Technology

Aerospace: Machining Titanium Quickly and Safely

Dirk Masur - Aerospace Component Manager & Titanium Machining Specialist at Walter | Jan 01, 2017

What You Need to Know

Walter's Xpress range for the aerospace industry is made to measure the exacting requirements of the aerospace industry.
In the aerospace industry, a product's weight determines profitability, rather than part and component process.
The challenge: Titanium is more difficult to machine than aluminum, which has largely been used until now.

Walter is improving titanium machining with special tools

Tübingen-based specialist Walter’s Xpress range for the aerospace industry is made to measure for the exacting requirements of the aerospace industry. In particular, their solid carbide tools with customer-specific dimensions are available for delivery within two to a maximum of three weeks. An innovative new tool coating and tool technology ensure that tool life is more than doubled in some cases.

In the aerospace industry, things are done a little differently in comparison to other sectors. Weight plays a pivotal role, and every gram less counts. It is ultimately a product's weight that determines its profitability, rather than part and component prices. No wonder then that titanium is enjoying considerable growth and popularity in this sector. This is the case especially for structural components for which high strength also matters. Typical examples are doors and door frame surroundings, landing gear supports, undercarriage struts or landing flap tracks. Titanium is also corrosion- and temperature-resistant.

However, manufacturers of aircraft for civil aviation in particular are finding themselves increasingly subject to the pressures of a series manufacturer, as is familiar for example from the automotive industry. Up until now, Boeing, Airbus, and to a lesser extent Bombardier, have mainly shared the market between themselves. Meanwhile, new competitors from China and Russia are preparing to enter the market. The pressure for manufacturing to become as cost-effective as possible is therefore increasing. Walter is making an important contribution in this respect with the Xpress Aerospace range.

Further development of the tooling systems

The challenge: Titanium is more difficult to machine than aluminum, which has largely been used until now. Its high chemical reactivity leads to chips becoming fused at the cutting edge during machining. The poor thermal conductivity of the material allows temperatures at the cutting edge to rise significantly. The resulting chips are often extremely tough and abrasive. The minimal modulus of elasticity leads easily to the workpiece bending. Together with material solidification in the edge zone, this reduces the tool edge life even at low cutting speeds.

The tool costs also significantly depend on the demands placed on the component and the material, as well as on the process. Decreasing the wall thickness can cause the parts to become extremely unstable, thus an important focus is the stability of the machine and the clamping. Using the right coolant strategy also has a significant influence on tool life. Walter is continually developing its tooling

systems with the aim of reducing machining times. Carbide substrates, new coating technologies and macro- and micro-geometries of the cutting tools play an important role here. The machining strategy can, however, also be further optimized in collaboration with CAD/CAM specialists.

This all makes high-performance cutting (HPC) and high-dynamic cutting (HDC) for finishing and roughing titanium possible today. Dynamic milling with the Walter Prototype Ti38 Z6-10 and innovative new coating enables cutting speeds of up to 140 m/min to be achieved. Multi-tooth solutions with up to ten teeth allow the feed to be increased by up to 50 percent at low contact widths. These solid carbide tool solutions can ultimately achieve an increase in metal removal rate of up to 50 percent in comparison with conventional solutions.

Coating determines tool life

An example of the newly developed substrate and coating technologies is the PVD-based coating (physical vapor deposition) for solid carbide tools in the Walter Prototype Ti range. This coating substantially increases tool life in comparison with the conventional ANC coating (aluminum chromium nitride) – by up to 100 percent and more. This means that the tool life of a window frame made of 3.7164 titanium with a tensile strength of 1250 N/mm² when semi-finishing and finishing using a Prototype HPC Ti40 has been able to be raised by 154% from 175 minutes to 444 minutes. Using a Prototype HDC Ti38 L for finishing the outer contour has extended tool life by 116%. The speed has been increased by 25% and the machining volume by 23%.

A further innovation is CVD coating technology for the indexable insert cutting tool material WSM45X, which is used for example for the Walter BLAXX M3255 porcupine milling cutter. The coating functions as a heat protection shield, facilitating high cutting speeds of up to 65 m/min and extending tool edge life to up to 130 minutes. This makes it possible to double the tool life of titanium structural components, which are typically made using a mixture of full slotting and climb milling at a cutting speed of 45 m/min and a feed of 0.12 mm. A further option is to increase the cutting speed to 65 m/min with a constant tool life of around 60 minutes. Finish-milling can also be carried out with PCD (polycrystalline diamond) cutting edges, which are amongst the hardest materials known.

An appropriate coolant strategy must be implemented in this case, however, in order to keep the machining temperature at the cutting edge under 600 °C. In general, the cutting fluid and the concentration of the cooling medium have a significant influence, especially on tool life. It is most important to introduce the cooling medium as directly as possible into the working zone. This is facilitated by special coolant-throughs in the tools. High-pressure cooling at up to 70 bar is state of the art for new machine tools. Special tool solutions for cryogenic machining go even further, working with liquid carbon dioxide or nitrogen, which is even colder.

Facilitates high-performance milling in titanium and titanium alloys at up to 60 m/min and with a 130-minute tool life: The Walter BLAXX M3255 Z5 porcupine milling cutter, fitted with WSM45X indexable inserts with the new CVD thin film coating.

From tool supplier to technology partner

Walter considers itself to be a digital process partner and is therefore developing tools which are ever more closely related to applications in the sense of "component solutions". This requires an entire team of specialists. Appropriate CAD/CAM skills are a key prerequisite for complete evaluation of the processes. Walter caters to its customers' needs and offers tools, solutions and services throughout the entire process.

With regard to this development, Walter developed the "Component Solutions" project in collaboration with the Advanced Manufacturing Research Centre at the University of Sheffield some time ago. In the course of the project, special machining strategies were developed for all pocket shapes occurring for structural components, using the CAM programs commonly used in the aviations and aerospace industry. This "toolbox" enables a suitable machining process to be quickly and efficiently derived from a 3D model of a customer component.

Highest quality in the shortest time

"Good things come to those who wait" no longer rings true today. Even high-performance tools with

customer-specific special dimensions are subject to immense time pressure. Since the beginning of the year, Walter has therefore been offering the long-established Walter Xpress service especially for the aerospace sector too. Xpress tool solutions are available for delivery within two to a maximum of three weeks. The speed starts from the ordering process itself. The my.Walter software solution enables the customer to design the tool online themselves or together with a trained field service employee. With "Walter Online Xpress", the customer receives a binding quotation including a 2D drawing and 3D model by e-mail within a maximum of one hour. The order itself, which is frequently a bottleneck within the company, is also significantly accelerated using Walter tool management.

Key Takeaways

- Dynamic milling with the Walter Prototype Ti38 Z6-10 and innovative new coating enables cutting speeds of up to 140 m/min to be achieved.
- PVD-based coating (physical vapor deposition) for solid carbide tools in the Walter Prototype Ti range. This coating substantially increases tool life in comparison with the conventional ANC coating.
- Walter considers itself to be a digital process partner and is therefore developing tools which are ever more closely related to applications in the sense of "component solutions".