



Machining

Grinding Getting Tougher? Try These 7 Tips to Maximize Your Superabrasives

Kip Hanson | Mar 07, 2023

Whether your shop grinds parts for the aerospace, medical or oil and gas industries—or all three—the metals used to make them seem to get tougher, harder, and sometimes both with each passing year.

Among the biggest drivers is increasing use of nickel-based alloys in the aerospace industry—whether cylindrical, centerless or surface—says Richard Crowley, a technical service specialist for the Abrasives System Division at 3M.

“Superabrasive grinding in aerospace and automotive requires finely tuned, fixed processes to avoid any weak links in the grinding chain,” says Crowley. “These processes are usually overseen by the Federal Aviation Administration, the Department of Defense, and other material quality policies.”

Reducing Cycle Times

Manufacturers tasked with meeting those standards, meanwhile, are grappling with tighter budgets and fewer technical personnel experienced in handling high-performance processes.

“In aerospace, these problems are further compounded by the gradual replacement of high-nickel alloys with even-harder-to-grind materials like ceramic matrix carbide (CMC),” he adds.

Alfredo Barragan sees similar challenges. A senior corporate application engineer for superabrasives in North America at Norton | Saint-Gobain Abrasives, it’s his job to train customers on the best practices of grinding wheel use.

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Like Crowley, he tells those attending his workshops to look beyond the relatively high cost of cubic boron nitride (CBN), diamond, and ceramic wheels. “In many applications, superabrasives reduce cycle times significantly while boosting part quality, resulting in a lower cost per part,” says Barragan.

“When transitioning to a superabrasive, there’s lots more to it than just changing the wheel,” he explains. “You must also ensure that you’re preparing and running that wheel properly.”

Superabrasive Tips & Tricks

Following are some recommendations from the two experts on getting the most out of superabrasives:

1. Consider wheel rotation. Similar to climb cutting on a CNC machining center, climb grinding—also referred to as uni-directional grinding—is when the wheel face and workpiece move in the same direction. This provides better coolant delivery to the work zone while reducing power consumption, allowing the operator to feed more aggressively. Conversely, up grinding tends to burnish the workpiece and improve surface finish, at least on light finishing grinds.
2. Speaking of coolant flow, a high-pressure “scrubber nozzle” that delivers at least two gallons of grinding fluid per minute for each horsepower of spindle draw helps keep the wheel clean and prevents air entrainment, which can lead to workpiece burning. And be sure to use a high-performance, laminar flow nozzle design for the most effective cooling. (Ask your grinding wheel provider for recommendations.)
3. Understand the difference between truing (which makes a wheel round, concentric, and restores its original shape) vs. dressing (which cleans and “unloads” a wheel of built-up workpiece material). Superabrasive wheels are generally trued offline on a universal grinder or brake-truing device using a silicon carbide or possibly an aluminum oxide wheel. The wheel direction during truing must coincide with its direction during use. Dressing is a manual operation performed as needed using a vitrified stick.
4. Also be aware of the different bonds available with superabrasives. A phenolic resin bond offers excellent dampening characteristics, gentle grinding action, and is the lowest cost bond available. Polyimide bonding provides fairly long wheel life, better form holding and higher performance (which equals higher material removal rates) than phenolic. Vitrified bonds are almost “glass-like,” making them self-sharpening. This open bond also tends to draw cutting fluid into the grinding zone, increasing performance. Metal bond wheels boast excellent shape retention and are thermally conductive, but require more power and are difficult to true. And for short production runs where truing is cost prohibitive, a single-layer plated bond does a good job, especially where complex shapes are required.
5. Be aware that grinding wheel manufacturers have introduced “best of all worlds” bonds and abrasive technologies. For instance, Norton has its Paradigm brand, which offers the porosity and dressing characteristics of vitrified wheels but the toughness of metal-bonded wheels. 3M says its Precision Structured Vitrified CBN Grinding Wheels offer performance increases of up to 40% in certain applications and can be 3D-printed to make custom wheel shapes.
6. As with wheel direction, wheel speed has a profound effect on grinding results. Doubling the spindle RPM, for example, brings twice as many cutting surfaces into contact with the workpiece per minute. If the feedrate is left unchanged, this will make the wheel act harder and generate a smoother surface finish. A similar effect is achieved by using a wheel with a higher concentration of abrasive, or one with a finer grit. Increasing the infeed rate creates higher cutting forces, but assuming the machine and workholding are rigid enough to support this, puts the wheel into “self-sharpening mode,” maximizing metal removal rates.
7. Finally, anyone moving to superabrasive grinding wheels (which, as noted previously, can greatly reduce costs and improve part quality) should be aware that sticking a modern wheel on a decades-old or ill-maintained grinder is probably a waste of time and money. As Norton's Barragan says, “It's a complete system. The wheel, the machine, the workholding, coolant and coolant delivery, and the grinding parameters—all of it must work together to achieve the desired results.” It's for these reasons that shops should partner with a knowledgeable supplier before merging onto the superabrasive superhighway.

Keep in mind that grinding is a complex process, and the recommendations above are high-level. Each type of superabrasive has its own set of usage criteria that varies based on the abrasive, the workpiece material and shape, grinding equipment rigidity and accuracy, the type of grinding operation (internal vs. external, for example), and much more.

Both 3M and Norton offer abundant product usage literature on their respective websites, and Norton provides training seminars throughout the year.

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For those who prefer to crack open a book and figure things out on their own, Crowley strongly recommends the *Handbook of Machining with Grinding Wheels* by Mike P. Hitchiner and others.

"Between that and our customer-facing documentation, it's my go-to whenever I'm troubleshooting a grinding problem," he says. "It's an amazing resource."

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