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The Shot Peener

Sharing Information and Expanding Global Markets for Shot Peening and Blast Cleaning Industries

The first machine shipped from Innovative Peening Systems' new in-line manufacturing plant

IPS Boosts Productivity in New Facility

PLUS: VIBRATORY PEENING: PROMISING PERFORMANCE | PANEL WIRING | HARDNESS MATTERS

THE SHOT PEENER

Sharing Information and Expanding Global Markets for Shot Peening and Blast Cleaning Industries

OPENING SHOT

Jack Champaigne | Editor | The Shot Peener

Life Outside of Electronics Inc.

IN THE PURSUIT of creating alliances between industry and research in the United States, I have take an interest in the Center for Surface Engineering and Enhancement (CSEE) at Purdue University. Through CSEE, organizations can take advantage of laboratory space and gain access to the academic facilities at Purdue for a myriad of surface enhancement projects, including shot peening.

One of CSEE's first projects is the evaluation of media inspection methods using image analysis. Equipment donated by WS Tyler will determine upper and lower spec limits for all types of media. Data will be presented in conventional histograms, allowing performance to 6σ guidelines. Ervin Industries has agreed to supply media samples and other contributors are being sought. The advantage of image analysis is that it provides not only size information but shape analysis, too. If you are tired of looking through the stereo microscope and counting defective pieces, you will like this new approach. Several job shops have expressed a strong interest since this could be a large time- and cost-savings method.

Contact Robyn Jakes at rnjakes@prf.org for more information on how to take part in the program.

What do I do in my "spare time"? I have been on the board of the South Bend Symphony Orchestra for several years. I recently placed the winning bid at a fund-raising auction for the Symphony. I won the opportunity to play the triangle in the "Romp for Symphony and Orchestra for Triangulist" during a recent symphony performance. The solo lasted 2:41 minutes and I responded to the standing ovation with an encore. Not bad for an Electrical Engineer. ●

My solo performance playing the triangle with the South Bend Symphony was the thrill of a lifetime.

THE SHOT PEENER

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Innovative Peening Systems Builds New Facility

INNOVATIVE PEENING SYSTEMS (IPS) has moved into its new manufacturing facility in Braselton, Georgia. Heavy metal fabrication, machining, robot assembly, component assembly, machine assembly, electrical panel building, and contract shot peening and abrasive blasting work areas are housed in the new plant. In addition, IPS now has a larger airfoil coating shop to accommodate their work in graphite coatings, sacrificial airfoil wear coatings, and airfoil moment weight scaling for blade radial placement.

The building also holds two 20,000-pound overhead bridge cranes. Both cranes have a 340-foot runway and a 22-foot hook height. The cranes move heavy components into the assembly areas for faster machine construction.

Building a new facility is a large undertaking for a manufacturer and we wanted to know more about the project. Dan Dickey, Chief Executive Officer at IPS, generously answered our questions about the building and the company.

THE SHOT PEENER STAFF:
What prompted the need for a new building?

DAN DICKEY:
We needed larger production areas to accommodate a rapid growth in machines sales, and we wanted to attract employees with manufacturing experience. The mild climate of northern Georgia and its resort amenities are wonderful. The facility is located northeast of Atlanta, Georgia. It's next to the Michelin Raceway Road Atlanta and the Chateau Elan Winery and Golf Resort. The 692 miles of Lake Lanier's shoreline are nearby. All this coupled with the manufacturing corridor of I-85 allows IPS to fulfill its goal of hiring quality key employees. We have increased our staff size by 20% in the first quarter of 2019.

THE SHOT PEENER STAFF:
Describe a feature of the new facility that has improved productivity.

DAN DICKEY:
IPS now has in-line manufacturing. The raw materials arrive in one end and move across the plant using the building bridge cranes until the machines are assembled and shipped. Machine deliveries are up 35% in 2019.

THE SHOT PEENER STAFF:
We notice you offer airfoil coatings. When and why did you add this service?

DAN DICKEY:
IPS added this service in 2005 at the request of a customer. It may be unusual for a shot peening OEM to offer coatings, but it is not unusual to add diversification to the business revenue.

THE SHOT PEENER STAFF:
Did you move to the new location to better serve a specific market?

DAN DICKEY:
No, IPS has a balanced portfolio of aerospace, energy and automotive customers.

THE SHOT PEENER STAFF:
Do you have advice for anyone thinking of building a new facility?

Innovative Peening Systems' new facility was designed to accommodate in-line manufacturing.

DAN DICKEY:
We designed the building for Innovative Peening's needs but also added many features with other users of the building in mind. Our mission is to outgrow this building one day and when that happens the building needs to be marketable to other companies. We designed the building with this in mind. We also spent the money for more square footage than was originally planned. The theory, which proved correct, is that the cheapest square footage of the building is the last square foot and the most expensive is the first square foot. The facility was planned for current production and growth.

THE SHOT PEENER STAFF:
What is the history of IPS?

DAN DICKEY:
I founded the Innovative Peening Systems as a division of a metal finishing company. Our first machine build was in 1994 for an aerospace company in Ogden, Utah. In December 1999, I purchased the assets of IPS and incorporated the company independent of all others in January 2000.

Dan Dickey, CEO at IPS, in front of the construction site of the new facility.

THE SHOT PEENER STAFF:
How did you get started in the shot peening industry?

DAN DICKEY:
I started servicing and selling blasting and shot peening machines in 1983 at the age of 21. I attended the first shot peening workshop as a student in 1991 in Atlanta, Georgia and I have been involved with the workshop as an instructor and exhibitor ever since.

I owe a great deal of our success to the workshop and its supporting members. The exposure to the students who are customers or potential customers is a critical part of the event. Having interaction with other people in the industry allows IPS to keep up to date with the industry and its trends.

THE SHOT PEENER STAFF:
What motivates you to continue to grow the company?

DAN DICKEY:
Innovative Peening Systems has a business philosophy that guides our actions:

"Satisfaction of past accomplishments stifles future achievements."

For us, every component of every machine must be better than the last. This improvement program will keep IPS competitive for as long as the improvement program exists. To improve in this manner you must also improve the facilities, the management team, the employees and your supply chain.

THE SHOT PEENER STAFF:
Is there anything else you would like our readers to know about Innovative Peening Systems?

DAN DICKEY:
IPS is an OEM of CNC and robotic shot peening and blasting machinery. IPS fills an industry niche with our standard CNC machines that comply to every high-end shot peening specification known, including AMS 2432.

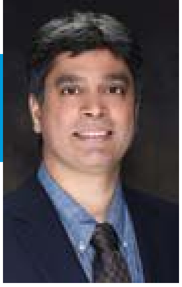
These standard machines are extremely versatile, permitting IPS to fill most shot peening applications with a proven machine design. This business practice allows faster machine delivery times at a favorable price to the customer.

The machines are controlled by a powerful Fanuc motion control system with a passive human machine interface and CIMCAP software. If you can fit a part inside the enclosure, the motion system can peen it accurately with repeatability. Our precision robotic gantry nozzle movement system eliminates the high maintenance of ball screw drives.

Our drive systems provide long service use with extreme accuracy. Our motion system is so accurate it can paint an exact replica of the Mona Lisa on Abraham Lincoln's forehead on a US penny.

THE SHOT PEENER STAFF:
Thank you, Dan, for your contribution to the magazine.

The IPS conference room window overlooks the full length of the production floor. Photographed from left to right: Nick Hart, Chaz Jackson, Dan Dickey (CEO), Kristina Loftis, and Julian Pisczak.



AN INSIDER'S PERSPECTIVE

Kumar Balan | Blast Cleaning and Shot Peening Specialist

Vibratory Peening: Promising Performance

IN THE WINTER 2018 issue of *The Shot Peener*, we discussed two non-conventional peening techniques—one of which was Vibratory Peening. In addition to the superior surface finish, we learnt that the layer of compression was deeper with vibratory peening when compared to conventional shot peening. The process itself was significantly different from conventional peening in terms of media life, dust generation and utility costs. We concluded that this technique of generating residual compressive stress was worth further exploration. The results are discussed here.

Vibra Finish, based in Mississauga, Ontario (Canada), has conducted multiple studies to validate the established facts and clearly define limitations of this peening process. They have attempted to identify components, both industrial and domestic, that demand and could benefit from a combination of fatigue resistance and superior surface finish, both in a single step process.

When reviewing a new process, especially one that simulates an established technique albeit with marked improvements, skepticism is common. Such doubts include the technical efficacy of the process, financial viability and its potential market reach. Our discussion will cover all these aspects courtesy of data provided by Vibra Finish. Given that Vibra Finish also operates conventional shot peening machines, our discussion is enriched by the comparison of both techniques under identical process variables.

Background

Vibratory finishing is a primary process in its own right and sometimes it is a supplementary process used to polish a shot-peened surface. As a secondary operation, it can eliminate surface roughness created during peening. Surface roughness, greater than a certain application dependent value, can have a detrimental effect on the fatigue life of the component. As we know, most specifications limit material removal in post-peening finishing to 10% of the "A" intensity value. Vibratory finishing could be controlled to stay well within this tolerance. Vibratory finishing is also used for deburring, burnishing, and descaling. It is ideal for finishing parts prior to painting, plating, heat treating, anodizing, or simply to achieve an excellent final finish.

Vibratory finishing is categorized as a "mass-finishing" process and, when designed properly, it will result in a batch of parts that is treated with uniformity and consistency. The process is not reliant on operator skill unlike other techniques such as buffing, filing, belting, etc. Instead, a batch of parts are loaded in bulk into a tub or continuously fed to a vibratory machine for in-line operation. The tub is filled with finishing media and suitable compound(s) that when combined act as thousands of small filing surfaces scrubbing the parts. The compound assists the cleaning/finishing action of the media (usually made from ceramic). The choice of compound will depend on the material to be treated, the desired surface finish, and the individual application and process requirements. Additives in the compound could serve other purposes such as alkaline cleaning, acidic burnishing, washing and rust inhibition.

Just like any other process, vibratory finishing has controllable variables that alter the finish quality. Two of the main factors include the amplitude and frequency of vibration. Given the advantages of this process, it is a natural progression that vibratory finishing be extended in its application range to provide a peened and finished product in a single step.

Past Research

In 2016-2017, Dr. Hongyan Miao and Prof. Martin Levesque from Polytechnique Montreal studied the fatigue life improvements of a certain alloy type using conventional peening and shot peening. The results from this test were encouraging enough to carry out further testing. The details of their testing are as follows:

- Conventional shot peening was carried out in an automated air-type machine with a ½" diameter nozzle propelling Z425 ceramic bead on the component. The target intensity was 8A, achieved at an air pressure of 20 PSI and media flow of 10 lb./minute. The part was fixtured on a rotary table.
- Vibratory peening (this term is used to signify the sole purpose of this operation—peening) was performed in a batch-type tub filled with AISI Type 1018 Carbon Steel balls with diameters 1/8", 3/16" and ¼", adding up to almost a ton in weight. The target intensity remained unchanged from 8A as in the conventional peening machine.
- It is interesting to note the mix of media sizes in this process as compared to conventional shot peening where the reliance is on consistent media size, to the extent of using classifier screens to maintain the same in the machine. Due to proprietary nature of this process, further elaboration on the use of multiple media sizes is not readily available. A reasonable explanation would be to consider the mechanism of media movement in a batch-type tub,

and the interaction of one size with another much like on a pool table. This is compared to conventional peening where a steady stream of media impacts the target.
- Both media types (ceramic and carbon steel balls) were of comparable hardness in the range of 60 HRC.
- In contrast to conventional shot peening where the part spinning on the table was targeted by the abrasive, the part in the vibratory tub was positioned 10" below the ball bed surface with constant contact of the carbon steel balls.

The team plotted saturation curves using data sets obtained from both peening techniques and, with their distinct process parameters, they arrived at an intensity of 8.3A and 8.6A with shot peening and vibratory peening respectively. Residual stress measurements carried out on the test parts using X-ray diffraction displayed some interesting results. Shot peening produced a larger surface and maximum compressive residual stress (-212 MPa and -297 MPa respectively), as compared to -148 MPa and -225 MPa produced with vibratory peening. However, the difference was in the depth of compression. Vibratory peening produced -50 MPa at 520 micron below the surface whereas with shot peening, the same magnitude of residual stress, -50 MPa, went only 340 micron deep into the surface. In practical terms, if we are able to alter the process parameters in vibratory peening so that it generates the same magnitude of compressive stress as shot peening, we can expect this stress to stretch over a greater depth than with shot peening.

The surface roughness results were as expected. The study compared the surface roughness of the sample part as machined, shot peened and after vibratory peening. Roughness was tested on three samples, on three individual locations and the trend was the same in all cases. One such set of results is documented below for brevity.

As Machined Ra micron	**Shot Peened** Ra micron	**Vibratory Peened** Ra micron
0.99 (% compared with As Machined)	4.88 (+517%)	0.6 (-16%)

Fatigue tests performed as part of this study generated similar average fatigue lives for both processes. However, they did find that the values from shot peening had significantly less standard deviation (minimal variation). The study concluded that rather than comparing similar Almen intensity values, future studies should compare the fatigue life measures for similar residual stress profiles at different levels of roughness. Ultimately, the measure of all such processes is based on the extent to which fatigue life has been impacted, preferably in the positive direction.

Commercial Components and Vibratory Peening

Encouraged by the results of the previous tests, Vibra Finish continued with comparative tests on more conventional components—a turbine blade and an automotive transmission gear. The tests were to study the following:

1. Compare the effects of shot peening and vibratory peening on (a) open and (b) relatively closed geometries in order to learn the limitations presented by certain part types to this process.
2. Surface roughness
3. Residual stress and nature of curves (relieving of compressive stress as measured into the depth of the part)

The conventional shot peening process was carried out in an automated airblast machine under the following process parameters: Target intensity: 10 to 12A and 100% coverage. This was achieved using S110 regular hardness steel shot propelled at 30 PSI by a ¼" diameter nozzle at a stand-off distance of 8" for a time cycle of 30 seconds.

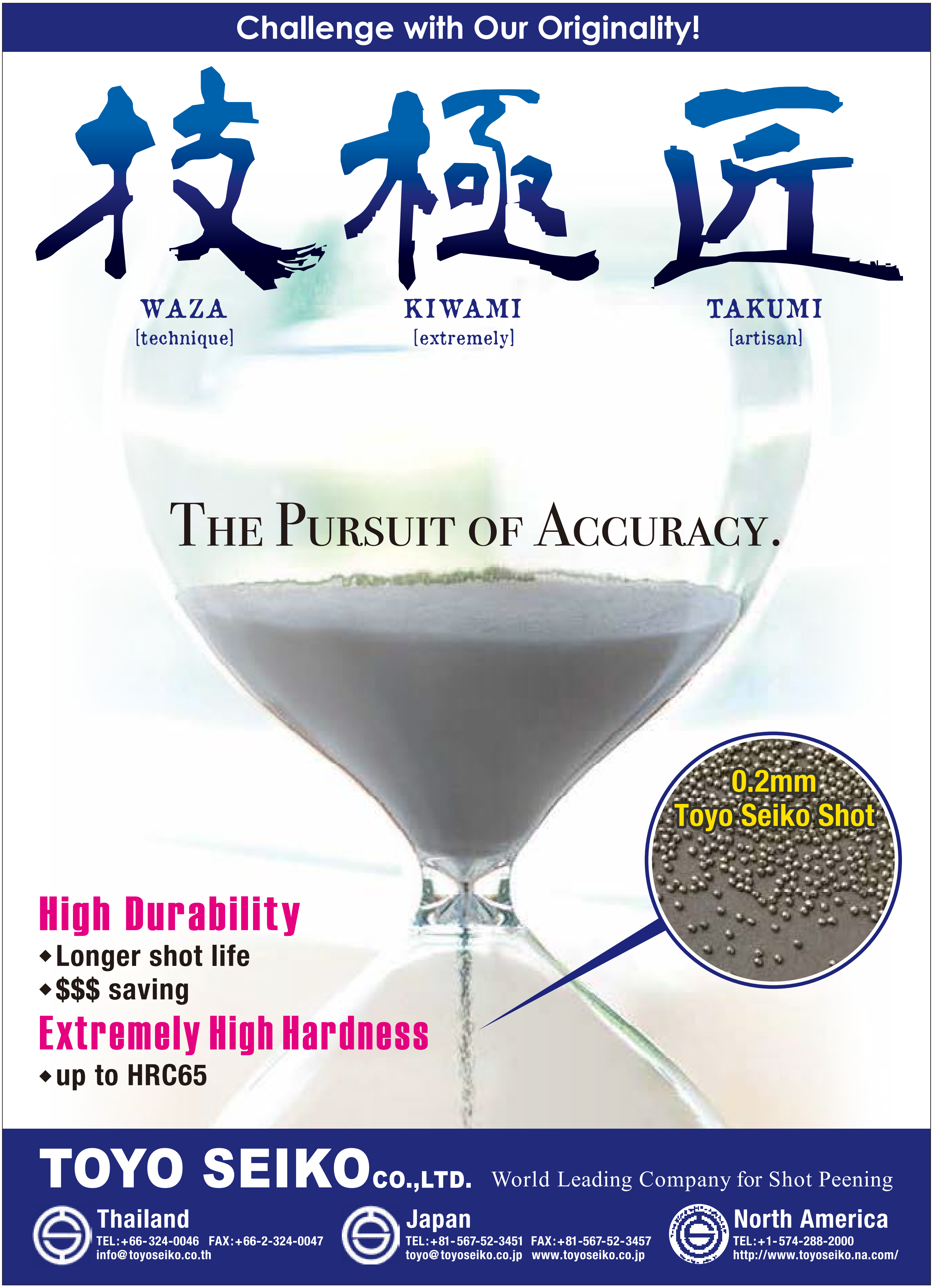
Vibratory peening was carried out using single size, 3 mm diameter steel balls, in a batch-type tub for a total cycle time of 10 minutes. Two sets of data, one for surface roughness and the other for residual stress (using X-Ray diffraction) were analyzed.

Surface Roughness Data:

Part Description	**As Machined** Ra micron	**Shot Peened** Ra micron	**Vibratory Peened** Ra micron
Gear (Root)	0.62 to 0.82	2.64	0.95
Gear (top of tooth)	0.53 to 0.82	0.74	0.72
Gear (face)	0.61 to 1.14	0.81 to 0.91	0.56 to 0.94
Blade – concave surface	1.18 to 5.79	4.93	1.09
Blade – convex surface	1.05 to 3.07	3.18	0.43

The surface finish results show an interesting trend in a relatively closed geometry component (gear) when compared with the blade with wide, open surfaces. The root section of the gear, which is the area of maximum stress concentration, is the most important region for measurement. In this region, the shot-peened component exhibited a much rougher surface finish when compared to an identical vibra-peened component. All other regions of the gear, such as the drive face, coast face and tip, showed comparable surface roughness values in both processes. Geometry of the gear tooth, media access and media size could all be factors that might have contributed to the final roughness value in vibratory peening.

Though S110 was ideally suited to peen the smallest radius of the gear tooth without causing coverage issues, the surface roughness ended up much higher than with vibratory peening. However, we have to consider the fact that in order to achieve the same intensity (8 to 12A), the S-110 would have had to penetrate deeper than the 3 mm balls in vibratory peening, resulting in a rough surface profile.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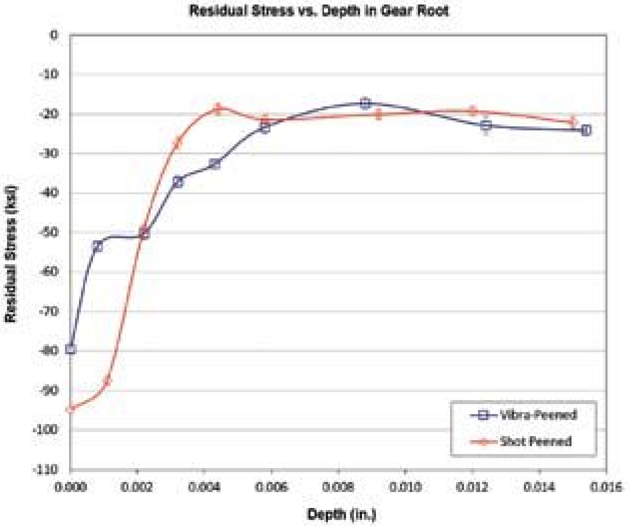
A study of the residual stress profile provided further insight into the characteristics of both processes to induce compression in the parts.



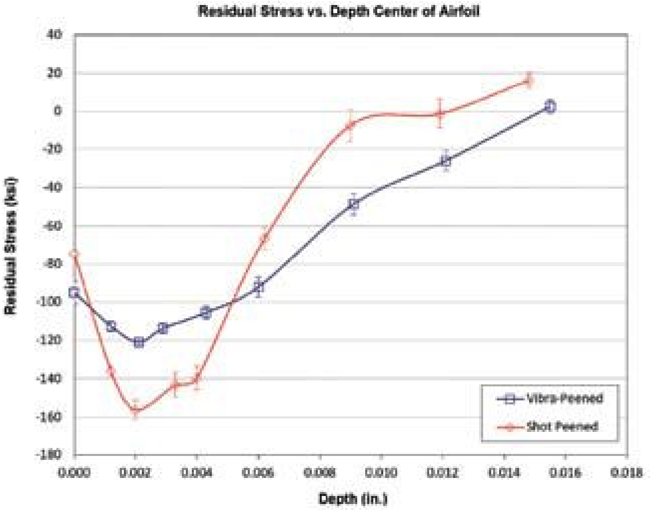
Gear

The residual stress curve for this component is different from the classic "J" hook curve that was expected before the results were obtained. Also, this is a carburized component that may not necessarily show high values of residual stress when shot peened with S110 size media to a relatively lower intensity range (8 to 12A). Though the residual stress at the surface of the shot-peened sample is greater than that achieved with vibratory peening, the dissipation (or loss) of residual stress towards the depth of the material is much more controlled with the vibratory peened sample. Vibratory peening did record a seemingly anomalous reading when measured at 0.0008" depth, registering a steep 33% drop from -79 ksi to -53 ksi before continuing with a controlled and gradual decline at deeper levels into the sample.

An obvious question that remains to be evaluated is whether the surface finish (roughness) was the cause of this steep drop in residual stress in the shot-peened sample, especially considering the smoother surface after vibratory peening. The gear being carburized might have also led to the relatively lower magnitude of residual stress using both types of peening techniques.

Blade

A blade from a turbine wheel was chosen for its open geometry. As it turned out, the resultant residual stress followed the all-familiar J-hook pattern. Surprisingly, the compressive stress generated at the surface was greater with vibratory peening when compared to the shot-peened sample. Once again, the open geometry of the part and material properties (softer than the gear) likely caused this result. An interesting observation is to be made at 0.0021" depth where both processes register the maximum compression. Assuming the shot-peened part had developed a rough profile after peening, if one were to polish it by 10% of the "A" intensity value, i.e., 0.0011", we will end up with a higher residual stress value (about -140 ksi) at the surface of the shot-peened part. At this depth, the vibra-peened part will have a residual stress of -113 ksi without the need to be polished.



- The drop in residual stress when going deeper into the component was drastic with the shot-peened part and followed a gradual decline with the vibra-peened component. This is a positive attribute of the latter process.
- In both cases, it appears that the geometry of the part played a big role in generating increased magnitude of residual stress.

Conclusions and Future Steps

Vibratory peening certainly shows a lot of promise in terms of combining the two essential features in surface finish—smooth profile and compressive stress—in a single step. Moreover, in both examples, it has shown a gradual and smooth dissipation of this stress as one travels deeper into the material, demonstrating the controllability of the process. The next steps are to study the operating cost of both processes to assess the financial viability of the process. Vibratory peening does not possess the same consumable pattern that we are all familiar with in conventional shot peening. This is also true in terms of capital costs involved in procuring a conventional shot peening machine.

Vibratory peening is not yet governed by a specification. This might be the next step to increase the adoption of this process in known sectors. Meanwhile, a whole range of consumer parts could greatly benefit from this combined process.

About Vibra Finish

Vibra Finish, located in Mississauga, Ontario, Canada, offers a full range of vibratory finishing services and equipment. Their services include deburring, burnishing, descaling, vibrapeening, polishing, rust removal, cleaning, drying, corrosion protection, and peening services. Visit vibra.com for more information.


Control
EMPIRE

Dr. Yuji Kobayashi | Sintokogio | www.sinto.co.jp

Evaluation and Control of Residual Stress Measurement Using Stress Standard Specimen

Introduction

Shot peening is a processing method in which particles of small size called media (shot) are made to impact the surface of a workpiece. It is often used on components such as gears and springs to improve fatigue strength. Residual stress is one of the parameters which represents the effect of shot peening. It helps prevent crack propagation.

Residual stress can be measured by an X-ray diffraction method. A commonly used technique is the $\sin^2 \psi$ method (with 0-dimensional or 1-dimensional detector).

On the other hand, a method using an image plate (two-dimensional detector) has recently been put to practical use. It is called the cosα method (Figure 1). This method reduces the size of the measuring device and reduces the measurement time in comparison to the conventional $\sin^2 \psi$ method.

Figure 1. Residual stress measurement device (cosα method).

Although there are many advantages, the data measured by the conventional method has differences, such as different X-ray penetration depths, so the presence or absence of correlation between $\sin^2 \psi$ method and cosα method differs depending on the user.

We propose using a standard specimen for residual stress measurement. The reference piece can be measured using devices with different calculation methods for comparison of each method or to simply compare results of multiple measuring devices. It can also be used for routine process control. This paper introduces the stress standard specimen and explains how to use it.

Concept of Stress Standard Specimen

Regarding residual stress measurement by X-ray, it is recommended to regularly check for zero stress with a powder sample in a non-strained state to check for any abnormality. It is often done as a daily check. Residual stress measurement by X-ray involves measuring the crystal lattice spacing of metal by X-ray diffraction and calculating the stress existing in the sample surface layer from the strain generated between the lattice planes. From an industrial point of view, materials that are greatly affected by processing and heat treatment are often targeted for residual stress measurement. Therefore, unlike laboratory use (where powder, etc. are used as reference), it is better to use what is actually handled at the factory. Typical materials to be shot peened are various gears and springs, which are also subjected to various heat treatment processes. If these materials are to be measured, a standard specimen subjected to shot peening after heat treatment is considered appropriate.

Application and Necessity of Residual Stress Standard Specimen

As described above, the stress standard specimen can be used for daily process control, alignment in the case of different calculation methods, and confirmation of machine differences. The setting of various conditions is important for residual stress measurement using X-rays. In particular, it is necessary to acquire the diffraction intensity distribution in a sufficient angle measurement range. The stress measurement conditions may need to be changed depending on differences in materials and heat treatments. Even when measuring the same type of material, measurement conditions may differ depending on the user's judgement.

Thus, caution is required in the handling of the measured stress values, which can vary depending on the measurement conditions even if the angle measurement range is the same. Since there is a possibility that the measured value may fluctuate for the above mentioned reasons, a method to confirm the certainty of that value is required. Therefore, we propose a stress standard specimen as such a method where it is necessary to measure the reference specimen on a daily basis or per lot and confirming that the residual stress measurement is performed reliably.

In addition, in order to grasp the differences in calculation methods and the variation in readings from different machines, it is necessary to use the same reference sample.

Introduction of Cosα Method

The cosα method is a method of stress measurement proposed by Taira et al. At first, the X-ray diffraction image was obtained by exposing the X-ray film. The peak of the diffracted X-ray was judged by the shading of the image.

With the development of detectors that acquire diffracted X-rays, Sasaki et al. proposed a method using an image plate (IP) which was then put to practical use.

Sinto, our employer, sells residual stress measuring instruments that adopt this method.

The measurement time is shorter than that of the conventional method because X-rays do not have to be incident on the measurement point multiple times.

In addition, since there is no need to move the X-ray irradiation position, a goniometer is not required and the apparatus can be miniaturized. In this method, since the entire circumference of diffracted X-rays (Debye-Scherrer ring) is acquired, diffracted X-rays can be visually confirmed (Figure 2).

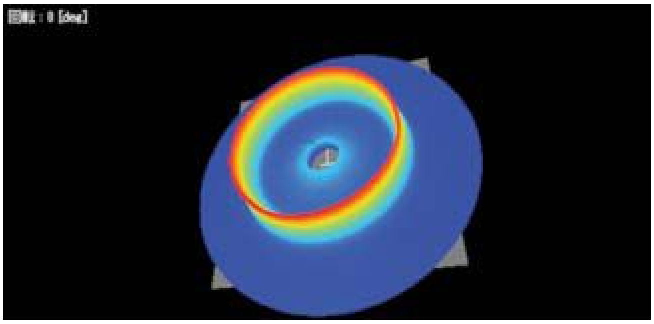


Figure 2. Example of DEBYE-SCHERRER ring (diffraction ring).

Introduction of Stress Standard Specimen

The stress standard specimen is given a target residual stress. The residual stress applied to the specimen is available in three levels, high, medium and low (-1600 MPa, -800 MPa, -400 MPa). An example is shown in Figure 3. The specimen size including the pedestal is 400 x 400 x 550 mm.

The measurement point is represented by a White circle at the center and the measurement direction is represented by a Black circle.

An inspection certificate is attached to this reference piece, and the stress value, written for such reference pieces, describes the measured value obtained by measuring the White circle portion. Applications may be daily management, adjustments in the case of different calculation methods, and confirmation of machine differences.

Figure 3. Standard specimen for residual stress measurement.

Example of Use: 1

As an application example, we show the comparative results of two different calculation methods, the $\sin^2 \psi$ method and the cosα method.

The $\sin^2 \psi$ method is a method often used for residual stress measurement. The results when measuring are shown in Figure 4 on page 18.

The vertical axis represents applied stress and the horizontal axis represents residual stress. In both the $\sin^2 \psi$ method and the cosα method, the changes in load stress and residual stress are linear. However, the actual residual stress values from both methods are not exactly the same. It considered that the trend the measurement result obtained from both methods should be confirmed by the reference piece.

In this case, the reference specimen can be used to confirm what kind of trend is shown by results from both methods (Figure 5 on page 18).

Example of Use: 2

If the measurement is made without noticing the difference in the parameters, the measurement result will not be certain. It is easy to notice if the measurement result is obviously wrong, but if the measurement result is not so large, it may be possible to perform the measurement without noticing it. Therefore, we think that daily management with the decided standard (standard piece) is important.

Conclusion

Residual stress measurement by X-ray diffraction is widely used in the automobile industry and other fields. Measurements can be done in a shorter time than before and more miniaturized devices have been put to practical use. Therefore, this technique is being applied to more products

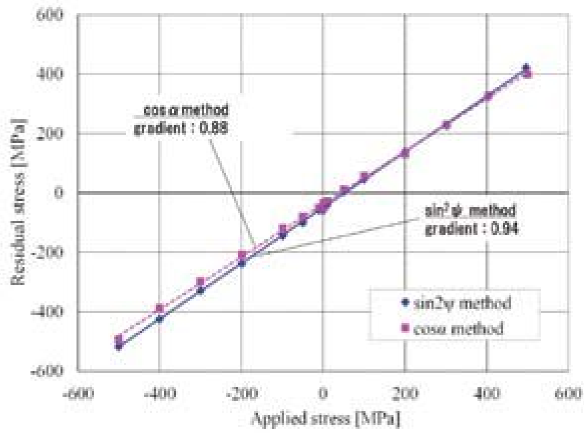


Figure 4. Comparison residual stress and applied stress.

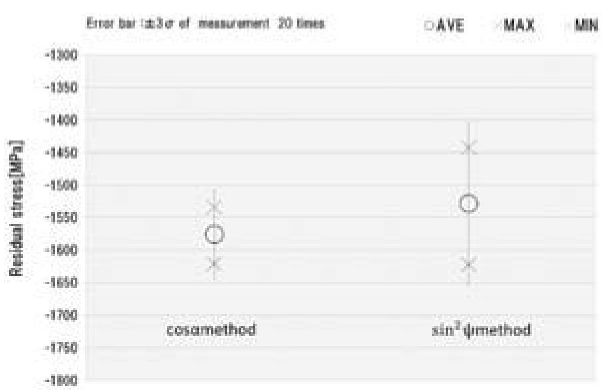


Figure 5. Comparison of measurement methods.

and fields than ever before. As the field of application becomes wider, X-ray diffraction measurement is gaining a wider acceptance as a common technique rather than being considered as a highly specialized technology.

Therefore, the certainty of the measurement result has become more important than ever. It would be highly advisable to use a stress standard specimen as a confirmation method for residual stress measurements.

About Sinto

Since its establishment in 1934, Sinto has accumulated numerous technologies related to the field of metal casting as a manufacturing and system engineering company of foundry equipment and plants.

Throughout these years Sinto has consistently followed its basic corporate philosophy of "Giving Form and Life to Process Materials" regardless of the expansion of its business fields.

Sinto's business operation has expanded to various fields of process materials industry through the advanced, integrated and applied technology based on its foundry-related technologies and accumulated know-how.

Saab's Global Defense and Security Company Lands in Indiana Near Purdue University

Global defense and security company Saab announced plans this spring to locate a new U.S. manufacturing operation in Indiana. The facility, located at Discovery Park District Aerospace on the west side of the Purdue University campus, will support production of the U.S. Air Force's next-generation T-X jet trainer and create up to 300 new jobs with hiring starting in 2020.

The expansion is a fundamental part of the company's strategy to grow its U.S. industrial and technology base. Saab also will collaborate with Purdue University to expand Saab's U.S.-based research and development within possible areas such as sensor systems, artificial intelligence and autonomous systems.

The Stockholm-based company will invest $37 million to locate and build an Indiana-based workforce in West Lafayette. Saab will construct and equip a facility to manufacture a significant portion of the Boeing T-X advanced pilot training aircraft, which will help train future U.S. Air Force pilots for generations to come. Saab is both a partner and supplier to Boeing on the program.

Construction of the facility is expected to begin in 2020 at the Discovery Park District Aerospace to support the rapid Boeing T-X production rate demanded of the program. Saab expects to begin hiring for assembly operators and airplane mechanics as well as for logistics, manufacturing engineering, and administration and management roles the same year.

Indiana Governor Eric Holcomb speaks before a crowd of more than 200 people during an event to announce that Sweden-based Saab Global Defense and Security Company is opening a $37 million facility in the Purdue University-affiliated Discovery Park District in West Lafayette, Indiana. Saab will conduct its contribution to the production of the U.S. Air Force's T-X pilot training program and other aerospace projects at the site. (Photo credit: John Underwood/Purdue University)

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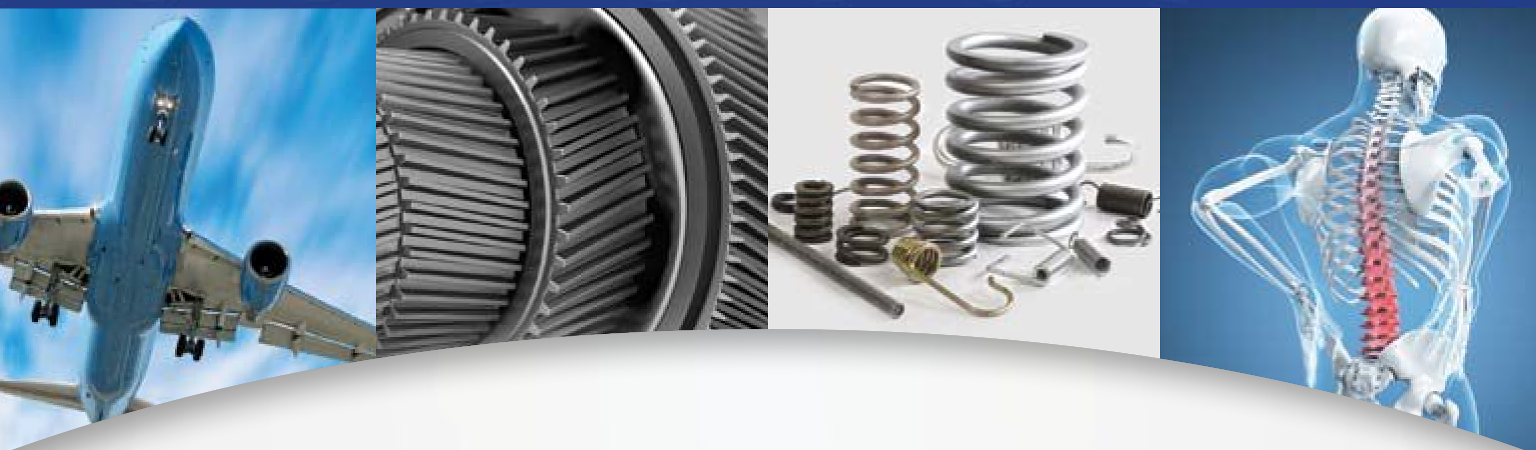
A Cut Above



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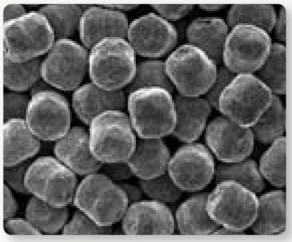
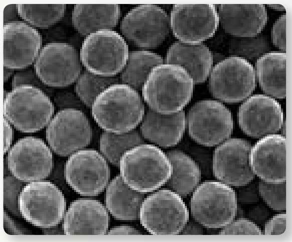
- **Highest Resistance to Fracture** Premier Cut Wire Shot media tends to wear down and become smaller in size rather than fracturing into sharp-edged broken particles, which may cause surface damage to the part.
- **Lower Dust Generation** Highest durability equals lowest dust levels.
- **Lower Surface Contamination** Cut Wire Shot doesn't have an Iron Oxide coating or leave Iron Oxide residue — parts are cleaner and brighter.
- **Improved Part Life** Parts exhibit higher and more consistent life than those peened with equivalent size and hardness cast steel shot.
- **Substantial Cost Savings** The increase in useful life of Premier Cut Wire Shot results in savings in media consumption and reclamation, dust removal and containment, surface contamination and equipment maintenance.

As Cut



Normal Conditioning



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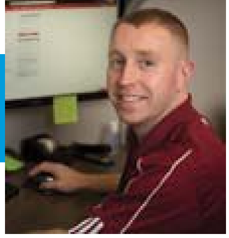

Bryan Chevrie | Product Engineer | Electronics Inc.

Panel Wiring: Re-Routing

THINKING BACK before the smartphone, many people used a GPS when traveling out of town. I had a Garmin and she did a great job, most of the time. I referred to the GPS as "she" because I always had it set to the female voice. I guess it felt more natural to be told what to do by a woman, more so than a man. Anyway, when I missed a turn, she would say "recalculating" and I swear she said it with an exasperated tone in her voice. Almost as if she was saying, "Hey idiot, you just missed your turn. Now hold on while I look for yet another route that you will probably ignore." Maybe it was imagined, but I'm still not completed convinced.

However, I get a similar feeling when I'm troubleshooting a MagnaValve at a customer's facility and I open the electrical panel. Most panels have very clean and neat wiring. All wires are neatly located in wire trays with the covers on, all wires are clearly labeled, and all the wires take the shortest route possible. These panels look great! But they all have the same problem—there was no thought put into the routing of the wires. And not just the wires inside the panel, but the conduit also.

The comical part of all this is that the designer/engineer chose all the correct parts and worked out all the logic, but the panel builder did not spend the extra 10 minutes to create a plan for wire routing. I prepared an example to illustrate this.

Let's say we're designing a small wheel blast system. The panel will be supplied with 480 Vac. The wheel is driven by a 25 Hp three-phase motor with variable frequency drive. It has a PLC with a HMI and controls shot flow using a 590-24 MagnaValve and FC-24 Controller. The panel will be mounted on the side of the machine so the HMI, FC-24, and any additional pushbuttons will be mounted on the side of the panel that faces the operator, see Figure 1. Remember, this is an example.

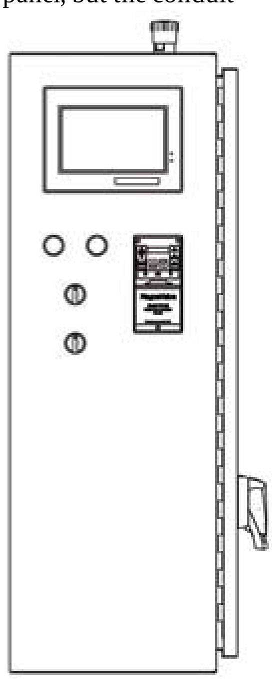

Figure 1

Figure 2 shows an example of a poorly planned panel layout and the conduits connected to it. In this example, the variable frequency drive (VFD), step-down transformer, fuses and disconnect are mounted at the bottom of the panel. The 24 Vdc power supply, PLC, ethernet controller and control relays are mounted at the top of the panel. In the middle are the terminal blocks that connect everything together.

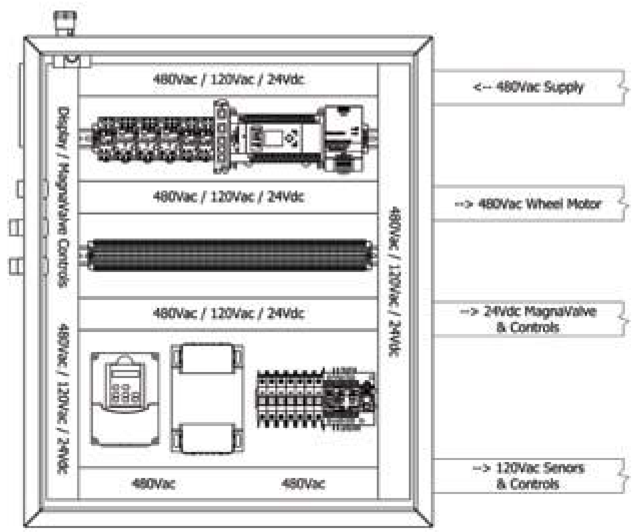

Figure 2

Looking at the conduits connected to the side of the panel, notice the 480 Vac supply enters the top of the panel while the lower voltage lines leave at the bottom of the panel. This might make the conduit on the outside of the machine look like a cascading waterfall. But is it the best way?

The question some of you are asking right now is, "What's the problem? I don't see anything wrong with that panel."

Well, the problem is the high-voltage AC and low-voltage DC lines are ran together. You can see in Figure 2 that the 480 Vac line enters the top of the cabinet and must travel towards the bottom of the panel to the disconnect. The VFD output then must travel upward and across the panel to exit through the conduit towards the top of the cabinet. The low-voltage sensor and control lines must travel down and across the panel to exit out their respective conduits. I have even seen

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some panels run one large conduit and all wiring types placed together. Fortunately, this is less common.

The problem with this layout is the high-voltage AC and low-voltage DC get placed in the same wire tray and are in very close proximity with one another. This allows coupling of the high-voltage into the low-voltage DC lines.

The VFD, typically the biggest source of noise in a system like this, will couple noise onto the low-voltage DC lines. This is why it is recommended and, in some cases, it is required to install line reactors, EMI filters, and/or RF filters on the input or output of the VFD.

All this high-voltage and noise coupling can create excessive noise in sensitive electronics and excessive jitter on the digital communication lines, such as ethernet. All is undesirable.

The good news is the solution doesn't cost a thing other than about 10 minutes of thought.

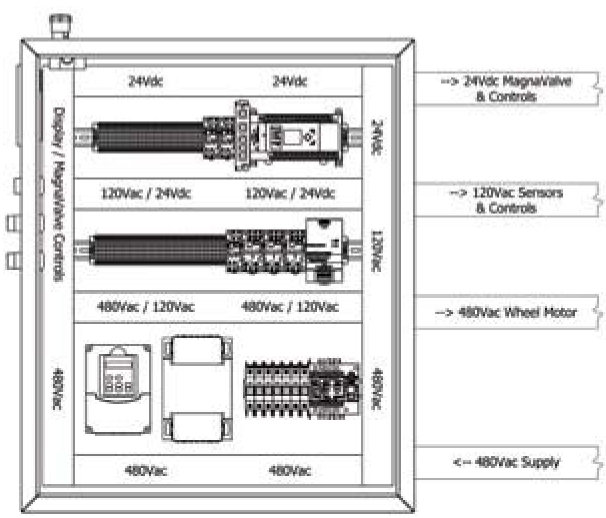


Figure 3

Figure 3 shows the same panel, same controls, same parts—the only difference is grouping of the parts and conduit. The VFD, step-down transformer, fuses and disconnect are in the same location; however, the 480 Vac supply enters near the bottom of the cabinet. The 480 Vac wheel motor conduit and 24 Vdc supply have been moved to the middle of the cabinet. This removes all the 480 Vac from the top of the panel, keeping all the high-voltage AC in the bottom of the cabinet.

The 120 Vac relays have been moved to the middle of the panel along with the terminal blocks that connect all the 120 Vac sensors and controls. This removes the 120 Vac from the top of the panel.

This leaves the top of the panel for the PLC, ethernet, low-voltage sensors, low-voltage controls, and low-voltage analog communication.

Notice that in the improved layout in Figure 3, the 24 Vdc/low voltage and the 480 Vac never cross and are kept enough distance from one another to prevent coupling.

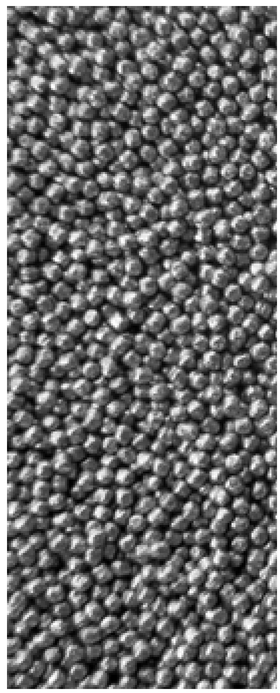
You may have noticed that the 480 Vac and the 120 Vac overlap as well as the 120 Vac and the 24 Vdc/low voltage. This is acceptable in most applications and it may be unavoidable in a tight panel such as this example. But if the space allows, another wire tray could be added to separate the 120 Vac and the 24 Vdc/low-voltage DC.

So the next time you're laying out a panel, take 10 minutes and plan your route. Keep in mind that the less contact low-voltage electronics have with high-voltage lines, the better.

Mike Deakin | Pellets, LLC | www.pelletsllc.com

A Happy Customer

FOLLOWING a two-year study, a major automotive parts manufacturer converted their multiple shot peening machines, one at a time, from cast steel peening shot to Pellets stainless steel (302/304 alloy) conditioned cut wire shot. After several months of using the stainless steel cut wire shot, the customer reported positive results to the Pellets' staff.



The study and conversion began primarily because of the threat of dust fires in the dust collection system. The customer was looking for an alternative shot peening media to reduce dust and therefore the threat of dust collection fires. The study began in the summer of 2016.

First, of course, the customer wanted to make sure the Pellets stainless steel cut wire shot would produce the peening results that were needed on their automotive parts. After months of study, the results were in and the customer's Product Development Group reported in June of 2017 that the peening results were excellent and met or exceeded all of their specifications and requirements.

And so they began to plan for the conversion of their peening machines—one at a time. This would be time consuming but the customer wanted to make sure no mistakes were made along the way. In an initial 24-hour study, the amount of undersized media produced with the stainless shot was three pounds compared with 60 pounds from the cast steel shot. The study personnel also commented that the operation was a lot cleaner using the stainless steel shot. And so the conversion of each machine began.

The customer historically consumed approximately 250,000 pounds of cast steel shot per year with the commensurate disposal of the spent shot.

After several months of operation, the customer outlined these results:

1. Our customers are reporting much cleaner and brighter parts.
2. Our employees like the media because it produces significantly less dust.
3. Management is impressed with the reduction in dust and the safety department has given us an A+ for the resulting risk reduction of dust fires.
4. Our outside lab reported that the cast steel disposal had a flammability issue and had to be disposed of as hazardous material. The stainless steel waste did not have a flammability issue and therefore did not have to be classified as hazardous ignitable waste material.
5. We no longer need to use a lubricant sheet in the blast machines to keep the parts from sticking together.
6. Consumption of media was less than 1/3 of the cast steel peening shot, resulting in significant cost savings and much less waste.
7. There is a strong possibility that the used undersized stainless steel shot can be recycled and reused by someone that needs smaller conditioned cut wire shot.
8. We couldn't be happier with the improved safety issues, the cleanliness improvement and the overall reduction in media required for our shot peening operations (and the resulting waste removal reduction).

While the initial cost of the stainless steel cut wire media was quite a bit more expensive than cast steel peening shot, the end result of using 2/3 less material and therefore 2/3 less waste resulted in a substantial cost reduction.

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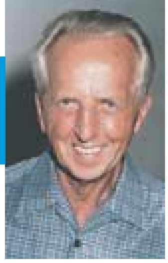

ACADEMIC STUDY
Dr. David Kirk | Coventry University

Hardness Matters

INTRODUCTION

Hardness, for shot peeners, is resistance to localized plastic deformation induced by impacting shot particles. We therefore have two areas of interest: the hardness of the component being peened and the hardness of the shot particles themselves. The hardness of the component is normally out of our control. One exception is the hardness of the Almen strips that are peened in order to establish the intensity of shot streams. Hardness appears in specifications for both shot particles and Almen strips and therefore requires testing.

It is common for peeners to blindly accept specified hardness values and test methods at face value. Unfortunately, hardness testing then becomes a minefield. There are three key areas that need to be considered if we are to be able to navigate through this minefield. These are (1) **sample heterogeneity**, (2) **test method** and (3) **indent size**. Metallurgists are, of necessity, relatively expert at matters concerning hardness testing of metals and alloys.

Hardness testing for shot peeners normally invokes reference to one or more of **Rockwell**, **Vickers** and **Knoop** techniques. The Brinell technique is commonly employed by component manufacturers. Details of these techniques are readily available via the Internet so that only selected features are discussed in this article.

The best approach when trying to optimize hardness testing is to follow Murphy's Law in the sense that "if anything can go wrong then it will go wrong"!

SAMPLE HETEROGENEITY

Sample heterogeneity can be divided into micro-heterogeneity and macro-heterogeneity. Micro-hardness and macro-hardness testing can be employed in order to monitor these two divisions.

Micro-heterogeneity

Virtually all components and shot contain more than one constituent, aka phases. Fig.1 is a useful analogy to a multi-constituent metal. It was selected as giving appropriate visual impact! A typical fruit cake contains hard particles (nuts), soft particles (fruits) and some pores (centers of stoned cherries) as well as the matrix cake mixture. This is analogous to the situation encountered in many metal alloys.

The fruit cake analogy is also useful in gaining an appreciation of component work-hardening. Imagine, or even try, squashing a piece of fruit cake using fingers. One thing is apparent—the hard nut particles do not deform.

Fig.1. Fruit cake composition (with acknowledgement to Simply Recipes).

This is precisely parallel to what happens when a piece of metal is plastically deformed—the hard particles (phases) offer greatest resistance to deformation. Soft matrix material deforms first and work-hardens. The hardest particles may never deform.

Macro-heterogeneity

Examples of macro-heterogeneity include peened component surface layers (as compared with sub-surface material), decarburization and steel shot particles. Micro-hardness testing is generally employed for studying these phenomena. Fig.2 exemplifies the macro-homogeneity induced by decarburization. Indentation location requires navigating between the constituent features and the indentations must be of an appropriate size.

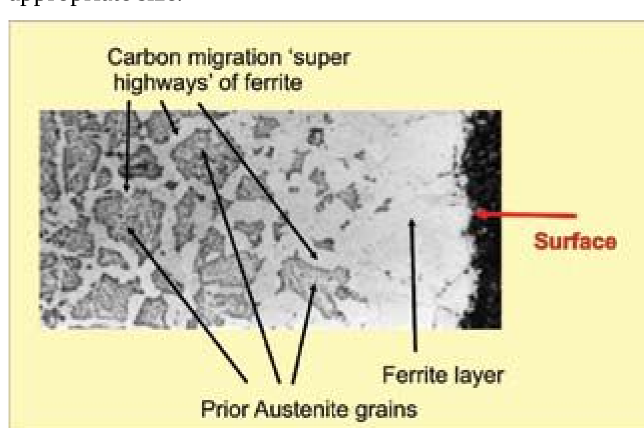

Fig.2. Macro-homogeneity of decarburized steel.


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BRIEF HISTORY OF MAIN HARDNESS TEST METHODS

As mentioned earlier, details of these methods are readily available via the Internet. A brief look at their history shows, however, how well-established hardness testing has become.

The **Brinell** technique, employing a spherical indenter, was invented in Sweden in 1900 and named after its inventor. A hard ball is pressed into the sample's surface and its diameter measured on a projection screen. Hardness is then calculated with reference to the load and ball diameter being employed.

The **Rockwell** technique, which can have spherical or square-base diamond-shaped indenters, was patented in the USA in 1919 and named after its inventors. This is a differential-depth technique where a smaller load is applied followed by a larger load. The differential-depth measurement of hardness was in fact conceived much earlier, in 1908, by a Viennese professor Paul Ludwik in his book Die Kegelprobe (crudely translated as "the cone test").

The **Vickers** technique was developed in 1921 by Robert L. Smith and George E. Sandland at Vickers Ltd in the U.K. and was named after their employer. The Vickers test uses a square-base diamond indenter which can be used for all materials irrespective of hardness.

The **Knoop** technique was developed in 1939 by Frederick Knoop and colleagues at the then National Bureau of Standards, USA. This technique produces elongated impressions from an extended pyramid diamond indenter.

Rockwell, Vickers and Knoop techniques can all be used for micro-hardness testing by applying small loads resulting in small indentations.

INDENTATION SIZE

Knowledge of indentation size is vital for the proper application and understanding of hardness testing. "Large" indentions are associated with macro-hardness testing and "small" indentations are associated with micro-hardness testing but what is "large" and what is "small"?

Prediction of Vickers and Knoop indentation size is straightforward because they are both based on measuring the length of indentation diagonals. Prediction of Rockwell indentation size is complicated because it is based on the indentation's depth. All hardness values are based on dividing the force, F, applied to the indenter by the area, A, of the indentation. The larger the force the larger the indentation. Indentation size can be calculated for each measuring technique using known sample hardness and magnitude of the applied load.

Keeping with the fruit cake analogy, fig.3 represents what might be regarded as a "large" indentation. This would be equivalent to a macro-hardness indentation on a multiphase metallic sample. The indentation is large enough to embrace all types of phase and gives us an **average** hardness value.

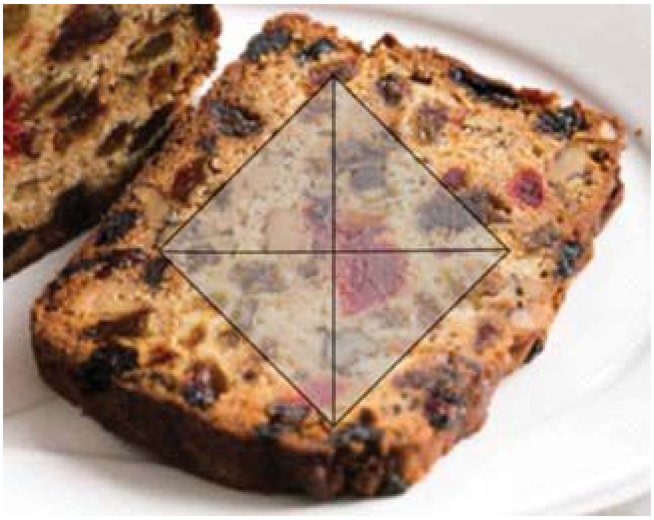

Fig.3. "Large" indentation analogy.

Calculation of Brinell Indentation Size

A Brinell hardness value, $\mathbf{H_B}$, is the applied force, F, applied to an indenter divided by the area, A, of the resulting indentation. The area of the indentation is given by:

$$\mathbf{A = \pi.D\,[D - (D^2 - d_B{}^2)^{0.5}\,]/2}$$

Where **D** is the diameter of the ball and $\mathbf{d_B}$ is the diameter of the impression. Applying algebraic manipulation to **F/A** shows that:

$$\mathbf{d_B = [D^2 - (D - 2F/H_B{*}\pi{*}D)^2]^{0.5}} \qquad (1)$$

Estimation of indentation diameter using equation (1) is easily achieved by employing an internet-sourced calculator. For example, Googling "Brinell Hardness Number Test Equations Formulas Calculator" reveals the Ajdesigner's excellent program. Entering a Brinell value of 443, ball diameter 1 mm, and 500 gf load indicates an indentation diameter of 0.038 mm.

Fig.4 on page 32 represents "small" indentations equivalent to those for micro-hardness testing. A variety of indentation sizes is indicated—attempting to represent different phase locations.

Calculation of Vickers Indentation Size

A Vickers hardness value, **HV**, is the applied force, F, applied to a 136˚ diamond indenter divided by the area, A, of the resulting indentation. The area of the indentation is given by:

$$\mathbf{A = d_V{}^2/\,(2{*}\sin(136^\circ/2)) = d_V{}^2/1.8544} \text{ so that:}$$

$$\mathbf{HV = F/A = F{*}1.8544/d_V{}^2}\ (\text{kgf.mm}^{-2}) \text{ and therefore:}$$

$$\mathbf{d_V = [F{*}1.8544/HV]^{0.5}} \qquad (2)$$

In SI units, Nmm^{-2}, $d_V = [F{*}0.1891/HV]^{0.5}$.


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Fig.4. "Small" indentation analogy.

As an example, consider the 500 gf (0.5 kgf) recommended for testing shot particles. If the hardness of a particular particle was 500 HV then d = $[0.500*1.8544/500]^{0.5} = [1.8544/1000]^{0.5}$ or d = 0.043 mm. Fig.5 is a graphical representation of equation (2) for a hardness range of particular relevance for shot peeners and uses only the two commonly applied loads.

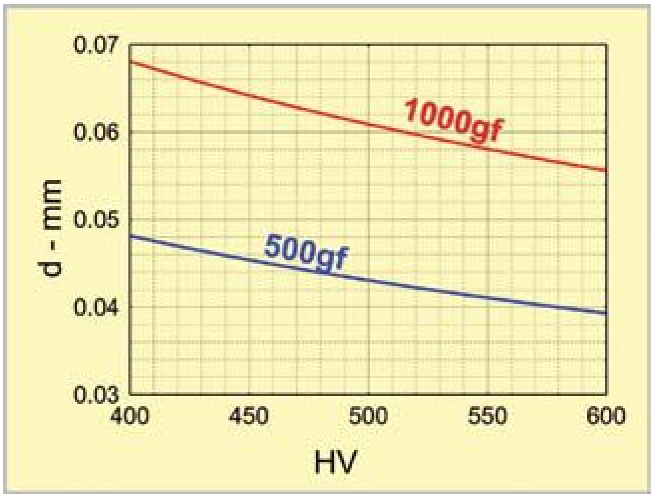

Fig.5. Effect of hardness and load on Vickers indentation size.

Conversion of Rockwell hardness values to equivalent Vickers hardness values can readily be achieved by using internet sites or the following relationships:

HV = (223*HRC + 14500)/(100 – HRC) and
HRC = (100*HV – 14500)/(HV + 223)

Fig.6 is a graphical representation of Rockwell/Vickers hardness conversion.

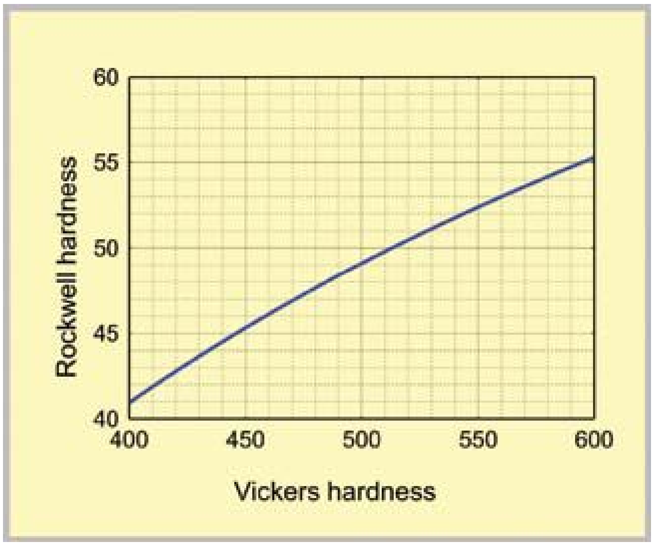

Fig.6. Rockwell/Vickers hardness conversion.

Estimation of Rockwell Indentation Size
Rockwell indenters have a 120˚ included angle as opposed to the 136˚ included angle of a Vickers indenter. This means that for a given applied load the following relationship applies:

$$d_{Rockwell} = 0.966 * d_{Vickers} \quad (3)$$

Looking back at the previous example (where a 500 gf was applied to a material having a Vickers hardness of 500 HV) a diagonal of 0.043 mm was predicted. Applying equation (3) indicates that a Rockwell indentation would have a diagonal of 0.042 mm. The difference is small!

The derivation of equation (3) is as follows:

Area of Vickers indent = $A_V = d_V^2/(2*\sin(136˚/2)) = d_V^2/1.8544$ whereas

Area of Rockwell indent = $A_R = d_R^2/(2*\sin(120˚/2)) = d_R^2/1.732$

Both Vickers and Rockwell indenters stop indenting when the same stress, F/A, is being applied on the same material. When the same force, F, is being applied on both indenters, it follows that:

$$F/A_R = F/A_V \text{ therefore } A_R = A_V \text{ so that}$$

$$d_R^2/1.732 = d_V^2/1.8544 \text{ or}$$

$$d_R^2 / d_V^2 = 1.732/1.8544 \text{ hence}$$

$$d_R/d_V = (1.732/1.8544)^{0.5} \text{ or}$$

$$d_R/d_V = 0.966$$

Estimation of Knoop Indentation Size
The equation for calculating Knoop hardness, HK, is given by:

$$HK = 14.229F/L^2$$

Where **L** is the length (in mm) of the longer indentation diagonal, see fig.7.

It follows that:

$$\mathbf{L = (14.229*F/HK)^{0.5}} \quad (4)$$

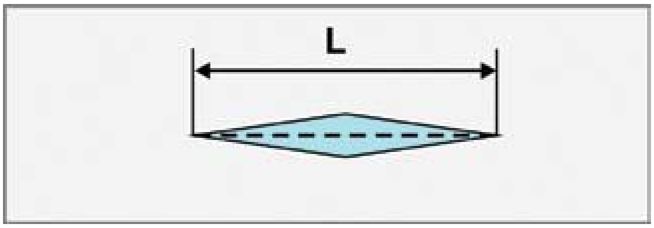

Fig.7. Measured longer diagonal for Knoop Hardness Test.

As an example, consider the 500 gf (0.5 kgf) recommended for testing shot particles. If the hardness of a particular particle was 500 HK then $L = [0.500*14.229/500]^{0.5} = [14.229/1000]^{0.5}$ or L = 0.119 mm. This can be compared with the diagonal length of both Vickers and Rockwell indentations (using the same load) of 0.043 mm. The long diagonal of a Knoop indentation is some three times the diagonal length of Vickers and Rockwell indentations made on metal of the same hardness. This ratio is commonly quoted.

Fig.8, based on equation (4), shows how the length of a Knoop diagonal varies with the two commonly applied loads and Knoop hardness.

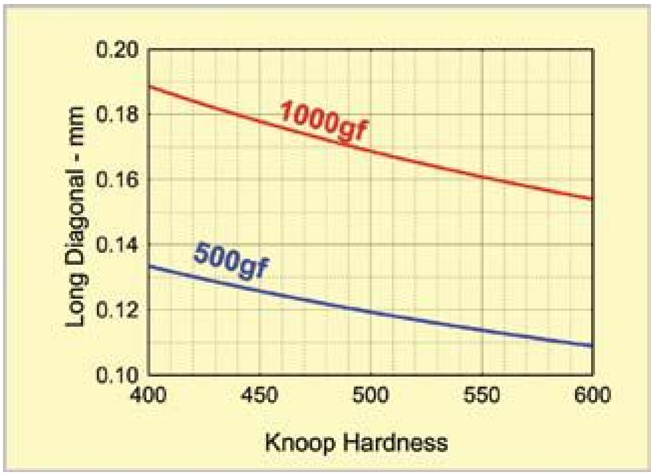

Fig.8. Effect of hardness and load on Knoop long diagonal.

SHOT HARDNESS TESTING

Shot hardness is of vital importance to shot peeners. To avoid superficiality, only testing of steel shot will be discussed. All hardness tests are, however, based on two considerations:

(1) **Technique to be employed** and

(2) **Procedure to be employed when applying the selected technique.**

(1) Technique to be employed

The technique to be employed by shot manufacturers is normally dictated by specification requirements. Unfortunately, published specifications are not always very clear as to which technique (Rockwell, Vickers or Knoop) is to be employed—or why. There is a gray area between macro- and micro-hardness techniques. This is exemplified by the nineteen-to-one range of standard shot diameters as indicated in Table 1.

Table 1. Nominal Shot Diameters Derived Using J444

Shot	Diameter	
	-inch	-mm
S70	0.0070	0.1778
S110	0.0110	0.2794
S170	0.0170	0.4318
S230	0.0230	0.5842
S280	0.0280	0.7112
S330	0.0330	0.8382
S390	0.0390	0.9906
S460	0.0460	1.1684
S550	0.0550	1.3970
S660	0.0660	1.6764
S780	0.0780	1.9812
S930	0.0930	2.3622
S1110	0.1110	2.8194
S1320	S1320	3.3528
Ratios highest/lowest	19:1	19:1

It is important to relate indentation size to shot diameter. Consider, as an example, that 450 Knoop hardness for S70 shot had been specified using a 500 gf applied load. Fig.9 on page 36 shows that the long diagonal 0.127 mm of a centrally placed indentation would then be a very large fraction of the 0.1778 mm nominal diameter! The deformation area around the indentation would certainly reach the shot's surface. On the other hand, for larger shot sizes this fraction reduces rapidly. This would then not be too much of a problem if the shot was uniformly hard from surface to center but that would be very exceptional. The obvious alternatives would be to employ either Vickers or Rockwell techniques. For 500 gf loads the Vickers/Rockwell indent diameter would be only 0.047 mm as included in fig.9. It should also be remembered that cast steel shot has a range of diameters. At the bottom end of this range the diameters of some S70 particles would be much less than 0.127 mm!

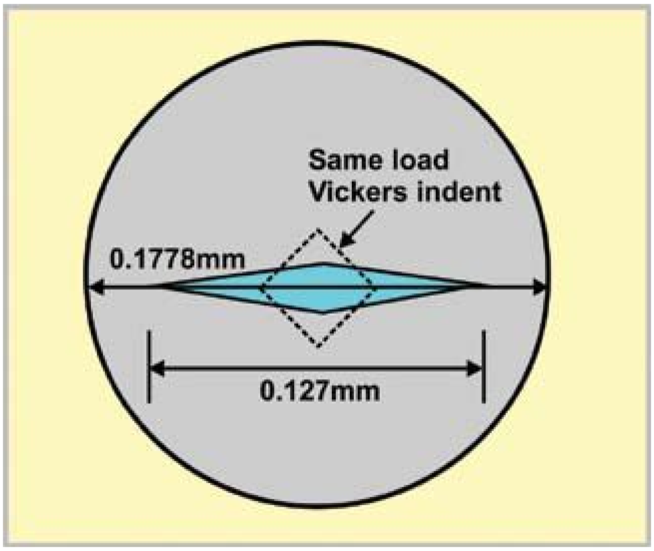

Fig.9. 500 gf Knoop indentation for 450 HK S70 shot particle.

(2) Procedure to be employed when applying the selected technique.
Some specifications include directions for the procedure that has to be employed for selected techniques. AMS 2431 gives extensive guidance on micro-hardness testing using either Knoop or Vickers techniques. SAE J827 contains the following specific guidance as to the procedure to be employed:

> **10.2 Sample Mounting for Testing.** Shot samples used for testing for hardness, microstructure and objectionable defects shall be mounted one layer deep in Bakelite or other suitable strong metallurgical sample mounting media.
>
> The mounted sample shall be ground to the center of the particles and polished by methods acceptable for microscopic examination. When grinding and polishing the sample, care must be taken not to overheat the sample and affect microstructure and/or hardness.
>
> **10.3 Hardness Testing.** Hardness measurements shall be taken at the half radius on a minimum of 10 particles in the mounted samples.
>
> The hardness shall be determined by using ASTM E 384 and using a 500 g load for HCS S280 and finer, and 500 or 1000 g load for sizes HCS 330 and larger. Other microhardness test methods may be used as long as a reliable hardness conversion can be obtained by calibrating the test machine against known standards. Approximate conversion to Rockwell C Hardness Numbers can be obtained from ASTM 140 and from manufacturers of hardness testers.

Having to take measurements at half radius appears to rule out employing Knoop testing for shot particle hardness!

The guidance on sample mounting raises the question "What effect will shot diameter variation have?" We cannot assume that every shot particle in a sample will have the same diameter. Fig.10 illustrates, schematically, the effect of diameter variation. Following the instruction: "The mounted sample shall be ground to the center of the particles" is tricky! There will be a range from what is obviously over-ground, some particles disappearing, to under-ground, where all particles present less than their diameters. A further complication is that the individual particles may well vary in hardness from surface to center.

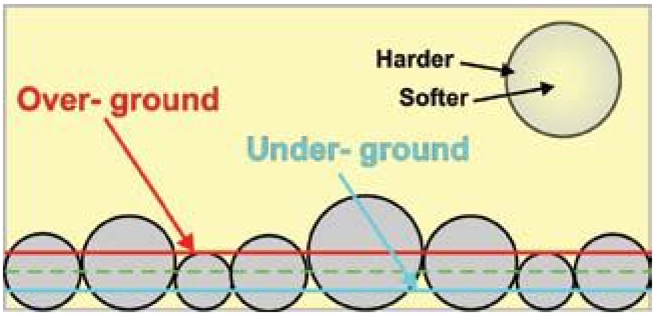

Fig.10. Schematic representation of mounted sample grinding.

HARDNESS TEST ALTERNATIVES

Hardness testing requires specialised skills and equipment not commonly available to shot peeners themselves. The question arises: "Are there useful alternatives to conventional hardness tests?" One possibility could be to use an inverted Scleroscope procedure. As an introduction, imagine holding the top of a (cheap) ball-point pen and then dropping it from a height onto a very hard surface. It will bounce up after impact.

With the Scleroscope procedure the impacting ball is harder than the target material. Inverting the procedure we could use shot particles as indenters and a target material that is much harder than the shot particles. On impact it would be the shot particle that deformed rather than indenting the target. The rebound height would therefore increase with hardness of the shot particle. An appropriate parallel to a pen's ball-point is indicated schematically in fig.11 on page 38. The rest of the device would be similar to that of a Scleroscope.

CONCLUSIONS

Being able to predict the size of hardness indentations gives us a much better understanding of their significance. For specific applications, such as shot particle hardness, care has to be taken to relate indentation size to shot diameter. Only Vickers and Rockwell techniques appear to be appropriate and Knoop to be inappropriate.

The inhomogeneous nature of hardness for most objects must be taken into account when applying micro-hardness tests. Mounting of a sample of shot particles introduces another source of hardness measurement variability.


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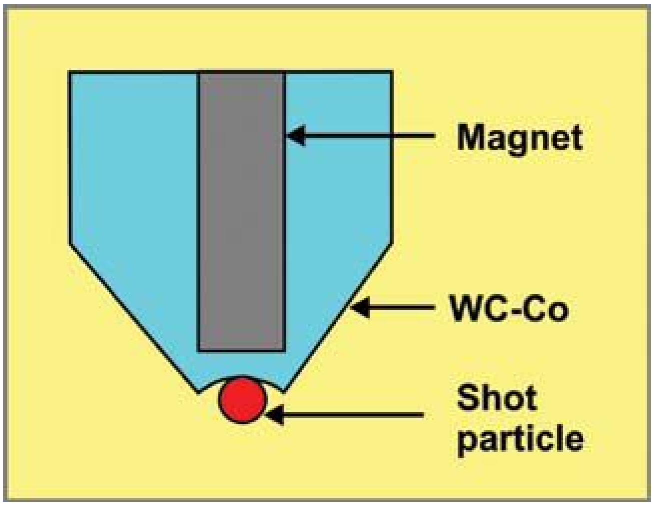

Fig.11. Schematic representation of proposed indenter point.

Alternatives to conventional hardness test procedures should be considered such as one based on fig.11. A secondary use of that device would be to assess toughness of shot particles. The device could be employed by monitoring the drop height needed to fracture particles.

Finally, it appears obvious that hardness measurement variability is unavoidable—even with the most careful application of existing specified procedures.

Clemco Goes Green

CLEMCO INDUSTRIES has received a $47,348.12 incentive from Ameren Missouri's BizSavers® program. Ameren Missouri is an American power company. It covers 64 counties and more than 500 communities including the greater St. Louis area. The incentive was presented to Clemco following extensive energy-efficiency renovations to the company's international headquarters located in Washington, Missouri.

"This is a great energy saver for us," said Mark Buersmeyer, Clemco Maintenance Manager. "The Ameren Missouri BizSavers team was easy to work with during this nearly yearlong process. We are now running a "greener" operation, which not only helps Clemco, but also the environment," he added.

Improvements to Clemco's office and manufacturing plant included replacing all interior lighting with highly energy-efficient LED lights, as well as replacing the majority of the facility's exterior lighting with LED lights. In its plant, Clemco replaced 268 high-bay fixtures, 114 ceiling-level fixtures, and 37 flat-panel fixtures. In the front offices, 670 lights bulbs were installed.

This new lighting will save Clemco an estimated $32,700 a year in electrical costs, which likely means a complete return on the company's $79,000 investment in 2.4 years. This translates into a savings of more than 348,000 (kWh) annually, which is equivalent to powering 43 average US homes for a year.

"Our BizSavers energy-efficiency program helps commercial and industrial customers reduce the cost of upgrading to more energy-efficient equipment," said Rich Wright, Manager, Ameren Missouri Energy Efficiency. "Companies like Clemco benefit by saving on the upgrade cost today and saving on energy costs for the life of the equipment."

Representatives from Ameren Missouri present the incentive check for Clemco's energy-efficiency renovations.


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Drum Shot Blasting Machines at Sinto America's Test Center

SINTO AMERICA'S Surface Treatment Test Center, a design and engineering operation for customer-specific applications, is located at our Grand Ledge, Michigan facility. Sinto's test center is equipped with our large and small drum blast machines along with spinner hangers, table blast and tumble blast.

"The facility includes full-scale shot blasting machines to test your parts as opposed to a machine that will "simulate" the results. This allows the customer to decide what application best fits their needs," said Todd Breault, Vice President Surface Treatment.

Sinto's drum blast machines allow for faster, safer and cleaner finishing. They feature powerful, centrifugal blast wheels that have been used in thousands of applications worldwide. The hydraulic loader on the drum blast machines minimizes breakage and damage to the parts with smooth and reliable loading. The core of these machines are a one-piece manganese drum, available in 3- to 35-cubic-foot capacities.

The manganese drum has an increased working life and a zero pinch design. An adjustable drum oscillation during blasting reorients the parts to expose more surfaces to the blast stream, increasing part cleanliness. These systems combine to decrease cycle time over conventional steel belt tumble blasts by as much as 50% with no flights to replace, no chains to break, and no pins or links to wear out.

Sinto has long strived to be the leader in the design and manufacture for all surface treatment, metal finishing and shot blasting applications. From standard to custom, simple or complex, a single piece of equipment to a full system, that's the Sinto difference. We are your one-stop solution.

Sinto Surface Treatment is a division of Roberts Sinto Corporation. Roberts Sinto Corporation is a part of Sinto America, Inc., the North American group holding company, of Sintokogio, Ltd., Japan. The Sinto group of companies has an international reputation for excellence in the foundry, manufacturing and surface treatment industry. With over 80 years of experience providing state-of-the-art systems to industries worldwide, Sinto Surface Treatment is well positioned to provide the optimum solution to your finishing challenges, offering a complete, comprehensive line of surface treatment blast machines to fit any application.

Sinto America focuses on six primary markets including Foundry, Sand Processing, Bulk Material Handling, Automation, Surface Technologies and Surface Treatment. Sinto also provides contract blasting and precision shot peening services through our National Peening and Technical Metal Finishing divisions.

Learn more at www.sintoamerica.com or contact Todd Breault at (517) 371-2460, extension 1011, or send email to Todd.Breault@sintoamerica.com.

Drum shot blasting machines at Sinto America's test center in Grand Ledge, Michigan.


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- LPB mitigated damage to a 1 mm depth of compression in both alloys.
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Read the complete technical paper titled, "Fatigue Life Extension of Steam Turbine Alloys Using Low Plasticity Burnishing" at www.lambdatechs.com/technical-papers.

For more information on this and other LPB applications, visit www.lambdatechs.com or contact Julie Prevey at 800-883-0851.


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Blast Cleaning Steam Turbine Diaphragms

MARKET
Power Generation

APPLICATION
Refurbishing steam turbine diaphragms using abrasive blast cleaning

THE CHALLENGE
A major supplier to the power generation industry wanted to automate the refurbishing of steam turbine diaphragms using abrasive blast cleaning. The existing process of manually blasting the diaphragms with a worker in a blast booth was labor intensive and time consuming. Part size and configuration would make automation difficult, however, as the diaphragms ranged in size from 4" to 90" in diameter and each part had many different faces. In addition, the parts had already been in service and extreme care was needed to ensure that the proper amount of material was removed. Each surface required a precise amount of blasting to bring it back to original specifications. An even bigger challenge was the fact that parametric programming would be required to segment the blast areas; however, 3-D CAD models of the parts did not exist.

THE SOLUTION
The power generation supplier was an Empire customer that was using an Empire blast system to process newly manufactured parts. Based on the success of this system, they turned to Empire for a solution to blast cleaning the steam turbine diaphragms. After careful analysis of the problem, Empire devised a solution and was also able to demonstrate to the customer how the system would work.

To automate the process, Empire provided two custom engineered automatic robotic blast cleaning systems featuring invert-mounted robots. Empire recommended the proper size and orientation of robots that would get the job done efficiently and meet the required quality standards. In order to allow for parametric programming and segmenting of the blast areas, Empire worked closely with Robot Master who developed a custom software program which would enable the supplier to create 3-D CAD models of the diaphragms.

Utilizing the industrial PC supplied with the blast system, the software program features the ability to enter up to 29 different dimensional parameters in a spreadsheet format and then programmatically generate a 3-D CAD model. This model can then be viewed on screen to make sure that it matches the physical part.

After confirming that the 3-D model matches the diaphragm, a robotic tool path simulation executes with exact robotic blast sequence. It can be viewed on screen for quality control purposes prior to actual processing. The software also offers the ability to upload the program from the industrial PC to the blast unit's robot controller via File Transfer Protocol (FTP) versus the traditional method of using a USB card. FTP is faster and more reliable.

The robot controller also utilizes a Robot Master software package that gives precise segmenting of the blast areas. A key feature of the software is the ability to programmatically select whether each surface of the part will be processed simultaneously or, if needed, selected individually. This selective feature allowed critical areas to be easily reprocessed, eliminating time-consuming manual touch-up.

BENEFITS
Empire's solution enabled the supplier to improve quality and lower costs by replacing a worker in a blast booth with an automated blast cleaning system. Manually blast cleaning a single diaphragm took four to five hours. The Empire system cleans a diaphragm in as little as 45 minutes, resulting in significant savings in time and labor.