Machining

Tooling and Machining Strategies for Automotive Parts

Kip Hanson | Jun 22, 2021

As the electric vehicle boom accelerates, new materials are being used to manufacture vehicle components, presenting a machining challenge for automotive suppliers. Here's why polycrystalline diamond cutting tools are quickly becoming an automaker's best friend.

For as long as there've been cars, automakers have been using aluminum to build them. In fact, automotive pioneer Carl Benz introduced the first aluminum engine parts in 1901, followed by Bugatti's use of aluminum chassis and body components in 1908 and Alfa Romeo's supercharged engine in 1934, also aluminum.

Since then, aluminum and its many alloys have continued to rise in popularity, one of the more recent and notable examples being Ford Motor Co.'s introduction of an aluminum body F-150 pickup truck in 2015. This trend is about to take a massive leap forward, however, given General Motors' plan to offer 30 new electric vehicle (EV) models by 2025, followed by the total elimination of internal combustion (IC) engines 10 years after that. Other automakers will surely follow in GM's groundbreaking path.

What does vehicle electrification have to do with aluminum? Plenty. Where this strong yet lightweight metal was already a darling of the automotive industry for its helpful role in meeting stringent fuel-efficiency standards, a recent survey by research firm ***DuckerFrontier*** suggests the average aluminum used in electric and non-electric vehicles in North America is expected to increase 24 percent by 2030.

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> Gerald Fitch
> Kyocera Precision Tools

Some of this consumption will be due to the wheels, pump bodies, cylinder heads and transmission housings already in use but will gradually expand to include battery trays and electric motor components such as stators and housings. There's just one problem, though: Where most forged and wrought aluminum alloys are relatively easy to machine, the cast materials used in some of these parts can be very abrasive, leading to poor tool life and increased downtime. In light of the industry's notoriously high production volumes, this would seem to present a serious concern for automakers and

their tier suppliers.

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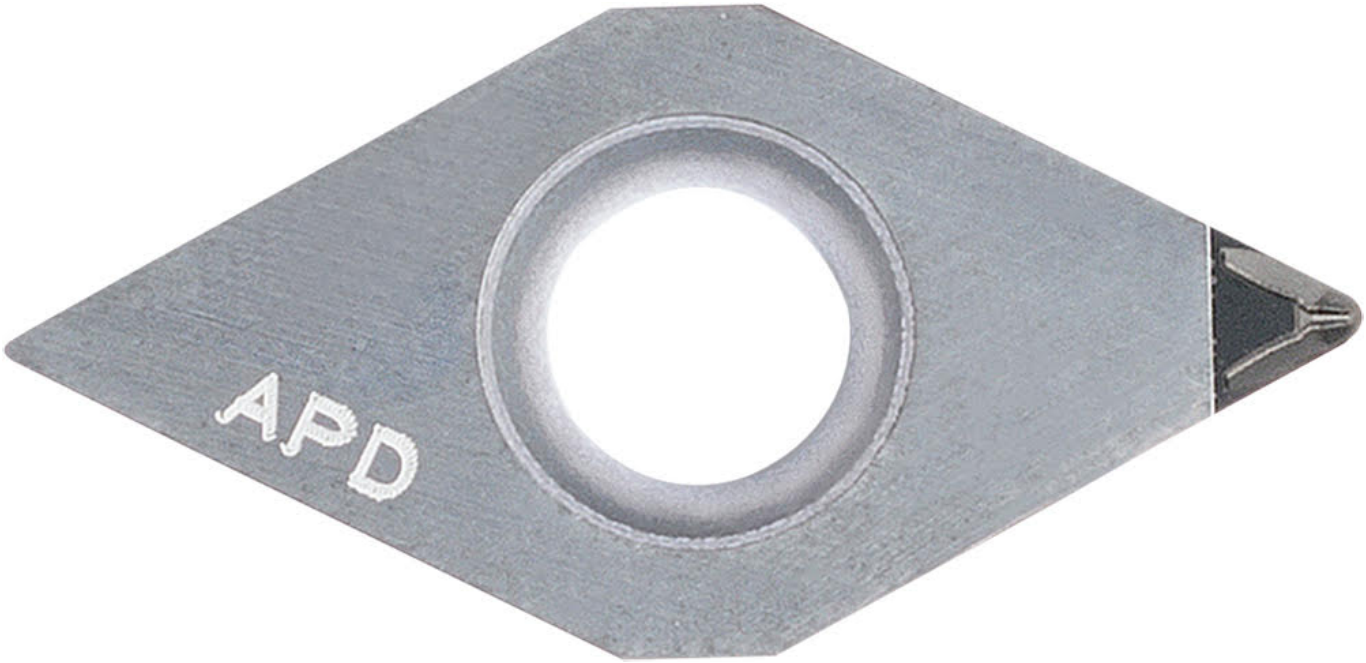
Tackling Hard Questions

Fortunately, there's a cutting tool material up to the task. It's called polycrystalline diamond (PCD), and as Gerald Fitch, automotive application specialist at Kyocera Precision Tools points out, there's a broad range of brazed PCD drills and end mills available as well as indexable cutters and custom solutions, all of which serve to reduce costs and increase productivity for any shop that routinely machines aluminum.

"For an automaker, cost per edge is everything, and even though a PCD tool might cost 10 times its carbide equivalent, the shorter cycle time and greatly increased tool life it provides more than makes up for the price difference," he says.



The need for high-quality PCD tooling extends beyond automotive milling operations, as shown in this chipbreaker-equipped PCD turning insert from Kyocera. (Image courtesy of Kyocera)

Fitch points to the company's MFAH and MEAS milling cutters as two possible solutions. Both are said to provide low cutting forces that minimize burrs and workpiece chipping while generating a high-quality finish, all of which are critical in high-volume aluminum machining. Indexable tools like these are also suitable for milling the tops of engine blocks where cast iron or powder metal cylinder liners are present, a common but challenging occurrence in the automotive market.

Boring Deep

Rick With sees many of the same challenges. The product manager and engineering supervisor for Guhring Inc.'s PCD/PCBN division, he points out that automotive part tolerances and surface finishes are often quite stringent, and in the case of electric motor stator bores, long length-to-diameter ratios can also be expected.

"One example would be the stator bore in an electric motor, which can typically measure well over 200 millimeters in diameter (7.87 inches) and perhaps 1 to 1.5 times that in depth," With says. "The

machining approach is quite similar to that of a conventional transmission housing, which can actually require significantly more reach. This requires a three-step machining process with rough, semi-finish, and finish boring operations. The difference here is the tool body material and adjustment system."

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Guhring offers a wide range of PCD specialty tooling to automakers and other manufacturers machining aluminum alloys. (Image courtesy of Guhring.)

Guhring's solution for this particular part was a custom cutter whose body is, somewhat ironically, itself made of aluminum. The boring tool has an HSK spindle interface and is equipped with six or more PCD inserts, each mounted in an adjustable cartridge for size control. "As is common with many automotive cutting tools, this was a full-blown special where you can machine multiple diameters and part features with one tool," With says.

Feeding Faster with PCD

Chad Hefflinger is the PCD/PCBN product manager for Kennametal Inc. He explains that, while automakers have been using PCD tooling for decades to improve their aluminum machining operations, their Tier suppliers have lagged behind for much of that time. That's all changed over recent years given the widespread availability of relatively low-cost CNC machinery that boasts the higher spindle speeds and feed rates needed for PCD, bringing its greater productivity within reach of even the smallest shops.

Another thing that's changed is the development of so-called "veined" PCD tooling. "The PCD in most cutting tools is produced from a flat puck that is cut out and brazed onto a carbide substrate," Hefflinger says. "The downside here is that you can't make a curved shape as with carbide cutting tools. With veined tooling, however, the PCD is sintered into curved slots within a prepared carbide blank, allowing it to be used in helical drills and end mills."

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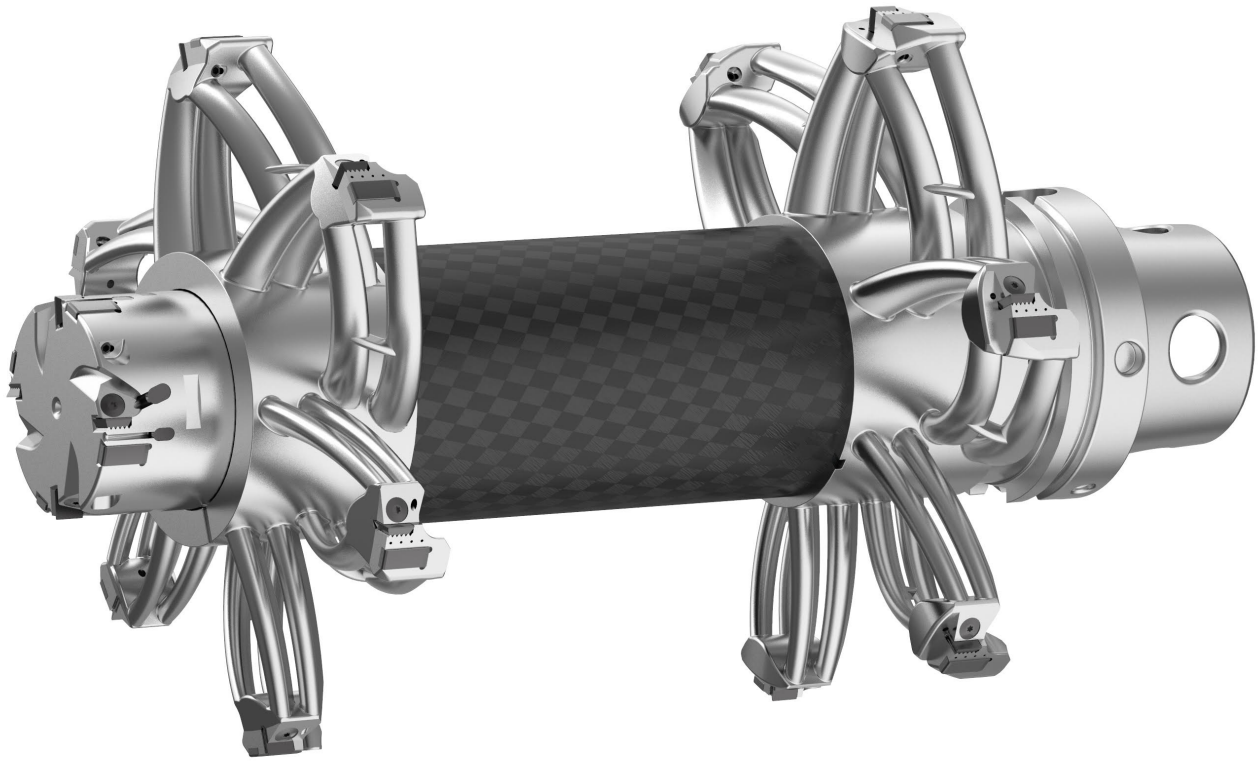

Kennametal used 3D printing and carbon fiber technology to construct this special lightweight PCD-tipped reamer for an automotive customer. (Image courtesy of Kennametal)

Hefflinger also suggests that aluminum isn't the only game in automotive town. An increasing number of manufacturers are turning to carbon fiber reinforced plastic (CFRP) and other composites for body panels, frame components, bumpers, and in the case of electric vehicles, battery trays. Here again, PCD tooling is the first and sometimes only choice for machining these aerospace-grade materials.

"CFRP is not only quite abrasive but also prone to chipping and delamination," he says. "This is part of the reason why veined PCD tooling is often preferred for these materials, particularly in the aerospace industry but also with automotive to some extent. You get the extreme wear resistance of PCD together with more flexible geometry options, which helps eliminate some of the problems encountered when machining composites as well as some aluminum alloys."

What steps are you taking to accelerate your electric vehicle production capabilities? Share your thoughts and insights in the comments below.

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