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Slippery When Blue

A coating system that combines a patented surface impingement process and tungsten disulfide prolongs cutting tool life, but does it promote faster speeds?

▶ BY RICH DZIERWA, EDITOR

At Urban Manufacturing Inc. in Pewaukee, Wis., machinists make wire crimp connectors out of copper. They're for Cooper Power Systems, a division of Cooper Industries Inc. that manufactures transformers. The tubular connectors vary in size. Lengths are up to about 6" and ODs to about 1¼". They are machined out of 110 copper, which has a 20 percent machinability rating, making it difficult to drill a 0.843"-dia. hole, for example, to a depth of 3.750" in a version that is 5.940" long with an OD of 1.150".

At best, Urban was able to drill some 40 holes with a cobalt-HSS, coolant-through drill running at 800 rpm and 0.008 ipr on a Mori Seiki slant-bed lathe. The wear on the drill's cutting

Tungsten disulfide is applied to a drill using a high-velocity impingement technique. The surface of the drill has already been prepared with another high-velocity impingement process. These two operations result in a mechanical/molecular interlock that cannot chip, flake or peel.

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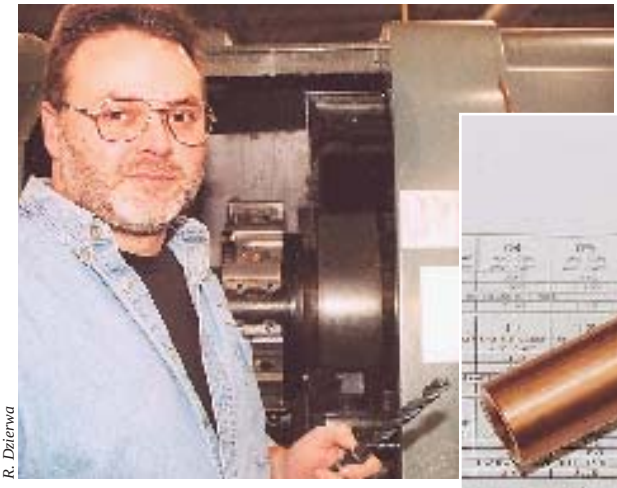
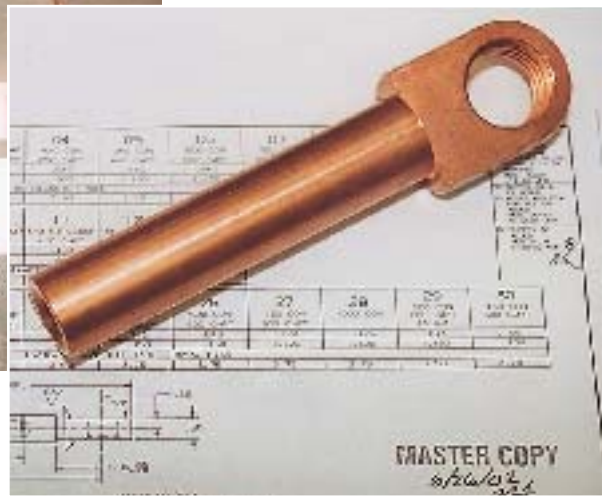


R. Dzierwa

Rob Hammond, operations manager, Urban Manufacturing, said drilling holes in 110 copper has been troublesome.



edges and margins, caused primarily by buildup of chips in its flutes, left no opportunity for regrinding.

Urban's Operations Manager Rob Hammond said it's been the toughest job for the shop during the 18 years he's been at the company. "We do hard boring with diamond-tipped inserts in cast 8620 steel, which is rather difficult, but even that isn't as tough a job as drilling the 110 copper for these connectors," he said. "No matter what type of tool we put to that copper, it got eaten up by the material."

Until recently. That's when Urban tested drills treated with tungsten disulfide. The shop found that the extremely lubricious nature of that coating significantly aids chip evacuation via the drill's flutes. Urban enjoyed an increase in drill life to about 70 holes and then could regrind the tool numerous times.

The tungsten disulfide is part of a coating system called MicroBlue, developed by Material Technologies Inc., Rockford, Ill. It combines the coating with a patented surface impingement process. Material Technologies has made a name for MicroBlue by treating dozens of racecar and motorcycle wear parts.

Intrigued by the potential to reduce friction at the tool/workpiece interface, numerous machine shops are testing MTI's system on drills and taps. Like Urban, they are experiencing increased

Downturn, upgrade

With all the press on machine shop woes and the difficulty U.S. shops have competing against low-labor-cost countries, it's easy to adopt a defeatist attitude. But not only can a no-win outlook doom an operation, it is not truly realistic. There are shops that are growing.

Urban Manufacturing is an example. On Nov. 21, 2002, it completed a 22,000-sq.-ft. addition. Its factory is now 62,000 sq. ft.

"Over the past year, we've seen profits grow each month between 1 and 2 percent vs. a year earlier," said Rob Hammond, Urban Manufacturing's operations manager.

That's a result of smart diversification. Once, 90 percent of the company's orders derived from one customer. Today, 93 percent is divided among three.

The new manufacturing floor space will allow the Pewaukee, Wis.-based firm to construct a dedicated prototyping and manual machining department. Five bar-feeding lathes will be shifted to the new attached building, and bar racks will be located adjacent to those machines and within short distance of a new receiving dock.

In June 2002, Urban purchased an Excel ST-1240 CNC lathe chucker with a 12" chuck. "Recently, we did some prototype parts for a medical device manufacturer with 12"-dia. blanks on a 10" machine," Hammond explained. When the medical device maker gave Urban the contract for the parts, Hammond and shop owner Alex Urbanchek knew they couldn't stand pat without a 12"-chuck machine.

Hammond told CUTTING TOOL ENGINEERING his company had a fairly easy go of it convincing its bank to loan it the money for the new lathe. He admitted, though, Urban is an exception to the rule. "There are a lot of shops I know personally that are struggling."

If history is any example, Urban will pay off the new 12" lathe in 3 years. "We've been going at that pace for the past 4 to 5 years," Hammond said. "This has made it much easier for us to upgrade."

The next machine tool Urban will likely purchase is another VMC.

"We make most of our own fixturing," Hammond said. "Our guy in charge of our milling area is top-notch" at fixture design. "We have customers asking us to quote fixtures. We've gotten so busy in the mill area that he's bouncing around from machine to machine. We would like to get him his own."

Freed-up space in Urban's existing plant will be utilized to construct a pseudo-clean-room production environment.

"Our owner has always believed that when things are slow that's the time to look at improving or expanding," Hammond said.

—R. Dzierwa

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A drill (bottom) coated via the MicroBlue system shows none of the detrimental effects of galling that an untreated drill (top) clearly exhibits. Both were used to drill a 1.50"-deep hole into 6061 aluminum. The tools were applied on a horizontal lathe running at 1,830 rpm, 120 sfm and 0.008 ipr.

tool life due to better chip evacuation.

But the question now is whether MicroBlue and its ability to improve chip removal affords opportunities to increase machining speeds and feeds. If it does, better machining productivity may be in the offing.

The Pledge: No Buildup

Craig LeClaire, MTI's president, is proud of MicroBlue's impact on NASCAR's Winston Cup racing circuit. In an environment where performance gains are measured in increments of 0.01 of a second, racing teams have shaved a couple of tenths of a second off lap times with MicroBlue-coated parts. The coating system proved particularly effective for teams running MicroBlue at Daytona and Talladega last season.

Tungsten disulfide, which has a coefficient of friction of 0.030 (dynamic), was developed by Stanford University at the behest of NASA in the '60s. NASA scientists sought a very slippery material for the Mariner space probe program. Yet, in all the time since, the use of the material in metalworking applications has not garnered widespread acceptance.

This intrigued LeClaire and prompted some investigation that ultimately yielded his creation of the high-velocity, preparatory impingement process that produces a surface texture that provides form-fitting landing pads for the particles.

"It creates a textured surface comprising microscopic 'pockets' about 1µm in size," said Robb Powell, director, cutting tool operations, MTI. The coating settles into the pockets to create a very smooth, very slippery surface, he explained. "You essentially have a mechanical/molecular bond between the substrate and the tungsten disulfide."

LeClaire touts his system as considerably more slippery than graphite, molybdenum and Teflon and added that it does not enlarge the size of the tool.

The MicroBlue system cannot be employed on a tool that has been coated with another material, nor can a coating be added on top of MicroBlue. Because of this, LeClaire and Powell are quick to note that MicroBlue doesn't make the cutting tool any harder or tougher.

"If the cutting edge does its job, MicroBlue will do its job," LeClaire said. "The role of chip evacuation is playing a far more important part in overall tool wear than we thought, and MicroBlue is the best antigalling agent out there."

"Any machining operation that generates heat, galling and/or rapid wear seems a suitable application for MicroBlue," said Urban's Hammond.

Hammond's interest in MicroBlue was piqued by Sean Walsh, who works for abrasive and cutting tool distributor Merwin-Stoltz Co., located in Menomonee Falls, Wis.

Walsh said he'd expect beneficial results of coating cutting tools with MicroBlue on such materials as 1026 and 8620 steel. "Those are buildup materials, like copper."

A Perfect Application

Perfecting Coupling Co., Charlotte, N.C., is a manufacturer of pneumatic and hydraulic couplings. Quick-disconnect air compressor fittings the company machines are for private-label contracts and its own branded line. The manufacturer tested MicroBlue on ⅜"-18 NPTF, 4-flute taps used to thread fittings made of 12L14 steel. Tapping was done on a National Acme multi-spindle screw machine, with cutting oil applied. Prior to MicroBlue, the taps lasted 10,000 holes. With MicroBlue, they lasted 25,000 holes.

Ron Earle supervises Perfecting Coupling's screw machine department. He said the tap he chose for testing MicroBlue was not the tap used at the time. "I chose a medium-duty tap, because I knew what a high-quality tap could produce and I wanted to compare."

Besides longer tool life, Earle was pleased with the better thread finish. "Without MicroBlue, I would have expected a duller finish on the threads, as chip removal wouldn't have been sufficient enough to allow the cutting oil to reach the tool's edge. With MicroBlue, the thread form was excellent." As good as with the high-end tap.

LeClaire pointed out that the marriage of the coating system and lubricants is also noteworthy. "Tungsten disulfide has a strong, dynamic relationship with hydrocarbon-based lubricants. That's why racing teams went faster at Daytona and Talladega, because we're introducing sliding/friction properties in a noncontact environment."

"That's what grabbed our attention," Hammond said, "reading about its use on pistons and similar parts. We said, 'OK, it's a friction-type thing. Friction is our biggest problem with this 110 copper part.' We're looking for something that can 'float' chips better."

Perfecting Coupling will soon test the coating system on every type of cutting tool it uses. This includes tools for dry drilling and milling applications.

Helpful, or Really Helpful?

Clearly, tungsten disulfide, applied in the way it is in the MicroBlue process, lengthens tool life in certain cases by facilitating chip evacuation. But, as cutting tools represent such a small portion of the cost of making a part, the more important question is what can the coating system do to improve machining productivity.

Unfortunately, testing thus far has completely centered around improving

shops' biggest machining headaches—e.g., Urban's experience with the 110 copper connector.

"Whenever we get into issues of tool life and things like that, we always seem to pick up on the 'failure-of-the-day,'" said LeClaire. "You know, 'If this is so damn good, prove it to me.'"

Urban's Hammond said his shop hasn't looked at hiking speeds or feeds as a result of MicroBlue-ing his drills and taps, because he wanted to keep parameters the same for test comparisons. But he and Walsh figure they'll soon investigate the possibilities.

"All failures in tooling have to do with heat," Walsh said, "and heat is derived from speed, with friction. If you're normally burning the edges of a tool, you're running too high an sfm, so you must back down. If you can eliminate the heat by reducing friction, you can run the faster speed.

"The biggest problem pretty much for all shops is that they're undermanned," he continued, "and to figure all this stuff out, you need somebody to be able to run holes, run holes and run holes."

One sector where there may not be a dearth of shop floor personnel is in the automotive segment.

MTI's Powell said, "To automotive people, increased productivity is paramount. So, if we can prove that we can drill a hole in an engine block faster, then we would really have something."

"I was recently at a Tier 1 automotive vendor," LeClaire said. "I asked them, 'Aren't you guys in the race business here? You're doing how many million heads and blocks for that Big Three company? Isn't this a race? Doesn't he who makes the most chips win?'"

"We've started identifying applications," Powell added. "For example, we believe we can achieve a faster penetration rate when drilling holes into aluminum."

Powell admitted harder steels are another matter. "I'm not sure additional feed rates will be possible in cast iron, for instance, because of the limitation of the [drill] insert itself. With an indexable, if you're feeding at 0.015 ipr, for example, you may not be able to raise that to 0.020 ipr, because that might break the insert. Remember, we're not coating the insert. We're just providing a means for chips to get out faster."

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Better tap performance is seen by Material Technologies as a primary application goal for MicroBlue. Dart Machinery, Melvindale, Mich., a manufacturer of aftermarket, high-performance engine blocks and cylinder heads, is currently conducting preliminary tests of the coating system on taps used in cast iron. Dave Tratechaud, owner, said one of those test programs has shown average tap life increasing to 280 minutes of use from 150 minutes, although he stresses his evaluation of the system is far from complete. (Previously, the taps were coated with TiCN.)

Another question that lingers is whether MicroBlue-ing inserts is worthwhile.

"We can coat inserts but not over another coating," Powell said. "So, we're limited, as such a large percentage of the inserts made in the world are coated with TiN, TiAlN or TiCN."

The company has done considerable work on solid-carbide tools with end users. LeClaire and Powell are convinced this coating is applicable to turning and milling as well as drilling and tapping.

Costs Less

MicroBlue-ing costs 60 to 80 percent of the price of a TiN coating, Powell said, and about half as much as TiAlN.

"And it's faster," he said, "because it is done at room temperature and there is no curing requirement following the application. Tools are ready for use as soon as MicroBlue is applied. For example, a 1"-dia. jobber-length drill can be processed in about 1 minute."

Meanwhile, the final touches are being put on a manufacturing line to produce the impingement and spray equipment necessary for applying the MicroBlue system. LeClaire sees a price tag well below $100,000.

"For the last month, a lot of cutting tool people have been telling me that if they could improve production rates 10 percent, that would be huge," LeClaire said. "I consider what MicroBlue does and I think, 'You know, that 10 percent doesn't seem too hard to do.'"

Of course, LeClaire is biased, but numerous companies have already put the MicroBlue coating system to the test. If MTI were publicly held, it might qualify in more ways than one for the moniker of "blue chip" stock.

For more information on MicroBlue, visit www.microblueonline.com or call (815) 874-1717.