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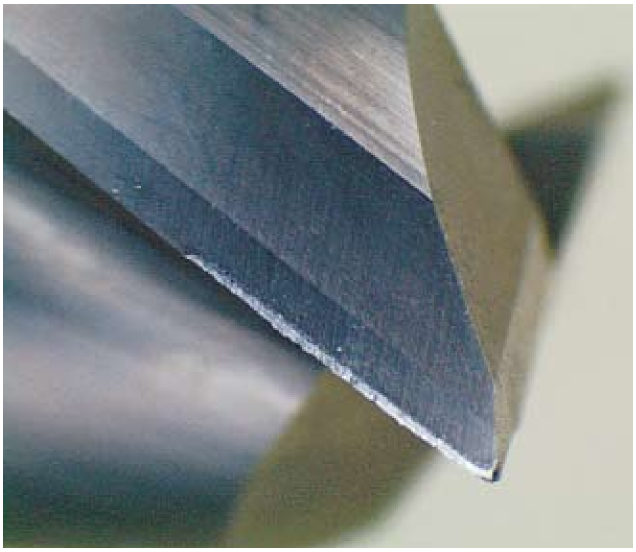

Figure 1: TiB_2-coated endmill with no coating delamination.

Figure 2: DLC endmill with coating delamination.

All images: Hardcoating Technologies

New Angle on Aluminum

A new PVD tool coating targets aluminum workpieces.

Traditional physical vapor deposition coatings, such as TiN, TiCN and TiAlN, are generally considered unsuitable when milling and drilling aluminum. The PVD process typically produces a coated surface that is rougher than the carbide substrate, causing aluminum chips to collect on this rough surface as built-up edge. However, a new titanium-diboride tool coating allows successful machining of aluminum.

A TiB_2 coating produced by Hardcoating Technologies Ltd., Munroe Falls, Ohio, reduces costs when machining workpieces made from aluminum, as well as titanium, magnesium and copper alloys.

TiB_2 is applied using a sputtering process that produces a smoother coating surface than traditional arc processes;

the surface has a coefficient of friction of 0.45. At 4,000 HV, TiB_2 is one of the hardest PVD coatings. Its ceramic structure and smooth surface resists chemically bonding to aluminum. Combined with tool geometries for machining aluminum, TiB_2 aids in chip removal at high speeds due to its smooth surface and the tendency for aluminum chips to resist sticking to that surface.

Endmill coated with TiB_2.

Edge Wear Comparison

Hardcoating Technologies conducted an edge wear comparison using aluminum test materials—including 6061 at 0.4 to 0.8 percent silicon and B-390 at 16 to 18 percent silicon. TiB_2 and diamond-like-coated (DLC) solid-carbide endmills from SGS Tool Co., Munroe Falls, Ohio, were tested on these materials using a vertical machining center with 9 percent concentration, water-based flood coolant.

In the tests, TiB_2 provided increased wear resistance compared to DLC, which provided no additional wear resistance over uncoated carbide, most likely due to delamination. The coating wore off behind the cutting edge wear land. This suggests the coating had no effect on the tool. The carbide endmill coated with TiB_2 had less edge wear (Figure 1) and no delamination compared to the DLC tool (Figure 2).

Hardcoating Technologies and SGS Tool worked with a medical parts manufacturer to quantify savings using TiB_2. The comparison between a TiB_2-coated carbide drill and a TiN-coated drill was conducted on a Haas VF-3 vertical machining center with oil coolant machining 6061 aluminum. To produce 20,000 finished units, the manufacturer needed to replace its ¼" TiN-coated drill five times, but needed only one TiB_2-coated drill to complete a 20,000-unit run. The TiB_2-coated drill provided total cost per unit savings of 51 percent, or $413 per 20,000 units.

More Holes, Less Breakage

In an automotive drilling application, a 0.138"-dia., uncoated carbide drill cut an average of 10,000 holes in aluminum with 7 percent silicon. The spindle was underpowered and application conditions prevented the use of a higher-powered spindle. Drill breakage was a common occurrence due to chip packing and low horsepower. Coating these drills with TiB_2 greatly reduced chip packing, allowing each drill to cut an average of 30,000 holes each with less breakage.

Using higher speed and feed rates when machining aluminum can increase productivity, and using cutting tools that eliminate BUE and provide substantial wear resistance can reduce manufacturing costs. TiB_2 coatings offer parts manufacturers another option to increase productivity and profitability. △

TiB_2 Specifications

- Microhardness: 4,000 HV (DLC coatings have similar hardness value)
- Coefficient of friction: 0.45
- Oxidation temperature: 1,562° F
- Thickness: 1µm to 2µm (based on tool diameter)

About the Author

Jim Haag is president of Hardcoating Technologies Ltd., Munroe Falls, Ohio. For more information on PVD TiB_2 coatings, contact Haag at (330) 686-2136, or visit www.hardcoatingtech.com.