drills and scrapping the part. This involved constant monitoring by operators and reduced efficiency and productivity.

Nachi optimized the process by introducing the Aqua Ex Coolant thru 3xD carbide drill to the customer. The Aqua Ex drill was able to complete 240 holes (4-Parts) consistently without breakage. The result is significant reduction in cycle time, tooling cost, improved surface finish, hole size and most importantly, consistent tool life for the customer.



Actual picture of customer part - Turbine Engine Component

<p>OLD METHOD CUTTING CONDITIONS: Competitor Drill Drill Diameter: Ø 4.1mm (3xD) Material: Inconel 718 Type: Carbide Coolant thru Drill Hole Depth: .250" or 6.35mm SFM=50 (V=15 m/min) RPM=1180 FEED: 100 mm/min (.003 IPR/ 4.0 IPM) No. of Holes: 30 holes RESULT: DRILL WORN OUT</p>		<p>NEW METHOD CUTTING CONDITIONS: NACHI AQUA EX SERIES Drill Diameter: Ø 4.1mm (3xD) Material: Inconel 718 Type: Carbide Coolant thru Drill Hole Depth: .250" or 6.35mm SFM=70 (V=21 m/min) RPM=1650 FEED: 100 mm/min (.003 IPR/ 4.0 IPM) No. of Holes: 240 holes RESULT: 8-times more tool life</p>
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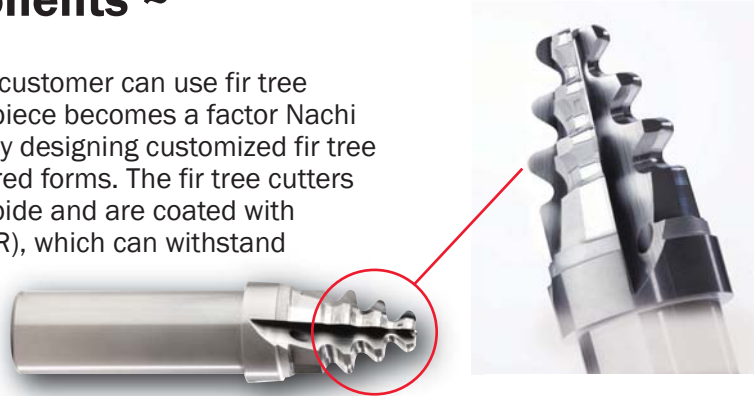




Solid Carbide End Mills for Heat Resistance Alloys & Turbine Engine Components ~

Solid Carbide Fir Tree Form Cutters

Cost as well as part production dictates if a customer can use fir tree broach cutters or not. Where cost and part piece becomes a factor Nachi has optimized customers' production runs by designing customized fir tree solid carbide milling cutters to cut the required forms. The fir tree cutters are manufactured from sub-micro grain carbide and are coated with Nachi's very own GSX coating (TiAlN + AlTiCR), which can withstand service temperatures up to 1200° C.




Solid Carbide End Mills for Heat Resistant Alloys

Titanium (Ti-6Al-4V) alloy, commonly used in turbine disks, blades and landing gear, is 1/2 the weight of steel and has comparatively superior hardness and high-temperature strength. On top of that, it is corrosion resistant and non-magnetic. Because of the great affinity between the material and cutting tool during cut, the end mills are prone to vibration and chipping during machining.


Nachi understands the need for designing end mills with special geometries, cutting edges and coatings. By using sub-micro grain carbide, superior coatings & special cutting edges that are heat resistant and have lubricity, these end mills can handle machining of Titanium alloys.


Features of Geometry




- Variable Helix & Variable Index for anti-vibration
- Aqua Mill Coating (Nanostructured AlTiN coating)

Component Examples





Variable Helix - Variable Index end mill with corner



5 Flute Ball nose End Mills for titanium and hi-temp alloys





Solid Carbide Drills / End Mills / Taps for Aluminum Components ~

The structural materials used for air frames, ribs & spars are comparatively lightweight aluminum alloys. However, high-performance cutting is necessary because more than 80% of the material is cut away and ejected as chips. Also, this demands high quality surface finish as most of the work pieces have thin walls.

Nachi has developed a line up of solid Carbide Drills & End mills for machining Aluminum alloys.

Nachi has also developed DLC thread forming taps for Aluminum alloys.

Features of DLC Drills / ALH End Mills / DLC Taps:

- DLC Coating has a low friction co-efficient that reduces adhesion to aluminum, which has extreme surface smoothness.
- The ALH Mill is superior in metal removal. With 3 flutes and a cylindrical land this end mill is able to maintain superior finish while reducing cycle time.
- DLC thread forming taps are designed for stronger and cleaner threads. Roll form taps eliminate chip clogging and promote stronger threads.



DLC Drills



ALH Mill End Mills



DLC Taps



Diamond Coated Carbide Drills for CFRP Material ~

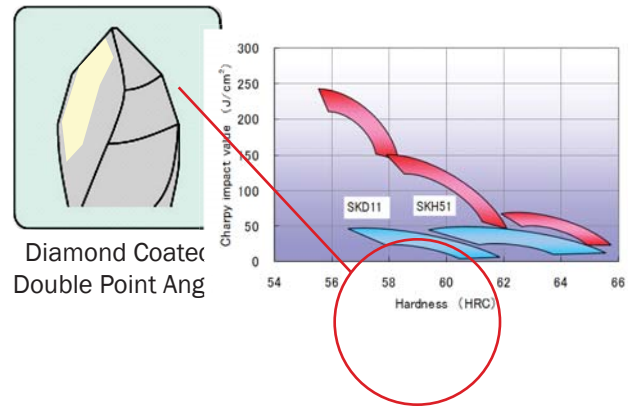
CFRP materials have a very high strength to weight ratio and so are rapidly becoming very popular in the aircraft industry. Due to their structure and machining properties, they are very difficult to process in terms of drilling and profile milling.

To avoid delamination of the layers and splintering, drills & end mills with special geometries have to be designed to machine them efficiently. To add to that CFRP materials are very abrasive and can have a big impact on tool life.

Nachi's tailor-made tooling solutions in Diamond Coated Carbide Drills & End Mills can provide excellent tool life and allow increased speeds and feeds. There is minimal delamination thereby reducing downtime and increased productivity.

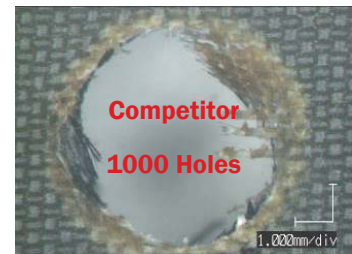
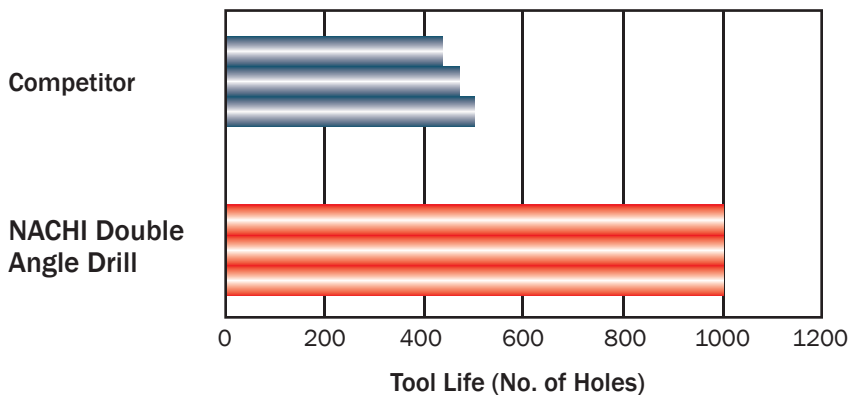
Features of Diamond Coated Double Angle Drills for CFRP:

- Optimal geometry for CFRP material
- Made from K10 grade carbide with 6% of less cobalt content for optimal diamond adhesion
- Nachi's very own Crystal Diamond coating for optimum tool life in Composite materials
- Double point angle sharp cutting geometry cuts the carbon fiber with low cutting resistance, resulting in no to minimum delamination.



Performance:

Consistently No Delamination or Burrs

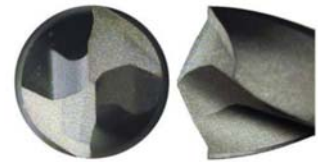




Diamond Coated Drills for CFRP + Aluminum Stack Material ~

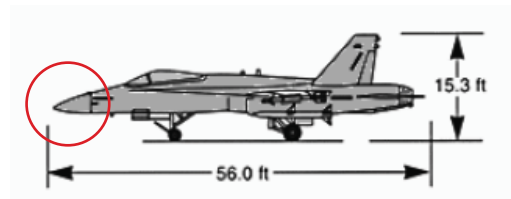
Features of Diamond Coated "Fish Tail" Drill for CFRP + Aluminum Stack:

- For Stack Drilling of CFRP & Aluminum
- Made from K10 grade carbide with 6% less cobalt content for optimal diamond adhesion
- Nachi's very own Crystal Diamond coating for optimum tool life in composite materials
- Specially designed point and flute geometry keep the exit burr in aluminum down to .005" or less
- Eliminates costly deburring operations



NACHI Fish Tail Point Configuration

Case Story: CFRP + Aluminum Stack (Aircraft Nose Barrel)



OLD METHOD

CARBIDE UNCOATED DRILL:

Hand Drilling & De-burring before Installing fasteners

No. of Holes: 1200

No. of Drills used: 17 (70 holes per drill)

Total Time: 4 Hrs (3-hrs Drilling + 1-Hr De-burring)



NEW METHOD

NACHI FISH TAIL DRILL

Success Criteria: 400+ Holes with exit burr height less than .005"

Automatic Flex Track 5-axis drilling machine using Nachi "Fish Tail Drill"

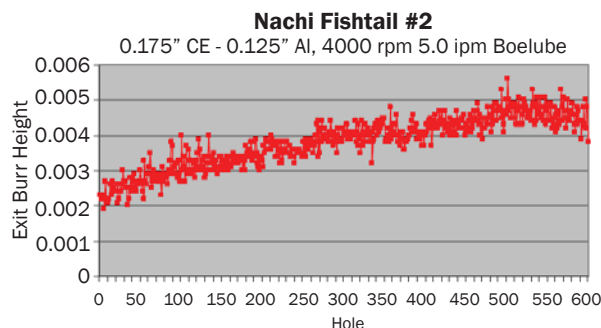
No. of Holes: 1200

No. of Drills used: 2 (600 Holes per drill with burr height less than .005")

Total Time: 2 Hrs (2-hrs Drilling — De-burring eliminated)

50% Cycle Time Reduction

55% Reduction in Tooling Cost



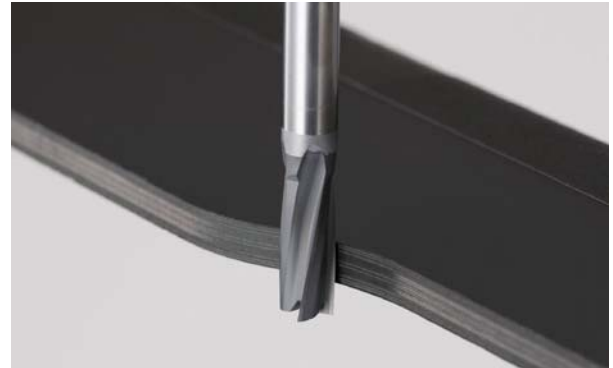


Diamond Coated Carbide End Mills for CFRP Material ~

CFRP materials pose the same problems when milling them. CFRP materials are harder on the cutting edges due to their abrasive nature. Standard End mills wear out faster and cause delamination. Nachi has developed end mills with special geometries and Diamond coating for trimming of CFRP Material edges.

Features of Diamond Coated Roughing & Finishing End mills for CFRP Trimming applications:

- Optimal geometry for CFRP material
- Made from K10 grade carbide with 6% of less cobalt content for optimal diamond adhesion
- Nachi's very own Crystal Diamond coating for optimum tool life in Composite materials
- Lower helix angle to prevent cutter flex.
- Sharp cutting edges for even trimming operations.
- Extended tool life due to Diamond Coating.



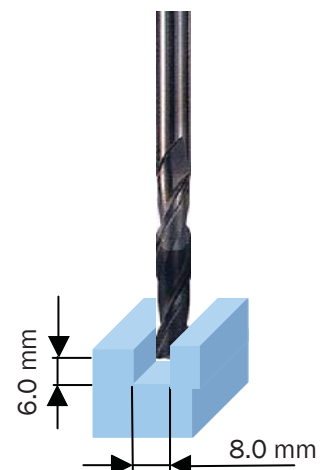
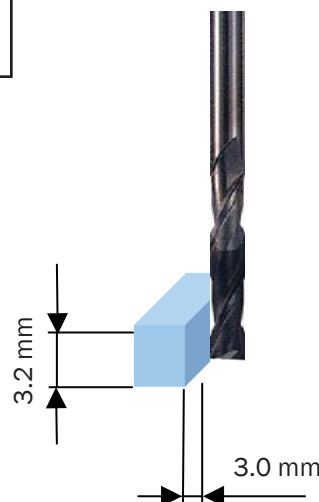
CFRP Trimming by Diamond Coated Mill

Case Story: Trimming by Diamond Coated End Mill

OLD METHOD
CARBIDE TiAlN Coated End Mill
 Grooving Tool Life: 2.6 meters
 Trimming Tool Life: 1.4 meters



NEW METHOD
NACHI Carbide Diamond Coated End Mill
 Grooving Tool Life: 29.2 meters
 Trimming Tool Life: 32 meters
15% MORE Tool Life than Carbide TiAlN Coated End Mill





The Ultimate High Performance Carbide Drill

- ◆ One drill does it all - Eliminates the need to use a “center drill” or “end mill” on inclined or curved surfaces.
- ◆ True 180° flat cutting edges creates minimal exit burr in tubing & thin plates.
- ◆ “Double Margin” for stable and precision drilling.




COMPETITOR PROCESS

ENDMILL + DRILL

AQUA EX DRILL PROCESS

ONE STEP DRILLING

AQUA Drill EX Flat

#1 Selling Flat Bottom Drill

ONE STEP DRILLING with MINIMAL BURR

L9610, L9611	
Non-Coolant Thru Stub Length Drill	
L9628	
Non-Coolant Thru Super Stub Length Drill	
L9818, L9819	
Non-Coolant Thru Jobber Length Drill	
L9816, L9817	
Extended Length up to 10D Reach	
L9812, L9813	
Coolant Thru 3D Flat Drill	
L9814, L9815	
Coolant Thru 5D Flat Drill	
L9830, L9831	
Ex Flat with Radius	



NACHI

SG DRILL SERIES POWDERED METAL COBALT DRILLS



Nachi's SG Drill line is a high performance Powdered Metal drill. Our Powdered Metal substrate gives you better wear resistance than standard cobalt drills. This combined with our SG coating gives you a drill that will perform in a wide range of materials from aluminum to nickel alloys.

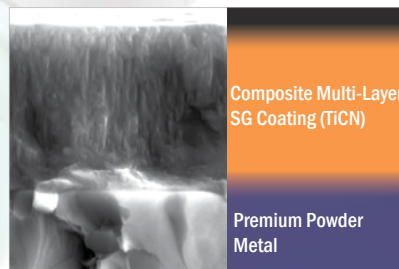
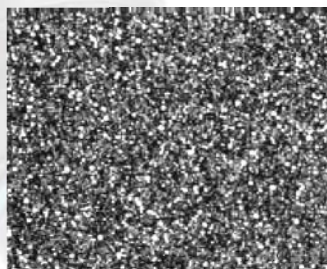
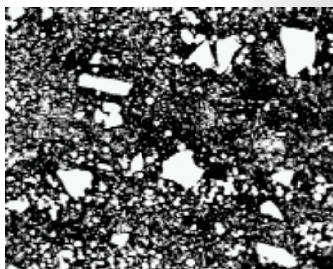
Nachi understands the difficulty of finding drills that will perform in multiple materials while keeping the cost down. With the SG drill you get faster feed rates and longer tool life than standard cobalt drills without paying the high price for carbide.



Conventional HSS

PM-HSS

SG Coating



SG Coating (Tin+TiCN)

We have a history of ninety years as a world-famous integrated manufacturer, with the renowned brand “NACHI”. With the continuous production system, from high class special steels to finished products, our well-coordinated techniques stand high in public estimation.



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Sales Office & Warehouse, Concord, Ontario, Canada



Sales Office & Warehouse, Queretaro, Mexico





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