More Solutions, Greater Challenges

As coating technology improves to handle harsher conditions, cutting tool manufacturers are faced with new challenges during the resharpening process.

Alex Cannella, Associate Editor

Cutting tools have come far. They operate at blinding speeds and can cut workpieces in a matter of seconds. Productivity has increased almost tenfold. We've even developed methods of dry cutting that don't require lubrication. And even while moving at increasingly dizzying speeds, they're accurate down to the micron. The way we cut gears has fundamentally changed since a few decades ago, and cutting tools are at the center of that change.

But as cutting tools themselves move ahead in leaps and bounds, there's another field that's working to keep pace: cutting tool coatings.

As they've been introduced over the years, new methods of cutting gears have required tools to move at higher RPMs and generate more heat, and accordingly, cutting tool coatings have stepped up to meet the increasingly rigorous demands of these methods. In order to do so, however, they've had to use different, heavier materials. First coatings suppliers introduced aluminum, then eventually carbide, and a growing issue started becoming increasingly pronounced: While heavier coatings were protecting the tool better during operation, it was becoming more difficult to strip the coatings without damaging the base material and just ruining the tool altogether.

That might not sound like too big a deal at first glance. Some manufacturers don't even repair their tools, and instead just toss and replace them once they wear down.

"When you talk to coating people or cutting tool people normally, they only look for the coating as a one-time solution," Keith Liston, VP of tooling sales at Gleason, said. "So they use the tool, such as inserts...and then the tool gets thrown away. From the gear cutting side, we are looking into coatings in a different way."

It doesn't take a whole lot of math to

Cutting tools have become increasingly sturdy over the years to keep up with increasingly rigorous demands, and their coatings have become more durable with them.

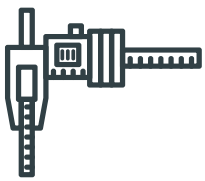
For Related Articles Search
coatings
at www.geartechnology.com

WE WANT YOU

We're Now

HIRING

Problem solvers, team players, gearheads, tinkerers, animal lovers, and mechanical geniuses to fill these positions:



Quality Assurance Manager

Gearing Supervisor: Gear Grinding, Hobbing, Shaping

Manufacturing Process Engineer

Supervisor: Secondary Operations

FOREST CITY GEAR™

For more information, and to apply on-line, visit:
www.forestcitygear.com/careers

CNC Machining Supervisor: Milling, OD/ID Grinding, Turning

Set-Up Machinist: Gear Shaping

Set-Up Machinist: Gear Hobbing

Machinist: CNC Lathe

Excellence Without Exception | **815.623.2168** | **www.forestcitygear.com**

see why resharpening a tool is better than buying a brand new one. Resharpening is cheaper, can be repeated multiple times to extend a tool's life, and if your service provider does their job right, that tool should come back just as sharp and effective as when you first got it.

But for those who get their tools resharpened (and if you want to get the most bang for your buck, you should be one of them), tool recoating becomes a critical issue. When it comes time to resharpen, a coating likely will not have worn down evenly, which leads to two issues during the resharpening process. If there's residual coating left on the tool, it sharpens unevenly, as you have to grind your way through the coating before you can start sharpening the tool, and exposed surfaces where the coating has already worn off start getting sharpened before surfaces where the coating is still intact. And then the new coating itself could be uneven, as well, with remnants of the old coating still underneath. In addition, stripping the coating before you start grinding exposes fresh material on the substrate that hasn't been touched by any of the chemicals involved while it was being used to grind gears, meaning no surprises during resharpening due to any past chemical contact.

"In any respect, if you take a hob, if you take a shaper cutter, if you take a power skiving tool, these tools get a new coating in the beginning, but also at the end, they come back for reconditioning several times…" Liston said. "So, any time you return the tool to be resharpened it has to be stripped, reground and recoated again. I think this is a totally different approach to the coating than what you would normally hear when talking to large coating manufacturers."

And when an average tool will be sharpened over a dozen times over the course of its lifetime, "uneven" or "inconsistent" are not adjectives you want describing your process. If resharpening an individual tool repeatedly is a primary way to stretch your dollar as far as possible, damaging a tool on its second sharpening drastically reduces savings and isn't an option. Cutting tool manufacturers are painfully aware of this, and endeavor to make sure that resharpening, and by extension,

recoating, is a reliable, repeatable process that makes the tool good as new again.

"These tools are reground 10, 15, 20 times perhaps throughout the entire life of their existence," David Goodfellow, president of Star SU, said. "And then recoated each time. And if you don't recoat it with the proper preparation of the cutting edge and the surface finish, you will not achieve the same tool life from the first use of a new tool, to the last use of a tool 10 or 15 times after it's been reground."

The issue gets compounded when you realize how much thinner the margin for error has become with newer cutting methods. When working at the higher speeds demanded by gear cutting today, a tool's fail state comes sooner — and happens faster.

"The risk of catastrophic failure now is by far greater if you don't do all these processes properly," Tom Ware, product manager of gear cutting tools at Star SU, said. "Historically when they were running low speeds, your tool life was a curve that went up after a few pieces, leveled off, and then wear started to gradually occur 10, 20, 30 thousandths wear on the flank, and then you pulled the tool and resharpened it. Now that curve is pretty steep, so if you get more than 10 or 15 thousandths of wear, you could get into a catastrophic failure very quickly, so we have to control the process much more closely."

"You can go from five thousandths edge wear to fifty thousandths edge wear in literally a matter of seconds," Goodfellow added. "So it's very important to know that critical point and to stay below it so that you don't risk destroying the tool."

When the margin of error is thin and the life of the tool is at stake, you can see why cutting tool manufacturers are very serious about their resharpening process. And why they don't take any chances with uneven sharpening caused by residual coatings.

According to Mark Duykers, cutting tool sales manager at Liebherr, the resharpening process is all about preparation.

"Just like anything else, preparation is the key to quality," Duykers said. "Electrochemical stripping must be monitored very closely so as to remove all of the coating, yet not damage the substrate. Whether grinding a new cutter or resharpening a used one, edge prep is critical: it is very important to remove any micro-burrs prior to coating."

That means that instead of just slapping a new coating on, you need to take the time to strip the coating off first. Then you can go about resharpening the tool, and finally after all that, you reapply an entirely new coating. The entire process is more or less about returning a tool back to the state it was when it was

The resharpening process is about more than just regrinding the cutting edge. You also have to remove the coating, perform proper edge prep, and then reapply it."

brand new, and the best way to go about that is to perform each step of the process with the tool in the same condition it was when it was first being manufactured. When the tool is being sharpened, it's already been stripped of its coating and you're working directly on the base material. When it's time for the coating to be reapplied, the tool has already been sharpened back into its ideal state — the same state it was in when its original coating was applied.

But the first step of the process, stripping the coating, got a lot more complicated once heavier coatings started coming into the market. Tool manufacturers tend to use chemical methods to strip the coating off, but once materials such as carbide get introduced, the coating becomes more stubborn and difficult to remove, and manufacturers are left with an increasingly tight balancing act. Leave the tools in the solution too long, and you damage the substrate underneath the coating and ruin the tool. Take it out too early, and you still have remnants of the coating on the tool, which leads to uneven sharpening and recoating and subpar performance once the tool returns to the spindle.

"The decoating process for carbide is very challenging," Julius Habermeier, product manager of cutting tools Americas for Oerlikon Balzers, said. "For different coating types you need different stripping processes so that you don't damage the carbide (e.g. cobalt leaching). We developed special stripping processes and also stripping equipment for different coatings that we can assure the quality."

Dry processes such as skiving often necessitate tool coatings that improve a tool's heat resistance.

Fortunately, tool manufacturers and coating suppliers are aware of this pain point, and they've been making great strides over the past few years in handling it. The most notable solution to the problem has been the advent of aluminum chromium nitrite coatings — most notable among them being Oerlikon Balzers' flagship coatings, Altensa and Alcrona — which have many of the benefits of older aluminum and carbide-based coatings, but are still easier to strip and reapply. The chrome in the coatings is significantly easier to break down via an acid-based stripping system than aluminum, and even though the latter is still technically present in the coating, the overall makeup makes ACN coatings much easier to work with.

When making tools for grinding gears, tool manufacturers need to be cognizant of of not just how that tool's coating will perform in the field, but also during maintenance.

"The key is time in solution," Goodfellow said. "You can do it with heavier concentrations of acids, but then that has its problems. They've been doing some work with trying to activate that solution with electrolysis... but the whole key is to limit the amount of time in solution, which then minimizes any potential for surface damage of the base materials."

The challenges continue into the sharpening stage, as well. Namely, if the cutting tool isn't sharpened properly, the coating still won't be reapplied evenly, even if you'd successfully stripped the old coating off without damaging the tool. This part is all about edge prep, making sure to remove any sharp corners from the tool.

"We've kind of taken a page out of the carbide insert world with the edge prep, and found that we can enhance the coating adhesion, rather than having a sharp corner, having a bit of a rounded, honed edge," Goodfellow said. "And depending on the application and the different coatings, that amount of edge prep is a factor in the performance of the tool."

According to Momper, removing small, residual burrs on a tool with just 10-20 microns of edge prep can affect a

hob, shaper or power skiving tool's life by up to 50 percent, and is only going to become more and more important with carbide hobs on the market.

And then finally comes the recoating process, which has its own considerations. Most notably, you have to consider which coating to use. According to multiple sources, about 80 percent of applications just use ACN, but for those one-in-five edge cases, cutting tool manufacturers need to choose a coating that can cater to their customer's needs. In addition, they have to consider a tool's base material. For example, a powder metal substrate won't be able to handle higher temperatures during the coating process, while carbide has a higher hardness and isn't as sensitive to heat in the coating process. But then when it comes time to strip the coating during resharpening, carbide is more susceptible to being damaged during the stripping process, while you'll have a much easier time with powder metal.

And it's here that a coating's stubbornness rears its head again. The final consideration when choosing what coating to apply is how easily it can be removed when it inevitably comes time to sharpen the tool. After all, if the supplier can choose a coating that meets the customer's requirements and is easier to remove, they save both the customer and themselves a lot of headache down the line.

"We not only simply apply the coating, we have to also think about how to remove the coating, which is completely unusual," Liston said. "What is the effect of removing a coating from a PM material? And what is the effect of removing a coating from a carbide material?"

Now, after reading all that, one might start to wonder: Why bother with all this at all? Why not just keep using lighter coatings on your tools that aren't so difficult to remove? The answer is the other major concern facing cutting tools right now: heat resistance.

As cutting processes have continued to evolve, they've begun to work at higher and higher speeds, generating more heat. And as dry cutting methods gain prevalence and the usage of coolants wanes, the onus to prevent a tool from overheating falls increasingly on the coating. Over the years, coatings suppliers have had to develop heavier duty, more temperature-resistant coatings to meet customer demands for higher temperature tolerances. But while coatings suppliers have done a pretty good job meeting this demand, as Eric Sevareid said so long ago, the chief cause of problems is solutions. Cutting tool coatings have been doing a pretty good job solving the temperature problem, but the next difficulty along the chain of causation is how to properly remove the most stubborn of coatings, and that one's still an ongoing discussion.

For more information:

Gleason Cutting Tools Corp.
(585) 473-1000
www.gleason.com

Liebherr Gear Technology
(734) 429-7225
www.liebherr.com

Oerlikon Balzers
(847) 619-5541
www.oerlikon.com/balzers

Star SU LLC
(847) 649-1450
www.star-su.com