

The Bug and the Slurry:

Bacterial Control in Aqueous Products

by Ron Abramshe

At a Glance . . .

- When a customer reported a problem using the polycrystalline diamond (PCD) slurry supplied by Warren/Amplex, we traced our product through the supply chain in order to identify the cause and quickly implement a solution.
- Understanding recent changes not only in customer requirements but also in customer processes proved to be key to understanding the problem.
- Collaborative teamwork with our customer and our West Coast sister company uncovered the source of the problem and enabled us to implement a successful solution within 72 hours.

Effective supply chain management depends upon streamlined production and distribution processes. Superior product manufacturing, quality assurance, cleaning processes, and delivery systems are critical for success throughout the entire product-to-market distribution system.

Particularly in a high-tech economy, the process must be flawless—from the raw material manufacturer to the distributor and end-product manufacturer, and finally to delivery to market. Any chink in the armor can result in increased costs, decreased profits, elevated stress levels, and eroding business relationships. To say that *disaster* looms around the corner is no exaggeration.

A relationship between Warren/Amplex Superabrasives and one of our Asian customers—a high-capacity manufacturer of data storage disks—provides a perfect illustration of the fundamental importance of teamwork, internal/external business communications, quality control procedures, and contamination-free manufacturing processes as requisite elements vital to business success. When our customer reported a problem using materials we supplied, we traced our product up through the supply chain—from our product, to the components our customer created, to their customer's needs—in order to identify the cause and quickly implement a solution.

About Warren/Amplex Superabrasives

Founded more than 50 years ago, Warren/Amplex is located in Olyphant, Pennsylvania. As a manufacturing unit of Saint-Gobain Ceramics and Plastics, Incorporated, Warren/Amplex manufactures and supplies polycrystalline diamond (PCD) slurries. Our diamond powder and formulated compound products are used in material processing, PCD manufacturing, coatings, and electrical component processing.

Our approach to our customer-supplier relationships is governed by our Ten-Point Customer First Plan:

1. Talk with your customers frequently; ask them to comment on your products. Surveys are a good way of eliciting a response from customers who may hesitate to tell you straight out.
2. Ask your customers what they want in terms of features and benefits.



A Warren/Amplex technician measures sterilized diamond for a customer sample.

3. Pay close attention to customer complaints, measure them, and ensure closure to the customer's satisfaction.
4. Train and reward employees who are outstanding customer advocates.
5. Pay close attention to your markets and to the actions of your competitors; benchmarking is a good practice to help you keep ahead of your competition.
6. Team size is important, as are team members' working relationships. In general, the larger the team, the more convoluted the effort and, more important, the solution for the customer may become. Keep it small. Keep it simple.
7. Maintain proper attire in anterior rooms.
8. Emphasize assurance. Ideally the team should have experience working and solving clean room and quality control issues and problems, providing the requisite confidence to tackle a less well-defined problem.
9. Communicate and collaborate. Each team member must have the opportunity to express a solution, idea, or opinion. While the team should have a designated leader, no one person should dominate the team; hence, the workload for a solution is distributed evenly and the customer benefits from a wide range of expertise and ideas.
10. Apply knowledge. A self-directed team of experts from each department involved is critical in maintaining clean room sustainability as well as finding effective and timely solutions for customers during incidents of management crisis.

A Customer in Panic Mode

I walked in to work early one morning—before any employees had arrived—and booted up my computer to review my e-mail messages. From that point on, I realized “high stress levels” would be the theme of the day.

The word “HELP” was typed in subject line after subject line. The messages described a potentially disastrous filtering issue metamorphosing at a disk manufacturing plant half a world away. The polycrystalline diamond (PCD) slurry Warren/Amplex had supplied was clogging the filtering processes, and to compound the problem, a film of unknown origin was appearing after the cleaning-up step from texturing.

Never one to implement the “ostrich syndrome,” we quickly called our quality control team together to review and manage the situation. And I immediately quit reading any further e-mails and went directly to our chemist.

Having received only one quality complaint over the past few years, Warren/Amplex had promptly implemented a structured line of questioning and review procedures to re-examine our slurry production whenever any new issue should arise. We were thus immediately ready to begin formal troubleshooting using the following questions:

- When was the problem first noted?
- What was the lot number?
- What shift was working? Were the operators new or experienced?

- Have the filters been analyzed?
- Can we have a bottle of slurry sent back for analysis?
- Was anything added to the slurry?

As the day progressed, we uncovered some answers. Apparently the problem was with the last slurry shipment. The disk manufacturer provided Warren with the lot number but tersely responded that they had no time to send back any samples. They had three days' worth of texturing slurry left, and the situation was critical. They needed more slurry or their lines would go down, which meant missing a shipment to their customer, causing a failure—something not permitted in the disk drive industry. Basically, they were in a panic mode.

Enter the Slurry

The end-user of the data storage disks was a high-capacity server manufacturer. In the electronic world, delivery schedules are tighter than deadlines in the daily newspaper business. Any delays, chronic or acute, in the production and delivery process inevitably create disastrous bottlenecks and poor results. Critical components—like data storage disks—are on a scheduled component completion date for delivery to the end user, with no wiggle room. Usually a monetary penalty is assessed for late deliveries.

With ever-tightening margins and reputations on the line, on-time or ahead-of-schedule deliveries become all the more important. “Everyone is pushing dates so they can get ahead of the delivery curve,” explains Nick Tumavitch, manufacturing and development chemist at Warren/Amplex Superabrasives.

Texturing the disks involves placing a texturing pattern on a nickel phosphate coated aluminum disk in a uniform pattern in width and uniform depth. These texture patterns can then be encoded so the read-write head can both deposit and retrieve information in binary code. From the texturing operation the disks are cleaned and moved to the next operation, which is to test the lot for compatibility to the corresponding read-write head. As Warren's quality control and management team delved deeper into this ever-threatening situation, some light began to appear.

Initially we were unaware that the disk manufacturer was running our slurry through their filters. Once aware, I instructed Nick to determine the PSD (particle size distribution) in the slurry, which means completing a data sheet listing all the particles in the supplied distribution, both in tabular and graphical form. I was trying to determine any possibility of coarse pieces clogging their filters.

Enter the Bug

We turned to Warren's West Coast sister company, Innovative Organics, to seek their expertise. “I've been on both sides of the fence, texturing and the abrasive portion. The more I reviewed the information the more convinced I became that our problem was ‘bugs,’” comments Bob Futrell, general manager of Innovative Organics. “Bugs” is shoptalk for bacteria, the latter being a four-letter word in the manufacturing industry that demands sanitary—contaminant-free—processes.

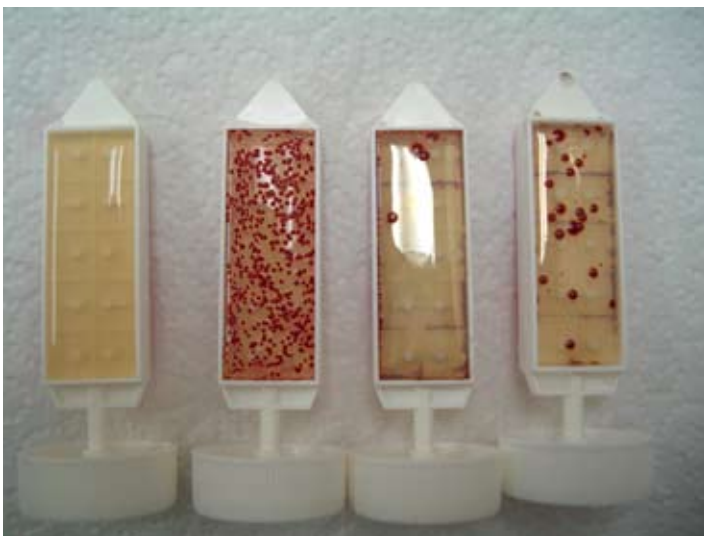
We were concerned that by the time we could use petri dishes, agar (a standard nutrient base for growing bacteria), and an inoculating loop to analyze the slurry, we would run out of time. The answer came in the guise of bug sticks, testers that enable fast screening of samples. The bug sticks are coated with agar and have a grid molded in for easy colony counting. Innovative Organics, which develops environmentally friendly process coolants, lubricants, slurries, and cleaners, uses bug sticks regularly. With the three-hour disparity in time being a blessing in disguise, Innovative Organics shipped the bug sticks to Warren overnight.

End Day One, Begin Day Two

The situation was getting dicey at the plant, with roughly one day and a half left for Warren/Amplex to solve the problem and prepare and deliver new slurry. We called in Warren's scanning electron microscope (SEM) technician. Placing slurry on a dried sample peg, the SEM technician began to look for bacteria 0.5 µm in diameter. After about 15 minutes of looking at different magnifications and scans, not even one amoeba type single cell bacteria appeared on the surface of our abrasive pieces. "I determined we could be vaporizing the critters at the magnifications we were looking at," comments Tumavitch.

At 10:00 a.m. the bug stick package from Innovative Organics arrived. I immediately read the instructions and sent for our chemist. We dipped the bug stick with the agar medium into the polycrystalline diamond slurry and then placed it in Warren's hot room to be maintained at 85 degrees Fahrenheit, the perfect temperature to grow bacteria. The bug sticks required a 24-hour incubation period, giving Warren/Amplex roughly one business day to fix the problem and send new material to the disk manufacturer before they would be forced to shut down and put 3,200 hourly workers on the street with no pay.

When the bug sticks coated in agar and dipped in polycrystalline diamond slurry had been incubating only eight hours, one-third



Bug sticks. From left to right, the first bug stick is free of any bacterial contamination, while the remaining three reveal various stages of bacterial contamination. Each dot represents a colony of 10,000 bacteria.

the time required for complete incubation, a few black spots had already formed. Remembering from the instruction sheet that each black dot represents a colony count of 10,000, I knew we had a problem. Proceeding on the basis that we had a bacterial infestation in the slurry, the next piece of the puzzle was determining how to eliminate the bugs from infecting new and existing slurry production runs.

Suggested remedies included:

- Dry the material and send it through fusion cleaning. However, this process would be time consuming.
- Use technical-grade hydrogen peroxide at 30 percent concentration and oxidize the bugs. Warren was not equipped to handle this type of oxidizer safely. Another problem was determining how much to use and how to dispose of the excess liquid. Using the peroxide would unbalance the percent solids since the slurry product was consistent to four decimal places in abrasive content, meaning Warren has precise control of the number of particles in our diamond solutions.
- Another suggestion was a bactericide, which would require a waiver from the data disk manufacturer since Warren manufactures chemical-free slurry composition.

Eureka!

"Anything short of a complete solution was unacceptable," says Jamie Montano, quality control manager at Warren/Amplex Superabrasives. "At that moment it came to us as an epiphany—pasteurization, just like milk is processed." We decided to heat the entire vessel containing the polycrystalline diamond slurry to a certain temperature and kill the bacteria. This process would not involve any additional liquids, which meant that if it worked, Warren could send the next slurry shipment in time to prevent a shutdown at the disk manufacturing plant. Fortunately, it is not necessary to boil water to pasteurize it. Heating water to 65 degrees Celsius for 6 minutes will kill all bacteria, viruses, and parasites. The vessels containing the bug-infested slurry were heated to 80 degrees Celsius for 10 minutes. "We discussed our solution with the customer and they gave us the green light to proceed," comments Tumavitch.

Another bug stick test after we followed the plan verified the solution. We produced a 400-bottle order of new pasteurized polycrystalline diamond slurry and shipped it overseas special delivery. The shipment arrived at the customer site and was immediately put into service. Soon the disk manufacturer was running full steam ahead on all texturing lines.

The Moral of the Story: Understand Customer Processes, Not Just Requirements

When our distributor first reported the problem with the initial e-mail, they clearly did not understand the fundamental problem. As required by our ISO 9001-based quality management system, we reported our final analysis to our disk-manufacturing customer at one of many follow-up meetings.

Warren had been supplying diamond slurries to this disk maker as well as others for the past three years on a make-to-demand basis. Warren would submit samples to the manufacturers and they would approve the particle size that best matched the technical requirements of the hard disk. Scratch patterns, texturing tone, and magnetics were the criteria. Once a particle size distribution (PSD) was approved, Warren duplicated the PSD throughout the program's life. The lead time between making the product and shipping was literally days. For a "just in time" product, delivery could even occur the same day, sent by courier.

With the advent of higher density drives (120 megabytes and higher), the requirement changed. Warren was now required to produce and specify the lot of the product, sample from the entire lot, and, upon approval, ship the entire contents. "This was a change that we did not fully appreciate at the time," explains Montano. Warren was now required to have diamond in de-ionized water sitting in a stainless steel vessel for a week or longer until the lot was approved. Their manufacturing team did not foresee that this change in operations could and did have an effect in the customers' operations: bacteria!

We were not apprised of the change in operations at the customer's facility. Their filtering of our product with the use of 0.5 µm filters was a requirement of their Asian customer. Had we known this, we could have filtered some of our product through the same

filter to see if there was any change in particle size distribution, not to mention clogging due to bacteria.

In the final analysis, the management principle of collaborative teamwork throughout the supply chain paid off in huge dividends in problem solving. In less than 72 hours, team building and its integration into the firm's operations had delivered a successful solution.

For More Information

- Learn more about Warren/Amplex by visiting www.warrenamplex.com.
- Contact Ron Abramshe at 508-795-5908 or via e-mail at ron.a.abramshe@saint-gobain.com.
- Learn more about customer-supplier relationships and supplier quality by visiting www.asq.org.

About the Author

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