EXPERTISE IN MACHINING

Machining composites intelligently.
Carbon-fiber reinforced plastic (CFRP) is the most well-known of composite materials. CFRP is a key technology material used in situations that call for a high level of weight-specific tensile strength and rigidity. For example in automotive and aerospace industries as well as in the manufacture of sporting equipment. The particular properties of CFRP used in aircraft manufacturing enables longer range flights together with lower energy consumption. Greater rigidity also allows for higher cabin pressures. CFRP’s excellent corrosion resistance permits a higher level of cabin air humidity, which passengers really appreciate especially on long flights. CFRP is also undemanding in terms of maintenance and care.

But the same does not apply when it comes to machining CFRP. What is required in this case is the elimination of fiber breakouts and uncut fibers. The abrasive fibers rule out the possibility of using conventional cutting tools for machining composites and stack materials. Stacks such as CFRP/Titanium are very difficult to machine due to the different material properties.

As a full-service provider with many years of experience, we can provide you with the right machining solutions for CFRP and other similar materials. To show you what we have to offer, this brochure contains a selection of our high-tech drilling tools for composites, as used in the aerospace industry. Our specialists look forward to hearing about your particular task. Please contact us for more information.
PCD VEIN TECHNOLOGY

When drilling CFRP and titanium, the Walter PCD Vein tools enable high cutting speeds and excellent dimensional accuracy with minimal wear. The innovative production technology for these tools is state of the art. Including a special designed carbide nib in which the PCD is sintered. The nib is brazed onto the shank before precision ground and final geometry eroded.

**Walter Titex PCD Vein rivet drill**
The PCD Vein is sintered at 2732 °F (1500 °C) and 870,226 PSI (60,000 bar), which turns this rivet drill into a special high-tech tool for excellent machining with no fraying and low burr formation in titanium.

**AFT1P 130° point angle**
Geometry for stacks made of fiber composite materials and metal. Cutting edge geometry optimized for titanium materials with integrated coolant channels for emulsions and MQL machining.

Reconditioning: 2 to 3 times

**AF3P 125°/90° point angle**
Geometry specially designed for uni-directional fibers and other fiber materials with a high risk of fiber breakouts. Also suitable for use with multi-directional respectively woven fibers.

Reconditioning: 2 to 4 times

**AFE1P E-point**
Geometry for curved CFRP components, thin materials and aramid fibers. The tool can alternatively be used for AF3P geometry.

Reconditioning: 1 to 2 times

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**PCD Vein**

Brazed PCD for countersinking

Internal coolant channels

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**Carbide nib**

Sintering process

Carbide nib filled with PCD powder

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**PCD Vein rivet drill**

The PCD Vein is sintered at 2732 °F (1500 °C) and 870,226 PSI (60,000 bar), which turns this rivet drill into a special high-tech tool for excellent machining with no fraying and low burr formation in titanium.

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**Carbide nib with PCD brazed onto blank**

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CNC-controlled fuselage riveting machines, flex tracks and robots, as well as automatic drilling units and hand-held drilling machines, are used for machining CFRP fuselage panels and their attachment parts. Walter has the right cutting tool for each of these applications, whether machining is performed with MQL, dry or with emulsion. For CFRP machining, we have decided in favor of using PCD Vein and diamond-coated solid carbide tools.

**Walter Titex** step rivet drill AF1D for window frames

The pre-drilling step allows the automatic drilling unit with C-clamping to be easily positioned. The countersink is created directly in a “one-shot-drilling procedure”, thereby saving time. The diamond coating significantly increases tool life.

**Walter Titex** step rivet drill AF1D for longitudinal and transverse seams

The Walter Titex rivet drill AF1D with diamond coating and without pilot, provides the same performance as a rivet drill with pilot, but reduces the machining time thanks to shorter approach to contact and drill depth.

**Walter Titex** rivet drill AF1D for longitudinal and transverse seams

**Walter Titex** PCD Vein rivet drill AF3P for longitudinal and transverse seams

Walter PCD Vein technology represents long tool life and multiple 100% reconditioning, while the same hole quality is maintained. The advantages of the PCD cutting material are a more even and slow progressive wear.
These cutting materials provide long tool life and excellent hole quality. Carbide substrate and diamond coating are perfectly matched in order to achieve optimum coating adhesion. For Walter a long tool life and process reliability have the highest priorities. The ratio between hole quality, machining speed and cost efficiency is individually adjusted for each particular operation.

**Walter Titex** drill AF1D All-round CFRP drilling tool

The AF1D geometry with diamond coating is designed to drill uni- and multi-directional carbon fiber composite materials. Even with the automatic drilling unit, the geometry delivers excellent roundness and dimensional accuracy thanks to its self-centering characteristic.

**Walter Titex** drill AFF1D for moderate machining conditions

The Walter Titex drill AFF1D with four cutting edges and diamond coating was developed specifically for unstable clamping arrangements and is exceptionally suitable for robot applications. In spite of the drill’s long tool life, no rework is required where copper mesh is at the hole exit.

**Walter Titex** drill MFF1 for manual pre-drilling and drilling

This Walter Titex drill with E-point geometry produces clean holes without uncut fibers. The centering point allows the tool to be precisely positioned. An ideal tool for hand-held drilling machines.

**Walter Titex** drill MFA1 for manual counterboring

The MFA1 with three cutting edges is particularly suitable for manual counterboring. Due to three optimally positioned lands, the drill produces dimensionally accurate holes even under difficult technical conditions.
STACK AIRCRAFT FUSELAGE

Stacks consist of at least two materials which may each have different properties. Commonly used composite-to-metal combinations are CFRP and titanium or CFRP and aluminum. In spite of the difference in the material properties, dimensionally accurate holes have to be guaranteed throughout a long tool life. That is the challenge for tool development. CFRP is a very abrasive material and quickly leads to rounded cutting edges. Titanium, on the other hand, is a tough material with very low heat conductance. When a CFRP/Ti stack is drilled, the rounded

**Walter Titex** step drill AFT4A for spar-clip holes

This tool was especially developed for use with automatic drilling units. Polished flutes and a smooth, heat-resistant ACN coating (aluminum chromium nitride layer) ensure optimal chip evacuation.

**Walter Titex** PCD Vein rivet drill AFT1P for skin-spar holes

Internal coolant channels and a protective chamber on the PCD Vein cutting edge ensure excellent cutting values in CFRP/titanium stacks. High cutting speed, practically no fraying in CFRP and low burr formation on titanium make this tool the number one choice.

**Walter Titex** counterboring MFT2 tool for holes in CFRP/Ti stacks

This counterboring tool is helically left-handed and pushes the chips forward through the pre-drilled hole. If the drilling sequence is CFRP→titanium, the titanium chips cannot damage the CFRP. If the drilling sequence is the other way round, the helically right-handed version of this tool is recommended.

**Walter Titex** step drill MFA4 for holes in CFRP-Al stacks

The tool can be used for manual drilling or counterboring. Four lands stabilize the tool and the secondary flutes prevent cold welding when dry drilling aluminum.
Walter Titex step drill AFT1N for spar-clip holes

The NHC coating (ta-C carbon layer) restricts wear. The smooth layer reduces built-up edges. The drill’s four cutting edges also significantly increase tool life.

Walter Titex drill AFT3A for stack material

The proven geometry of the Walter Titex A3366 drill has been perfected for stack machining with internal coolant channels, polished flutes and ACN coating, and is designed for high feed rates.

Walter Titex drill MFT1 for manual pre-drilling

A reliable Walter Titex tool for pre-drilling stacks with a hand-held drilling machine. Suitable for small diameters in CFRP, titanium and aluminum stacks.

cutting edge has negative effects on CFRP like fiber breakouts and uncut fibers, while in titanium, it generates additional frictional heat. For that reason, Walter has decided in favor of low-wear PCD Vein tools and solid carbide, as well as coated solid carbide, depending on the task at hand. In addition, optimized cutting edge geometries are developed and offered for the best possible result.
STACK AIRCRAFT WINGS

Aircraft wings contain stacks made of CFRP, titanium, aluminum and stainless steel, as well as sandwich materials such as honeycomb aluminum. The material thickness of the different stacks also varies considerably. From hole sizes of a few millimeters for the leading edge outer skin through to 15 x d holes towards the center wing box.

The diameters of the holes also vary more sharply than in the fuselage segment and reach diameters of more than 1.181 inch (30 mm).

Walter Titex PCD Vein rivet drill AFA1P for wing skin to ribs

The cutting edge geometry of the AFA1P is specially designed for CFRP/Al stacks. A sharp cutting edge and the internal cooling channels for MQL or wet machining reduce burr formation to a minimum even for platinized pure aluminum.

Walter Valenite B4017 Point Drill for drilling

Ideal for CFRP/aluminum one-shot-drilling. Cost-effective solution for hole diameters of 0.472 to 1.496 inch (12 to 38 mm). Maximum process reliability thanks to the optimized drill insert in the well-proven Xtra-tec® Point Drill body and low hole tolerance due to additional lands.

Walter Titex drill AFA1N for wing spar to ribs

The four cutting edges of the AFA1N enable long tool life in metal-to-composite material combinations as well as fewer uncut fibers. The non-metallic NHC coating (ta-C carbon layer) also reduces built-up edge formation.

Walter Titex step drill MFA5 for manual counterboring

The Walter Titex MFA5 is designed for manual counterboring CFRP/Al and Al/Al stacks. The low twist of the tool reduces the speed when the drill exits the hole.
STACK VERTICAL STABILIZER

The construction of the vertical stabilizer has similarities to the structure of the wing, in terms of both materials and drilled hole diameter. The vertical stabilizer as well as the wing and the fuselage segments are dynamically stressed, safety-related components. Therefore the tolerances for drilled hole quality result in being very small and the process reliability of machining and component quality are of primary importance.

Walter Titex drill AFT2:16 x Dc drill for CFRP/Ti

The Walter Titex AFT2 drill is a 16 x Dc tool and is suitable for deep pre-drilling holes. The materials CFRP and titanium, and even stainless steel, can be machined with this tool.

Walter Titex step drill AFT1A for Ti/steel stacks

This tool was especially developed for use with automatic drilling units. Polished flutes and a smooth, heat-resistant ACN coating ensure optimal chip evacuation.

Walter Prototyp ConeFit* countersinker for Ti, steel and Al

The countersinker’s pilot aids tool positioning and maintenance of concentricity of the hole in relation to the countersink. The tool is available as Z = 2 or Z = 3 and is suitable for countersinks from 0.394 inch (10 mm), and also for cost reductions.

* Can be combined with the entire ConeFit holder range.

Walter Titex step drill MFA4 for CFRP/Al

The tool can be used for manual drilling or counterboring. Four lands stabilize the tool and the secondary flutes prevent cold welding when dry drilling aluminum.
**CUTTING DATA AND TOOL DIMENSIONS**

The cutting data table contains starting values for composite machining. Many of these applications are non-recuring and require adapted cutting parameters and tools. In order to improve hole quality, cutting speed can be increased and feed rate reduced. Low feed rate and high cutting speed, however, shorten tool life. A gradual approach to find optimal cutting parameters is recommended, which allow the correct balance between hole quality and tool life.

<table>
<thead>
<tr>
<th>Material</th>
<th>CFRP UD (unidirectional)</th>
<th>CFRP MD (multi-directional)</th>
<th>Thermoplastic with carbon fiber</th>
<th>CFRP/Al</th>
<th>CFRP/Ti Al/Ti</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machining</td>
<td>Geometry</td>
<td>Vc</td>
<td>f (inch)</td>
<td>f (inch)</td>
<td>f (inch)</td>
</tr>
<tr>
<td>PCD Vein</td>
<td>AF3P</td>
<td>330 - 980</td>
<td>0.002 - 0.003</td>
<td>0.002 - 0.005</td>
<td>0.002 - 0.008</td>
</tr>
<tr>
<td></td>
<td>AFE1P</td>
<td>260 - 660</td>
<td>0.002 - 0.003</td>
<td>0.002 - 0.004</td>
<td>0.002 - 0.006</td>
</tr>
<tr>
<td></td>
<td>AFA1P</td>
<td>260 - 660</td>
<td>0.002 - 0.003</td>
<td>0.002 - 0.004</td>
<td>0.002 - 0.006</td>
</tr>
<tr>
<td></td>
<td>AFT1P</td>
<td>260 - 590</td>
<td>0.002 - 0.003</td>
<td>0.002 - 0.004</td>
<td>0.002 - 0.006</td>
</tr>
<tr>
<td></td>
<td>AF1D / AF1D</td>
<td>260 - 660</td>
<td>0.002 - 0.003</td>
<td>0.002 - 0.005</td>
<td>0.002 - 0.008</td>
</tr>
<tr>
<td></td>
<td>AFA1N</td>
<td>260 - 520</td>
<td>0.002 - 0.003</td>
<td>0.002 - 0.005</td>
<td>0.002 - 0.008</td>
</tr>
<tr>
<td></td>
<td>B4017 with P6004 indexable insert</td>
<td>200 - 330</td>
<td>0.001 - 0.002</td>
<td>0.002 - 0.004</td>
<td>0.002 - 0.008</td>
</tr>
<tr>
<td></td>
<td>AFT1N / AFT1A</td>
<td>200 - 460</td>
<td>0.002 - 0.003</td>
<td>0.002 - 0.004</td>
<td>0.002 - 0.008</td>
</tr>
<tr>
<td></td>
<td>AFT2</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>AFT3A</td>
<td>260 - 390</td>
<td>0.002 - 0.002</td>
<td>0.002 - 0.003</td>
<td>0.002 - 0.005</td>
</tr>
<tr>
<td></td>
<td>AFT4A</td>
<td>200 - 390</td>
<td>0.002 - 0.003</td>
<td>0.002 - 0.004</td>
<td>0.002 - 0.006</td>
</tr>
<tr>
<td></td>
<td>ConeFit countersinker</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Carbide with or without various coatings</td>
<td>VFA1A / VFT1A</td>
<td>100 - 200</td>
<td>0.001 - 0.003</td>
<td>0.001 - 0.003</td>
<td>0.001 - 0.003</td>
</tr>
<tr>
<td></td>
<td>MFI1</td>
<td>50 - 200</td>
<td>0.001 - 0.003</td>
<td>0.001 - 0.003</td>
<td>0.001 - 0.003</td>
</tr>
<tr>
<td></td>
<td>MFA1 / MFA4 / MFA5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>MFT1 / MFT2</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Note: When drilling stacks with one parameter, the CFRP/Al or CFRP/Ti, Al/Ti column is used. If the parameters are changed between the materials, the CFRP parameters are used for fiber materials, CFRP/Al values for aluminum and CFRP/Ti data for titanium.

<table>
<thead>
<tr>
<th>Type</th>
<th>Dc inch [mm]</th>
<th>d1 inch [mm]</th>
<th>d2 inch [mm]</th>
<th>l1 inch [mm]</th>
<th>l2 inch [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>without IC</td>
<td>with IC</td>
<td>without IC</td>
<td>with IC</td>
<td>without IC</td>
</tr>
<tr>
<td>Carbide</td>
<td>0.098 - 0.984</td>
<td>0.157 - 0.984</td>
<td>≤ 0.984</td>
<td>(4.0 - 25)</td>
<td>≤ 0.984</td>
</tr>
<tr>
<td></td>
<td>0.098 - 0.504</td>
<td>0.185 - 0.504</td>
<td>≤ 0.630</td>
<td>(12.8 - 12.8)</td>
<td>≤ 0.630</td>
</tr>
<tr>
<td>PCD Vein</td>
<td>0.098 - 0.827</td>
<td>0.157 - 0.827</td>
<td>≤ 0.984</td>
<td>(4.0 - 21)</td>
<td>≤ 0.984</td>
</tr>
<tr>
<td></td>
<td>0.157 - 0.394</td>
<td>0.185 - 0.394</td>
<td>≤ 0.630</td>
<td>(7.10 - 16)</td>
<td>≤ 0.630</td>
</tr>
</tbody>
</table>

* Step difference factor for tools with three cutting edges only 0.055 inch x d₁ (1.4 mm x d₁) and no step possible for MFT2 and AFT2

Note: When drilling stacks with one parameter, the CFRP/Al or CFRP/Ti, Al/Ti column is used. If the parameters are changed between the materials, the CFRP parameters are used for fiber materials, CFRP/Al values for aluminum and CFRP/Ti data for titanium.
VIBRATION DRILLING TECHNOLOGY

Vibration drilling is recommended for machining stack materials, especially CFRP/Ti stacks. Using this method, the drilling tool is additionally moved in the feed direction. The movement corresponds to a sine wave, whereby the tool cutting edges are constantly at work. In the sinus wave trough, controlled chip breaking is performed at the minimum feed rate. Short chips lower the process temperature and improve the surface quality and dimensional accuracy of the entire hole.

<table>
<thead>
<tr>
<th>Conventional drilling (without vibration)</th>
<th>Vibration drilling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drill</td>
<td>Drill</td>
</tr>
<tr>
<td>Drilling direction</td>
<td>Drilling direction</td>
</tr>
</tbody>
</table>

* Picture provided by: IWT Bremen

Walter Titex vibration step drill VFA1A

Walter Titex vibration drill VFT1A

The vibration step drill is particularly suitable for C-clamping automatic drilling units. The cutting edge geometry and optional coating have been optimized for the vibration drilling process in order to achieve excellent results.

The vibration drill for machining centers and fuselage riveting machines works process reliable. The tool is suitable for CFRP/Ti stacks with considerable material thickness and high tolerance requirements.