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The Shot Peener

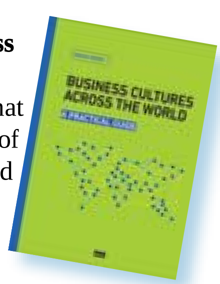
Sharing Information and Expanding Global Markets for Shot Peening and Blast Cleaning Industries

Kelly McClurg

2019 Shot Peener of the Year

PLUS:

- THE UPCOMING DOD CYBERSECURITY MATURITY MODEL CERTIFICATION PROGRAM
- CUT WIRE OR CAST STEEL SHOT?
- THE APPLIANCE OF SCIENCE



Press Releases

THE SHOT PEENER
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OPENING SHOT

Jack Champaigne | Editor | The Shot Peener

Welds: A Favorite Topic

MY INTEREST IN SHOT PEENING WELDS began in 2004 at a SAE weld challenge that included peening. Since then I've uploaded 48 papers on the topic to the Library at www.shotpeener.com.

In the past few months, several things happened that broadened my respect for shot peening's ability to improve the fatigue strength of welds. First, I met Civil Engineering Professor Robert Conner with Purdue University. He was one of the authors of "Fatigue Life Improvement of Welded Girders with Ultrasonic Impact Treatment." Ultrasonic Impact Treatment (also called "Needle Peening") is especially valuable to retrofitting applications such as aging steel bridges.

In addition, Julien Jeanneau, with Empowering Technologies, loaned needle peening equipment to Purdue through Purdue's Center for Surface Engineering and Enhancement (CSEE). The equipment is being used for student projects. Electronics Inc., through CSEE, is funding further student research on needle peening.

Coincidentally, Empowering Technologies used their needle peening technology on the Route 52 bridge over the Wabash River in northwest Indiana. According to Professor Connor, "Many of our country's bridges are at least 50 years old. We have found that needle peening can extend the useful life of older bridges by improving their fatigue strength." It's rewarding to me that the peening of welds can be part of the maintenance and repair solution for the United States' aging bridges.

Congratulations to our 2019 Shot Peener of the Year

I couldn't end this column without acknowledging our 2019 Shot Peener of the Year. Congratulations, Kelly, on this well-deserved recognition of your contribution to our industry.

Purdue engineering students gain hands-on experience with needle peening equipment on loan from Empowering Technologies. From left to right: Zane Smith, Sebastian Aldwin, Erik Dabagian, Steven Clark and Brandon Thornell with Empowering Technologies.

THE SHOT PEENER

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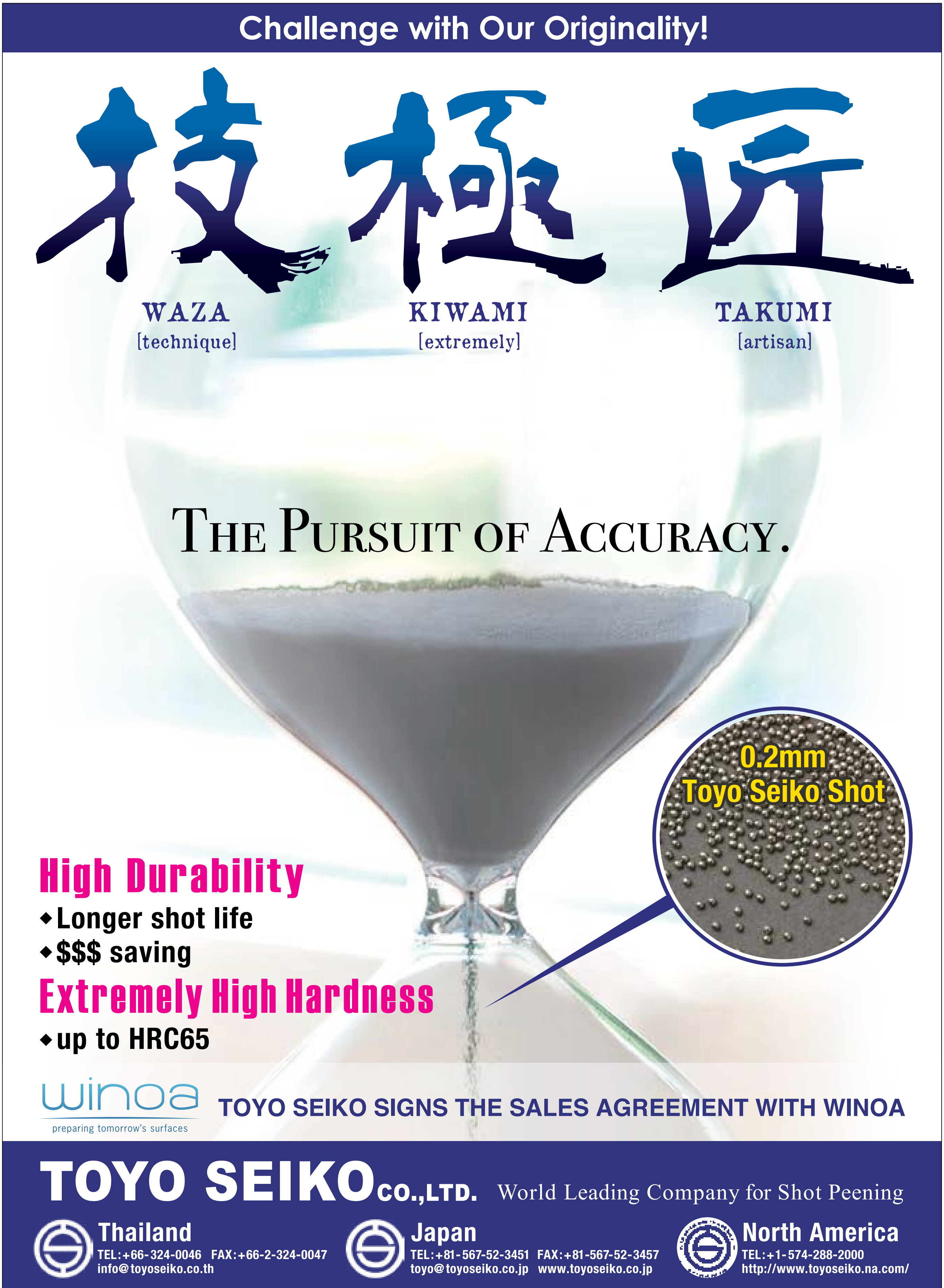
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2019 Shot Peener of the Year
Kelly McClurg

ANNOUNCING THE WINNER of "The Shot Peener of the Year" award is a U.S. Shot Peening and Blast Cleaning Workshop tradition. It was an especially fun event this year because Kelly McClurg is a workshop instructor and was sitting in the audience.

Since 1992, *The Shot Peener* magazine has given the award to individuals in our industry that have made significant contributions to the advancement of shot peening. "Kelly is a rising star in our industry that deserves recognition for all she has already accomplished. Her work in Ultrasonic Shot Peening has helped establish it as a viable tool in aviation repair and maintenance. In addition, she gives back to the industry through teaching and taking an active part in SAE committees," said Jack Champaigne. Jack is the Editor of *The Shot Peener* magazine and he presents the annual award at the workshop.

Kelly McClurg received "The Shot Peener of the Year" award from Jack Champaigne at the U.S. Shot Peening Workshop.

Kelly is a Metallurgical Engineer III in the Metallic Materials and Processes department at Bell Textron Inc. in Grand Prairie, Texas. Bell produces manned and unmanned vertical-lift aircraft for commercial and military usage and the company is the pioneer of the revolutionary tiltrotor aircraft. Kelly focuses on heat treatment for the drive systems center. She audits suppliers for heat treat and special processes and acts as a liaison to these companies.

Kelly is also part of a team at Bell that is continuously looking at improved surface treatments, including peening methods, that can improve their products' performance, reliability, and cost. Some of the current technologies under consideration and investigation at Bell include cavitation peening, flapper peening, ultra fine peening, low plasticity burnishing, laser peening, and variations on process controls for conventional shot peening (such as shot hardness). Bell is investigating repair capabilities with this process.

In addition to her responsibilities at Bell, Kelly has been an active member in the SAE Surface Enhancement Committee and Aerospace Surface Enhancement Committee since 2013. Kelly became the secretary for these committees in 2018. She also leads classes on specifications for the U.S. Shot Peening and Blast Cleaning Workshop.

Kelly graduated from Texas A&M University with a bachelor's degree in Biomedical Engineering. It was at Texas A&M that she was first introduced to shot peening. "It was a single paragraph in a chapter on surface enhancement," said Kelly. She went on to receive a master's degree in Material Science and Engineering from the University of Texas in Arlington.

Kelly started her career with Avion Solutions. It was at Avion that shot peening became more than a paragraph in a book. When she joined Avion, the company was in their final phases of a Small Business Innovative Research (SBIR) project with the U.S. Army. The project studied Ultrasonic Shot Peening (USP) as a repair procedure for military helicopters and fixed-wing aviation. Shot peening became one of Kelly's biggest projects with Avion. She also conducted research on mini-Almen strips that led to her position as a PhD candidate at the Clausthal University of Technology in Germany. Kelly's PhD dissertation focuses on the further qualification of Ultrasonic Shot Peening on aerospace-grade materials. She will present a paper on this topic at the 14th International Conference on Shot Peening (ICSP-14).

Kelly's paper for ICSP-14 will not be her first research paper. She has co-authored nine papers on USP research for aircraft. She presented a paper titled "Mini-Almen Strips: A Promising New Technology" at the 2013 U.S. Shot Peening and Blast Cleaning Workshop.

Keeping the name of the award's recipient a secret is always a challenge but *The Shot Peener* staff managed it again this year. It wasn't until Jack Champaigne, during his opening remarks, spent a lot of time sharing her profile as an instructor that Kelly realized she had won. "I am beyond thrilled to have won this award and appreciate the acknowledgement of my dedication to the shot peening industry. It is an honor to be only the second female and youngest winner of this award," Kelly said.

We look forward to many more accomplishments from Kelly.

A complete list of "The Shot Peener of the Year" award recipients is available at www.theshotpeenermagazine.com.

Are You Prepared for the Upcoming DoD Cybersecurity Audit Program?

DO YOU SELL PRODUCTS to any division of the U.S. Department of Defense (DoD)? Are you a subcontractor on a major defense contract? Do you want to be a DoD supplier? If you answered "yes" to one of these questions, please take note of an upcoming deadline that may affect your business. Beginning in September 2020, all vendors must show evidence of their Cybersecurity Maturity Model Certification (CMMC) when submitting a proposal for a DoD contract. Certification is achieved by passing an audit by an accredited and independent third-party commercial certification organization. The CMMC will have five levels, from Basic Cybersecurity Hygiene to Advanced. The contracting authority will request the necessary certificate level to bid on their contract.

Certification will be mandatory even if you aren't working with classified information and this includes sub-contractors for the DoD. "Please note that the landscaping contractor who cuts DoD facility grass will need at least a CMMC Level 1 Cert," wrote Eugene Jones, a Manufacturing Business Consultant with the Purdue Manufacturing Extension Partnership (MEP), in a recent newsletter.

For our readers being exposed to this information for the first time, let's review the backstory of the CMMC.

Why It's Needed

"Terrorists, criminals and foreign adversaries are using cyber to steal our technology, disrupt our economy and government processes, and threaten critical infrastructure," wrote Katie Lange in an article titled "DoD's Cyber Strategy: 5 Things to Know" published on the Department of Defense's website (www.defense.gov). Ms. Lange went on to describe the DoD's cyberstrategy that outlines their efforts to support the U.S. National Cyber Security platform, released in an Executive Order by the White House in 2019. Ms. Lange's article cited these goals of the DoD's cyberstrategy that are of particular interest to our industry:

- Preventing harmful cyber activities before they happen by strengthening the cybersecurity of systems and networks that support DoD missions, including those in the private sector
- Setting and enforcing standards for cybersecurity, resilience and reporting
- Holding DoD personnel and third-party contractors more accountable for slip-ups

In a 2016 cybersecurity summit at the U.S. military academy in West Point, Richard H. Ledgett Jr., then the deputy director of the National Security Agency, pointed out the vulnerabilities in the DoD supply chain. "More and more devices are being connected to the Internet," Ledgett said. "Some 6.4 billion things worldwide will be connected by the Internet this year, and by 2020, that number will be about 20.8 billion. The challenge is identifying emerging risks and vulnerabilities that come about with the introduction of new hardware and software. Any system is only as strong as its weakest link," he added. "Most types of devices connected to the Internet are built with differing security profiles and updated on differing timescales, and every time it's updated, that's another opportunity for a security vulnerability."[1]

While DoD prime contractors have been held to high cybersecurity standards for several years, the small- to mid-sized companies that supply DoD prime contractors often do not have robust cybersecurity defenses, making them targets for hackers. To overcome these weaknesses, DoD is launching CMMC to verify cybersecurity practices and processes are in place and to protect Controlled Unclassified Information (CUI) on the networks of DoD industry partners.

NIST 800-171, DFARS and CMMC

NIST 800-171 is a NIST Special Publication with requirements for protecting the confidentiality of Controlled Unclassified Information (CUI). Defense contractors had until December 31, 2017 to implement its requirements. NIST 800-171 has the following 14 sections that are then broken down into 110 required controls:

- Access Control
- Awareness and Training
- Auditing and Accountability
- Configuration Management
- Identification and Authentication
- Incident Response

1. "Critical Infrastructure Vulnerable to Attack, NSA Leader Says" by David Vergun at www.defense.gov.

- Maintenance
- Media Protection
- Personnel Security
- Physical Protection
- Risk Assessment
- Security Assessment
- System and Communication Protection
- System and Information Integrity

Defense contractors are also required to comply with the Defense Federal Acquisition Regulation Supplement (DFARS) Clause 252.204-7012 titled "Safeguarding Covered Defense Information and Cyber Incident Reporting." The clause specifies that all Department of Defense contractors and sub-contractors that process, store, or transmit Controlled Unclassified Information must demonstrate adequate security by, at a minimum, implementing the NIST 800-171 security requirements.

CMMC incorporates NIST 800-171 and several other cybersecurity control standards. Implementing NIST 800-171 assures compliance to the DFARS clause 252.204-7012. According to Eugene Jones, compliance to NIST 800-171 is a good approximation to achieving CMMC Level Three and Level Three will be necessary for any contractor manufacturing a product to DoD specifications.

The Benefits of CMMC to Industry

CMMC is being presented as a more realistic approach for small suppliers since a small company may not have to meet the stringent requirements of NIST 800-171. "If you are only selling nuts and bolts to a larger prime, there is no need for you to go through the effort of implementing all 110 requirements of NIST 800-171. You may only need to implement 63 of the new requirements to achieve a level 2 certification for CMMC, or even less to be level 1 certified," said Katie Arrington, Special Assistant to the Assistant Secretary of Defense, in an article at www.ComplyUp.com. The standard is meant to reduce ambiguity by clearly outlining what is expected to achieve compliance and how CMMC will be reinforced. (NIST 800-171 relies on organizations to self-assess and then report their compliance.) The consequence of non-compliance to CMMC will be very clear and immediate—a company without the appropriate level of certification will not be able to bid on DoD contracts.

An additional benefit of CMMC certification is that it's an asset to your entire customer base, not just the DoD. It shows your commitment to protecting their confidential information and it is an accomplishment similar to achieving ISO certification. A strong cybersecurity policy will also protect your company from threats like Ransomware and cyber theft from inside and outside your organization.

Timeframe for Compliance

According to the DoD, CMMC Version 1.0 (an assessment and accreditation tool) will be available in January 2020. In June 2020, industry should begin to see the required CMMC level in Requests for Information (RFIs). The standard's requirements will be included in Request for Proposals (RFPs) starting in September 2020.

Questions With Answers

If you think you will be affected by CMMC, you may have the following questions.

How Will CMMC Impact My Business?

Every contractor's existing work will be up for grabs depending upon which CMMC level is required by the contracting authority. You could lose or gain business, depending on if you obtain CMMC certification.

How Much Will Compliance Cost in Time and Money?

This depends on your level of cybersecurity hygiene now. The first step to obtaining CMMC certification will be an analysis of your current practices by an outside resource. (More on these resources later in this article.) After an analysis, you can determine if DoD business is worth the time and money needed to keep it. Ms. Arrington, at a Professional Services Council event in July 2019, said contractors could write off a portion of their cybersecurity spending for government contracts, including implementing NIST guidance. As of November 2019, no further information was available on this.

Questions With No Answers

Despite the hours of research I conducted for this article, I couldn't find a good answer to several questions.

- What is the appropriate CMMC Level for the contract? The only information I could find was "The government will determine the appropriate tier for the contracts they administer and the CMMC requirements will be part of Requests for Information."[2] (This could make it difficult to achieve the appropriate level in time to bid on the contract.)
- If a company sells an off-the-shelf product to a prime or subcontractor, will that company need CMMC certification?
- Since a supplier needs to be certified by a third-party certification vendor, is it realistic that every supplier can be certified by September 2020?
- What happens if a large number of DoD suppliers can't be certified in time? Will the deadline be extended? Or will many small companies drop out of the supply chain?

I'm not the only one with questions. CMMC is getting pushback from industry. Three of the largest defense industry associations—the Professional Services Council, the National Defense Industrial Association and the Aerospace Industries Association—are raising questions about CMMC,

2. The Office of the Under Secretary of Defense for Acquisition & Sustainment Cybersecurity Maturity Model Certification at www.acq.osd.mil/cmmc/faq.html.


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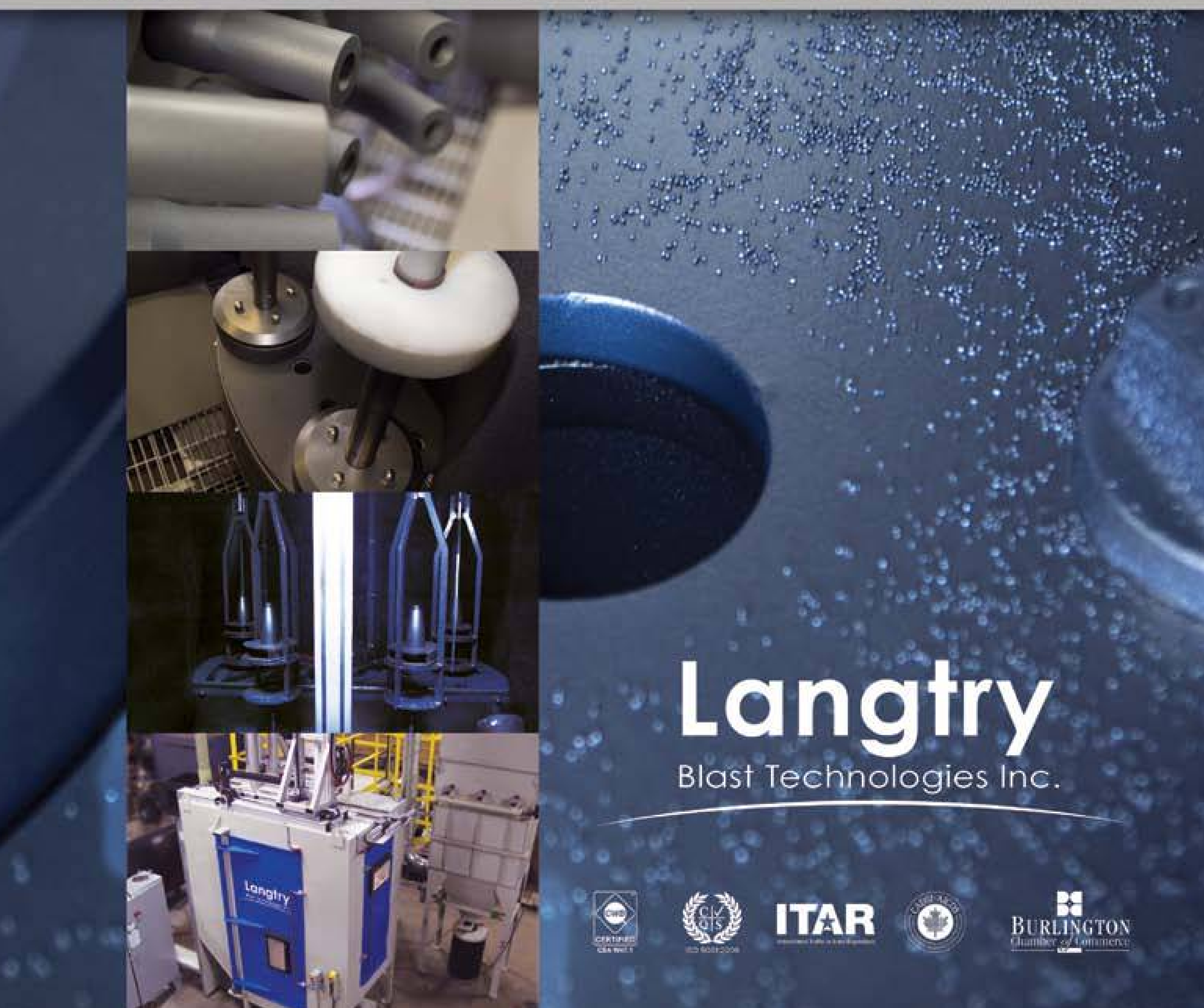
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including concerns about the implementation time line and the lack of clarity on how it will be applied across different programs and suppliers. “This would have severe unintended consequences on small businesses that do not have the resources and sophistication to obtain a high CMMC level, producing market entry barriers and limiting competition,” the Professional Services Council wrote in a Sept. 25, 2019 letter to the DoD after a draft release of the plan.[3]

Next Steps

If you are unsure if you need to achieve CMMC, check with your prime contractor or subcontractor. They are already preparing for accreditation and they may know if you need to attain CMMC, and at which level, to keep their business.

If you do need to achieve compliance, a good place to seek information is the National Institute of Standards and Technology Manufacturing Extension Partnership (NIST MEP) program in your state. There are MEP Centers in all 50 states and Puerto Rico. (Visit www.nist.gov/mep/mep-national-network to find the program in your state.) Your MEP center may have already launched CMMC compliance assistance seminars. If you have IT staff, it is possible to achieve the appropriate CMMC level in-house, following the NIST Handbook 162 (see Resources below).

There are also numerous CMMC Consultants online that can help companies through the process, from assessment to audit.

In Conclusion: It’s Only the Beginning

When I wrote this article in the fall of 2019, the launch of CMMC seemed very fluid to me. And I recognize that I lightly touched on critical components of CMMC, in particular NIST 800-171 and DFARS. To this end, I provided a few resources below to help you learn more about CMMC.

3. “Should Contractors be Fined for Their Subprimes’ Cybersecurity?” by Andrew Eversden at www.federaltimes.com.

Resources

NIST Handbook 162 “NIST MEP Cybersecurity Self-Assessment Handbook For Assessing NIST SP 800-171 Security Requirements in Response to DFARS Cybersecurity Requirements.” Download at www.nist.gov/publications/nist-mep-cybersecurity-self-assessment-handbook-assessing-nist-sp-800-171-security.

The National Institute of Standards and Technology Manufacturing Extension Partnership at www.nist.gov/mep/mep-national-network.

Frequently Asked Questions on many aspects of CMMC are at the Office of the Under Secretary of Defense for Acquisition & Sustainment Cybersecurity Maturity Model Certification. (www.acq.osd.mil/cmmc/faq.html)

Kathy Levy | Associate Editor | The Shot Peener

Seven Reasons You Need Strong Cybersecurity

1. Ransomware

According to Cybersecurity Ventures, Ransomware will have cost businesses and organizations around the world $11.5 billion in 2019 in ransom money, downtime and lost data.

2. Email

Email accounts are hacked because they are often a weak link in an organization’s security pipeline.

3. Data breaches

A data breach can be caused by:

- Human error
- System glitches
- Malicious or criminal attacks

4. Laptops

Lost or stolen company laptops are a common cause for security incidents.

5. Employee theft

IBM’s 2016 Cyber Security Intelligence Index found that 60 percent of all breaches are carried out by insiders, including current and former employees who—intentionally or unintentionally—take classified or proprietary information with them when they depart.

6. Lack of employee training

Do your employees know what to do when a data breach occurs?

7. Your customers

Your customers entrust you with their financial and business information. It’s your responsibility to protect it. A strong cybersecurity policy should be part of your marketing materials—it demonstrates your commitment to good business practices.

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- **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.

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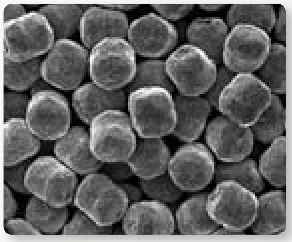

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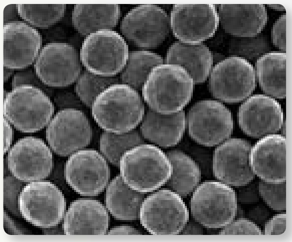

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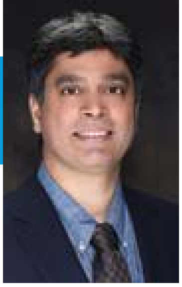


Kumar Balan | Blast Cleaning and Shot Peening Specialist

Cut Wire or Cast Steel Shot – A Review

INTRODUCTION

One of the challenges in our industry has been to increase the awareness for shot peening, but with concerted efforts we are seeing this move in a positive direction. During a re-cap after the recent EI USA Shot Peening Workshop, the instructors all agreed that the understanding and participation level of students had increased over the years. The questions and comments discussed in the classes were quite advanced. That said, I would like to highlight a recurring conversation at the workshop that will benefit from additional elaboration. This discussion pertains to the choice between conditioned cut wire (CW) shot and cast steel shot.

CUT WIRE OR CAST STEEL SHOT – WHICH ONE IS BETTER?

I was part of interesting discussions during a class on cut wire media from Toyo Seiko at the recent workshop. Conversations during this class prompted me to conduct additional research, courtesy of Toyo Seiko and Ervin Industries. These companies are two leading manufacturers of cut wire shot and cast steel shot respectively.

Common practice is for end-users to specify peening media type, size and sometimes the hardness. For example, the drawing might require you to peen the landing gear component to an intensity range of 0.012 to 0.015A using S230 for 100% coverage. The specification might even narrow down the scope to the use of ASR (regular hardness: 45 to 52 HRC) or ASH (high hardness: 55 to 62 HRC) media. Such specifications are now being enhanced to include an optional media type. The same specification will now read, 0.012 to 0.015A using S230 or CCW 28, with the scope sometimes further narrowed to stipulate the use of AWCR (regular hardness: 45 to 52 HRC) or AWCH (high hardness 55 to 62 HRC). Being a relatively new type of media as compared to cast shot, cut wire shot (conditioned) is a cold-drawn product, cut into cylindrical pieces and conditioned (rounded) by bombarding it against a fixed target. This process rounds the sharp edges; thereby attempting to eliminate part damage due to edge sharpness. The length of the cylindrical portion is the same as the diameter of the cylinder. This results in an almost spherical shape after conditioning. Drawings calling out for the use of CW shot also specify the desired level of conditioning, such as single conditioned, double or special conditioned cut wire. VDFI8001 (Deutsche) standards categorize this as G1, G2 and G3. Evaluating such levels of conditioning are visual and the AMS standards committee continues to explore means of quantifying them.

As compared to CW shot, cast steel shot is a tempered martensitic material manufactured by water atomization of molten steel and air or water quenched. Post-atomization, the product is screened multiple times and heat treated to achieve the desired hardness range.

Some common beliefs in our industry include:

- Cast steel shot fractures rapidly and is unsuitable for shot peening
- CW shot lasts longer than cast steel shot
- CW shot is not liable to damage part substrate since it does not fracture like cast shot
- Transfer of impact energy (and resulting residual stress levels) is better with CW shot than cast steel shot
- CW shot is more expensive than cast steel shot

WHAT DETERMINES DURABILITY?

Let us first try and understand the different specifications pertaining to this media. The primary attribute of any shot peening media is its ability to transfer impact energy effectively and repeatedly. This attribute is largely determined by the media's chemical constituents. Please refer to "The Critical Role of Metallic Shot in Achieving Consistent Shot Peening Results," (*The Shot Peener*, Fall 2017) for an in-depth report on this topic. Listed in Table One are the percentage chemistry of the two media as in AMS and SAE J documents.

Table One

	AMS 2431/1 & /2	SAE J827	SAE J441	AMS 2431/3 & /8
Percentage	ASR & ASH Cast Shot	High-Carbon Cast Steel Shot	Cut Wire Shot	AWCR & AWCH Cut Wire Shot
Carbon	0.80 to 1.20	0.80 to 1.20	0.45 to 0.85	0.45 to 0.85
Manganese	1.20 max*	0.60 to 1.20	0.30 to 1.30	0.30 to 1.30
Silicon	0.40 to 1.50	0.40 min	0.15 to 0.35	0.15 to 0.35
Phosphorus	0.050 max	0.05 max	0.040 max	0.040 max
Sulphur	0.050 max	0.05 max	0.050 max	0.050 max

* min MN content based on shot size

As seen in Table One, the chemistry of both media types is comparable in most of the constituents, with some minor exceptions. The carbon content requirement is lower with CW shot than cast. In general, lower carbon content will lead to the shot absorbing most of the impact energy, leaving less for the actual peening. However, one could also make an argument that higher carbon content could render the media brittle and susceptible to fracture. Overall, the carbon content in both media types draws a balance between the positives and negatives. Silicon (Si), in higher percentages, adds to the durability and acts as a de-oxidizing agent. The higher Si percentage in cast shot as compared to CW shot should address any concerns of loss of durability due to its higher carbon content.

In summary, if we were to look at chemistry determining durability, we will be reviewing comparable products without much of a chemical compromise.

In the case of CW shot, all commercially sold material either conforms to SAE, AMS and VDFI standards. SAE or industrial grade material, in the case of cast steel shot, is commonly used in cleaning applications. However, when not specifically stated in the requirement, it is not uncommon for the shot peener to use SAE grade material for shot peening as well. A quick look at Table One will point to comparable chemistry between SAE and AMS grade cast shot. The differences in the two grades are more to do with size (screening tolerance), shape tolerance and hardness ranges. Table Two lists those specific differences.

Table Two: **Specification Comparison – SAE & AMS for Cast Steel Shot**

Characteristic / Defect	SAE J827 (J444 for screening)	AMS 2431-1
Particle shape	≤ 5%	Specs list marginal and unacceptable shapes – tighter tolerance than SAE J827
Voids	≤ 10%	≤ 15%
Shrinkage	≤ 10%	≤ 15%
Cracks	≤ 15%	≤ 15%
Microstructure	≤ 15%	
Screening		Tighter than SAE J444

Needless to say, AMS grade cast shot goes through several additional rounds of processing in order to maintain conformance, leading to a higher price as compared to SAE grade material.

SHOT HARDNESS, DURABILITY AND FRACTURE

Dr. Yoshihiro Watanabe, President of Toyo Seiko Co. Ltd. in Japan, presented a paper at the Fourth International Conference on Shot Peening, October 1990 in Tokyo, Japan. His work explains the effect of broken media particles on shot peening. He categorizes "hard shot peening" as peening to arc heights greater than 0.7 mmA (0.0275"A) in order to increase the fatigue life of case-hardened components, typically auto transmission gears that are designed to transmit power from high-performance engines. Citing an increase of 25% to 30% in fatigue strength with hard peening as compared to conventional peening, Dr. Watanabe's study takes into consideration two shot samples, at different hardness, HV 550 and HV 700 (55 and 66 HRC). His findings—even though they don't specify the exact specifications of Shot A and B—draw the following conclusions in addition to increase in fatigue strength cited above:

i. High-energy bombardment required to develop increased intensity (0.7 mmA) and corresponding fatigue life also resulted in greater number of broken particles. This was more evident with the media sample of greater hardness.
ii. Harder shot increased the surface hardness of the specimen.
iii. Residual stress generated was comparable between the media types for the lower hardness media, and significantly different for the higher hardness media.
iv. With the lower hardness shot, neither shot sample yielded detrimental quantity of broken material, but that wasn't true in the higher hardness shot. High hardness Shot B disintegrated into increased quantity of smaller particles, leading to scattered peening results that contributed to less than desirable peening quality.

Though the identity of Shot A and B are not known in this study, one can conclude from Dr. Watanabe's findings that higher-hardness media particles, though beneficial for specific high-intensity applications, could lead to greater particle breakdown and not achieve the desired fatigue resistance. Most shot peening machines operate with an inline size classifier sized to remove broken (by size) peening media, and sometimes a spiral separator to separate particles with sharp edges. Also, nothing can replace regular media inspection offline to the main process. So, does cut wire media actually last longer than cast steel shot?

I continued this discussion with Michael Konecny, Quality Manager at Ervin Industries. Ervin is a quality supplier of SAE and AMS grade shot peening media. Mr. Konecny explained the logic and corrections behind the myths in our industry surrounding cast steel shot. "Almost all cleaning applications out there use SAE grade material, with little importance placed on certification, until they see comparative results when we test media in our lab. Specifications have been formulated for a reason and their compliance will result in media that has

Background image courtesy of Progressive Surface.

predictable durability, particularly to address issues found by Dr. Watanabe in his research. Of course, broken particles are never good, especially in critical peening projects." Mr. Konecny added, "All AMS material manufactured at Ervin goes through multiple levels of conditioning and spiral separating (to remove non-rounds) before we certify it to be compliant."

As a cast steel shot supplier, Ervin regularly conducts comparative studies of cast steel shot with cut wire shot with the following results. A summary of two recent tests follows.

Peening Media	Durability %	Transmitted Energy
S330M (47 to 56 HRC)	78% of CCW35	103.1% of CCW35
S390M (47 to 56 HRC)	85% of CCW47	91.2% of CCW47

Given the nature of the process, it is not possible to generalize and advocate for the use of one media type over the other in terms of durability and cost-benefit. Every other aspect being equal, the end-user has to make the determination for the optimum choice.

In terms of transmitted energy, the calculation was done in an Ervin Test Machine that generates a velocity of 200 feet per second. In a production machine, this velocity can be increased by increasing the wheel speed or the air pressure (in an airblast machine) to increase the transmitted energy up to the threshold value for a particular size of media.

Cast shot will fracture as compared to CW shot that wears to a smaller size. Ultimately, both media types that are no longer within tolerance/specifications have to be eliminated from the peening system using process control components.

CONDITIONING, RESIDUAL STRESS AND SHOT FRACTURE

There is no doubt that a cold-drawn product, absent of the voids and other imperfections seen in castings, will wear differently due to its manufacturing process. Toyo Seiko provided me with their comparison documentation that placed CW shot at significantly higher durability than claimed by Ervin's cast shot. Their research interestingly also revealed that the fatigue strength developed by both media types was comparable, except at high hardness, as seen in their study cited earlier. I came across more research presented by Advanced Remanufacturing Technology Center in Singapore comparing AWCR 14 and ASR 110. It validates that residual stress values were indeed comparable even with the smaller size of media, giving us a comparison over a sizeable range. Cut wire, in its "as cut" form has sharp edges and it is critical that conditioning be carried out effectively. That said, other than random visual inspection, there is no quantitative process to determine the extent of conditioning and the percentage of media that has been conditioned. Moreover, there is insufficient evidence that proves CW shot does not fracture. It is imperative that CW shot be 100% conditioned to avoid the risk of as-cut particles with sharp edges residing in the new CW shot. This is of greater relevance when working with smaller-sized media where the diameter has to match the length of the cylinder for proper size control.

Random sample of conditioned CW shot could include traces of insufficiently conditioned, cylindrical particles.

Cast shot fails by fracture. However, this fatigue occurs later in the life of the shot particle and after measurable diameter wear. With this, fractured shot could remain in your machine until it wears down to a size that the classifier screen identifies as being too small. Whether this fractured shot in the interim, with its partial sharp edge (instead of an intended smooth dent), could damage your component is difficult to predict given the relatively random nature of the discharge process from the blast wheel or nozzle. Moreover, the impact value from a broken particle is likely too minimal to cause surface damage.

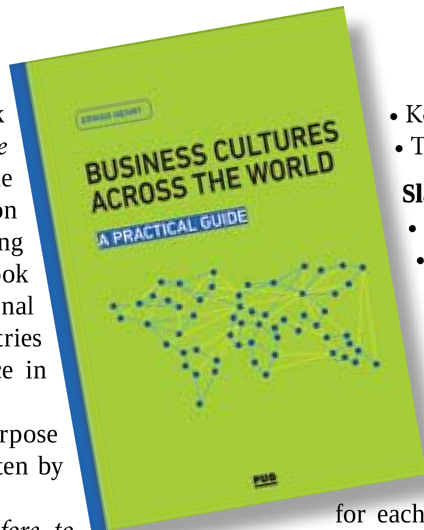
In other words, both media types have their strengths and weaknesses. With vacuum-carburized furnaces replacing their gas-carburized counterparts due to lower CO_2 emissions from the former, parts being produced have hardness exceeding 62 HRC. There might be a niche market that requires hard peening media that guarantees hardness greater than this value. Special-hardened CW shot might be the answer in that market over H hardness shot that provides a minimum hardness of 60 HRC without an upper limit.

SUMMARY

Shot peening applications have different variables and one solution will not address everything. Variables are not only in media options, but in equipment type and process, too. Two different media chemistry values, both conforming to specifications, could lead to slightly different results which is why specifications will give you a target range over a finite value. Consider the data in our discussions and determine which solution will work best for you. After all, that is the reason the specification has not dismissed one media type as ineffective and given you the choice to select.

Business Cultures Across the World

A Practical Guide



ERWAN HENRY'S latest book titled "*Business Cultures Across the World*" is truly a practical guide. The book is filled with useful information in an easy-to-read and engaging format. According to Erwan, the book is the result of 30 years of international business, travelling in over 70 countries with hands-on management practice in 25 countries.

An explanation of the book's purpose was taken from its Forward, as written by Erwan:

> *The aim of this guide is therefore to provide a simple, easily accessible and functional perspective for executives engaged in international business. I shall start by underlining the deep, far-reaching influence of business cultures in the way people behave and interact at work. Then I shall look at the unique features and striking differences between the various families of business culture, to which most national patterns can be linked. My aim is to greatly facilitate the work of executives and reduce stress, when travelling to unfamiliar countries or targeting new markets. Lastly, I shall highlight the buttons to press, to get things done.*

The book covers five key cultures which are further broken down into subcategories.

Anglo-Saxon Business Culture
- American
- British
- German
- Scandinavian and Dutch

Latin Business Culture
- Brazilian
- French
- Italian
- Mexican
- Spain and Hispanic America

Asian Business Culture
- Chinese
- Indian
- Indonesian
- Japanese
- Korean
- Thai

Slav Business Culture
- Polish
- Russian

Other Business Cultures
- Arab
- Sub-Saharan Africa
- Turkish

A particularly helpful aspect of the book is the "Doing Business Takeaways" that are provided for each business culture. These sections are organized into:
- What You Need to Know
- What Does that Mean?
- Which Button to Press
- Handling Negotiations
- Women in Business
- Business Meeting
- Things to Avoid

Again, the information in these sections is concise and useful. For example, "What Does that Mean?" explains the meaning of **Yes** and **No** in several cultures that differs from their literal translation in Anglo-Saxon business cultures. In Mexico, "Si" (yes) means "possibly" or "why not." In France, "Non" (no) is a common first answer to a request. "It is a kind of precautionary principle, 'better to say no and keep all options open, rather than make a commitment I may regret later'," wrote Erwan. As you can see, this will be valuable information when negotiating a business transaction.

The book is available from the European Amazon at 18,00 € and from PUG (the publishing house) at www.pug.fr/produit/1651/9782706142949/business-cultures-across-the-world. In addition to the hard copy, PUB offers eight e-versions at various prices.

About Erwan Henry
Erwan is a global business developer. He has worked all over the world in senior corporate positions. He lectures on Executive MBA courses in Asia, Brazil, Russia and Europe. Erwan also has written five editions of the *Shot Blasting and Metallic Abrasives Global Study*. He may be reached at erwan.henry@yahoo.com.

PRESS RELEASE
Midwestern Industries | www.midwesternind.com

Small Footprint, Big Productivity

IN RESPONSE to the demand from small volume material users, Midwestern Industries, Inc., a leading manufacturing mainstay of innovation for the screening industry since 1953, is introducing their new **MR-18 Gyra-Vib® Separator**. It features an 18" diameter size—their smallest size vibratory separator unit on the market.

A "next-generation" version of their leading MR Gyra-Vib® Separator series, the MR-18 is more compact and versatile. It is ideal for select markets with applications that don't require a lot of material volume including steel shot peening, blast and sponge media, reclaiming systems, bakery, etc.

The MR-18 Gyra-Vib® Separator

Used to separate particles by size or separate solids from liquids, the MR-18 vibratory separator is designed for maximum screening efficiency and easy handling for smaller operations. It features a conventional design utilizing a center-mounted sealed motor and innovative balance cage weight system to control the vibratory screening motion during the screening process. Easy change of the lead angle by adjusting the weights provides for optimal flow patterns and top performance.

Notably, the MR-18 unit comes standard with 1800 RPM motors in a wide range of voltage options. Running at 1800 RPM gives the unit a shorter stroke, which adds to overall through-put to the machine. This delivers less amplitude of up/down vibration thereby keeping the material on the screen longer to ensure more efficient screening.

Specifications

Perfect for both wet and dry applications, the MR-18 is quality built and engineered at Midwestern's Massillon, Ohio manufacturing headquarters (147,000 sq. ft.) and features these essential design and engineering benefits:

- Anti-binding devices including ball tray assembly and slider tray assembly.
- Multiple screening decks are available for simultaneous separation.
- Wide range of screen meshes available down to 25 microns.
- Fully customizable to meet customer's specific screening needs.

Additionally, the MR-18 features innovative balance cages that can extend screen life and ensure the longevity of each vibratory screener. These cages are mounted directly on the motor shaft, and are designed for quick-and-easy weight adjustments for the compact and versatile unit.

Testing

Full-scale screening testing is available for MR-18 Gyra-Vib customers at Midwestern's recently expanded Materials Testing Lab. Testing services are free of charge. Comprised of over 10,000 sq. ft. in Midwestern's manufacturing headquarters, the Lab is an invaluable testing facility platform. It is considered one of the best tools for customers to make informed decisions about their screening processes. Ultimately, end-users can use the facility to gain vital quantitative data into their screening processes via running "real-time," full-scale material tests for new applications as well as improving on existing ones.

Conclusion

Used to separate particles by size or separate solids from liquids, Midwestern's vibratory separators are designed for maximum screening efficiency. The MR-18 Gyra-Vib is the perfect extension of the MR Series' tradition, offering versatility and range in a customer-demanded 18" diameter footprint for a myriad of small volume material applications.

According to Midwestern Sales Manager, Joe Bailey, "We have supplied 18" screens and parts for competitors' equipment in the past, so the unique 18" size has been in demand and on our radar for development for a long time. We've responded accordingly, featuring it at the 2019 USA Shot Peening and Blast Cleaning Workshop in October."

Midwestern's separation equipment can be constructed and finished to industrial, food, dairy, and pharmaceutical standards. Additional screening decks are available for multiple separations.

Speak to a sales representative today to discuss your specific round screening needs by calling: 877-4-SIZING (877-474-9464) or visit: www.midwesternind.com.

PRESS RELEASE
Hardide Coatings | www.hardide.com

Independent Testing Confirms Hardide-A Improves Fatigue Life

NEW INDEPENDENT TESTING has proven that Hardide-A tungsten carbide/tungsten metal matrix composite coating improves the fatigue life of metal components by 4.5% when compared to uncoated substrates.

Hardide-A also eliminates the need for costly secondary shot peening making the coating a significant advancement in materials optimisation for the aerospace and other industries where fatigue debit of surface-coated metals is a problem.

The tests were conducted by Westmoreland Mechanical Testing and Research Ltd (WMTR), a leading aerospace qualified testing laboratory in the UK and USA.

WMTR used the Rotating Bend Fatigue test method complying to BS ISO 1143:2010. This test is considered to be the most sensitive to the effects of surface treatment on fatigue properties. Samples of S99 steel were coated with Hardide-A to a thickness of 63-70 microns and hardness of ~950 Vickers, which are mid-value thickness and hardness properties for this coating type. The test was discontinued after 15 million cycles.

Traditionally, the fatigue debit after hard coatings such as hard chrome plating (HCP) and HVOF coatings have been applied can be as much as 60% and only following shot peening of the coated surface can this be reduced to around a 20% debit. The Hardide-A coating recorded a fatigue life increase of +4.5% after coating without any need for shot peening. The Wöhler S-N curve for the coated samples is clearly positioned above the uncoated control samples' curve by ~40 MPa throughout the whole range of the N cycles to failure.

Fatigue debit of surface-coated metals has been a long-standing problem for the aerospace industry and Hardide-A was developed specifically to meet the needs of the sector. This environmentally compliant and technically superior replacement for HCP and HVOF coatings provides enhanced protection against corrosion and chemically aggressive media, wear, galling, fretting and fatigue.

Dr. Yuri Zhuk, technical director at Hardide Coatings commented: "Metal fatigue is an enduring problem in aerospace as well as for the steam, and industrial gas turbines industries and we recognised the value in commissioning independent testing to verify the fatigue advantages of Hardide-A. The positive 4.5% improvement to fatigue life provides the detailed analysis and assurance that our solution is an alternative to traditional HCP and HVOF coatings. Unlike these other coatings, Hardide-A has no through micro-porosity so it creates an excellent barrier against corrosion as well as improving fatigue performance."

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*** U.S. Patent No. 6,568,239 for Coverage Check Finish**

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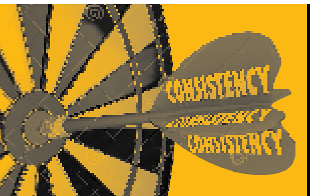

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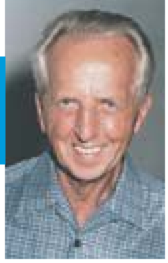

ACADEMIC STUDY
Dr. David Kirk | Coventry University

The Appliance of Science

INTRODUCTION

The following is a quotation from a previous article in this series: "Science is almost always able to provide answers to questions about observed phenomena. Consider as examples: "Why are honeycombs made up of regular hexagons?", "Why are snowflakes sometimes large and sometimes small?" and "Why will a glass of warm water solidify more quickly than an identical glass of cold water when placed together in a freezer?" The ability of science to provide answers to these problems also applies to subject areas such as metals science, aka metallurgy. We do not, however, need to be subject specialists in order to appreciate and utilize the answers.

This article describes the general methodology that is involved when science is applied to the solution of problems. The three universal problems quoted above are used as examples. A Google search for solutions to these problems was surprisingly unrewarding. As a consequence, the author's own attempts are presented. Science can, of course, also be applied to all aspects of shot peening. Graphical representation is included here as being a particularly relevant topic.

Why are Honeycombs Made Up of Regular Hexagons?

Fig. 1 (a photograph by Matthew T. Rader on Unsplash) shows the remarkable structure of bees' honeycombs. The problem is "Why do bees choose this structure?"

Fig. 1. Regular hexagon structure of a honeycomb.

The solution to this problem is reasonably incontrovertible. Bees make honeycombs using eight parts of honey to one part of wax secreted from their own bodies. The honeycomb provides storage space for honey. It follows that they need maximum storage space for each unit of beeswax. Put another way they want to have maximum "bang for buck." The storage space needs to be made up of identical interlinked units that are two-dimensionally symmetrical. It turns out that there are only three possible shapes that will satisfy this criterion: squares, equilateral triangles and regular hexagons. Fig. 2 presents these three shapes as interlinked arrays. This introduces the concept of models which are widely used in science because they simplify any calculations that have to be made.

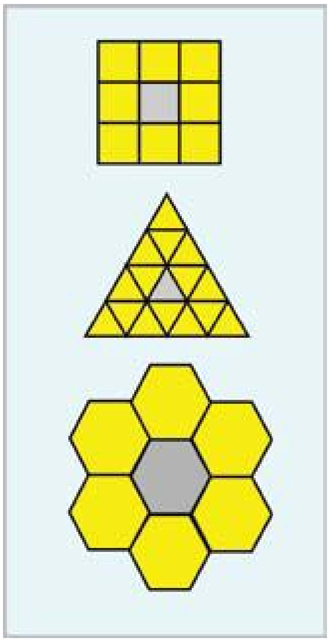

Fig. 2. Interlinked squares, equilateral triangles and regular hexagons.

The "bang for buck" efficiency of the three alternative shapes can be deduced by simple calculations using the three greyed units. Let us assume that each straight side has the same length of 1 unit.

(1) Square

The area of a square of unit side is the square of its side length, therefore:

Area = 1.00

All four sides of the square contribute to a neighbouring square. The square's area of 1.00 has therefore consumed only two sides. Hence we have that:

Square storage efficiency = 0.500

(2) Equilateral Triangle
The area of an equilateral triangle of unit side length is given by:

Area = $3^{0.5}/4$ = 0.433

All three sides of the equilateral triangle contribute to a neighbouring triangle. The area of 0.433 has therefore consumed 1½ straight sides so that equilateral triangular storage efficiency is given by:

Equilateral triangle storage efficiency = 0.433/1.5 = 0.289

We see that the triangular storage efficiency is much lower than that of square storage efficiency.

(3) Regular Hexagon
The area of a regular hexagon of unit side length is given by:

Area = $3^{1.5}/2$ = 2.598

All six sides of the regular hexagon contribute to a neighbouring hexagon.

The area 2.598 has consumed three straight sides so that regular hexagon storage efficiency is given by:

Regular hexagon storage efficiency = 2.598/3 = 0.866

We see that regular hexagon storage efficiency is much higher than that of square storage efficiency and very much higher than that of equilateral triangle storage efficiency.

Bees worked this out 100 million years ago!

Metal Packing Efficiency
The three common metal crystal structures are body-centered-cubic (b.c.c.), face-centered-cubic (f.c.c.) and close-packed hexagonal (c.p.h.). F.c.c. and c.p.h metals both contain close-packed planes of ions. These close-packed planes correspond to maximum packing efficiency. Their packing is illustrated by fig. 3 in which a hexagon has been inscribed. It took until the 20th Century before Sir Lawrence Bragg, using x-ray diffraction, was able to discover close-packed planes.

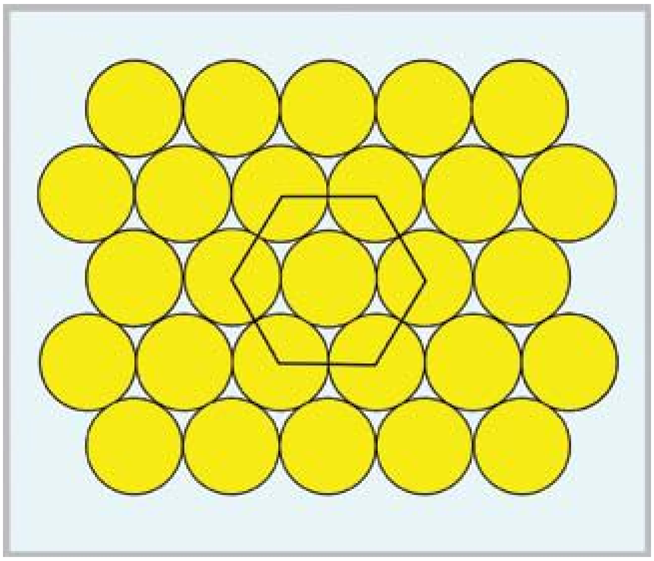

Fig. 3. Arrangement of ions as close-packed planes.

Why are Snowflakes Sometimes Large and Sometimes Small?

A solution to this problem can be found by employing nucleation and growth theory. This theory has numerous applications such as explaining the properties of heat-treated metals.

Whenever a phase change takes place, such as freezing of water or pearlite formation in steels, nucleation and growth are the controlling factors. These can be regarded as competitors. New particles are trying to be nucleated while growth is competing to use the available phase change energy. *Temperature has opposite effects on nucleation and growth rates* which is the key to explaining the phenomenon. Fig. 4 is a schematic representation of the effect of temperature on competing nucleation and growth rates. The axes are deliberately non-dimensional because the effects apply universally.

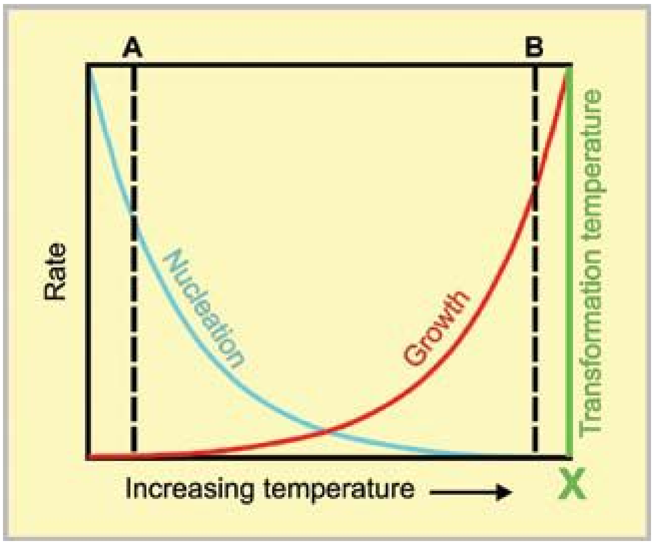

Fig. 4. Effect of temperature on nucleation and growth rates.

Consider the current problem of water freezing to form snowflakes. The temperature marked X in fig. 4 would then be 0˚C. If the air temperature was well below 0˚C (A in fig. 4), the nucleation rate would be very high but the growth rate would be very low — hence we get small snowflakes,

Conversely, if the air temperature was only just below 0˚C (B in fig. 4), the nucleation rate would be very low but the growth rate would be very high, leading to large snowflakes.

Large snowflakes are only just below their melting point. Squeezing a handful injects sufficient energy for some melting to take place at myriad contact points. Immediate re-freezing at these points gives rise to a usable snowball. Small snowflakes, well below their melting point, do not respond by melting and re-freezing on squeezing, leaving one with a handful of powder.

Why Will a Glass of Warm Water Solidify More Quickly Than an Identical Glass of Cold Water When Placed Together in a Freezer?

This is a popular puzzle question first posed by Mpemba in 1963 whilst in Form 3 of Magamba Secondary School, Tanganyika. The headmaster had invited Dr. Denis Osborne from the University College in Dar es Salaam to give a lecture on physics. After the lecture, Mpemba asked the question, "If you take two similar containers with equal volumes of water, one at 35˚C (95˚F) and the other at 100˚C (212˚F), and put them into a freezer, why does the one that started at 100˚C (212˚F) freeze first?" He was ridiculed by his classmates and teacher. Osborne, however, later experimented on the proposition back at his workplace and confirmed Mpemba's finding.

The fact that warm water can freeze faster than cold water has been known for thousands of years, being first recorded by Aristotle and later studied by many scientists including Bacon and Descartes. No generally accepted explanation for this anomalous behaviour has, however, been put forward so here goes with my own!

The heat that has to be extracted from the water is in two parts. Firstly that for lowering the water's temperature to its freezing point and secondly that required to extract the latent heat of freezing. If the warm water was 50˚C above the temperature of the cold water then 50 more calories per cc would be required to be extracted by the freezer than would be required for the cold water before freezing could take place. This amount is, however, dwarfed by the magnitude of the latent heat for freezing the water. Rounding up this magnitude we get 350 calories per cc — freezing therefore requires about seven times the heat extraction needed for simply cooling the water.

Figs. 5 and 6, drawn to the same scale, represent the different stages anticipated for glasses of cold and warm water when placed together in a freezer.

The liquid cooling stage, 0 – A, for the warm water must be longer than that for the cold water. This time difference is much less than simply the initial temperature difference because of the stronger convection currents in warm water. The freezing stage will, however, be much shorter for the warm water than for the cold water!

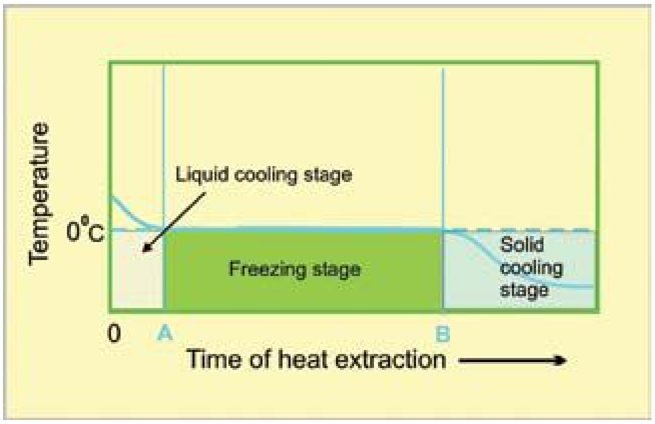

Fig. 5. Cooling curve for glass of cold water placed in a freezer.

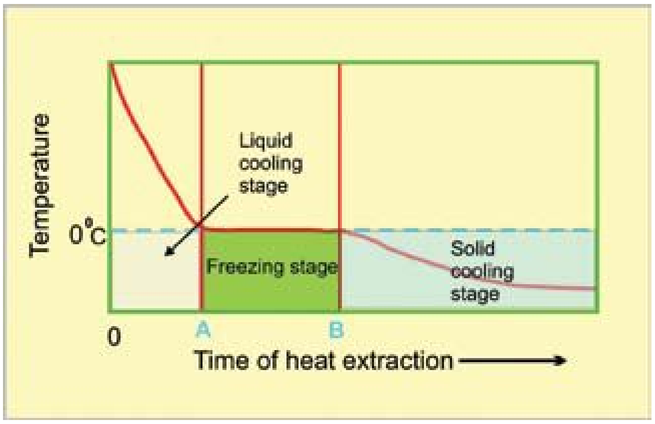

Fig. 6. Cooling curve for glass of warm water placed in a freezer.

During the freezing stage, ice crystals are being nucleated and subsequently grow. Ice crystals can only nucleate slowly on the outside of a warm water glass — the warmth preventing the temperature from falling much below the freezing point. These crystals can, however, grow inwards quickly because the water temperature is being kept just below its freezing point. This results in a short freezing stage. For the cold water, ice crystals form rapidly on the outside of the glass because its temperature is being reduced well below the freezing point. These myriads of tiny crystals can, however, only grow slowly. This results in a much shorter freezing stage. Hence, the overall time for solidification, O – B, is shorter for the glass of warm water than it is for the glass of cold water.

NUCLEUS FORMATION AND GROWTH

Nucleation and growth controls the properties of all of the metals used by shot peeners. They go together like the proverbial "horse and carriage."

Nucleus Formation

Metal atoms are very reluctant to collectively change from

one state to another. There has to be a sufficient driving force available if a different state particle is to nucleate. Hot steel exists as a face-centered-cubic arrangement of ions. The steel has to be cooled sufficiently for the ions to form nuclei that have a body-centred-cubic arrangement. Solid-to-solid changes of state are the essence of metal heat treatment.

The surface of a nucleus corresponds to a negative energy force whereas the inside corresponds to a positive energy force. If the positive energy is greater than the negative energy, the nucleus will be stable. If smaller, then it will be unstable. The ratio of energies depends on the particle radius as depicted in fig. 7. Particle A will be unstable (negative energy being greater than the positive energy) whereas particle B will be stable (positive energy exceeding negative energy).

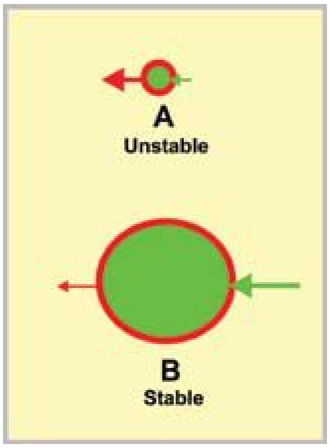

Fig. 7. Effect of radius on interior/surface energy ratio.

It is worth noting that spheres have the smallest surface area-to-core volume ratio of any physical shape. When cast steel shot is manufactured, a powerful water jet blasts into a stream of liquid steel. Myriads of solid particles are formed that minimise the ratio by forming spheres. The Earth and planets approach sphericity.

Nucleus Growth

Once a nucleus has reached a stable size it has a natural tendency to grow. The precise mechanism involved depends upon the state change — gaseous-to-solid, liquid-to-solid or solid-to-solid. Gaseous-to-solid, liquid-to-solid and solid-to-solid particle growth all follow the same basic principle — reducing energy by increasing the interior/surface energy ratio.

The most important example of nucleus growth is that involved in the formation of the planets. Gaseous matter is attracted to their surfaces by gravity. Once deposited on a surface, matter reduces its energy. Heat treatment examples include precipitate particle growth and austenite coarsening. Both are speeded up by raising the temperature.

GRAPHICAL REPRESENTATION

Scientific principles are involved in all of the graphs used by shot peeners — for example, in peening intensity curves, residual stress profiles and shot size distributions.

Peening Intensity

Curve-fitting is an essential feature of computer-based peening intensity estimation. We first decide on an appropriate equation for the curve and then employ a program to fit the curve normally using a technique called "Least Squares". Fig. 8 is a typical Solver Suite peening intensity curve that uses a two-parameter exponential equation. A key feature of the Solver Suite of programs is the RMS value. This tells us, quantitatively, by how much data values deviate from the fitted curve. For the example given as fig. 8 the RMS value for the residuals (RMS-R) is 0.14 which is excellent.

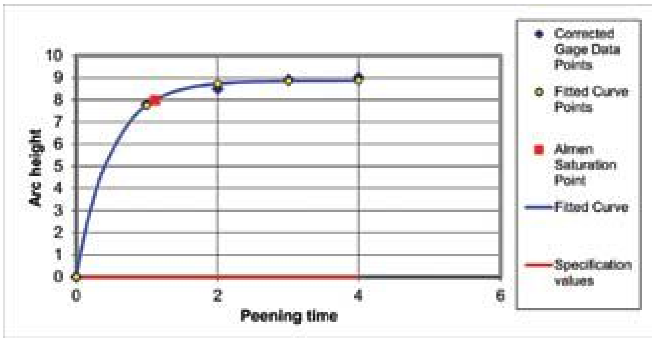

Fig. 8. EXP2P Peening intensity curve.

If a repeat set of data produced using the same conditions gave a much higher RMS value, we should investigate the reason such as faulty equipment, operator error, peening intensity fluctuation, etc. A typical repeat set is shown in fig. 9.

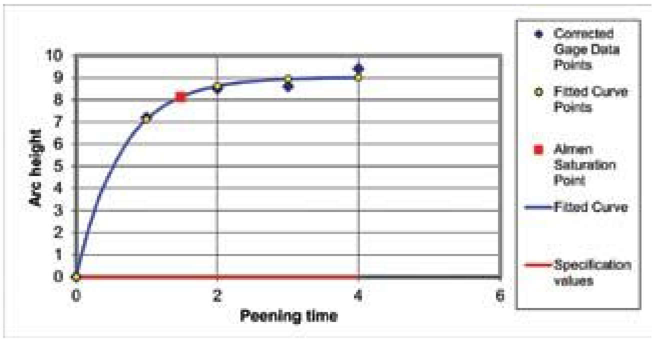

Fig. 9. Repeat EXP2P Peening intensity curve.

Residual Stress Profiles

Residual stress profiles are another form of graphical representation that is familiar to shot peeners. Their shape is quite different from that of a peening intensity curve. Fig. 10 is taken from an early article in this series ("Curve Fitting for Shot Peening Data Analysis", Spring, 2002). The scientific application here takes the form of modelling. Instead of using actual data, a simple cubic equation is employed. This

particular model represents the known shape of residual stress profiles but is based on four assumptions:

1. The level of surface compressive stress is half the yield strength, Y, of the as-peened material.
2. The maximum level of compressive stress is two-thirds of Y and occurs at 20% of the depth of compressed material, D.
3. A balancing tensile stress of 10% of Y is reached at 1.2D.
4. A cubic polynomial interpolation will be appropriate.

Models are a useful scientific application because they simplify comparisons between actual and expected data distributions. A useful guide when perusing graphical representations is to employ EVA (Expected Versus Actual). Compare one's expectation for a fitted curve versus the actual curve.

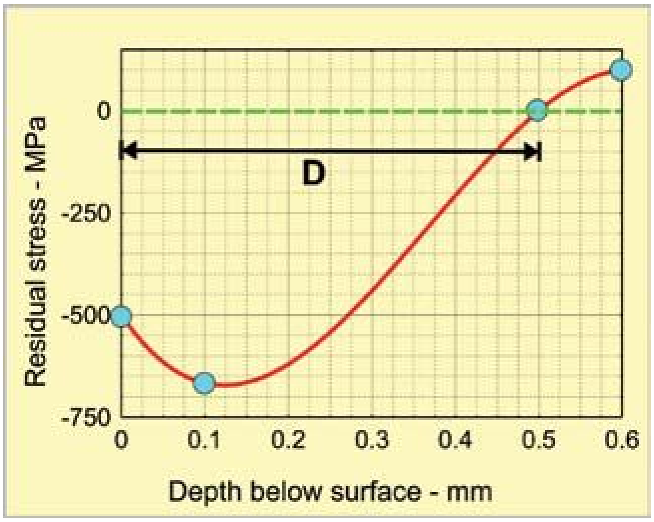

Fig. 10. Model of residual stress profile.

Shot Size Distributions

Specifications, such as SAE J444 and AMS 2431, nominate cast steel shot sizes in terms of sieving results. If we are simply trying to comply with specifications, histograms would not normally be constructed. Histograms can, however, be used to demonstrate shot size distribution. Because of the nature of sieve data, ordinary graphs are inappropriate.

The universal availability of Excel simplifies the task of producing histograms. As an example, consider the Excel histogram shown as fig. 11. A sample of S170 cast steel shot was tested for conformity with J444. Percentage weights on 0.850, 0.710, 0.425 and 0.355 mm sieves were 0, 5, 87, and 6% respectively which satisfies J444 requirements. Each column in the histogram represents the contents of a "bin". Each bin contains a range of shot sizes — for example, everything between 0.85 and 0.71 mm for the first bin. The individual sieve results are therefore entered as separate bin values.

The example shown as fig. 11 does not, however, tell us very much about the size distribution within the sample. For scientific study we would need to produce a set of bin values

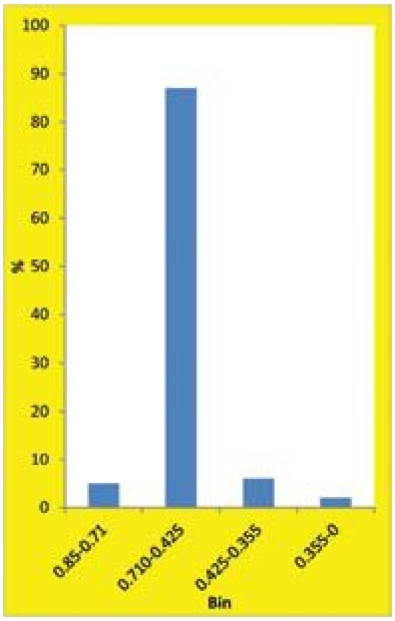

Fig. 11. Specimen sieve results for S170 cast steel shot.

involving a larger number of sieve sizes such as 0.85, 0.75, 0.65, 0.55, 0.45 and 0.35 mm. An alternative approach would be to use image analysis.

DISCUSSION

This article has attempted to show how science can be applied to explain a variety of problems. Classically, explanations of major problems evolve in stages, starting with a hypothesis, using data to then provide a theory and finally generating a law that is universally acceptable — as with the Law of Gravity. The appliance of science to explain observed experimental features does not, however, always meet with universal accord as Galileo found out to his cost.


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PRESS RELEASE

Claudiu Ionescu | Stelux Manager and Customer Solutions Engineer | Winoa

WA CLEAN Technology Receives ISO Certification

THE WA CLEAN TECHNOLOGY is an electronic optical device using as its working principle the analytical colorimetry to support the visual assessment of the surface preparation grades of uncoated steel substrates as defined in ISO 8501-1 or in SSPC-VIS 1. In July 2019, the WA CLEAN Technology received official accreditation via the ISO/TR 22770.

WA CLEAN Technology Adopted by the End Users

WA CLEAN Technology has been adopted in several industrial fields and not only in surface preparation projects. The WA CLEAN device has been developed in order to help our customers to implement the ISO 8501-1 standard. To avoid any misinterpretation, the goal of the device is not to replace the ISO 8501-1, but to support the appropriate implementation.

The cornerstone of the customer benefits provided by the WA CLEAN device is reinforcing the surface preparation grades visual assessment done by using the ISO 8501-1 reference photographs. Due to its analytical colorimetry working principle, the WA CLEAN device will measure specific cleanliness indexes on the initially visually qualified blast-cleaning grades. The usage of WA CLEAN device will allow to our customers to implement a quality follow-up on their blasting process in terms of the cleanliness level of their blasted parts.

The WA CLEAN Technology can be also used to reduce extra blasting time, saving money and improving the quality level by fending off the eventual over-blasting phenomenon that could affect other important surface preparation parameters after the blasting process such as the roughness level.

Some examples of industrial applications where the WA CLEAN Technology is already employed are mentioned here:

- Steel pipes manufacturing for oil and gas industry where the cleanliness level is one of the required parameters after the blasting process and before the next stage of process, namely the epoxy coating application.
- Cast iron automotive parts in cast iron foundries for the quality control of the desanding operations.
- Trailer manufacturing for the control of the cleanliness level of the blasted parts prior to galvanization.
- Freight wagons for the control of the cleanliness level of the blasted parts prior to coating applications.
- Cold-drawn bar producers for the optimization of their descaling operations.

Availability

At this time, the WA CLEAN Technology is promoted through our internal commercial networks. We invite you to get in touch with our local commercial teams, or directly contact us via our W Abrasives website at www.wabrasives.com/en/contact-world-leader-steel-abrasives.html. A helpful video on the device is available at the website. We will be more than happy to answer your requests.

A Step Ahead

We will see more and more examples of how our industry is migrating to Industry 4.0 and the digitalization of tools and instruments used in the manufacturing processes. And it's what we are looking forward to at Winoa. Soon the WA CLEAN technology will be functional via a smartphone with the possibility to generate instant quality follow-up reports of your blasting process, everywhere and at any time with the WA CLEAN 2.0 version.

The WA CLEAN Tool Kit

This patented and ISO TR 22770-certified technology is the ideal way to evaluate and check the cleanliness of a blasted surface in accordance with international standards independent of any human interpretation. It reads, quantifies and archives the degree of surface cleanliness you have achieved while being very easy to use.

Siavash Ghanbari and David F. Bahr | Center for Surface Engineering and Enhancement, Purdue University

An Indentation Technique for Evaluating Residual Stresses Generated by Shot Peening

Introduction

Residual stresses, those present in a material in the absence of load or changes in the temperature, can be related to the microstructure of the materials or macroscopic scale. Since shot peening creates small elastoplastic deformation on the surface and creates compressive elastic residual stresses into the depth of a part, evaluating those stresses is a key aspect of process development. We present here a refined method for using nanoindentation to map residual stresses in cross-sectioned parts. The technique is validated by both conventional x-ray methods and simulations of the double-side shot-peened thin wall sheet.

What is the Nanoindentation Method?

The nanoindentation technique creates a microscopic impression (on the order of 1 µm, or 0.04 mil) on a surface and concurrently measures the loads and displacements during the entire sequence of loading and unloading [1]. Residual stresses on the specimen can change the load-displacement curve and can be determined in one of two ways: Examining the amount of material that "piles up" around an indentation impression or by comparison of load-depth curves with those in a stress-free sample. The true hardness and elastic modulus are generally independent of the elastic residual stresses [2]. The indentation impression is quantified by the projected area of impression. By comparing the contact area of the tip in a stressed sample to that in an unstressed sample at the same load, and by knowing the hardness of the unstressed sample, you can determine the compressive or tensile stresses using Eq 1 and Eq 2. An alternative method (by examining the work done by the indenter) also allows you to estimate residual stresses based on comparing the input energy needed to drive the indenter in the stressed sample and stress-free sample. In this method, residual stresses can be found by Eq 3 and Eq 4 [3].

$$\sigma_t = H\left(\frac{A_0}{A} - 1\right) \qquad \text{Eq(1)}$$

$$\sigma_c = \frac{H}{\sin\alpha}\left(1 - \frac{A_0}{A}\right) \qquad \text{Eq(2)}$$

$$\text{Compressive stresses} \quad \left(\frac{p^{s}_{max} h_{max}}{(m_1+1)} - \frac{p^{s-f}_{max} h_{max}}{(m_0+1)}\right) = (\sigma_{res} A_1 \sin\alpha)\, h_{max} \qquad \text{Eq(3)}$$

$$\text{Tensile stresses} \quad \left(\frac{p^{s}_{max} h_{max}}{(m_1+1)} - \frac{p^{s-f}_{max} h_{max}}{(m_0+1)}\right) = (-\sigma_{res} A_1)\, h_{max} \qquad \text{Eq(4)}$$

where p^{s}_{max} and p^{s-f}_{max} are the maximum load for stressed and stress-free samples in the maximum depth of indentation h_{max}. In these equations, m is the fitting parameters where subscripts 1 and 0 represent the stressed sample and stress-free sample, respectively. *A* represents the indentation contact area and *H* is the hardness of the stress-free sample. The area comparison method relies on knowing the "true" hardness (which can vary on the nanoscale with position and orientation of the materials' grain structure), and the energy method relies on fitting the loading curves. Both methods can lead to some uncertainty in the extraction of residual stresses, but both benefit by concurrently measuring local hardness at the same time as the stresses, and both have sub-mil lateral and depth resolution.

Creating the Validation Systems

We tested two common material systems in this study: A shot-peened 52100 steel plate ≈ 5 mm thick and a double-side shot-peened Al sheet of AA7050-T7451 that was 1.6 mm thick. Both materials were polished prior to shot peening and peened with commercial vendors using processes they would consider standard for each material. Residual stresses were measured after shot peening with a Pulstec µ360 residual stress analyzer. The Pulstec determines the residual stresses by measuring changes in the Debye Scherrer ring with an incident X-ray beam [3]. Depth profiles of residual stresses were made by sequentially electro-etching material and re-measuring the stress on the new surface each time.

Comparing Residual Stresses Measured with Indentation to Simulations and X-Ray Methods

For the double-sided shot-peened aluminum sample, we used the area-based model to measure residual stresses based on the contact areas' formulation across the entire width of a cross section of the material, performing several indentations at each position on the cross section, and averaging the values to give a stress at a relative depth (Fig. 1a on page 44). Finite element modeling using ABAQUS was performed for a double-sided shot-peened aluminum sample to predict and simulated residual stress profile after shot peening. This simulation result is shown in Fig. 1b.

As seen in these figures, the residual stress profile, obtained by the nanoindentation method, are in good agreement with dynamic simulation modeling. Both results showed one side of the shot-peened sample has a higher compressive residual stress in comparison with the opposite side. This can be attributed to the cold working and the thin-wall structure which caused hardening on the opposite side of the shot-peened sample. When the sample was flipped to peen the second side, the deformation on the first side impacted the residual stress. The stress couldn't be measured through the entire thickness with an electropolishing method, so the indentation allows access to a larger sample volume than could otherwise be measured.

We also used X-ray diffraction on the steel shot-peened material and compared the X-ray with the nanoindentation

Continued on page 44

4th International Symposium for Fatigue Design and Materials Defects

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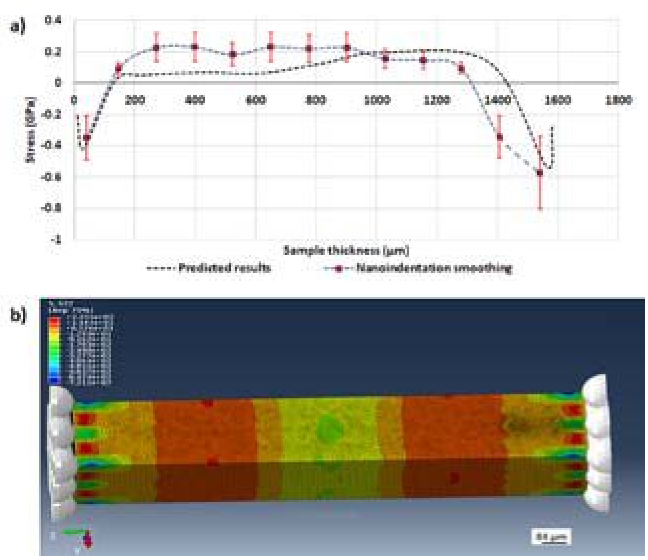

Fig. 1. a) Residual stress measured by nanoindentation and predicted by FEM modeling, b) Double-sided shot-peened aluminum sample.

results. In this experiment we used the work-energy formulation with the nanoindentation method. Ten indents were made on the peened surface and on the cross-section in both stress-free (pre-peened) and stressed (post-peened) samples. Eq 3 and Eq 4 were used to determine residual stresses on the surface and cross-section area. The average residual stresses on the shot-peened sample was -1220 MPa. The X-ray result was slightly different from the individual results, but it was close enough to the average residual stresses. This difference can be attributed to the X-ray resolution and metallography parameters. The X-ray system lateral resolution is about 2 mm which can collect information from the surface. Residual stresses in the surface (Fig. 2a) and cross-section (Fig. 2b) show good correlation between the nanoindentation and X-ray methods.

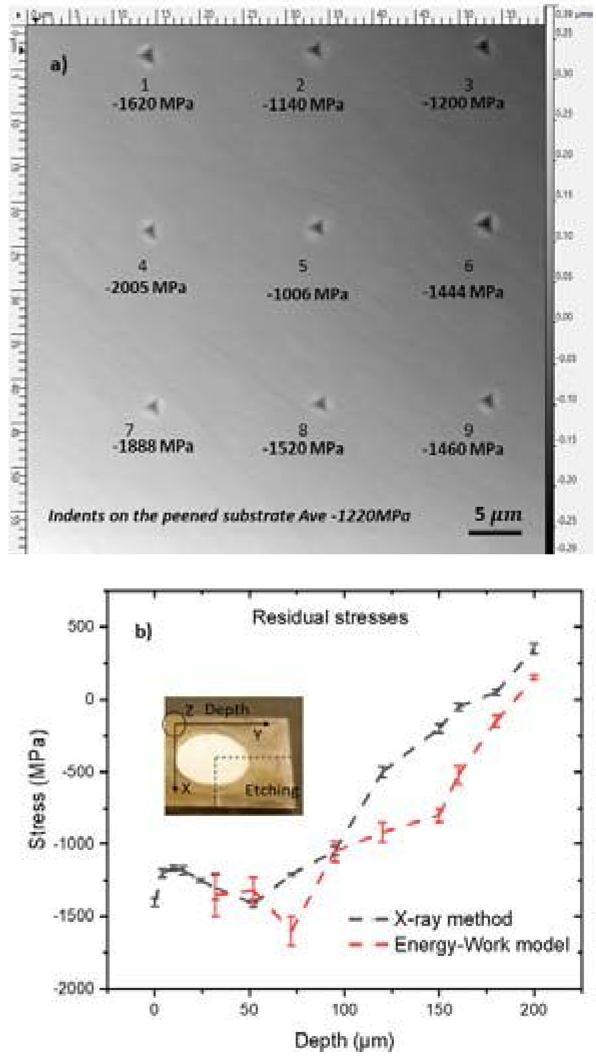

Fig. 2. Residual stress measured by nanoindentation and X-ray methods, a) steel 52100 substrate, b) stress profile on the cross section.

Conclusions

We've demonstrated that it is possible to measure the residual stresses of a range of materials and structures (a double-sided shot-peened thin aluminum sheet and 52100 steel plate) using nanoindentation. This simulation and the experimental results compare favorably in terms of the magnitude of the maximum residual stress and the differences between the "first" and "second" side of the thin Al sheet, and the depth profile of the stress in the steel is very similar to both the x-ray and indentation method. We think using indentation-based methods to extract both hardness and residual stresses will be of use in some process development applications, as well as having some applicability for quality control measurements on the surface of peened parts, particularly when very fine lateral positioning is required (around a fine feature such as a thread or hole).

Acknowledgements and Bibliography

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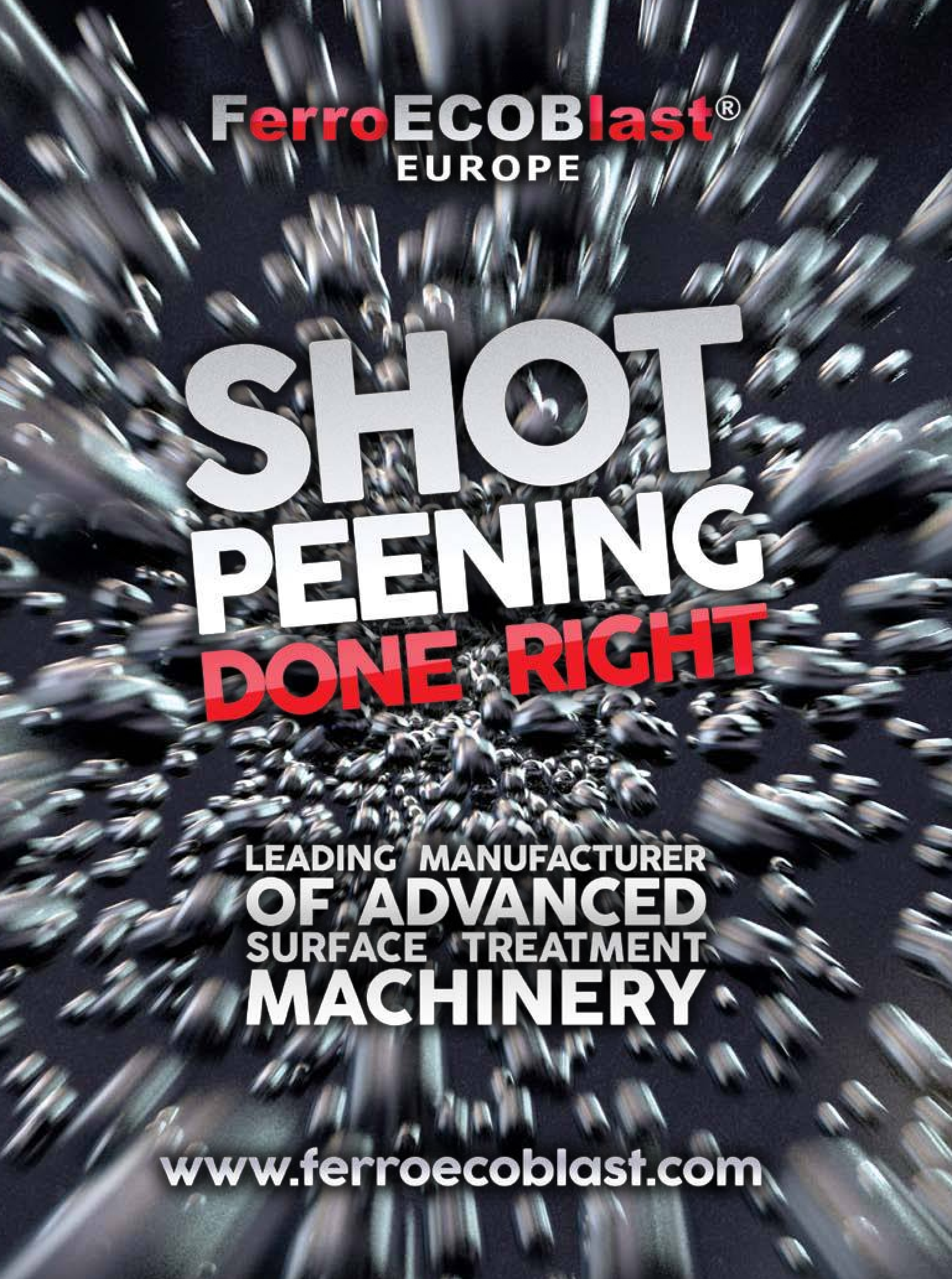
[1] W. C. Oliver and G. M. Pharr, "Measurement of hardness and elastic modulus by instrumented indentation advances in understanding and refinements to methodology," J. Mater Res, vol. 19, p. 3, 2004.

[2] T. A. Venkatesh, K. J. Van Vliet, A. E. Giannakopoulos and S. Suresh, "Determination of elasto-plastic properties by instrumented sharp indentation guidelines for property extraction," Scripta Material, vol. 42, p. 833, 2000.

[3] S. Ghanbari and D. Bahr, "An energy-based nanoindentation method to assess An energy-based nanoindentation method to assess shot-peened materials," Journal Of Materials Research, vol. 34, no. 7, pp. 1121-1129, 2019.

[4] S. Ghanbari, M. Sangid and D. Bahr, "Residual Stress Asymmetry in Thin Sheets of Double-Sided Shot Peened Aluminum," JMEPEG, vol. 28, no. 5, pp. 3094-3104, 2019.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