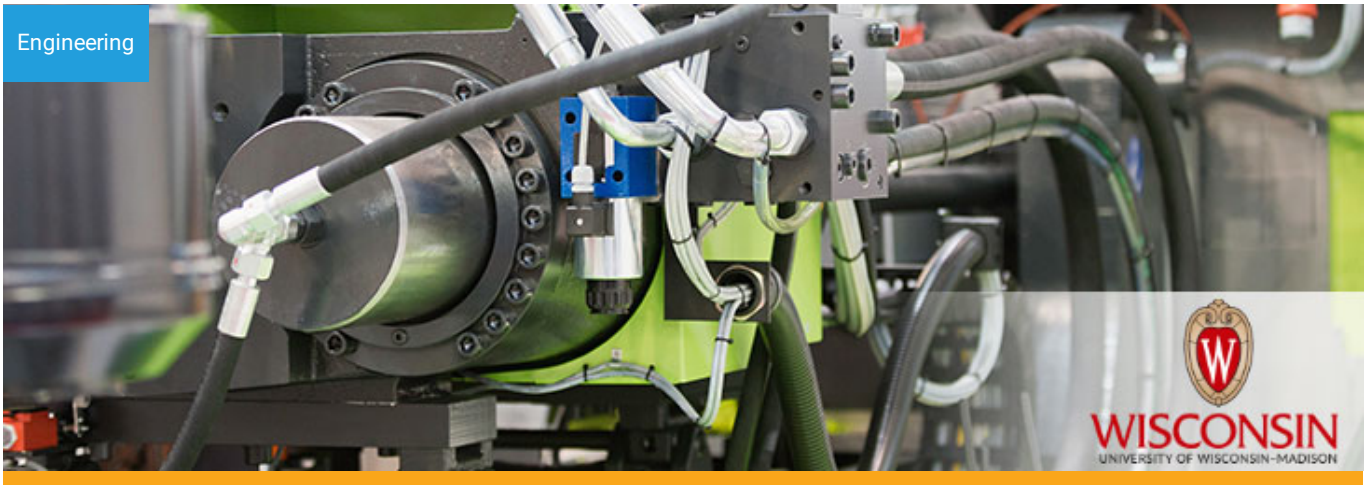
Engineering



Wear-Resistant Nanocrystalline Diamond Coating for Micro-End Mills and Other Micro-Cutting Tools

View U.S. Patent No. 7,947,329 in PDF format.

WARF: P06146US

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a nanocrystalline diamond coating capable of strengthening and improving the performance of micro-cutting tools.

Overview

Micro-end mills are tools with tips just 10 to 500 micrometers in diameter. As part of emerging micro- and meso-scale machine tool systems, they are used for high-precision machining of miniature parts for the medical device, micro-satellite, microfluidics, optics and electronics industries. Typically made from tungsten carbide with a cobalt binder, today's micro-end mills have several drawbacks: They degrade rapidly and unpredictably, produce a poor surface finish, and soft materials such as aluminum and copper stick to them during machining.

The Invention

A team of UW-Madison engineers has developed a nanocrystalline diamond coating (NCD) to strengthen and improve the performance of existing tungsten carbide-containing micro-end mills and other micro-cutting tools. To apply the coating, the team first etched cobalt from the tool surface and seeded it with diamond powder composed of particles less than 50 nanometers in size. They then deposited an NCD coating on the surface by using the hot filament chemical vapor deposition process. In tests comparing the performance of NCD-coated and uncoated micro-end mills when cutting an aluminum alloy, the inventors found the coating greatly increases wear resistance, reduces adhesion of workpiece material to the tool, significantly reduces required cutting and thrust forces, and produces a cleaner, more uniformly machined workpiece.

Applications

- High-precision micro-cutting tools

Key Benefits

- Provides uniform nanocrystalline diamond (NCD) coatings less than one micron in thickness that promise to greatly enhance the performance of micro-cutting tools
- Significantly reduces required cutting and thrust forces, enabling larger cuts and higher feed rates, and lowering power consumption
- Achieves dry (un-lubricated) machining with little or no burr formation
- Prevents adhesion between the tool tip and soft metals, such as aluminum, achieving an improved surface finish
- Eliminates need for lubricants and reduces burr production; these coatings could lessen both the environmental impact of micro-machining and the need for post processing

- Nanocrystalline diamond, as opposed to regular diamond, can be deposited in layers less than one micron in thickness, enabling conformal coating of the tool tip without significantly increasing cutting edge radius
- Applicable to many types of cutting tools including micro-end mills, routers, drills, drawing dies and razor blades
- Uses hot filament CVD, a well established, scalable technology capable of large-area deposition on large quantities of tools

Tech Fields

- Engineering : Micro & nanotechnologies

For current licensing status, please contact Michael Carey at mcarey@warf.org or 608-960-9867