

# COAT, PLEASE

There is more to recoating cutting tools than meets the eye.

**I**t is common industry practice to regrind and recoat carbide and HSS cutting tools. The price to regrind and recoat is a fraction of the cost of new tools, and, of course, recoating prolongs tool life.

This refurbishing process is typically performed on specials or higher-cost tools. The types of tools that are re-ground and recoated include drills, endmills, hobs and shaper tools.

To remove the coating from a drill or endmill, the coating is simply ground off the cutting edges during the re-sharpening process. The grinding wheels are hard enough that they can remove the coating.

The edge preparation during regrinding is critical. Not only should the original edge geometry be reproduced faithfully, the grinding method must be "safe" for physical-vapor-deposition coatings. (Chemical-vapor-deposition coatings are not typically used on round-shank tooling.) Therefore, abusive grinding practices, such as rough or dry grinding that leave thermally damaged surface layers on the tool, must be avoided.

During recoating, the tool can be "masked off" to prevent buildup on critical surfaces and just the designated areas are recoated in the PVD chamber, or the entire tool can be recoated, leaving only those areas masked by the fixturing uncoated.

The entire coating can also be chemically stripped off the tool before recoating. This is done on tools with com-

plex designs, such as hobs and shaper cutters, or on tools that have been recoated a number of times and the coating thickness is a problem.

The use of chemical stripping solutions is typically limited to HSS tools, as the solutions can damage carbide substrates. The chemicals leach the cobalt from the surface of the carbide substrate, leaving a porous surface that is difficult to recoat.

"Chemical stripping solutions are designed to preferentially etch away the hard coatings," said Dennis Quinto, technical director of Balzers Inc., Amherst, N.Y. "Because the chemical composition of carbide substrates can contain compounds similar to the coatings, the stripping solutions are more likely to damage carbide substrates compared to HSS substrates."

Therefore, when carbide tools are stripped, it must be done carefully. "The residence time in the stripping solution is critical," said Bill Langendorfer, vice president of Gold Star Coatings Inc., West Branch, Mich. "The longer you leave the tool in the solution, the more it attacks. The attack rate is much less on HSS tools, but it is still a good practice to get those tools out of there and rinsed off as soon as the coating is off."

Proprietary chemicals are available that can strip PVD coatings and have minimal reaction with the substrates, but they are not widely used yet. There are other ways to strip the

coating, too, such as with a laser process or abrasive blasting, but liquid chemicals are the most common because they offer good surface-stripping uniformity.

Because of the effects of the chemical stripping process on all substrates, the ideal procedure is to strip the tool before regrinding. Only companies that have both regrind and recoating equipment can practically implement this practice.



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HSS hobs, shaper cutters and a broach, all with TiN coating.

Therefore, the coating is typically stripped after the tool is resharpened.

## Coating Changes

The most common cutting tool coatings are titanium nitride, titanium car-

bonitride and titanium aluminum nitride. Other hard nitride/carbide types are used, but are less common. Tools with PVD-diamond coatings can also be reground and recoated.

Sometimes customers buy the tool

uncoated and then have a coating added when they have it resharpened. In other cases, they may even have a different coating put on a new or reground tool.

"In a lot of cases, we decoat the TiN

## Not so expendable

Inserts are always defined as throw away," said Robert Laflamme, president of R & J Tool Inc. "We don't dispute that. We dispute when to throw them away."

Although indexable inserts are usually thought of as expendable, R & J Tool Inc. is changing that perception. R & J Tool specializes in regrinding and recoating carbide, ceramic and CBN inserts.

Most regrinding of an insert is done on the flank and radius, which reduces its overall size, or material is removed from the top, which changes the clamping height. This leads to problems with clamping, size control and toolholder clearance.

Laconia, N.H.-based R & J Tool takes a different approach. An insert is resharpened by grinding the radius and cutting area of the flank to a standard size. This does not change the overall size of the insert, so there are no locating and clamping problems.

"We remove material only to sharpen where the insert is dull," said Laflamme. "We don't go completely around the cutting tool so we don't make the cutting tool itself smaller. That is really crucial because you can't clamp it or hold it in the tooling if it is smaller, or you can't do it well."

Another R & J Tool method is resharpening the insert on the top by applying a T-land. This offers a ground and lapped top edge of  $\pm 15^\circ$ . The clamping height is not reduced and the edges are honed and recoated to match specific cutting requirements.

"The T-land goes around the top of the cutting edge. It brings the edge back, but it doesn't change the area where the clamp goes," said Laflamme. "Other sharpeners simply go all the way across the insert. This sharpens the edge too, but then the clamps don't fit well."

An insert is typically resharpened once. But by using it to its optimal amount of wear—using it until it is properly dull, but not overusing it because then it can't be resharpened, or taking shallower depths of cut—a customer may realize multiple sharpenings.

"A lot of it has to do with how hard the customer uses the insert," said Laflamme. "In a lot of automotive applications, they use them so hard and they are so dull that by the time we use our sharpening process, we can bring it back once. If they use them that hard a second time, there is not enough material left. For a customer that doesn't use them hard, say, they are doing

finishing cuts, they might be able to have them resharpened six times."

R & J Tool works with its customers to ensure that the ground, honed and lapped cutting edges suit specific applications. Coatings and customized geometries can allow a remanufactured insert to perform as well or better than a new insert, according to Michael King, R & J Tool's sales technician.

"In some applications, our process allows for an increase in feeds or speeds over that of a new insert," said King. "For example, by applying our ground edge and a coating to a worn, uncoated insert, we were able to increase tool life by 70 percent and reduce cycle time by 25 percent in a customer's milling application."



Examples of special carbide inserts resharpened by R & J Tool.

Another customer, said King, was so satisfied with the performance of the resharpened inserts it decided to send its new inserts to R & J Tool to apply its ground edge and coating prior to usage.

The regrinder offers a variety of coatings for resharpened inserts, from standard single-layer TiN to specialty multilayer coatings for machining aerospace material. The coating is usually applied to the entire insert, with the exception of the area used to hold it in the coating vessels.

Sometimes it is necessary to selectively coat the insert, masking off areas to prevent buildup that may affect proper seating. "A customer was concerned because his cutoff-style insert seemed to be popping out of the holder," said King. "It turned out to be the fine amount of additional coating was [creating] enough of a buildup that the insert wouldn't seat properly. Masking the locating edge alleviated the problem."

R & J Tool provides resharpened inserts for major automotive and aerospace manufacturers. The company began with smaller job shops, but the focus now is on larger companies. Runs usually consist of 250 to 1,000 inserts.

"On the small side, we have had one customer that uses 250 inserts a year in an aluminum application," said King. "The cost savings justified the customer sending in one order annually and maintaining a year's inventory. On a larger scale, we have the capability for customers to realize six-figure cost savings."

—S. Woods

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HSS hobs and shaper cutters with TiN or TiAlN coating.

coating and reapply with TiAlN,” said Langendorfer. “The reason is because the customer is trying to increase the productivity of the tool, and you can run TiAlN faster and hotter than TiN.”

They could go to the manufacturer and have a new tool manufactured with a better coating, but “the manufacturer might have to make a complete tool and then put the TiAlN coating on it,” he said. “The TiN coating could be removed and a TiAlN coating put on in a much shorter time than it would take to remanufacture the tool.”

### Layer Limit

Cutting edges can be recoated as many times as a tool can be resharp-ened. “You’re going to get one well-adhered layer where the surfaces have been reground, which is critical for improving performance,” said Rob Bokram, national field sales manager, IonBond LLC, Madison Heights, Mich.

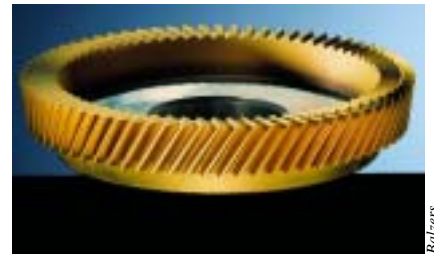
As for the rest of the tool surface, stripping and recoating may not be nec-

essary after every regrind, but it depends on the type of tool and the machining parameters being used.

“Hobs and shapers are two tool types that our company strips every time we receive them back for recoating,” said Bokram. “If you don’t strip every time with that type of tooling, your performance will be degraded.”

There are only so many times a tool can be recoated without stripping before stress-induced adhesion problems start to become a factor. PVD coatings have residual compressive stress that is beneficial during metalcutting, but the stress increases with coating thickness, and beyond a certain threshold, coating delamination can occur.

“Every time you recoat without stripping, you’re building thickness on the OD,” said Quinto. “With a drill, that means the size of the hole that you are drilling gets bigger. So you have to think in terms of the thickness that you are putting down and what that means to the OD and relate that to the toler-



Balzars

A TiN-coated gear-shaper cutter.

ance of the hole dimensions as well.”

Quinto said a drill generally can be recoated five to 10 times without being stripped, “but after that you have severe tolerance problems.”

Dennis Klein, vice president of Spec Tool, Sparta, Mich., said that with tolerances of  $\pm 0.001$ ”, the coating thickness should not be a problem, “but you might have problems with tolerances that have to be held within 0.0001” to 0.0005”.”

As long as the coating thickness is not a problem, it is possible that a re-ground and recoated tool might be better than the original. “It is well known that with a good combination of edge prep and coating, you can certainly increase cutting parameters and do very well,” Quinto said.

### The following companies contributed to this report:

**Balzars Inc.**  
(800) 792-9223  
www.bus.balzars.com

**Gold Star Coatings Inc.**  
(800) 426-2538  
www.goldstarcoatings.com

**IonBond LLC**  
(248) 398-9100  
www.ionbond.com

**R & J Tool Inc.**  
(877) 508-4925  
www.randjtool.com

**Spec Tool**  
(616) 887-1714  
www.spec-tool.com