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Tech Focus: Cutting Tools

Coating for higher productivity, quality and profit

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Ta-C high-performance thin-layered coating, high cutting capacity,the new tool series of the same name from Inovatools, make the process of machining aluminium and its alloys more productive.

<https://cdn1.vogel.de/unsafe/fit-in/1000x0/images.vogel.de/vogelonline/bdb/1764000/1764017/original.jpg>

The VHM mills from the new Inovatools ta-C range for aluminum machining are ideally matched to their applications and milling strategies in terms of substrate, geometry and coating.
(Source: Inovatools)

Machining aluminium is a specialised discipline but generally no problem for modern tools such as those with zirconium nitride (ZrN) coatings. But things become a little more difficult when, for example, casting alloys contain high levels of silicon. In this case, the tool has to be protected in particular against the high abrasiveness of the silicon alloying additive in order to ensure that service lives remain cost-effective. Machining very soft wrought aluminum alloys without silicon hardening agents is more a matter of ensuring that chips are removed reliably to prevent welding deposits and material "caking" on the tool.

Nilüfer Cebic, head of Product Management and Marketing at Inovatools: "Our VHM tools are made from well-balanced ultra-fine-grained carbide, the mixture of which has been optimised to meet the special demands to which the tool is exposed during aluminum machining. Throughout the manufacturing process, we maintain control over all the most important quality factors — including design, microgeometry, chipping, edge preparation,

grinding, chip control and the coating — with our new ta-C high-performance thin-layered coating. This means that we can adjust the tools precisely to match different applications and machining strategies, thereby unleashing latent potential and enhanced performance to boost productivity and cut costs."

Making the difference

The amorphous, hydrogen-rich ta-C carbon high-performance thin-layered coating, with a microhardness of 6,000 to 7,500 HV, is the most wear-resistant variant of diamond-like carbon (DLC) coatings and allows for more efficient machining of challenging materials such as aluminum with a maximum silicon content of 10 %, copper materials, graphite, glass-fiber-reinforced plastic (GFRP) and carbon-fiber-reinforced plastic (CFRP).

ta-C has excellent sliding properties, and its coating hardness amounts to roughly 60 % to 80 % of the hardness of a diamond coating.

ta-C is extremely wear-resistant and low-friction in both lubricated and unlubricated applications. The coating is applied at less than 250°, which means that even temperature-resistant substrates can be coated without the geometry changing. It can be applied thinly enough to prevent the rounding of sharp cutting edges.

Cebic: "Acute rake angles and thus cutting edges are retained after the coating process as well. The smooth carbon surface and high coating hardness ensure that chips do not adhere to the tool cutting edges. This minimises cold welding. The ta-C coating is therefore especially well suited to aluminum cutting. One particular benefit that arises in the machining of hard aluminum casting alloys and composite materials such as GFRP and CFRP is that the high resistance to abrasive wear and the low friction between tool cutting edges and chips combine to produce very long service lives."

In a comparative test involving machining an aluminum section made from AlMg0, 7Si (diameter: 16 mm, Z = 3, type W, helix angle = 20°, polished chip groove, service life criterion = burr formation), a ZrN-coated mill (2,000 HV) managed 2,000 acceptable parts, but a mill from the Inovatools ta-C tool range (6,000–7,00 HV) achieved 10,000 acceptable parts.

Wide range of tools for every application

The mills from the new Inovatools ta-C range for aluminum machining are ideally matched to their applications and milling strategies in terms of substrate, geometry and coating. The line-up includes single- and multi-edged tools for roughing and finishing, long and short versions, variations with corner radius and full radius, for standard use and for HPC, HSC and trochoidal (TSC) applications.

In the process, special geometries adapted to the relevant application featuring large chip grooves ensure that the aluminum chips are removed from the engagement area quickly and without built-up edges. Thanks to the hard, extra-smooth ta-C coating, not only are the tools well protected against the abrasive effects of silicon, but friction is also minimized, which reduces temperatures in the contact zone. All in all, this has a positive effect on tool service life and surface quality.

Primus

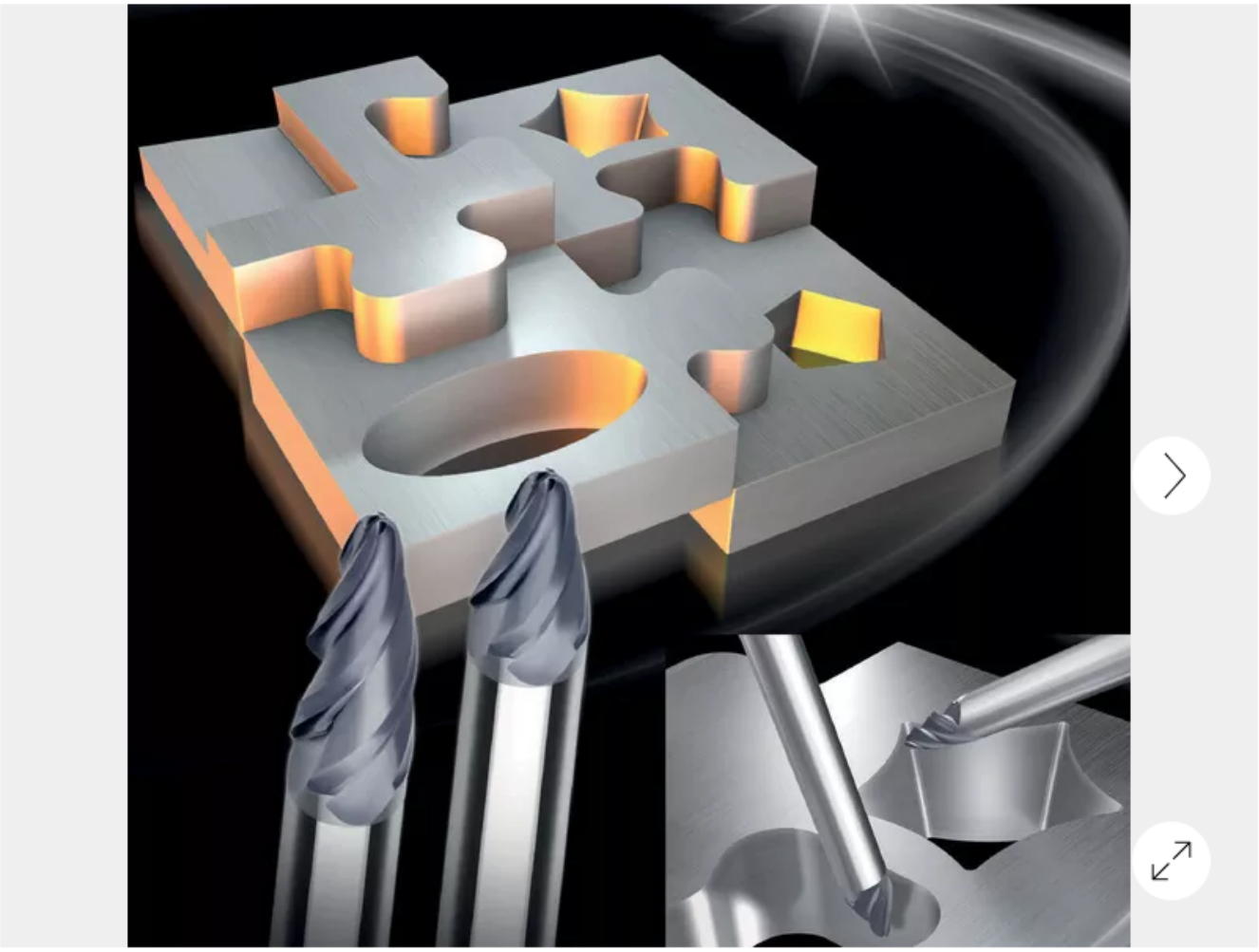
One example from the ta-C series is the Primus HPC aluminum roughing end mill. With internal cooling and multi-turning, the Primus is equipped to deliver consistently quiet, low-vibration, energy-efficient performance at extremely high feed rates. To this end, the tool has a special knurled section with optimized chip control as well as the ta-C high-performance coating. This enables it to eliminate the usual problems in cutting aluminum such as high adhesion tendency with built-up edges, welding deposits, chip caking, burr formation and so on.

Ta-C — combined with the microgeometry in conjunction with the cutting edge preparation— make the tool highly resilient. This prevents micro-chipping and makes the cutting edges more resilient. This “defect-free cutting edge design” considerably increases the service life of the Primus. This is supported by the entwined profile’s special chip separators. They break the aluminum chips quickly and at an early stage, and, thanks to large chip grooves, these can be rapidly transported away from the engagement zone with cutting fluid. Not only does this bring a high level of process security, it also ensures low-vibration running for high surface quality, even during HPC roughing. This means that Primus tools operate with minimal vibrations even at exceptionally high feed rates; for example, during the machining of aluminum for airplanes.

The three-edged Primus is available in diameter ranges from 6.00 mm to 20.00 mm, with internal cooling, multi-turning and straight and Weldon shank designs.

During a customer test in cutting aluminum 3.2315 (AlMgSi1/AlSiMgMn), Inovatools reported that the Primus emerged as the victor over a competitor's HPC aluminum roughing end mill, with up to 30 % more cutting capacity. With cutting data of D1 = 20 mm, ae/ap = 1xD, vc = 750 m/min, fz = 0.3 mm, the Primus achieved a cutting volume of 4,297 cm3/min compared with the 3,008 cm3/min of the reference tool.

Cebic: “In addition to the ta-C series, we recommend some other top mills and drills for optimized aluminum machining as first-choice products from our full range. One example is the CurveMax CSC (curve segment cutter) with a ta-C coating for aluminum structural components or copying applications, such as in the aerospace industry.”



Compared with conventional full-radius mills, the Curvemax mills from Inovatools have special geometries allowing bigger path distances and line jumps during pre-finishing and finishing. This means that although the working radius is larger, the tool still has the same diameter.
(Picture: Inovatools)

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Nilüfer Cebic, head of Product Management and Marketing at Inovatools: "Extreme feed rates, more cutting volume — our tools for machining aluminum and its alloys show that it is possible to employ optimisations to aspects of design such as microgeometry, chip control, grinding and high-performance coatings to take aluminum machining to a whole new level of performance." **2/3**
(Picture: Inovatools)

The Primus VHM HPC aluminum roughing end mill with internal cooling and multi-turning technology is designed to deliver consistently quiet, low-vibration, energy-efficient performance at extremely high feed rates. **3/3**
(Picture: Inovatools)