

# Expanding complexities

**The increasing use of composites throws up challenges for cutting tool companies; and not only because of the diverse materials, explains LMT (UK)**

The world of composite machining is changing fast, and according to Onsrud Cutter, based in Illinois, USA (part of the LMT group of companies) the different materials that come under the heading 'composites' are not evolving progressively, they are changing rapidly.

"This is especially being influenced by the latest trend of combining materials such as titanium and aluminium and is a continual challenge to the tooling industry. We must keep up to date to provide viable and economic cutting solutions," says Trevor Tolley, managing director of LMT (UK) of Coventry.

Today more than 30 per cent of Onsrud's business is in the commercial, military and related aerospace sectors where the US is by far the largest market, but business is also growing fast in Europe, Canada, the Far East, China and South Korea.

In response, Onsrud has set up a specialist aerospace team with different areas of expertise such as honeycomb milling, routing and milling, plus drilling and trimming of the growing multitudes of different composite types.

Composites are not only being widely used in new aircraft such as Airbus A380, where they now represent some 20 per cent of the material by weight and the Boeing 787 Dreamliner where the percentage is even greater at 50 per cent, they are also being used in many other

sectors and – even in aerospace – new opportunities are beckoning. Repair, for instance, is a market of massive potential due to the cost and time lost scrapping composite panels and components



*US-based Onsrud is the LMT Group's composites tooling specialist. This panel cutter is just one of its many offerings*

and replacing them with new ones. This means tools are being developed to support repair in the field – setting a totally new series of demands on the tool supplier.

And totally different solutions are demanded for similar applications, largely due to production volume, and the capability and resource a particular manufacturer has available. While an application on a certain material in one company may involve lots of hand working, in another company the focus may be on the use of 5-axis machining technology. And that machine may cost £1 million or under £100,000.

Larger companies could be willing to invest in more expensive diamond tooling to reap maximum benefits, offers Scott

Feimster, Onsrud's global manager for aerospace and composites, while smaller volume producers prefer to adopt a lower investment two-step production process such as using coated solid carbide tool followed by a cheaper diamond tool, for finishing.

In 2007, Onsrud invested heavily in manufacture of polycrystalline diamond (PCD) tooling for milling and drilling composites, but due to material market demands, the company also supports fire-brazed diamond grip, diamond film coated, diamond solid carbide, carbide tipped and high speed steel cutters.

## VARIETY DEMANDED

And there are many variations in tooling, required due to the need to accommodate high abrasion from the material and compensate for the differences in the proportions of resin and adhesives used. Other problems faced are varying concentrations and strengths of fibre in the material – the tool must provide good shearing notwithstanding such variation. And,

with the growing use of dual materials, such as the addition of titanium and aluminium, yet another challenge is presented.

When drilling, the percentage of fibre fill can cause significant differences to the process especially on tool entry and breakout. Side cutting loads bring a whole different set of problems when milling and routing, while the effects of dust and compaction have to be considered. This is well demonstrated when working on unified tape which has very strong fibres resulting in high levels of material compaction. Other parts, such as ones that have been filament wound, have similar fibre strength but introduce added problems from voids in the material creating vibration and chatter under cutting conditions leading to material delamination. This not only applies to the top and lower covering layers of the material, but also between the inner layers.

#### INCREASED FEEDRATES

Among recent tooling developments by Onsrud for composite and reinforced plastics is the QuadraMax, the first three-flute shear/compression cutter that combines a roughing and chip-breaking edge into a single PCD coated tool that enables feedrates to be increased significantly while employing much lower cutting forces. Each of the three flutes of the tool incorporates shear flutes pointing upwards and downwards with the addition of a special roughing 'wing'. As a result of the tool design, not only can a high feedrate be applied but also two chip-breaking finishing wings create a finer and smoother edge in the component.

SERF – which stands for Sinusoidal Edge Rougher and Finisher – is the latest introduction for roughing and finishing composite materials reinforced with glass and carbon fibre. The new tool range overcomes problems normally associated with multi-layer structured materials and prevents fibre breakaway. And because cutting is cooler, the effects of temperature on the resin used in the material adhesive are reduced.

Tools are available between 6 and



*QuadraMax is a recent tooling development from Onsrud. It is the first three-flute shear/compression cutter and it offers faster cutting speeds but lower cutting forces*

12 mm diameter and can be run at up to 18,000 rpm at feedrates of 3 m/min due to optimised geometry in the design that reduces mechanical loading on both materials and tool for extended 'in-cut' life and high surface finish.

Onsrud has also developed special parabolic groove geometry. This reduces thrust forces, provides more manageable chip formation, better centring and allows higher penetration rates to be maintained when drilling both carbon fibre and carbon graphite materials.

The Parabolic Flute Form Drill also overcomes problems associated with delamination, flaking, splintering and whiskering and gives improved chip flow

and abrasion resistance due to the multi-layer, nano-crystalline diamond coating. While just six microns in thickness, it creates a very low coefficient of friction – between 0.15 and 0.2. Cutting trials have demonstrated an ideal speed of 75 m/min at feedrates of 0.075 mm/rev to obtain the best surface finish.

While Onsrud is the specialist composite company in the LMT Group, the organisation's French operation, Belin – which specialises in tungsten carbide, PCD and CBN boring tools – has developed a new series of solid carbide and PCD tools for orbital drilling of burr-free holes or cavities in composite, as well as aluminium, producing a hole tolerance and surface finish that is equivalent to reaming. Having two helical flutes and with through-tool air or coolant feed, diameters are from 3.4 to 10 mm. Flute lengths can be up to 60 mm.

#### ORBITAL DRILLING

Orbital drilling is being widely adopted by the aerospace industry. A tool is rotated in the machine spindle around its own axis and fed axially into the workpiece in an off-centre line of the hole position to progressively generate the desired hole size. By adjusting the offset of the tool to the centre line, precise sizing can be achieved. Both flat or curved surfaces can be machined and the resulting holes tend to be produced in a totally burr-free condition.

The process also enables a single tool to be used for a variety of different hole sizes in the same component and holes can be off-set on different centre lines, be produced with complex shapes already profiled with chamfers and even used to straighten crooked holes because the process is not influenced by any pre-machining.

Components such as plates or covers can be stacked for machining, and, compared to a conventional drill, burrs are not created with the orbital method, while the likelihood of chip-induced damage to the component is also reduced. Finally, with lower heat generation, any chance of metallurgical damage to the material or de-lamination is unlikely. □