



Metalworking

Milling Aluminum: Tools to Tackle Industry's Favorite Switch-Hitter

Kip Hanson | Jan 21, 2025

Of all the metals used in modern manufacturing, aluminum and its many alloys are among the favorites—especially in the *automotive* and *aerospace industries*, where they help make vehicles from cars to drones, planes and rockets lighter and more fuel-efficient.

Medical manufacturers, meanwhile, use aluminum for bone saw guides and *orthopedic components*, electronics makers produce heat sinks and connectors from it, and machine tool builders and other equipment manufacturers prize the versatile metal for pump and valve housings, gear casings, heat exchangers and much more.

Aluminum, it seems, is the switch-hitter of the industrial world.

Tools to Fine-Tune Aluminum Milling

Many reasons for its popularity exist. Aluminum is the third-most abundant element in the Earth's crust. Depending on the alloy, it has a strength-to-weight ratio several times that of steel. Aluminum is corrosion-resistant, nonmagnetic, thermally and electrically conductive, and 100 percent recyclable. Perhaps most important to manufacturers, the metal is formable, weldable and, above all, very machinable.

That said, care must be taken to avoid several common problems, particularly in milling applications. Without proper chip evacuation, recutting can lead to poor surface finishes and even tool damage. Feeds, speeds and depths of cut must also be appropriate for the workpiece and machine tool in order to avoid burrs, chip welding and premature tool wear.

But as many machining center operators and programmers have found, investing in a top-quality milling cutter helps prevent these issues, spelling the difference between mediocre performance and

blowing the doors off of production quotas.

Alex Nguyen, a milling product engineer with OSG USA Inc., knows all about this last part. He provides several recommendations, starting with the company's AE-N series end mill. "It's a top-tier option designed specifically for aluminum and other nonferrous materials like copper and bronze, and as with other offerings in this class, it is available in both short and long cut," he says.

Factoring in Toolpaths, Cutting Parameters

Among the more popular in the series is the TL-N three-fluted long-length, advanced performance end mill, Nguyen adds. Its features include a large core for additional rigidity, a nicked edge on the flutes to break chips into smaller pieces, and a DLC (diamond-like carbon) coating for increased *abrasion resistance*.

Advanced cutting tool design is only part of the machining equation, however, especially for shops looking to achieve a mirror-like surface finish. As capable as OSG's and other manufacturers' premium cutting tools are, the best milling results are achieved with the correct balance of machine tool, workholding equipment and toolholders, as well as properly applied toolpaths and cutting parameters. "It takes the right technology on all accounts," Nguyen says.

Note the mention of diamond-like carbon coating a moment ago. Machinists reading this might say, "Hold on. Coated tools offer increased heat and wear resistance, but any coating process tends to break up the sharp edge needed for aluminum milling. What gives?"

It's a fair statement, although Nguyen is quick to point out that the TL-N's "micro margin" helps to support the cutting edge. He says its users can "run quite a bit faster than you normally would" with tools that don't have the feature.

"We recommend a starting speed of 500 to 600 surface feet per minute, but the tool can take pretty much whatever you throw at it in terms of spindle revolutions per minute," he adds. "Of course, you're also getting the benefits of the DLC coating, which is extremely thin—in this case, just 0.3-micron total coating thickness—so we're able to retain a very sharp edge, even sharp enough for many plastics."

Avoiding Abrasive Woes in Finishing

DLC-coated end mills not only have a sharp edge, but they're also quite abrasion-resistant. This last quality is particularly important in the automotive market, where high-silicon aluminum alloys are common.

But as Rick Crabtree, Sandvik Coromant's aluminum machining manager for the Americas, explains, one of the benchmark cutting tool materials in the industry continues to be polycrystalline diamond (PCD).

"Whether you're milling an electric vehicle motor housing or maybe an engine block for an internal combustion engine, there are always faces to machine," he says. "In practically all cases, the automaker or one of its Tier suppliers will finish these with an indexable face mill equipped with a series of cartridge-based inserts."

In Sandvik Coromant's case, one prime example is the *M5B90*. Unlike many of what Crabtree refers to as "industry standard" face mills where the cartridges are all set to the same height, those in this "superfinishing face-milling cutter for aluminum" are positioned both axially and radially to share the cutting load equally, with a single PCD wiper insert to generate an ultra-smooth finish.

A Broaching Approach

Crabtree describes the cutting action as a rotary broaching effect. Since each roughing insert “shares the load,” so to speak, tool life is better. Cutter setup is also easier, as there’s no need to adjust, or “dial in,” 10 or 20 inserts to the identical height as with a conventional tool (a time-consuming, sometimes impossible task, Crabtree notes).

And because the wiper insert is only removing around 40 microns of material, burrs are minimal. Finally, the body is largely made of aluminum, so even an 8-inch cutter only weighs 7 pounds.

“It’s shaped kind of like a Christmas tree,” he adds. “Each of the periphery inserts is made of carbide, so this provides increased strength for what is essentially a roughing operation. These sit in a precision fixed pocket and are each designed to remove 70 microns of material, but if one cuts 71 microns and another removes 68, it’s not a problem since the PCD wiper insert comes in last and cleans everything up. This shared approach also allows us to push the feed rates much harder, with a smoother cutting action besides.”

With that in mind, sometimes a super smooth finish isn’t called for. In that case, the M5B90 can be tooled with a “scratching” insert, generating what European automakers call a “frame roughness gasket surface.”

As suggested by the name, this crisscrossed, slightly roughened finish provides a better sealing opportunity for the gasket.

“The finishing cartridge is adjustable to get you exactly the surface finish requirement that’s called for,” Crabtree says. “Given its many advantages, the OEMs are really loving this product.”

What are the biggest challenges you encounter in machining aluminum? Tell us in the comments below.