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Reinventing the Wheels

Gleason Cutting Tools' new superabrasives wheel plating facility is helping gear manufacturers keep pace with increased demand for high-performance hardened and ground gears.

Gear designers around the world are seeking to increase their use of hardened gears to squeeze optimum performance out of smaller, quieter transmissions and gearboxes. After all, highly accurate hardened gears offer greatly improved strength and wear resistance (service life), while at the same time delivering a greater load carrying capacity (higher torque) than larger gears.

But if the use of hardened gears solves many problems, it can also create a few. For example: where to find the super-accurate cubic boron nitride (CBN) plated wheels highly prized for the precision finish grinding of hardened gears after heat treat? Sourcing these wheels has always been notoriously difficult. Lead times are often long, quality usually suspect, and costs painfully high — until now.

Controlling the process at Gleason Cutting Tools Corporation. Today, a new multi-million dollar facility in the heart of the Midwest is doing what few thought would be possible just a few years ago: turning out hundreds of high precision, uniform, single layer CBN and diamond plated products for use in the hard finishing and grinding of bevel and cylindrical gears as well as other non-gear profiles.



Bill Stauffenberg, Plated Products Supervisor at Gleason Cutting Tools Corporation, claims that the wheels made in this Loves Park, IL facility are simply the best in the industry, and he has the facts to prove it.

“Holding profile tolerances of 0.0001" to 0.0002" (one to two ten-thousandths of an inch) is routine for our wheels, and we have produced profile tolerances of 0.00005" (50 millionths of an inch) for some aircraft gear applications,” says Mr. Stauffenberg. “I think many in the electroplating industry would be shocked to learn that this is even possible. However, in the gear-making industries these accuracies are imperative because of the critical nature of gear profiles and surface finishes. There is very little margin for error.”

Roger Hackman, Gleason Cutting Tools' Vice President, Technology and Quality adds that their ability to consistently produce these kinds of results wheel-to-wheel enables the company to do what few in the electroplating industry would dare: furnish customers with a guarantee of quality, accurate estimates of tool life (number of gears that can be produced), and recommendations on feeds and speeds to achieve optimum performance.

Mr. Hackman attributes much of the company's success to its willingness to invest in all of the resources needed to control the production of these products in house. This includes:

- The use of advanced CNC equipment for blanking, turning, heat treating and finish grinding

of the A2 steel body (called the core) — all done in accordance with ISO 9001 International Quality Standards;

- Inspection of the core and its profile after finish grinding using super-accurate computer-driven Coordinate Measuring Machines (CMM);
- Application of a single layer of abrasive CBN or diamond crystals that are mechanically bonded to the body with a layer of electrolytic and electroless applied nickel, performed in an ultra-modern electroplating facility;
- Full-profile grinding of a coupon by the finished wheel, and final CMM inspection of the profiled coupon, with verified wheel profile and expected K-chart results furnished with every wheel.

Single layer, multiple benefits.

The advantages of using single layer CBN (or diamond) plated grinding wheels are well-known. The single layer structure — CBN or diamond crystals of a specified size bonded to the wheel profile in a thin layer of nickel — is considerably harder than ferrite and other conventional abrasives.



It also offers the most compressive strength, best wear resistance, and highest heat conductivity — all in an open structure that facilitates chip clearance at even the heaviest stock removal rates. Yet, creating a CBN single layer with anything approaching the precision needed to achieve the tolerances and surface finishes found on today's gear profiles can't be done without the special technology and expertise found in Gleason Cutting Tools' plating facility.

“CBN and diamond abrasive crystals are available in many sizes, from an average diameter of 35 microns (0.0014") for 400/425 USA MESH, to 76 microns (0.0030") for 20/30 USA MESH,” explains Mr. Stauffenberg. “However, if you were to simply apply, say, a 100/120 MESH crystal size right off the shelf, the deviation in crystal size would be enough to ultimately throw the wheel profile out of tolerance. So we employ a unique method to more precisely control their size and shape.”

Gleason Cutting Tools has developed a system of 'quarter sieving' or 'sub sieving' the crystals prior to the electroplating process. The crystals are put through a series of high quality electroformed sieves, ultimately ensuring that the particle-to-particle size separation in a single layer is within just 5 microns (0.0002").

This is just one of a whole series of steps that Gleason Cutting Tools believes are required to ensure that the wheel ultimately produces the results specified by the customer. Among the most important in achieving uniformity of the abrasive layer is Gleason's proprietary electroplating chemistry. After a thorough ultrasonic cleaning to ensure cores are free of contaminants, the cores are put in engineered precision masking fixtures to protect non-plated

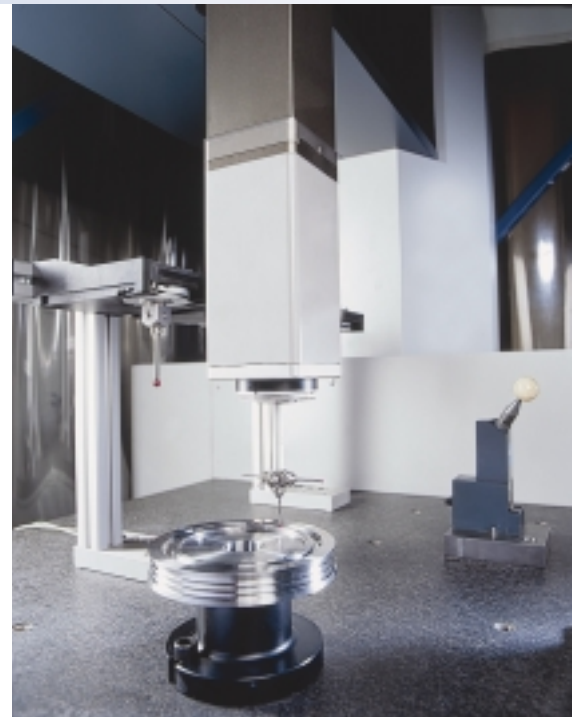
surfaces. An electrolytic process then uses nickel to tack down the abrasive to the exposed wheel profile. The duration of this process and the required amperage is precisely controlled based on the abrasive size and the surface area it covers.

But it's the next step in the process that's really critical, according to Mr. Stauffenberg. "Once we've achieved this initial bonding of a single layer of CBN to the wheel, it's necessary to 'tack down' the layer and encapsulate the crystals by building up the nickel to perhaps 50-60% of the height of a crystal," says Mr. Stauffenberg. "Most suppliers continue to use the electrolytic process — we've proven that electroless nickel plating at this stage provides a more uniform thickness and higher hardness of the nickel plating. Simply put: if you can't control the layering of the nickel you can't control the tolerances of the profile. Electroless is the only way to gain this control."

The finished wheel is then put through a rigorous inspection process that includes the microscopic evaluation to verify particle distribution, and the full-profile grinding (on an actual CNC grinder) and inspection of a graphite coupon, thus verifying that the wheel will achieve the desired accuracies.

More leads, less leadtime.

Since the facility ramped up to full



production, Gleason Cutting Tools has seen the demand for its high-quality products rapidly increase — and its leadtimes decrease. Despite the fact that the facility now produces the industry's highest quality CBN and diamond plated wheels, it has been able to reduce leadtimes for these products well below the industry average of 10 to 12 weeks. "We've actually managed to reduce our delivery from many weeks on new wheels down to six weeks or less," says Mr. Hackman. "Nor are we limited to just gear applications or new wheels. We've found a receptive audience in other industries as well for non-gear related applications. We are also an excellent source for the replating and refurbishment of all types and sizes of wheels."



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