Aerospace Frame

SANDVIK Coromant

Titanium solutions

For successful machining

Four keys to secure success in titanium

Titanium machinability is reputed to be poor. Its machining window is small, and careful consideration must be given to more than the tool.
In order to secure successful machining in titanium, there are four areas that require special attention: coolant pressure and volume, programming techniques, machine requirements and tools with their tool holding. This brochure will give you hands-on recommendations for each of them.

Coolant pressure and volume

The first issue is the coolant, which has tremendous effect when cutting titanium. The recommendation is simple; always apply coolant when cutting titanium, in large amounts and if possible at high pressure.

Using high pressure coolant, tool life is doubled compared to normal coolant pressure. The critical re-cutting of chips that damages the tool is prevented as welded chips are blown off.

Recommendations:

- Apply coolant through spindle and tool.
- Use high pressure coolant.
- Volume and pressure should be carefully planned in relation to the number of coolant holes and diameter of coolant orifice.
- Nozzle sizes should be kept small to maximize pressure.
- Recommended pressure: 70 bars (1000 psi) or more.
- Recommended volume ≥ 50 liters/minute (13 gallons/minute).

Example: Nozzle size influence

To keep up the pressure of 70 bars (1000 psi) for a long-edge cutter with 30 inserts and 2.5mm (0.1") coolant holes requires 760 liters coolant/minute (200 gallons/minute).

Using smaller coolant holes with 0.7 mm (0.028") threaded nozzles, only 60 liters/minute (16 gallons/minute) is needed to keep the pressure up.

Tool holding:

Coromant Capto®

The Coromant Capto modular system gives flexibility to optimize the length required to keep maximum stability and radial run-out, allowing high metal removal. With over 5000 standard products, any tooling assembly can be built - for milling, drilling and boring.

Hydro-Grip®

For high speed machining, shrink fit and Hydro-Grip chucks ensure close radial tolerances for secure machining with high component quality.

Optimize magazine space through tool rationalization

When recommending tools and machining solutions, we always consider tool rationalizations to optimize magazine space in the machine. Hole making can easily fill up magazine space if not carefully planned. Using helical ramping and circular interpolation, the number of tools can be drastically reduced.

Your demands set our standards

When the component costs tens of thousands, the programming time can be weeks, the manufacturing time is tens of hours, and you will be making this part for years, you need to get it right from the start.

The power behind your specialists

Behind our team of dedicated specialists is a whole toolbox of technical support to ensure that you always have full access to the latest solutions.

- Titanium programming training courses
- Application centers
- Application guides
- Productivity Improvement Program - PIP
- Productivity centers
- Training
- Seminars
- Global network

Necessity drives innovation and our solutions set you apart from the competition.

Application Centers

Our specialized Application Centers are investing in the future, developing pioneering solutions to give you the edge.

To ensure you always stay at the forefront of technology we have joined forces with one of the most advanced research facilities in the world. The AMRC; where aerospace component manufacturers, cutting tool manufacturers, machine tool makers and software companies develop scientific theory, environmentally sustainable solutions and manufacturing principles to bring new solutions to advanced production problems.

The AMRC building – Courtesy of Bond Bryan Architects

For more information please visit ***www.aero-knowledge.com*** or *www.sandvik.coromant.com/us*

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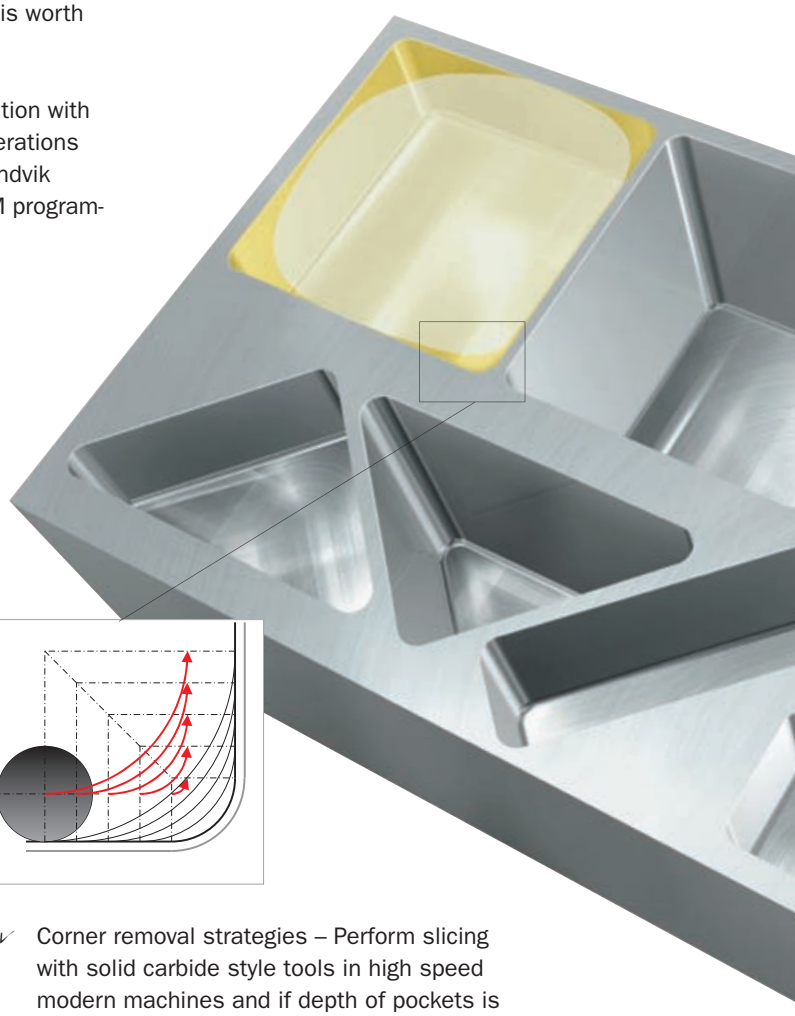
Your success in focus

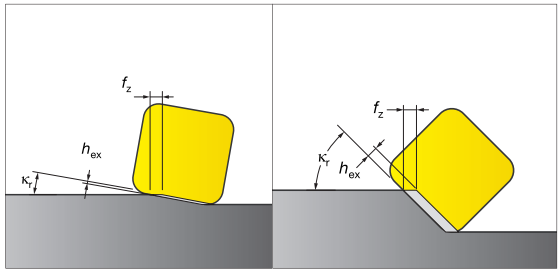
Programming techniques for optimized tool paths

Making the program fully optimized takes more time than using existing canned cycles in CAM systems. If just one part was to be made, the payback would not be worth it. But when the parts will be made for many years it really is worth making it right the first time.

Optimized programming can increase productivity by 50% in combination with longer tool life and better process security. Top programming considerations are described below. For more in-depth programming techniques, Sandvik Coromant offers titanium programming training courses for your CAM programmers both in-house and off-site.

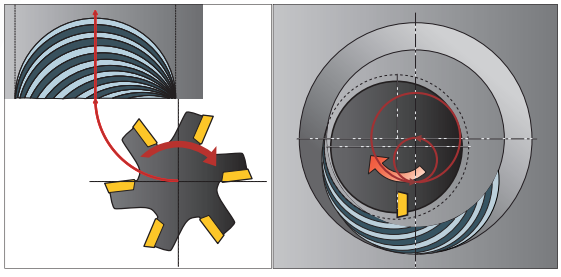


Recommendations:

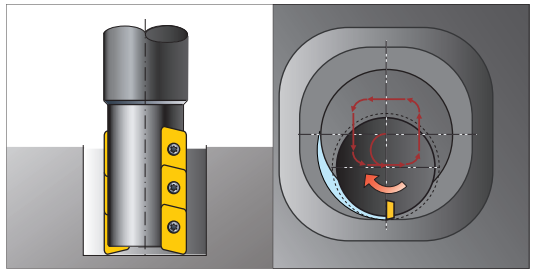


- Utilize chip thinning – Face mill with a low entry angle or with round inserts. End mill with less than 30% radial engagement.

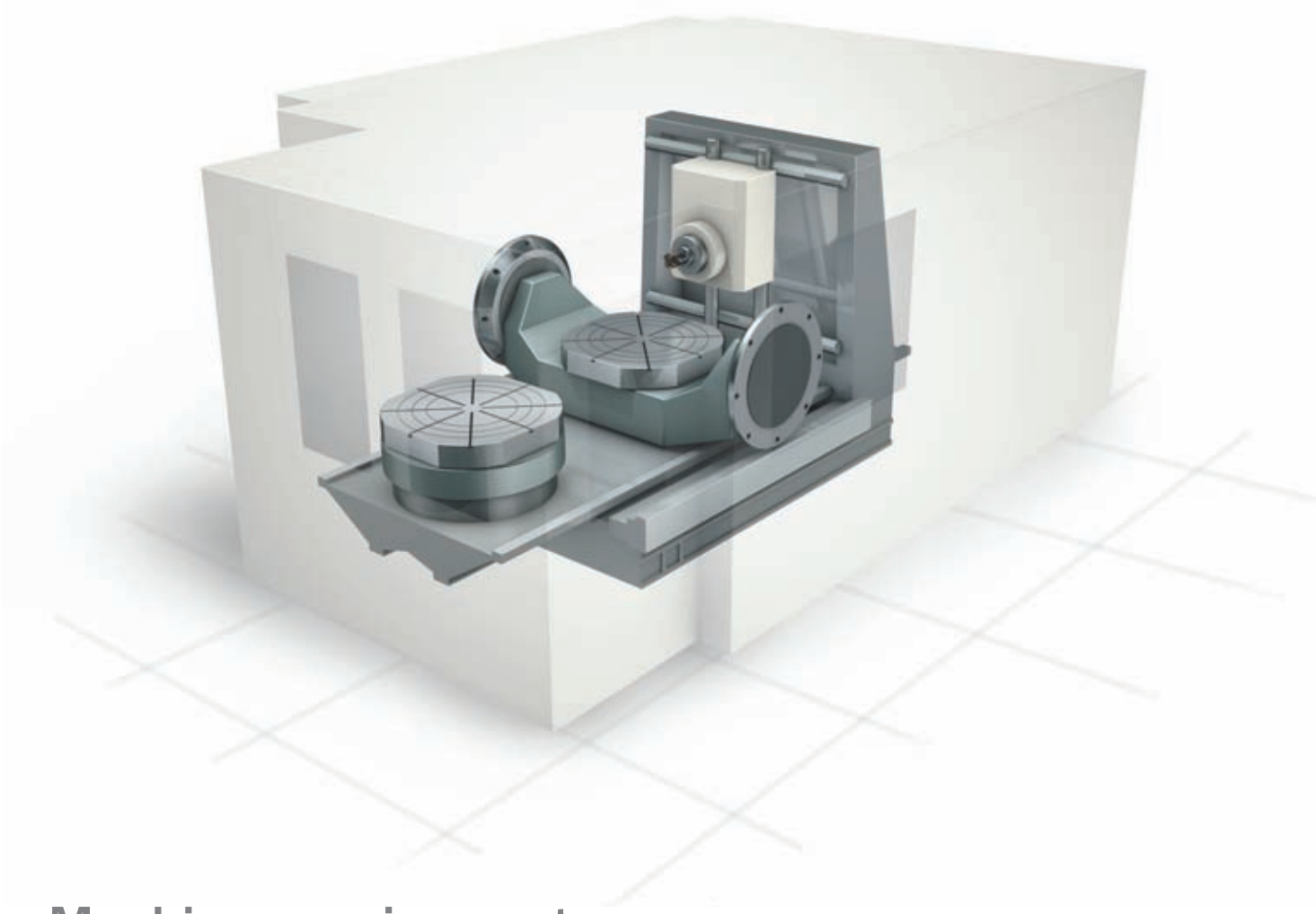
- Corner removal strategies – Perform slicing with solid carbide style tools in high speed modern machines and if depth of pockets is less than 4 times diameter. When deeper, use plunging for stability and axial cutting forces.



- From thick to thin chip – Control the chip formation via: roll in to cut; drive around corners; a large programmed radius and avoid sharp changes in direction.



- Keep arc of engagement low when pocketing - produce a large entering hole (made by either drilling or helical ramping), roll into cut, then program with large corner radii to avoid vibration in corners.



Machine requirements

The machine tool itself has great influence on the output. With the wide range of rotational speeds, power and torque requirements, the machine must function within a broad application area.

Recommendations:

- Power and torque – Power 40 HP (30 kW) and torque 738 ft-lbs (1000 Nm) at 350 rpm for powerful roughing at low surface speeds.
- Spindle speed – 6000 rpm to handle finishing with small diameter tools.
- Stable interface – Coromant Capto has highest capability, followed by Big Plus, when it comes to bending stiffness and clamping pressure. This is especially important when using long-edge end mills.
- Dynamics – Rapid changes of direction in pocket corners plus high table feeds when finishing requires both flexibility and speed.

Tools and tool holding

It is important to use the right tools to find the balance of approach angle, number of teeth in cutter and optimized metal removal rate. Here is a selection of tools, optimized for frequent applications in titanium.

New, stable interlocking interface

Face milling:

CoroMill® 300
A round insert cutter provides best productivity and tool life thanks to the lead angle and chip-thinning effect. CoroMill 300 has a light cutting action. With through coolant and close pitch option, it is optimized for titanium. CoroMill 300 is also a good solution for helical ramping and holes. Now available in insert sizes up to 20mm (metric) or 1.0” (inch).

CoroMill® 210
High feed cutters are being employed to a great extent on lighter machines for a light and fast approach.
Low depth of cut but up to 1.0 mm (0.04”) feed per tooth provides good metal removal rate. As with CoroMill 300, it is a flexible concept that can be used for helical ramping and holes.

2D profiling and pocketing:

CoroMill® 690
Long-edge end mills are the workhorses that remove lots of material. CoroMill 690 has been developed exclusively for titanium. The axial location of the inserts is built into the bottom of the insert to prevent insert movement and enable high metal removal rates with security. Its design makes it cut light and require minimum power. Each coolant hole is threaded to allow small diameter nozzles for high pressure coolant applications.

Plunge milling:

CoroMill® 215

Working with the z-axis is not a first choice when conditions are stable. But conditions are not always stable and plunging is a good solution for weaker set-ups and long overhangs. To maintain a good degree of productivity, it is important to be able to take a reasonable step over. CoroMill 215 has maximum step of 22 mm (0.85”).

Strength and precision in unique coupling

Semi-finishing and finishing:

For semi-finishing and finishing in deep pockets with small corner radii and large fillet radii, long tools with necked down shanks are required.

CoroMill® 316

CoroMill 316 is a new introduction. Its unique coupling is conical, has axial stop and an end pin providing extremely close radial and axial repeatability as well as unique bending stiffness. This makes it the perfect tool for secure machining.

CoroMill® Plura

The CoroMill Plura standard range has been developed to cover typical lengths and radii for pocketing in 3 and 5-axis applications.