TEXT: CHRISTER RICHT

CHALLENGE: To provide the tools and processes to improve the rapidly expanding area of composite machining.

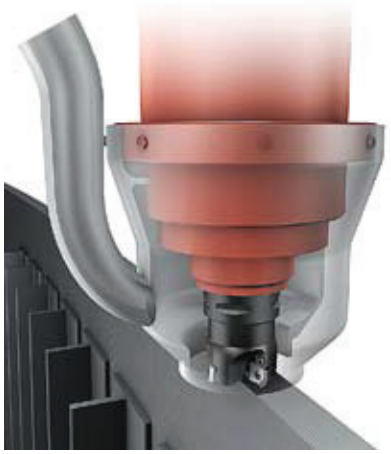
SOLUTION: A new approach to machining, including dedicated tools and the latest application strategies.

The next step in composite machining

MACHINING COMPOSITES IS very different from machining metals, and machining one type of composite is different from machining another composite. Moreover, the range of composite materials is broader than that of metals. This has daunting implications for machine shops that are beginning to manufacture parts made of composites as well as challenges for shops that are already working with composites. Machining composites needs a reassessment of methods, tools, setup and in some cases even machinery and fixturing. In fact every new composite material entering the machine shop needs a new approach in machining.

The cutting action in composite materials is quite different from that of metals in that the cutting edge does not generate chips through shearing, as with the majority of metals. The edge breaks off the composite material to be removed, often cutting the epoxy resin and fracturing or cutting the fibres in the process.

The general principle of machining composites is to use extra-sharp cutting edges that have sufficient clearance in order to give a clean cut and minimize the tendency for the tool to rub against the workpiece. Tool wear needs to be absolutely minimized, as even minor geometrical changes to the edge can rapidly lead to excessive heat generation and edge breakdown and if not addressed can affect the all-important quality levels.



For milling composites, the CoroMill 590 facemill is equipped with PCD inserts for high demands on tolerances and surface finish. It is capable of high cutting data with minimal splintering of fibres in dry machining – ideal when dust extraction (see picture) is in place and when the machining is last in line followed by assembly.

WHERE VARIOUS TOOL geometries are needed to suit the varied character of the composite material, cutting need to cut easily, generating minimal thrust forces.

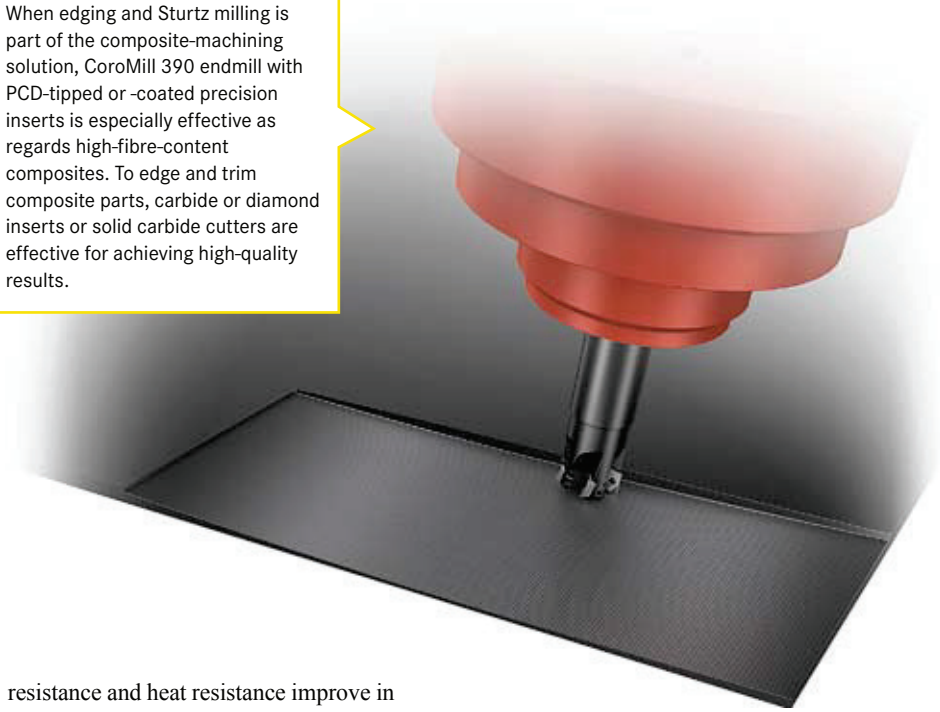
Achieving successful performance, security and results requires establishing individual processes to suit and optimize operations and the composite materials in question. An economic calculation should determine what solution is the most favourable in situations where the material removal rate is important but not the main factor.

Hole and edge quality combined with satisfactory hole cost and cost per metre will affect productivity more when it comes to composite machining. The finish achieved in one operation can reduce or eliminate secondary operations, contributing to improved tool life and reduced machine downtime.

In the continually evolving world of composite machining, use of dedicated cutting tools for a particular type of composite is essential. It is also essential to establish the right parameters for the operations at hand and to achieve the correct setup.

DRILLING, A DOMINANT operation in composites, is particularly challenging because the material can splinter or even split into separate layers (delamination) at the entry and exit of the hole. Achieving the necessary surface finish requires extra effort to obtain satisfactory cutting action between the fibre layers and the matrix. As impact

When edging and Sturtz milling is part of the composite-machining solution, CoroMill 390 endmill with PCD-tipped or -coated precision inserts is especially effective as regards high-fibre-content composites. To edge and trim composite parts, carbide or diamond inserts or solid carbide cutters are effective for achieving high-quality results.



resistance and heat resistance improve in composites, machining must also evolve.

Specially adapted polycrystalline diamond (PCD) tipped or coated tools have the best tool life, as diamond stands up to the wear of various carbon fibre and stacked materials, including titanium.

Demands on flat machined surfaces are often high for composite components, as are those on edged and trimmed features, demanding innovative approaches with suitable indexable inserts and diamond-coated solid carbide tools.

Engineered PCD cutters are a solution to most milling operations, where vein-PCD and brazed PCD tools are designed with various flute designs to meet application demands. Improvements include achieving better surface finish by applying a particular tool geometry in the best possible way. This may also entail transporting dust while further reducing splintering and fraying tendencies. ■

Composites solutions are application-specific. Solutions can include one of the CoroDrill geometries selected or adapted to the material and operation. Due to the variation in materials in different components, three geometries have been developed, including an all-round drill CoroDrill 855, to arrive at optimum processes that deliver hole quality to meet the highest demands.

The CoroDrill 856 is designed to minimize delamination tendencies at hole entries and exits, particularly in resin-rich composites. But drilling fibre-rich materials needs a geometry that will reduce splintering such as the new CoroDrill 854 drill, with similarities to geometry used for aluminium.

CD 854

CD 855

CD 856

The composite material

A composite is produced when two materials, each with different individual characteristics, are combined to form a material with a certain property.

Fibres, whiskers, particles or woven materials are dispersed in a matrix where they add stiffness and strength. Structural composites are made up of laminates or sandwich layers. A laminar composite has stacked sheets cemented together in a way that the strength orientation varies with successive layers.

The main matrix materials are organic materials, metal and ceramic, and the reinforcement may be a continuous or discontinuous material of carbon or some inorganic material.

Carbon fibre, aramid fibre and carbon-aramid fibre reinforced-plastic composite materials are common airframe materials. The fibres are bonded in the matrix material such as an epoxy resin. Applications for composites are growing rapidly, and thus the development of materials is also growing. ■

SUMMARY

In addition to developing cutting tools that will lift performance in composite machining, Sandvik Coromant is also focusing on the development of optimum processes in this area.

A range of new drills and milling cutters is improving performance in the use of composite materials. Carbide drills have been designed with diamond coatings suitable for a number of applications as well as with vein-PCD technology. Several new drill geometries have been developed to date for making high-quality holes in various carbon fibre reinforced (CFRP) materials. For milling, edging and trimming composite parts, endmills and facemills with specially developed PCD inserts and coated solid carbide provide new advantages. Both standard and engineered products form solutions for the present and future in drilling and milling composites. ■