THIS ISSUE

Tariffs and Trade Actions Affecting the Superabrasives Industry

News & Notes

Quick and Smooth: Double Layer Grinding of PCBN Tools

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In Memoriam: Donald G. Cooper

Volume Production of Machining Tools Using Laser MicroJet® Technology

New Products

Evaluation of the Influence of Impurities in Single Crystal Diamond on Wear Characteristics

First Aid for Burned-Out Teams
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Tariffs and Trade Actions Affecting the Superabrasives Industry
Quick and Smooth: Double Layer Grinding of PCBN Tools
Volume Production of Machining Tools Using Laser MicroJet® Technology
Evaluation of the Influence of Impurities in Single Crystal Diamond on Wear Characteristics
First Aid for Burned-Out Teams

FINER POINTS is the longest running publication devoted exclusively to the understanding, selection and application of diamond, cubic boron nitride and related materials. It is edited for recipients who are involved in some way with these “superabrasives”, either as providers of the materials, producers of products containing the materials or users of these products (e.g., grinding wheels, dressing tools, drill bits, saw blades, sawing wires, cutting tools, polishing compounds, CVD film products, etc.).

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To our members and readers,

Terry Kane has created an identity for the (IDA) Industrial Diamond Association with LinkedIn. Please take the time to visit our profile and make your connection. We ask that you consider posting your technologies and your implementation of diamond or CBN products with our LinkedIn site. The Social Networks such as LinkedIn, Twitter and Facebook are a great way to share our technologies and can give your companies great exposure.

The overall U.S. economy is showing signs of stabilizing from a few years of growth. Some industries are flat and others are still going strong; the overall unemployment rate is still low, companies are hanging on to their talented employees.

Training has always been a major factor with me in part because of my involvement over the years with instructing and implementing of many programs. The need today for instructional training in our industries and companies is in great demand. Companies that are precision grinding and machining with Diamond and CBN products have experienced smaller resource pools of individuals that have the knowledge base for these applications and industries.

When I entered the industry 45 years ago, the industry had an influx of talented people who chose manufacturing for their careers after WWII, Korea and Vietnam wars. The last 20 years fewer people have chosen manufacturing for their career choice.

The IDA promotes training by offering training classes in machining and grinding utilizing Diamond and CBN products. We will be announcing our next course offering and location in the near future. Keep an eye open for the communication and consider participating in the programs being offered.

Regarding Government Tariff’s, As mentioned in the previous edition of the Finer Points with the Government tariffs are well in place, it creates a further challenge for the manufacturers to find ways to keep their costs at a manageable level.

Recently a customer reached out to me for assistance with a new process. He purchased a new Internal Bore Grinding machine for grinding High Performance Valve Lifter Bodies for NASCAR car engines.

The grinding process in itself is very challenging. I have had the experience of grinding hundreds of thousands of these parts throughout my career.

When the OEM delivered the process the cycle time was 2-3 minutes per/part, the abrasive type they were using was Plated CBN.

In order to maintain a level of confidentiality I will not get into the particulars of the process or events. What I can share with you is we reduced the cycle time to 30 seconds and with some further modifications to the machine tool, we should be able to get the customers cycle to 20 seconds.

For all you process engineers, the opportunities are there for further optimization. Improving your process 3, 5, or 10% can reduce your manufacturing cost enough to absorb the tariff increases.

Our industries are constantly changing, the machine technologies, process requirements getting even tighter and the baby boomers are retiring.

With the surge of retiring baby boomers comes the challenge to acquire the knowledge of these individuals before they move on. Sometimes the delay at instituting the knowledge transfer is so slow or it never takes place. This creates a void and a challenge to replace or fill the void.

The companies who are proactive with training and filling the voids for their retirees will find to be in a better position for the future of their companies.

Best Regards,

Kevin Stiles, President
Industrial Diamond Association of America

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Kevin Stiles
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EXECUTIVE DIRECTOR
Mr. Terry M. Kane
Industrial Diamond Association of America, Inc.
P.O. Box 29460 • Columbus, Ohio 43229
Phone: 614-797-2265
FAX: 614-797-2264
Email: tkane-ida@insight.rr.com

BUSINESS MANAGER
Kathryn A. Kane
Industrial Diamond Association of America, Inc.
P.O. Box 29460 • Columbus, Ohio 43229
Phone: 614-797-2265
FAX: 614-797-2264
Email: kathykgc@insight.rr.com

Website: www.superabrasives.org

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ARE YOU HOLDING ON TO YOUR MAN-CARD?

Men have an ongoing joke about when we should turn in our “man-card” indicating we have done something that is not in a “manly” nature! Needless to say I have been subjected to calls for my card on a number of occasions.

I distinctly remember a friend calling for me to shred and burn my card when I told him how much I liked the movie The Notebook ... I was chastised and told that it was not a manly movie! I understand that some movies are man approved and endorsed because they have an extreme amount of “good guy” heroism, swashbuckling and action. Anything with John Wayne or Steve McQueen is usually at the top of the list! Of course there are the movies where men are even allowed to cry, Brian’s Song and the final scenes of Saving Private Ryan come to mind.

The man-card is not a stable or fixed item it is more fluctuating with degrees of manliness. It has credits that increase your manliness or deductions that influence how manly we remain! I am sure I pumped up the man-card credits by running those machines doing some serious grinding or machining. Creating a tremendous halo of sparks accompanied by an extreme crescendo of abrasives meeting steel with smoke and steam had to crank up the points on my man-card! Smoke, fire and noise... to quote Tim Allen on Tool Time, “growl, grrrr”! I have even taken the famous man quiz and scored a very high “Man Rating”. In fact I remember the defining question ... A Real Man: 1. Likes Cats, 2. Likes Dogs, 3. Likes Cats and Dogs, or 4. Likes Dogs That Eat Cats ... You guessed it, my answer was number 4!

As men, we also gain points on our card for courage in the face of great danger like hunting down that strange noise in the middle of the night, chasing down that field mouse that snuck into the house or killing that dangerous spider on the ceiling ... extra points can be achieved (from the lady of the house) for capturing previously mentioned creatures and turning them loose safely outside.

Manly activities like tuning up an engine, changing a tire or replacing brake pads can add to the man-card credits. I have to admit these functions in my life have been replaced by my mechanic and AAA! Nowadays my limitations on engine repair have been reduced to opening the hood and looking wisely into the compartment! Men like me expect there is going to be a flashing green arrow on the motor pointing to any problem that I can fix! Gone are the days of me pulling out a timing light or putting the car up on jacks to delve into the wonders of modern automotive repair! These activities are no longer on my list of things to do and negatively affect my man-card points!

There are mundane “man” chores like mowing the yard, minor carpentry, plumbing and hanging that picture or rearranging the furniture that get us all a few points. I believe projects like assembling that mail-order kitchen cart she purchased with 2000 pieces gets me maximum number of points, plus a place in Heaven!

Seriously ... courtesy, kindness, honestly and being a gentleman score highest in any manly conversation. A guy can get extra points for a simple task like opening a door for a lady or remembering an anniversary or planning a romantic evening with that special someone. You get extra points for changing that diaper, helping with homework, making dinner and being a good father and husband.

Here’s to those men out there who go to work every day and have high integrity ... extra points to all of you, you have earned your mancard!
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Numerous international trade developments over the past two years should be of the highest concern to the superabrasives industry. The current Administration has responded to ongoing challenges with an array of new and traditional measures. This white paper provides an overview of traditional and non-traditional actions taken by the Trump Administration in regard to international trade issues, as well as providing a case study involving diamond sawblades.

Tariffs and Trade Actions Affecting the Superabrasives Industry

By: DANIEL B. PICKARD
Wiley Rein LLP

The Trump Administration Team and Strategy

Three key officials in the current Administration who are responsible for developing and implementing trade policy are: U.S. Trade Representative Robert Lighthizer; White House Office of Trade and Manufacturing Policy Director Peter Navarro; and Secretary of Commerce Wilbur Ross. Robert Lighthizer Peter Navarro Wilbur Ross.

U.S. Trade Representative Robert Lighthizer is a Georgetown University Law Center graduate and was a practicing international trade attorney for several years before and between periods of government service. Ambassador Lighthizer previously served as the Chief of Staff for the Senate Committee on Finance under Senator Bob Dole, and then as Deputy U.S. Trade Representative under President Ronald Reagan. President Donald Trump appointed Ambassador Lighthizer to his current post as United States Trade Representative in 2017.

Director of the White House Office of Trade and Manufacturing Policy (OTMP), Dr. Peter Navarro, holds a PhD in Economics from Harvard and is the author of several books including The Coming China Wars (2006) and Death by China (2011). Dr. Navarro's Office of Trade and Manufacturing Policy was created by President Trump in 2017. The OTMP’s mission is to “defend and serve American workers and domestic manufacturers while advising the President on policies to increase economic growth, decrease the trade deficit, and strengthen the United States manufacturing and defense industrial bases.” In his capacity as OTMP Director, Dr. Navarro has advocated reducing or eliminating the trade deficit and repatriating global supply chains.

Secretary of Commerce Wilbur Ross, a Harvard MBA, was an investment banker specializing in corporate restructuring. Secretary Ross is both a policy advisor and a spokesman for the Administration’s trade initiatives and the Secretary is an influential voice both within the Administration and in the public square. The Trump Administration’s trade strategy can be viewed on three distinct bases, namely: unilateral actions, bilateral negotiations, and multilateral disruption.

First, the Trump administration is acting unilaterally to remedy certain perceived problems where years of negotiations have failed. Second, this unilateral action is being used as leverage in bilateral negotiations to force changes to trade behavior. Third, both the unilateral actions and bilateral negotiations are conducted in a context of potential changes to the multilateral system.

The Current Challenge

China’s state-led industrial expansion has been viewed by many as harmful to U.S. interests and the global trading system. The Administration has voiced concerns regarding the fact that some significant portion of China’s GDP growth is due to perceived violations of international treaty obligations, including the protection of intellectual property rights.

Alternate Remedies in Action

The Administration has “dusted off” two tools in the U.S. trade policy toolbox to address growing concerns about over capacity outside of the United States, failure to protect U.S intellectual property rights, and/or the effects of imports on U.S. national security. Both tools are
unilateral measures that were more common in the years predating the World Trade Organization (WTO). The first is Section 232 of the Trade Expansion Act of 1964; the second is Section 301 of the Trade Act of 1974.

The first tool, Section 232 of the Trade Expansion Act, allows the President to adjust imports if the Commerce Department finds that the imports threaten to impair U.S. national security. In the steel industry, the Administration has used section 232 to impose a 25% tariff on iron and steel imports from most countries, but with certain exceptions. For example, Australia has a blanket exemption as compared to Argentina, Brazil and South Korea that are subject to tariff rate quotas. In the aluminum industry, the Administration imposed a 10% tariff on imports from all countries except Argentina and Australia with a similar quota for Argentina but none for Australia.

The second tool, Section 301 of the Trade Act of 1974, authorizes investigations into foreign trade policies and practices that (1) violate trade agreements, or (2) are unjustifiable and burden or restrict U.S. commerce, or (3) are unreasonable or discriminatory and burden or restrict U.S. commerce. The Act authorizes the President, at the recommendation of the U.S. Trade Representative, to take “appropriate and feasible” action to enforce agreements and respond to such policies or practices. Section 301 has been used by this Administration to address Chinese intellectual property violations, among other concerns. In a Section 301 investigation conducted under the current Administration, USTR found that China was using unfair trade practices to dominate access to important raw materials. Key findings of the investigation included that, "A longstanding focus of China’s foreign investment has been the acquisition of mineral deposits ... with a particular aim to mitigate China’s reliance on resource imports.” The investigation also revealed that, “China pursues an outbound industrial policy with government capital and highly opaque investor networks to facilitate high-tech acquisitions abroad.”

On March 22, 2018, USTR found that Chinese intellectual property and technology transfer policies were violations within the meaning of Section 301. On June 20, 2018, USTR announced a 25% tariff on 818 tariff lines covering $34 billion in Chinese imports effective July 6, 2018. On the day the tariff took effect, China retaliated in kind. A month later, on July 17, 2018, USTR proposed a 10% tariff on an additional $200 billion in Chinese imports. Then, on August 16, 2018, USTR announced a 25% tariff on 279 additional tariff lines covering $16 billion in Chinese imports effective August 23, 2018.

Subsequently, President Trump announced via tweet that the current “Tranche 3” import duties on $200 billion in Chinese goods would rise from 10% to 25% effective Friday, May 10, 2019. On May 8th, the Chinese delegation arrived in Washington, D.C. Two days later, Ambassador Lighthizer released the following statement regarding additional action under Section 301: “Earlier today, at the direction of the President, the United States increased the level of tariffs from 10 percent to 25 percent on approximately $200 billion worth of Chinese imports. The President also ordered us to begin the process of raising tariffs on essentially all remaining imports from China, which are valued at approximately $300 billion.”

On August 13, 2019 the United States Trade Representative (USTR) issued two lists of Chinese-origin goods that would be subject to 10% tariffs. The first list, List 4A, identified tariff lines that would be subject to additional duties of 10% effective September 1, 2019. The second list, List 4B, identified certain tariff lines for which duties would not go into effect until December 15, 2019. Products on List 4B include, among other things, cell phones, laptop computers, video game consoles, certain toys, computer monitors, and certain items of footwear and clothing. The announcement came after the Trump Administration indicated on August 1, 2019 that it intended to impose additional Section 301 tariffs covering $300 billion in consumer and industrial items, nearly all Chinese imports not subject to the prior three rounds of tariffs.

On Friday, August 23, 2019, after the Chinese Government unveiled its plan to impose additional tariffs on approximately $75 billion in annual U.S. imports, the Administration made two announcements of its own. First, the Administration announced that it would increase the existing and planned Section 301 tariffs on China by 5%. Specifically:

- Chinese-origin goods subject to the first three rounds of Section 301 tariffs, i.e., Tranches 1, 2, and 3, would be subject to 30% duties effective October 1, 2019. Currently, the Section 301 tariff rate applicable to such goods is 25%.
Chinese-origin goods subject to the forthcoming Tranche 4A and Tranche 4B tariffs would additional duties of 15%, rather than the previously announced 10%.

Recent reporting has indicated that US-China negotiations, including the Section 301 tariffs, will begin again shortly. However, this is far from a foregone conclusion.

**Traditional Actions**

In addition to the recently “dusted off” tools, the Administration continues to employ traditional tools to counteract what they perceive to be unfairly priced and/or injurious imports. These traditional remedies include Section 201 investigations, antidumping and countervailing duty investigations. Section 201 allows the President to impose relief – usually tariffs or quotas – if the International Trade Commission (ITC) determines that a surge in imports is a substantial cause of serious injury or threat thereof. Invoking this section does not require a showing of “unfair trade,” i.e., dumping or subsidies. Section 201 is generally a global measure, and it has heightened requirements for relief on NAFTA imports.

Antidumping and countervailing duties (AD/CVD) are imposed by the U.S. Department of Commerce (DOC) to remedy unfair trade practices that injure or threaten a U.S. industry. Notably, the Trump Administration has broken with previous administrations by “self-initiating” antidumping and countervailing duty cases against aluminum sheet from China.

The DOC will impose antidumping duties when a foreign producer sells a product in the United States at prices below the product’s normal value. Normal value is defined as either a foreign producer’s sales price in its home market, a foreign producer’s sale price in a third country, or a foreign producer’s cost of production plus their profit.

The DOC will impose countervailing duties on imports that it finds to be improperly subsidized. Examples of potentially countervailable subsidies include grants, loans at preferential rates, preferential relief from taxes and fees, and provision of inputs at artificially low prices. Antidumping and countervailing duties can be imposed only if the U.S. International Trade Commission finds that the unfairly traded imports are materially injuring the domestic industry or threaten to injure the domestic industry. To make this determination, the ITC traditionally examines the volume, price effects, and impact of the imports. Material injury is defined as “harm that is more than inconsequential, immaterial, or unimportant.” Importantly, imports do not have to be the only cause of harm to the industry.

**Case Study**

One well known example of a trade remedy investigation involving the superabrasives industry is the antidumping order on diamond sawblades. An ad hoc coalition of mostly small, family-owned U.S. diamond sawblade manufactures filed petitions that alleged that Chinese sawblades were being sold below normal value and that such imports were injuring domestic production operations. As a result, for the past several years, the majority of imports of such diamond sawblades have been subject to antidumping duty deposits of 82.12% and as a result there has been a significant decrease in the volume of such imports (see graph upper right).

**Conclusion**

Trade issues are a high priority for the current Administration. Part of this Administration’s strategy is to use unilateral tools like Section 232 and Section 301 that were more common in the pre-WTO years. But traditional options like AD/CVD and safeguards investigations are still in play and have been used with demonstrable success. The situation remains fluid and to a certain degree unconventional. It will be imperative for the foreseeable future for both domestic producers and importers to closely monitor this extraordinarily dynamic scenario.

For Questions Contact: Daniel B. Pickard, Wiley Rein LLP, 202.719.7285, dpickard@wileyrein.com
HYPERION MATERIALS & TECHNOLOGIES ACQUIRES ARNO FRIEDRICHIS HARTMETALL GMBH & CO. KG

Complementary transaction will create leading player in tungsten carbide blank production

WORTHINGTON, Ohio — Hyperion Materials & Technologies Inc., a leading global materials science company focused on the hard and super-hard materials space for high precision applications, today announced that it signed an agreement to acquire Arno Friedrichs Hartmetall GmbH & Co. KG and its affiliates (AFC), a global solutions provider in premium tungsten carbide blanks used in the manufacture of high precision rotary cutting tools for drilling and milling applications. The transaction is highly complementary and will create a leading player in tungsten carbide blank production, with a global footprint that is well-equipped to support finished toolmakers in the metal cutting industry with a wide portfolio of products. “We are thrilled to combine AFC’s leading innovation capabilities and differentiated manufacturing processes with Hyperion’s deep application expertise and materials science capabilities,” said Ron Voigt, CEO of Hyperion. “In combining the talent and capabilities of both companies, we will be able to enhance our product offering through customer-focused innovation and provide even greater value to our customers.” For further information contact: David Means, Communications Specialist david.means_c@hyperionmt.com +1 (614) 438-2396

TYROLIT GROUP CELEBRATES ITS 100TH ANNIVERSARY IN 2019 AND PRESENTS THE LATEST GRINDING TECHNOLOGY DEVELOPED FROM TRADITION AND EXPERIENCE

With the aim of creating a diamond for everyone, Daniel Swarovski laid the cornerstone for his crystal empire in 1895 in Wattens, Austria. The developing and manufacturing of the tools necessary for the processing of glass jewelry also enabled him to build up extensive know-how in the field of precision grinding applications. This led to the founding of a second company in 1919 – TYROLIT came into its own as a specialised grinding tools manufacturer. Over the last one hundred years, TYROLIT has developed into one of the world’s leading suppliers of abrasive solutions, with numerous innovations that have had a lasting impact on technological advancements in the abrasives industry. TYROLIT is one of the world’s leading manufacturers of grinding and dressing tools as well as a system provider for the construction industry. Headquartered in Schwaz (Austria), the family-owned business combines the strengths of being a part of the dynamic Swarovski Group with over a century’s worth of individual corporate and technological experience. For further products and information visit: www.tyrolit.com

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Fives, internationally recognized for pioneering technologies, will showcase its Grinding, Ultra Precision and Cutting Tools. On this occasion, Fives will present high-precision grinding, dressing & cutting tool solutions for key industrial markets such as automotive, bearings, transmissions, trucks, heavy equipment and aerospace. Grinding & Ultra Precision solutions offer a complete range of grinding and specialty high-precision machines. This includes a comprehensive range of systems, grinding accessories and service programs based on the renowned Bryant, Cincinnati, Cranfield Precision, Daisho, Gardner, Giustina and Landis legacy names. Fives will also display its full range of custom-engineered CITCO Tools & Gardner Abrasive products, such as PCD & PcBN cutting tools, diamond, CVD and Peerless diamond dressing tools and superabrasive and disc abrasive grinding wheels. Visit Fives at SOUTHTEC 2019, taking place at the Greenville Convention Center in Greenville, South Carolina, booth #639.
Through interdisciplinary cooperation Agathon, Element Six and Tyrolit have made the grinding process using PCBN tools with a low CBN content even more productive. For this optimised, low-wear double-layer grinding wheels and a unique conditioning process are used. This results in the highest productivity during the grinding process of low PCBN grades with a mean cutting edge chipping of 2.3 µm.

PCBN Tools for Precision Hard Turning

Turning of hardened steel with PCBN (polycrystalline cubic boron nitride) cutting tools has mainly taken over from grinding as the final processing step. Illustration 1 shows a typical processing example. This manufacturing advance was made possible through the development of modern PCBN grades. Above all low-content PCBNs, i.e. grades with CBN volume content of less than 65 percent, are both economically and technically interesting due to high tool life, small grain size and attractive material costs.

A particularly low-wear low-content PCBN is the material from Element Six with only 45 percent by volume of fine cBN particles with a particle size that is smaller than 1 µm. The binder is brittle and hard titanium carbonitride (TiCN), a mixed crystal consisting of titanium carbide TiC and titanium nitride TiN [1]. The material is available both as full PCBN (DSN450) and with a cemented carbide substrate (DCN450). The DCN450 grade was specifically developed for slightly interrupted hard turning and high-speed hard turning. Its resistance to crater wear is one of the highest on the market. It has one of the finest structures, which means that extremely fine surfaces can be achieved. When constructing a PCBN indexable insert there are three variations. Using a solid PCBN without a carbide substrate is one possibility. The second variation is to sinter a PCBN-layer on a carbide body. For the third variation a PCBN segment is brazed onto a carbide base body. This variation is the focus of the current investigation. The periphery and protective chamfer are ground after brazing the PCBN segment onto the carbide base body. Due to its brittle and hard property low-content PCBN material is prone to edge chipping during grinding. When using an indexable insert these edge chippings can lead to reduced tool life as they have a negative effect on the chip removal and cause a higher stress on the cutting edge. For this reason, a protective chamfer is ground after grinding the periphery when producing the indexable insert. A chamfer width of 0.1 – 0.2 mm and a chamfer angle of 15° - 25° are typical. For the tests, the insert geometry CNGA120408T0225 with 0.2 mm chamfer width and 25° chamfer angle was used (Illustration 2).

Conventional PCBN Processing with Vitrified Bonded Grinding Wheels

Sometimes contrasting requirements have to be fulfilled for the manufacture of high-quality PCBN cutting tools. On the one hand economics requires short processing times, on the other hand many applications require minimal cutting edge chipping. Both of these are mainly influenced by the grinding of tools. The grinding of indexable inserts made from PCBN is conventionally carried out using vitrified bonded diamond grinding wheels. For this, the grinding wheel has to be continuously conditioned with vitrified bonded silicon carbide or corundum grinding wheels during the process, to ensure that the diamond grinding wheel remains level and cuts easily and thus results in a stable grinding process. Dividing the grinding process into roughing and finishing offers an economic approach. For this a wheel with the larger grain size is used for efficient volume removal at the periphery of the indexable insert. The protective chamfer is then carried out in a second step using a finer grinding wheel. Generally smaller diamond grain sizes.
lead to less edge chipping but also longer cycle times due to smaller feed rates. This two-step grinding strategy would be difficult to achieve with ceramically bonded double layer wheels as two different ceramic layers would have to be dressed using one dressing tool. Above all, the coordination of the two sizes of diamond grain would be difficult to achieve with conventional abrasive grain in dressing the wheel (SiC, corundum). Therefore, the following section will describe a highly productive double layer strategy for peripheral insert grinding with erodible metal bonded diamond wheels.

**PowerGrind PCBN Processing with Metal Bonded Grinding Wheels**

Over recent years new developments with regard to metal bonded diamond grinding wheels have led to considerable progress when grinding superhard materials. Metal bonded grinding wheels have the highest dimensional accuracy and superb thermal conductivity as well as thermal resistance. The good bonding of the diamond grains enables high grinding forces, which simplified the processing of superhard materials such as PCBN. However, fine grain wheels cannot be conditioned very much or at all conventionally. With PowerGrind Agathon offers a unique method for the conditioning of metal bonded grinding wheels [2]. The integration of an electro-erosive in-process dressing unit (Electrical Discharge Conditioning, EDC) makes it possible to ensure that metal bonded grinding wheels are always kept flat, clean and sharp when grinding the indexable insert. By continuous erosion of the metal bonding material the abrasive diamond grains always have the desired protrusion. The erodibility of the metallic bond is independent of grain size and diamond quality. It is solely influenced by the type of metal bonding and its content in the diamond grinding wheel. Thus, the grinding process can be divided into two concentric wheels. This double wheel configuration is shown on Illustration 3 on an Agathon Evo Combi. Both wheels are electro-erosively conditioned simultaneously. The grinding of the periphery is carried out with a coarse grain (D15 to D25) metal bonded diamond wheel. Afterwards the protective chamfers are carried out with a fine grain (D6, D9) metal bonded diamond wheel.

**Development of Metal Bonded Grinding Wheel for Maximum Productivity**

Above all, grinding wheels have to be electrically conductive for spark erosion. This is achieved by using a metal bond as a binder for the diamonds and gluing the diamond abrasive layer with an electrically conductive glue onto the aluminium base. In addition, the grinding tools must be suitable for grinding the PCBN inserts and simultaneously eroding in process. Suitable diamond quality and concentration, a brittle, well bonding metal bond, which does not clog during grinding and is easily eroded [2,3], a suitable wheel width and the grinding strategy are parameters, which have a considerable influence on the workpiece quality of the PCBN wheel to be ground and the tool life of the grinding tools. Only by observing the relevant process variables can we obtain valid statements concerning the processes during grinding. The grinding forces are the central process variables both normally and tangentially to feeding direction of the grinding wheel. The normal force operates in the direction of the feeding axis between grinding wheel and workpiece. It corresponds to the feeding force. The tangential force corresponds to the effective moment of the grinding spindle motor. For the investigation an Agathon grinding machine for transverse side surface grinding with 4-axis kinematics and a 400mm diameter cup wheel. Through the force measurement option, the central process variables normal force and tangential force are continuously available. A multi-step process was chosen for the development of the grinding tools. For the first preliminary test grinding was carried out with a single diamond layer on full PCBN indexable inserts, without carbide substrate (type DSN450) and brazed PCBN inserts ground at periphery and chamfer. This enabled the identification of the diamond grain size as the main influencing factor with regard to the wheel wear, the normal forces and the chipping size of the cutting edge. The infed was selected to obtain similar maximum normal forces of about 150 Newton. Table 1 shows the

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<th>Grain Size</th>
<th>Mean Chipping (REM)</th>
<th>Feed</th>
<th>Layer Wear</th>
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<tr>
<td>D9</td>
<td>2.5 µm</td>
<td>2.5 mm/min</td>
<td>11 µm/insert</td>
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<tr>
<td>D25</td>
<td>8 µm</td>
<td>8 mm/min</td>
<td>8 µm/insert</td>
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**Table 1: Process parameters depending on grain size for brazed PCBN**

**SUMMARY**

The wear-resistant low-content PCBN grade from Element Six can be processed with little wear of the grinding wheel in an efficient manner and a stable process and minimal cutting edge chipping when using metal bonded diamond double grinding wheels from Tyrolit. Agathon indexable insert grinding machines with PowerGrind enable the conditioning of a double rim with different grain sizes (parallel to the grinding process). Through this a high removal rate for periphery grinding is combined with minimal chipping during chamfer grinding.
effect of the diamond size on mean chipping, the feed and the wear of the grinding tool. Chipping was measured optically with the scanning electron microscope (REM). The table illustrates the fundamental problem when grinding brittle PCBN. A rough grinding wheel enables high feed at the cost of an unacceptably high cutting edge chipping. In contrast, a fine wheel results in an almost chip-free cutting edge, but shows a high wear of the wheel and is uneconomical for complete processing. Illustration 4 shows a SEM image at 200-fold enlargement with cutting edges ground with D9 and D25 layers.

Further tests with solid PCBN and brazed PCBN inserts showed that after grinding the periphery the chips at the cutting edge, independent of the diamond size used, were clearly above 10 µm. For this, the diamond size was varied in the range of D9 to D25. Only when grinding the protective chamfer (width 0.2 mm, chamfer angle 25°) could a strong dependence of the chipping on the diamond size selected be seen (see Table 1). For the final test double layer grinding wheels were used. Solid CBN and brazed PCBN inserts (type DCN450) were ground with selected grinding wheels. Using the best layer combination, the grinding programme for processing brazed PCBN inserts was optimised and finally 60 brazed inserts were produced and evaluated.

Test Results with Brazed PCBN
To verify the process, a batch of 60 brazed PCBN inserts were ground with a double layer wheel and measured completely during the main test. For the periphery a 12 mm wide D20 wheel is used. (Illustration 5). The chamfer was ground with a 4 mm wide D9 wheel. The widths of the partial rim are adjusted to the tool geometry. The wheel wear is 2.2 µm per insert. The grinding process for the complete process of an indexable insert has a cycle time of 128 seconds including loading, unloading and measuring the inscribed circle. The cutting edge chipping was determined by automatically taking photos of the edges of the inserts and calculating the chipping with Element Six’s own software for all indexable inserts. For this measuring method, there was on average 2.3 µm with a standard deviation of 0.86 µm.

While quality features such as geometric size accuracy are easily achieved even for large measuring sequences, the 100 percent measuring and evaluation of edge chipping is not part of the standard. Due to the superior resolution of the method the measuring of chipping using the SEM represents the reference value for other measuring methods. Due to the work required for this (e.g. each sample has to be put into the vacuum of the measuring chamber) this measuring method is not feasible for automated measuring of cutting edge chipping in an industrial setting. For the investigations of larger test series an optical method was used. For this the whole cutting edge was captured with an optical microscope with 200-fold enlargement. Through suitable geometric arrangement of the sample a direct image of the chipping can be taken and evaluated with the aid of software. During the preliminary tests parallel measurements were carried out using the SEM and the optical microscope. A good consensus of the measured chippings was found. As a result, the optical microscope could be used for the main measuring for complete quality control of the cutting edge chipping.

Information on Partners
AGATHON develops and produces precision grinding machines for the manufacture of indexable inserts as well as lasers for pre-machining of superhard materials. Agathon also manufactures precision guide elements.

ELEMENT SIX is a member of the De Beers Group of Companies and a world-leading company for synthetic diamonds and other supermaterials.

TYROLIT is a leading manufacturer of bonded high-tech grinding tools for numerous applications. With regard to cutting tools Tyrolit offers customised complete solutions for customer-specific requirements.

IN MEMORIAM: DONALD G. COOPER

Donald G. Cooper, 85, died August 7, 2019 at his home in Melbourne, Florida, surrounded by his loving family. Mr. Cooper was an Air Force war veteran and graduate of Missouri School of Mines and Metallurgy in Rolla, Missouri, with a degree in Metallurgical Engineering. He worked for Bay State Abrasives in Westborough, Massachusetts for several years as a senior research engineer. Mr. Cooper was an inventor, entrepreneur and originally the Metallurgist for Bay State Abrasives. Bay State Purchased Felker in the early 1970’s and Don also took over as metallurgist for Felker. Don and Owen Welch left Bay State and purchased the diamond saw blade manufacturing of Oregon Chain Saw in Portland and relocated to Massachusetts as Wel-Co Metallurgical Inc. Owen later purchased Don’s Share of Wel-Co and relocated to Florida. Don then formed Phoenix Metallurgical Inc. and Laser Services, located in Hopedale, Massachusetts and provided saw blade segments and laser welding services to a number of diamond saw blade manufacturers.

Mr. Cooper retired in 2005 and spent several years touring the country in an RV before settling in Florida. He is survived by Constance - his dearly loved wife of 66 years, his three daughters, Christine Sheehan, Rebecca Amir and Catherine Bertolet, six grandchildren, two great-grandchildren and two sisters, Claire Frysalis and Cynthia Frost.
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TECHNOLOGY BEGINS HERE

The world seeks better technology. Amid many aspects that define better technology, tools are among the most influential ones. As much as tools are important, there are challenges in building a suitable tool for machining superhard materials. Let ILJIN’s PCD and PCBN, with assured quality by advanced quality control system, be your breakthrough for finding the right solution. When you create a new technology, ILJIN will always be by your side.
Volume Production of Machining Tools Using Laser MicroJet® Technology

Volume production of high precision tools with new 5-axis Laser Machining System LCS 305

Jacques Coderre, Rémi Laure, Amédée Zryd

INTRODUCTION:
Industrial diamond materials are replacing tungsten carbide and ceramic composites in cutting tools where high surface finish quality is required. The choice of materials ranges from lower end polycrystalline diamond (PCD) to high-end single crystalline diamond (SCD). As an example, SCD tools have proven their value-add in the super-finishing of ultraprecision optical grade surfaces. In many cases, the use of PCD tool inserts can eliminate grinding operations, thereby improving machining process times. PCD tools have also shown a longer tool life.

Such materials being as hard as natural diamond, lasers are most suitable for machining them. Synova’s patented Laser MicroJet® (LMJ) technology delivers better results than conventional dry lasers and has become a benchmark in the processing of diamond materials. In this paper, results achieved in machining diamond inserts are presented. The novel LCS 305 Laser MicroJet system with 5 axes is introduced as a production-ready system to manufacture such tools.

The LMJ Process

In the Laser MicroJet system, a laser beam, passing through a pressurized water chamber, is focused into a nozzle. The low-pressure water jet emitted from the nozzle guides the laser beam by means of total internal reflection at the water/air interface. The water jet diameter is usually 50 microns and the laser power required is between 25 and 30 watts. While the principle is simple, years of experimentation and optimization have gone into the industrialization of the process and in the design and manufacturing of advanced machining systems.

The LMJ process works in two stages. The energy of the laser pulses vaporizes the workpiece material by heating, while the water cools and cleans the surface in the interval between the pulses.

Through a scanning process, a trench is formed that becomes deeper with each pass. As compared to conventional dry lasers, the LMJ ‘wet laser’ technology has many advantages. The most important advantage is that the Laser MicroJet cuts with a cylindrical beam (no V-shape) and the cutting depth can reach up to several centimeters. This is not the case with conventional lasers where the focused laser beam has a limited working distance of just a few millimeters due to beam divergence. The beam converges at a focal point and then diverges. Therefore, a focus distance control is required, and the working distance is short.

The technology behind the Laser MicroJet is based on creating a laser beam that is completely reflected at the air-water interface, using the difference in the refractive indices of air and water. The laser is, therefore, entirely contained within the water jet as a cylindrical beam, similar in principle to an optical fibre. There is no need for focal adjustment, and one obtains parallel kerf sides. There is a minimum heat affected zone thanks to the cooling effect of the water. Finally, there is a high removal rate with debris washed from the kerf.

The LCS305 Laser Cutting System

The LCS 305 laser cutting system can cut extremely hard materials with high precision and complex shapes. It is a
5-axis machine with precision components for processing accurate tools. Linear and rotative axes are mounted on separate carrier frames to increase stability at high speed. This results in a dynamic accuracy lower than ± 3 µm and repeatability of ± 1 µm with angular precision of ± 0.9 sec. The LCS 305 is typically configured with an HSK-63 holder, enabling a positioning radial accuracy lower than 3 µm, and an axial accuracy lower than 1µm.

Combined with a unique axis system, it allows a cylindrical working envelope of 130 mm in diameter, with a height of 260 mm. It was designed with high-accuracy machining of hard materials in mind, from small inserts to large rotative tools.

**Volume Cutting System**

To ensure high-volume manufacturability of hard material tools, the LMJ technology leverages geometrical precision with high-quality finished cutting surfaces, ensuring the manufacturing of a tool that shows a long tool life and optimal performance. The LCS 305 is designed and manufactured in a way to get the full potential out of the LMJ technology, thanks to its axis and holding system. In addition to cutting quality and speed, it is possible to produce parts in volume by eliminating the need for probing or pre-cutting procedures. To generate the data presented in this paper, a production run of 20 samples was done. After one calibration cut, all 20 parts were machined without any additional setup.

Results pertaining to the 20-sample run are presented in the table below. Using the LCS 305, a geometrical tolerance of profile lower than ± 0.1 mm was obtained, versus drawing nominal targets. The achieved surface quality eliminates the need for a subsequent grinding operation.

- Edge Radius: 5 µm
- Roughness: < 0.300 µm
- Overall Cutting Speed: 4.5 mm/min

This test also demonstrated how high precision in primary and secondary clearance angles can be achieved, as shown in the graph and table below. The results are consistent all along the profile path, even if there are
different angles for each face. The same test was performed on rotative tools composed of several inserts. Similar high accuracies were obtained on all inserts of a given tool. The use of an HSK 63 holder guarantees a highly precise positioning. The availability of a fully automated calibration of the LCS 305, along with an optimal repeatability in the process, enables a production with minimum operator coverage and maximum machine availability.

**Complex 3D Shaping**

The LCS 305 allows complex 3D form-cutting or form-engraving. To demonstrate such capability, small pyramids with a 1 mm square base and 1 mm in height, were cut out of a SiC blank. A production run of 40 pieces was completed in order to demonstrate the repeatability of the process, as well as the uniformity of the cutting profile along the 4 faces. As depicted below, a well-defined peak pyramid, with a roughness of 500 nm on all the faces, was achieved. In addition to 3D cutting, 3D engraving trials were conducted, where blind holes (diameter 0.25 and depth 0.9) and conic shapes (diameter 1.20 and depth 0.85) were ablated (see Figure 11). First, the ablation rate per pass is determined. The number of repeated passes is then adjusted to achieve the desired depth. Repeatability and shape control of this test demonstrate the ability to produce a wide range of high-precision forms by using the LCS 305.

**CONCLUSION**

The results shown in this paper highlight the capabilities of the LCS 305. With its 5-axis capability and intuitive CAM software, this advanced system is ideally suited for the machining of super hard materials, able to cut tools of different geometries and size. By using automated setup procedures, a high-precision axis system and holders with high repeatability in positioning, the LCS 305 provides low cost of ownership by reducing the need for operator interventions during volume production. Once calibrated, parts are produced without the need for probing or pre-cutting procedures. The LCS 305 produces parts with high cutting quality that ensure geometrical and surface tolerances. Combined with an overall cutting speed of up to 5 mm/min in PCD, it delivers finished parts at a high rate. In cases where manufacturers need a high cutting-tool edge finish, a hybrid solution can be used whereby an LCS 305 is combined with a CNC polisher. In such cases, a sub-0.1 um Ra roughness is achievable.

In 1999, LACH had a patent granted for the worldwide first PCD chipbreaker; many variations and further patent registrations followed. First introduced at the last EMO, the PCD insert with active chipbreaker for finishing long-chipping aluminum alloys immediately became a true problem solver and therefore a bestseller. Application engineers agree that “it runs and keeps running – a true cost killer...” The insert with XIS/XXIS chipbreaker functionality – proven for over ten years – is available for turning higher finishing allowances; once again a product without any comparison worldwide. For two decades, the compact programme has been completed by a laser-produced classic, the PCD insert with chip guide step, type CO. With positive cut for type CO and especially recommended for turning thin and unstable elements. For information visit: www.lach-diamond.com

New Norton Winter Vitrified cBN Wheels Reduce Costs Per Part While Extending Wheel Life With Less Power

High Performance Vitrified Bond Technology Substantially Increases Grinding Productivity in Automotive and Bearing Industry Applications. Saint-Gobain Abrasives, one of the world’s largest abrasives manufacturers, announced the introduction of its new Norton Winter Vitrion™ cBN Grinding Wheels. The wheels feature a high-precision vitrified bond specifically designed for the high performance external grinding of cam and crankshafts and internal grinding applications in automotive and bearing industries. Norton Winter Vitrion™ wheels feature premium cBN grain particles uniformly dispersed throughout the bond matrix for maximum grinding efficiency. This enables manufacturers to achieve substantial increases in the number of finished parts between dress cycles, significantly reducing cycle times and extending wheel life up to 40 percent over existing products. Visit http://nortonsga.us/vitrion7

Sunnen Products Company and Sweden’s Applied Nano Surfaces (ANS) Collaborate on Friction & Wear Reduction Technology

Sunnen Products Company and Sweden’s Applied Nano Surfaces (ANS) have entered into a joint market development agreement to advance technology and applications based on the unique triboconditioning® process recently patented by ANS. The process reduces friction and wear on various steel and cast iron surfaces while improving surface finish, preventing seizes, and enhancing product life. Triboconditioning is a combined mechano-chemical surface treatment process which uses a machining procedure to level off surface peaks and apply a friction-and wear-reducing compound to the component surface. Unlike spray coatings, the compound becomes an integrated part of the component structure at a nano level. The process is mechanically simple and, in most cases, can be done with Sunnen precision honing equipment. It is very cost-efficient in mass production environments, making it perfect for in-house manufacturing as a part of component manufacturers’ production lines. Key applications include automotive engine components, industrial applications and compressors. For additional information email sunnen@sunnen.com

Fraunhofer IFAM Gas Turbine Development Showcases Potential of Powder Bed AM

Together with the H+E-Produktentwicklung GmbH in Moritzburg, Saxony, Germany, the Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM) in Dresden, Germany, has developed a fully-functional, true-to-scale gas turbine which demonstrates the current potentials and limitations of powder bed-based Additive Manufacturing technologies. The scale model of a gas turbine for power generation, was completely manufactured with additive processes in all areas except for the shaft. The component assembly consists of sixty-eight parts made of aluminium, steel and titanium, which through component optimisation and the possibilities of Electron Beam and Laser Powder Bed Fusion technologies replace the almost 3000 individual parts that make up the original component. For further information visit: www.ifam.fraunhofer.de

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Evaluation of the Influence of Impurities in Single Crystal Diamond on Wear Characteristics

MINORI TERAMOTO
Sumitomo Electric Industries, Ltd. • Itami-shi, Hyogo, Japan

INTRODUCTION
Diamond differs in the type and content of impurities, and the form of its presence in the crystal, due to differences in the crystal growth conditions and environment. In particular, it is known that there is a remarkable difference in the amount and form of nitrogen impurities between synthetic diamond and natural diamond [1]. While nitrogen contained in synthetic diamond included as substitutional impurity, in natural diamond, nitrogen is present in aggregated forms. In some cases, multiple nitrogen atoms are bonded to a vacancy. The differences due to the content,
existence form of such impurities affect the properties of the diamond material and may significantly change the tool performance. In addition, single crystal diamond has a large difference in mechanical properties depending on the crystal orientation.

Therefore, it is important to recognize these effects in detail when we used diamond crystals as cutting tools or wear resistant tools. We established a method to evaluate the mechanical wear due to the sliding movement along a specific crystal orientation using a small diameter diamond wheel and a machining center. We report the results of evaluating the difference in wear characteristics using single crystal diamond with different types and contents of impurities.

**EXPERIMENTAL METHOD**

Focusing on the fact that natural diamonds used for tools are identified not only by impurities but also by color as an important factor, three kinds of natural diamonds with different colors shown in Fig. 1 were prepared. There are some types of nitrogen aggregation. In each sample, the presence of “A-center (2N)” composed of two neighboring substitutional nitrogen atoms, “B-center (4N-V)” which is a cluster of 4 nitrogen atoms surrounding a vacancy and planar aggregation “Platelets” was observed by infrared spectroscopy. On the other hand, HPHT synthetic diamonds do not have these aggregates but contain some isolated substitutional nitrogen atoms “C-center”. The nitrogen content in the crystal can be estimated from the absorption characteristic of 1130 cm\(^{-1}\) of “C-center” by infrared spectroscopy. The nitrogen content of the 7 synthetic crystals prepared for evaluation is from 100 to 700 ppm.

Using these HPHT synthetic diamonds and three kinds of natural diamonds were subjected to the wear tests using metal bonded diamond wheel. A schematic diagram of the wear test method is shown in Figure 2. The test pins was prepared as below. The test pieces of \(\phi 2 \times 2\) mm prepared from each diamond specimens were brazed to sample holders, and processed into a conical shape with a tapered angle of 120°. And a test surface of \(\phi 0.3 \pm 0.005\) mm was formed by scaife polishing at the tip of the cone of each sample. A \(\phi 30\) mm metal bond grinding wheel diamond disk (grit size 3000) was clamped on the main axis of the machining center so that the diamond disk is vertical. From the lower part of the grinding wheel surface rotated at high speed.
at 6000 rpm (sliding speed 260-340 m/min), the test pin was pressed and slid with a constant load of 2.83N. After sliding for 60 minutes, the change in diameter of the test surface was measured to derive the wear rate.

**WEAR RESISTANCE EVALUATION**

The results of the evaluation of wear rate for grinding wheel are shown in Fig.3. For both single crystal diamonds of HPHT synthetic diamond and natural diamond, the wear rate of the (001) <100> direction (Fig. 3-a), which is the easy wear direction, is at least 100 times higher than that of the (001) <100> direction (Fig.3-b), which is the wear resistance direction. In the easy wear direction (001) <100>, the wear rate of HPHT synthetic diamond increases rapidly with nitrogen content of 400 ppm or more. In addition, the wear rate of White is at least ten times higher than Brown or Light Yellow. On the other hand, in the wear resistance direction (001) <110>, the wear rate of the samples of the nitrogen content 700ppm of HPHT synthetic diamond and White of natural diamond are significantly high. In each of HPHT synthetic diamond and natural diamond, the difference ratio of the maximum wear rate to the others of the wear resistance direction was smaller than the easy wear direction.

**NITROGEN AGGREGATION MORPHOLOGY & MECHANICAL PROPERTIES IN NATURAL DIAMOND**

The absorption spectra of three natural diamonds used in the experiment were analyzed and the height of the peak from each aggregation form of nitrogen was compared. The results are shown in Fig.4. Light Yellow and Brown crystals have 2N, 4N-V, and Platelet at almost the same ratio, whereas White crystals have very few Platelets. The Platelets is a planar aggregation of nitrogen atoms in an oval shape of about 30 to 60 nm in diameter parallel to the (100) plane. In order to confirm the influence of the Platelets on the mechanical properties, thin sections were sampled from the end of the Knoop indentation with FIB, and the propagation state of the micro cracks and dislocations were observed by TEM. The Knoop indentations were formed so that the major axis was parallel to the (001) <100> direction. By forming the Knoop indentation in the crystal orientation, it will be possible to observe the dislocations along the (111) <110> slip plane and micro cracks [2]. Figure 5 shows a TEM image observed from the [100] direction. Oval dislocation defects generated around Platelets on the (100)

---

**Figure 3a – Wear rate of each sample for diamond grinding wheel – easy wear direction (100) <100>**

**Figure 3b – Wear rate of each sample for diamond grinding wheel – wear resistance direction (100) <110>**

**Figure 4 – FT-IR absorbance peak heights due to each aggregated nitrogen impurity.**
plane and similar dislocations present on the (001) and (010) planes are observed as horizontal lines and vertical lines. In addition, many dislocations and micro cracks have developed in the [011] direction from the Knoop indentations, and propagate parallel to the cleavage plane (111). It was confirmed that the tip of these dislocations and micro cracks are pinned down or changed the propagation directions at Platelets. Thus, Platelets suppresses the propagation of dislocations and cracks. These phenomena are thought to produces an effect of improving wear resistance.

CONCLUSION
In wear test using metal bonded diamond wheel, the wear characteristics of synthetic and natural diamonds were evaluated by comparing the content and the aggregation form of nitrogen impurities. It was found that the mechanical wear resistance decreases with increasing nitrogen content in the easy wear direction, but the effect is low in the wear resistant direction. It is suggested that Platelets in natural diamond may suppress the propagation of dislocations and micro cracks and improve the wear resistance.

REFERENCES

Figure 5 – TEM image of microstructure under Knoop Indentation formed on (100) <100> of Natural diamond crystal at room temperature.
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The Industrial Diamond Association of America, Inc. is a non-profit trade association and was incorporated on March 29, 1946 in the State of New York. It is the oldest and most prestigious association in the superabrasive/ultrahard materials industry. Activity and focus has evolved from natural diamond to superabrasives and most recently, to all ultrahard materials including CVD Diamond. Members include material suppliers, tool manufacturers, component producers, machine tool builders, end users, academia/research affiliates and other companies related to the research, manufacture, application, use and sales of superabrasives.

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The team’s exhausted. They’re burned-out, and I am too. I don’t know if we can recover. We’ve been working at 150% for over a year – at least most of us have.

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Team? We work in the same building, but that’s about where it starts and stops. I’m hoping to get out of here soon.

By: Kate Zabriskie

About the Author: Kate Zabriskie is the president of Business Training Works, Inc., a Maryland-based talent development firm. She and her team help businesses establish customer service strategies and train their people to live up to what’s promised.

Step One

The first step is accepting a list of truths.

Truth One: People have different levels of buy-in, a range of professional goals, and varying home/work demands.

Truth Two: Not everyone experiences burnout in the same way nor is work always distributed evenly in most organizations. Some people probably are more burned-out than others.

Truth Three: Great teamwork will compensate for a lack of resources in the short term. However, teams that are stretched too thin for too long begin to show signs of wear and tear after a while.

Truth Four: If the leader isn’t a believer in what the team needs to accomplish or isn’t working as hard as he or she can to bring the team over the finish line each day, team members will know it and react in a range of ways – most of which are neutral at best.

Truth Five: Transparency matters. People don’t like being left in the dark, or worse still, lied to.

Truth Six: Too many changes at once usually don’t go over well unless there’s a logical flow to them, a sense of fairness about what’s being changed, and the absence of unnecessary chaos or drama.

Truth Seven: Elephants in a room stay there if they’re allowed to do so. If a team is not prepared to operate with candor and address any unspoken issues, there’s only so much that can be done to save the group.
Even in the best of times, creating and maintaining a high-functioning team is work. When the team is burned-out, the task is infinitely harder, but it can be done.

**Truth Eight:** Team members’ perceptions of the team’s condition are their truth. You may have plenty of data to argue to the contrary, but until people are ready to listen and believe what you show them, what they currently think is what is.

**STEP TWO**

Once you’ve got a firm understanding of the basic truths, the next step is taking a long and hard look at what’s working, what isn’t, and why. Does everyone understand and buy into the team’s mission? Is work distributed fairly? Are some people doing more than they should have to do and others doing less than they should? Are people resentful of each other? Is there drama, and do you know the source? Is the team’s burnout a recent phenomenon or has its decay been long in the making? Is the burnout caused by internal factors, external factors, or a combination of both? Have people been misled or lied to in the past by those in positions of authority?

Those questions are just the tip of the iceberg and some ideas to get started. In fixing burnout, asking the right questions is as important, if not more, so than taking action. A good list of questions will help you reduce the likelihood that you are treating symptoms or curing the wrong disease altogether.

**STEP THREE**

When you think you have a good grasp of the current situation and have verified your findings with others, it’s time to start thinking about what could be. A fast way to imagine a different state is to work through some more questions.

- Why does our team matter to the organization and what value do we offer?
- How do we want to feel about our work?
- What gets us excited about our work or what do we enjoy?
- What changes do we need to our work product, our work processes, or our people interactions?
- What needs to stay the same?
- What level of performance do we need from each team member?

- What are we going to do if those levels aren’t met?
- What additional resources do we need?
- What would success look like?
- What can we do to encourage transparency and communication?
- How will we celebrate improvements?

**STEP FOUR**

With a clear view of the present and a possible future, the next step is prioritizing. In most cases, burned-out teams don’t burn out overnight. Often the process is long and marked by a series of declines, bad luck, and unfortunate circumstances. Consequently, the recovery process is often long. In fact, the team may never realize some of the elements identified in step three for a long time, or maybe ever. Most recoveries don’t happen overnight. The trick is to keep the truths discussed in step one in mind as you prioritize a plan of action to get from the reality you uncovered in step two and the future you envisioned in step three.

**STEP FIVE**

The final step in the recovery planning process is creating a deliberate communication plan. Recognize that you need to over explain and repeatedly share information. Once is not enough. Also, not all recoveries are linear. Your team will have some good days and bad. What’s important is making progress in the right direction over time. After a series of successes, everyone who is still with the group should be feeling a little less burned-out and a lot more excited about the work at hand. With these five steps well in hand, you’re positioned to provide some immediate triage to your team members that are battling burnout. Burnout can be pervasive throughout an entire company, so get your first-aid kit out as soon as you pick up on the problem, and mitigate the issue before it negatively impacts your operation.

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