Feature Article

Pushing The Profile

A collaborative effort by three grinding companies has resulted in a process for creating profiles in diamond grinding wheels. It solve manufacturing problem for one Connecticut manufacturer and holds promise for others.

By Chris Koepfer

It may take two to tango, but sometimes it takes even more than that to design and execute a new manufacturing process. CiDRA Precision Services benefited from the combined services of three companies, each with a different grinding specialty. These three companies worked together to create a process solution that made parts faster and better and resulted in a reduction in capital equipment requirements for the manufacturer, CiDRA.

That's not bad from a customer's perspective. It's good for the suppliers too, because they now have a proven process that has applications beyond what CiDRA is doing. Call it win-win.

To Be Precise . . .

Founded in 1996, CiDRA designs and manufactures high-precision optical components and modules for networks and real-time monitoring solutions for scientific and industrial applications. The company's founding products were higher resolution fiber optic pressure sensors. These were designed for use in very nasty places, such as the bottom of an oil well. Fiber optic sensors, developed in-house, were used to permanently monitor the oil well to help the operator maximize the extraction of oil from the reservoir.

This hostile environment generates pressures of 20,000 psi and temperatures of 200°C. These sensors must survive and work uncalibrated for 10 years in a hot, wet and very dirty environment.

Successful development of precision machining processes for the glass elements that went into these devices was the genesis for the company's Precision Services Division, which now parlays those captive skill sets into a business. This division manufactures high-precision mechanical components from a variety of difficult to machine materials.

Commercializing the processing skill sets that it takes to make the company's products has led CiDRA to develop its precision machining capability as part of its multi-industry high technology focus. Think of this division as a very high-tech job shop. To serve its internal and external customers, the company has invested significant capital in precision manufacturing and inspection equipment with processing capabilities that include precision grinding, sawing and polishing of difficult materials to tolerances within 2 microns.

These difficult materials include glass, quartz, ceramics, sapphire and hard metals. Processing these materials—specifically, the ability to form grind them in a single plunge using superabrasive diamond wheels—is the focus of this article. The development of the process involved three companies that worked in concert to solve a difficult processing problem and the results perhaps represent a precursor of how future process solutions may pan out.

Risk / Reward

The prime driver to look at a different method for the company's precision grinding operation came from trying to process a relativel parts. These were glass parts for the telecommunication industry, which at the time was very busy.

"In a relatively short period of time, we needed to gear up to run 10,000 to 20,000 discreet parts a month across our Agathon cente Kirk Schoell, operations manager for the Precision Service Division. "Our original grinding process entailed nine different grinds to cr profiles on the part. A limiting factor was the resin bond wheels we were using. These wheels had to be dressed off-line and only allo profiles and simple geometries to be dressed into the wheel. That necessitated more wheels and more machining steps to complete a

Mr. Schoell was caught in the proverbial cross hairs of satisfying an increased production schedule and asking for capital outlay to m Traditionally, if you need to make more parts, and you have a proven process, a shop simply buys more machines and tools them up and true way of increasing capacity," says Mr. Schoell. "It's the safer course for the manager whose responsibility is getting good pa But that's not what CiDRA did.

Change The Process

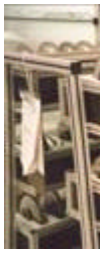
Using CiDRA's existing process to meet the higher production volumes would require that the company increase its centerless grindir to nine machines. In addition to the capital investment required, adding machines only met the current production demand. It left lit additional capacity.

The idea of doing something different started on the shop floor. CiDRA's cell leader, Rich Dills asked, "Why can't we replace our mult machine process for profile grinding with a single plunge grinding operation? We could dramatically increase the workflow across our and reduce the need for some of the additional capital outlay." That started the investigation into an alternative process.

Mr. Schoell asked Mike Lagace, the senior manufacturing engineer, to investigate the feasibility of Mr. Dills' idea. Mr. Lagace brought companies to see if Mr. Dills' idea had practical merit. Agathon provided centerless grinders, S.L. Munson & Company contributed gri technology and Applied Grinding Technologies provided wheel dressing expertise.

At first blush, the news wasn't good. Form dressing the grinding wheel with the highly accurate profiles necessary was not feasible u current off-line process. The solution would require on-machine CNC profile dressing to achieve accuracy. The other hurdle was to fir be dressed and produce an optical quality specification. In spite of the challenge, the up side for CiDRA, if this concept could be mad good to dismiss out of hand.

Building A Solution



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The new wrinkle that CiDRA and its vendors came up with first required a change from resin bonded diamond wheels to vitrified bonded wheels. These are dressable, with the ability to accept CNC profile of very fine contours. These accuracies are in the ±0.001 mm range.

A new dressing process, patented by Dr. Kaiser (Celle, Germany), is called rotary point dressing. It provides on-machine dressing of vitrified bonded diamond grinding wheels. This was combined with the correct wheel specification, using very fine grain abrasive, to achieve the surface finish required.

Typically, a form diamond roll dressing process requires the use of a relatively robust dressing system. In effect the diamond dressing wheel "ground" the diamond grinding wheel as a result of a speed differential between the two wheels.

In rotary point crush dressing, the surface speed of the grinding wheel and the surface speed of the dressing disk are synchronized. This creates virtually a single point of contact between the diamond grinding wheel and the dressing disk. Because there is no slippage between the diamonds, forces are lower and a thinner dressing disk can be used.

The point dressing process differs from traditional crush dressing by fracturing the vitrified bond that holds the diamond grit as opposed to fracturing the grit itself by shearing motion from a speed variance. Thinner disks actually work better for this task and thus allow finer profiles to be formed in the wheel.

S.L. Munson supplied CiDRA with both the dressing wheel from Dr.Kaiser and the grinding wheel fr vitrified wheel was specified for the CiDRA application. To allow the profile to be formed in the whee diamond and binder is 10 mm on the radius or 20 mm on the diameter. The wheel supplier, DWH, l molding process that forms the rough profile in the wheel. This reduces the amount of expensive di dressed out of the wheel to get to the final form. On the machine, the rough form passes remove a material. The final dressing to size takes off 2-3 microns of material.

To maintain the synchronous speed between the dressing wheel and the grinding wheel, which is a speed, the dresser unit must have very fine speed control. Applied Grinding Technology (AGT) deve two-axis CNC unit that replaced the template-dressing unit on the Agathon machine. It is full CNC, micron positioning resolution to the dressing wheel. Moreover it's programmable to compensate for the dressing wheel rises and falls into various profile features of the grinding wheel and maintains t speed.

AGT designed the CNC dressing system unit specifically to fit the Agathon machine. The unit include motorized dressing spindle for precise speed control, CNC control and an acoustic sensing system t

The dressing unit built by Applied Grinding Technologies was designed to fit the Agathon grinder. This CNC unit drives the Dr. Kaiser dressing wheel, which profiles the DWH diamond grinding wheel (inset).

when the wheel was fully dressed and could be used to prevent damage in the event of a crash. Th CiDRA to use the rotary point crush dressing process in situ, eliminating the off-line dressing steps. software had the ability to easily program profiles at the machine, or profiles could be generated wi off-line. With some advanced features in the software, shape correction could be easily achieved. F accuracy, Mr. Lagace came up with an offset routine for the dresser unit that programmed a slight i nominal profile to compensate for deflection of the workpiece in the grind.

Results

The net result to CiDRA for implementing the rotary point crush dressing on its Agathon centerless reduction in cycle time per part from 2 minutes to 37 seconds. Nine machining steps were reduced

Throughput was also dramatically increased, obviously because of the cycle time reduction, but also elimination of off-line wheel dressing and the attendant setup of truing in the dressed wheel when i the machine. The parts come off the grinder ready for inspection. The rotary point crush dressing s consistent results in part accuracy.

According to Mr. Schoell, "using our existing grinding machines, we were able to meet the productio originally needed and increase the shop's overall capacity by 75 percent. We went from requiring ni machines just to make production to a significant increase in overall shop capacity using our existin was risky to try unproven technology, but the rewards have been tremendous."

More Than Glass

The specific production advantages of the rotary point crush dressing process are transferable. CiDRA is applying them to other hard come up. Basically, if a material needs superabrasive wheels, it can use this dressing system. Of course not all grinding applications high accuracies that CiDRA meets, but the production advantages gained from a single plunge profile have wide application in many

For Results, Try Relationships

American manufacturing industries are under intense pressure to reduce costs in order to remain competitive in ou global economy. CiDRA's successful implementation of rotary crush dressing reflects the trend toward collaborative working relationships among metalworking suppliers.

It is common for companies to shy away from being the first to use anything that "hasn't been done before." Consequently, many manufacturing companies find themselves losing jobs to foreign companies and falling further behind in a very competitive business environment. At the same time, there is a growing awareness in the manufacturing and the machine tool industry that some level of shared risk is essential to the process of gaining significant reward.

The entire grinding package has reaped huge production rewards for CiDRA.

Agathon, for example, effectively walked away from the sale of five machines in order to support the process change that would best serve CiDRA. In conjunction with Dr. Kaiser and DWH, Agathon test ground components to prove the grinding process. They also worked closely with AGT, providing machine specs and other technical data necessary to upgrade the existing machines with state of the art dressing systems.

S.L. Munson, working through its suppliers Dr. Kaiser and DWH, brought the rotary point dressing process to CiDRA and worked closely with both Agathon and AGT technicians to get the right wheel and dresser formulation to do the job. With each party working in close coordination, the development time was cut to a very short 16-week completion.

CiDRA was an active partner in the development process. It acted as a technology patron, taking the risk of trying something new and working through the inevitable ups and downs of such an endeavor.

Collectively, these four companies pushed the envelope for precision grinding a little bit further. Each company possessed specific pieces of the technical puzzle, but with mutual cooperation the pieces came together in a new w to solve a very real problem. Perhaps this kind of venture should be more the rule and less the exception.