**HARDER THAN DIAMOND**

Researchers at North Carolina State University have reported the discovery of a super-hard form of solid carbon that could play an important role in machining. The scientists also claim to have developed a relatively inexpensive technique for producing the substance, called Q-carbon, at room temperature and ambient atmospheric pressure.

Besides being harder than diamond, Q-carbon is ferromagnetic, unlike other solid forms of carbon, and glows when exposed to even low levels of energy, according to the scientists.

The researchers believe Q-carbon may exist in the cores of some planets. To produce it artificially, they coat a substrate with amorphous carbon, which lacks a well-defined crystalline structure. This carbon is hit with a single laser pulse lasting about 200 nanoseconds, during which time the material’s temperature is raised to 4000 K. The heated spot then rapidly cools to become a film of Q-carbon. At present, the researchers can control the process to make films from 20 to 500 nm thick.

Q-carbon could have many applications in both industry and medicine. Cutting tools could benefit from the material’s hardness and its amorphous structure, which is not prone to cracking, according to Jay Narayan, the lead Q-carbon researcher. “I’m expecting that if you put a [Q-carbon] coating on top of diamond or cubic boron nitride cutting tools, the tools will last longer,” Narayan said, adding that a coating thickness of a couple of microns should be sufficient.

For industrial applications, Narayan and his team will need to scale up Q-carbon processing. “When you have hundreds of tools, you’ll need to coat them all in a limited amount of time,” he noted. In addition, he said, scaling up the processing of Q-carbon might make it practical to actually make tools out of Q-carbon rather than just coating them with the material.

Another challenge for Narayan and his team is coating uneven surfaces. Right now, surface features such as steps, with areas that are perpendicular to each other, could present problems for the coating process.

But as for Q-carbon downsides, “I can’t think of any,” Narayan said. “I feel it’s a holy grail.”

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**WHY GO DRY?**

Italy-based Samputensili recently unveiled a machine designed to eliminate the need for cutting oils when manufacturing gears, reducing grinding costs and making the process safer and more sustainable.

During grinding operations, oil-based lubricants cool the workpiece, as well as reduce friction and evacuate chips. On the downside, however, oil use accounts for a significant amount of total grinding costs. Expensive equipment is required to supply, chill, catch, and wash away oil in grinding processes. In addition, Samputensili estimates that oil-treatment equipment uses 75% of the energy consumed by a grinding machine.

Another disadvantage is the composition of cutting oils. Samputensili describes them as “chemical cocktails” that pose a threat to the environment and people who work around them.

To banish oil from the manufacturing process, Samputensili’s SG 160 Sky Grind features two spindles, one for skive-hobbing and the other for grinding. With the first pass, the SG 160 takes care of 90% of required material removal using its skive-hobbing tool, which does not heat the workpiece too much, explained Enrico Landi, division director of Samputensili Machine Tools.

Skive-hobbing, the hobbing of hardened gears with carbide tools, can be done without oil even in mass production. But Samputensili says the process has never successfully produced transmission gears, so grinding must be used for finishing.

Samputensili’s idea was to produce a machine offering the removal rate of dry skive-hobbing along with the geometric accuracy and surface quality of dry finish-grinding for mass production of automotive gears. During the second or finishing pass, the SG 160’s grinding wheel is designed to handle the remaining material removal without overheating the workpiece. This completes a totally dry manufacturing process that requires no oil-related auxiliary equipment, allowing it to fit into a more compact footprint than conventional gear-grinding systems.

In addition, the SG 160 is faster than conventional dual-table grinding machines, Samputensili claims, and its cycle times for finishing gears meet automotive industry requirements. The manufacturer also maintains that the machine’s innovative structure can shorten nonproductive part-changing times to less than 2 seconds.

By partnering with major automotive companies in the development of the technology, Samputensili said it has already proven that the SG 160 will work as planned. The company reports that its experience with the machine thus far indicates that annual savings in manufacturing planetary gears could be more than 50,000 € per machine compared to production using conventional wet grinding processes.

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