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The Shot Peener

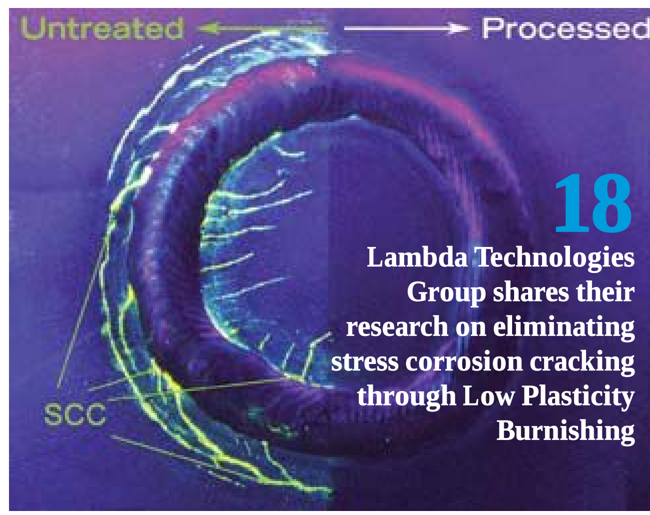
Sharing Information and Expanding Global Markets for Shot Peening and Blast Cleaning Industries

CWST Laser Peening contributes to successful nuclear canister storage program

PLUS:

- WHEN AND WHY TO BUY A REFURBISHED MACHINE
- A STUDY ON THE EFFECTS OF DESIGNED COMPRESSION
- COMPONENT DISTORTION: AN OVERVIEW
- THE RELATIONSHIP OF SURFACE COLD WORK TO COVERAGE

CWST personnel inspect the laser peening of a longitudinal weld on a canister that will hold spent nuclear fuel



Cover Photo: The CWST mobile laser peening unit at the Holtec Manufacturing Division's Pittsburgh facility.

THE SHOT PEENER
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Staying On Topic?

JACK CHAMPAIGNE

SOMETIMES WE PLAN THE MAGAZINE around specific topics; sometimes it just happens. This issue was a combination of both. We anticipated that we would have two industry leaders submit articles on preventing Stress Corrosion Cracking on welded materials for the Energy sector. It's good news that the Laser Peening division of Curtiss-Wright Surface Technologies (CWST) (page 6) and the Lambda Technologies Group (page 18) are tackling this serious issue with great success.

As good fortune would have it, laser peening was again addressed in an article on the upcoming 7th International Conference on Laser Peening (page 44). The Conference Committee is interested in pushing the boundaries of the process and asked for papers on laser peening in marine, automotive, and medical applications.

Kumar Balan submitted an informative article (page 10) on refurbished machines that will be useful to anyone weighing the benefits of refurbished versus a new machine and Dave Barkley has advice for the owner of an older machine that needs to update the media flow control on their equipment (page 46).

As always, no matter the diversity of topics, we have one goal—we want to share information on new peening processes and provide practical advice, too. However, we're not always serious—the article on the 2018 Dodge Challenger SRT Demon (page 42) is pure entertainment for car lovers. Did you know that we have at least four race car drivers in our shot peening community?

I was honored to give the keynote speech—"SAE: Past and Present"—at the recent shot peening workshop at the Meiji University in Tokyo. Gathered for a photograph at the workshop, from the bottom left, are Dr. Yoshihiro Watanabe (Toyo Seiko), Tom Brickley (Electronics Inc.), Jack Champaigne (SAE and Electronics Inc.), Dave Barkley (Electronics Inc. Shot Peening Training), Dr. Yuji Kobayashi (Toyo Seiko), and Dr. Katsuji Tosha (Meiji University).

THE SHOT PEENER

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Laser Peening by CWST Contributes to Successful Nuclear Canister Storage Program

THE LASER PEENING PROGRAM at Curtiss-Wright Surface Technologies (CWST) has contributed to the successful launch of a new manufacturing process for Multi-Purpose Canisters that hold spent nuclear fuel. Their contribution was the result of extensive research, prototype testing, and validation at the CWST facility in Livermore, California on the prevention of Stress Corrosion Cracking (SCC) in the welds of the canisters. The Multi-Purpose Canisters are being laser peened by CWST at the Holtec Manufacturing Division's Pittsburgh facility.

The project was a collaborative effort between CWST and Holtec International—the company that designed, licensed, and manufactures the Multi-Purpose Canisters. Holtec is a global turnkey supplier of equipment and systems for the energy industry. The company provides solutions for managing the back end of the nuclear power cycle for commercial nuclear power plants. Holtec and Curtiss-Wright worked jointly to develop a peening process of Holtec's Multi-Purpose Canisters as a barrier against SCC.

The Challenge

Dry canister storage of spent fuel at nuclear plant sites is being used as an interim approach until a permanent dry storage site is available. The dry canisters are necessary because spent

The laser peening process in development and testing with a Holtec Multi-Purpose Canister at the CWST facility in Livermore, California.

fuel pool storage is reaching capacity at nearly all nuclear plants in the US. However, the corrosive nature of the moist air in costal or lakeside regions and humid environments can make the welded regions of the canisters susceptible to pitting and Chloride Stress Corrosion Cracking (CLSCC). These canisters are commonly made of 304 or 316L stainless steel and are roll-formed and welded to a cylindrical shape. After being loaded with spent fuel, the cylinders are then sealed welded and filled with an inert gas, such as helium. The canisters are placed vertically in concrete/metal overpacks to provide radiation shielding and reduce exposure to the environment.

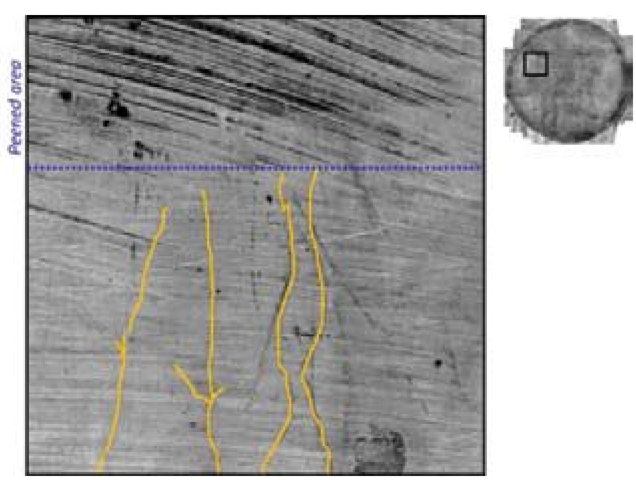
The laser peening team at CWST was eager to address the challenge of preventing stress corrosion cracking in the weld sites of the Multi-Purpose Canisters.

The Backstory

The groundwork for the nuclear waste storage program began 20 years ago when CWST participated in a Department of Energy study on the treatment to prevent corrosion cracking in nickel-based canisters for long-term storage at the Yucca Mountain Nuclear Waste Repository. Under a cooperative research and development agreement between CWST and the Lawrence Livermore National Laboratory, research on nickel materials and 316L stainless steel proved that laser peening would prevent stress corrosion cracking in welds. With funding provided by Holtec in 2016, CWST tested and verified a laser peening process on Holtec Multi-Purpose Canisters to meet a June 2017 deployment.

The Research

CWST performed a series of tests, demonstrating the benefit of laser peening to prevent chloride stress corrosion cracking (CLSCC) of dry canisters for spent nuclear fuel storage. The research centered on panels of 316L stainless steel from Holtec. The panels were fabricated with the same process the company uses to manufacture its Multi-Purpose Canisters.



Test plate of 316L stainless steel fabricated by Holtec with stress corrosion cracks highlighted. Observation was done after 57.5 hours exposure to $MgCl_2$ at 155˚C. Cracks developed in un-peened areas, but did not develop in peened areas and arrested as they propagated from un-peened into peened areas.

CWST presented its findings in a paper written by Dr. Lloyd Hackel, Vice President at CWST, titled *Preventing Stress Corrosion Cracking of Spent Nuclear Fuel Dry Storage Canisters*. The conclusion of the paper stated:

> It is generally accepted that corrosion pitting reaching a tensile field can initiate CLSCC that will continue to propagate. Literature analysis and verification show that pitting will self-terminate in 316L at a depth of about 200µm (0.008 inches) due to cathodic current limits. Thus deep levels of compressive stress are critically important to prevent corrosion pitting from reaching tensile stress and thereby initiating and propagating CLSCC. Our measurements conclusively show that laser peening generates compressive stress in canisters greater than 4 mm in depth that is well beyond the self-terminating pit depth. Our accelerated ASTM G36 (2013) tests conducted at 155˚C with $MgCl_2$ (Magnesium chloride) clearly show that CLSCC will not initiate in areas treated with high-energy laser peening and that CLSCC originating outside of a laser peened zone will arrest upon reaching the peened area. The high-energy laser peening thereby offers an excellent safety margin for structural integrity of dry storage canisters of spent nuclear fuel.

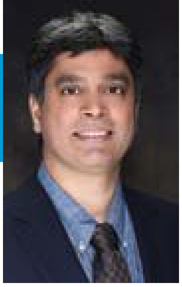
The Results

Due to the success of their laser peening research and development work, CWST became the laser peening service provider to Holtec for the Multi-Purpose Canister program for a specific client. Holtec International mentioned the results of the project in a November 2017 edition of their newsletter, *Holtec Highlights*:

> "Another recent noteworthy development is the pioneering effort by Southern California Edison and Holtec to further fortify the SONGS' multi-purpose canisters against attack from marine air by a *laser peening* process guided by the established science on corrosion protection of stainless steel."

Holtec's Program Manager, Dr. Fred Bidrawn, said, "This pioneering peening operation is a giant step in our industry's efforts to substantially inoculate MPCs from the threat of stress corrosion cracking."

Dr. Hackel added, "The benefits of deep compressive stress generated by laser peening are highly effective in preventing stress corrosion cracking in an ever-expanding range of applications including short- and longer-term storage of spent nuclear fuel, in sensitization cracking of 5000 series aluminum plaguing Navy and commercial ships, and in the upstream and downstream oil and gas industry. We are excited to be able to solve these problems."



AN INSIDER'S PERSPECTIVE

Kumar Balan | Blast Cleaning and Shot Peening Specialist

When and Why to Buy a Refurbished Machine

A FEW YEARS AGO, when representing a large wheelblast machine manufacturer, I had the opportunity to visit a custom heat treat shop in the Detroit area. This shop had machines from the 1950s and were looking to add new equipment. Upon further enquiry, I learned that even the machines from the 50s were purchased used! We often hear the terms "self-destructing" and "self-consuming" when referring to blast machines. However, this heat treat shop discredits these terms because of its attention to maintenance and essential upgrades. In a technologically intense world, albeit with its relatively slow pace in our industry, my visit opened my eyes to a new world of possibilities with refurbished machines.

This article summarizes my discussions with companies that refurbish machines, and users of such equipment. Specifically, the article will attempt to address the following points: (a) Used and Refurbished: industry definitions, (b) When to consider a refurbished machine (c) Which machines have refurbishment potential, (d) The advantages of refurbished machines, and (e) The limitations of refurbished machines.

USED AND REFURBISHED MACHINES

The term "used" machine needs little introduction. My own interpretation reads, "a machine that is sourced from its current user, who may or may not have been actively using it, and the new owner uses the machine with or without modifications." If your experience with a used machine has been to use it without any modification, repair or refurbishment in a new process, you are indeed very fortunate! Refurbishment of a used machine is a very common practice due to the poor condition of the machine and/or to prepare it for a new application. Other than the obvious reasons relating to the machine's condition, the extent of refurbishment depends on several factors including the need to blast a new part style, the need for a faster cycle, an upgrade to the control system for conformance with specifications, to list a few.

Common refurbishments can be classified based on the machine type.

Wheelblast	Airblast
Blast wheels (new, efficient designs), critical wheel wear components, wheel motors, etc. Media flow control valves and slide gates, if worn or outdated	Blast tank valves, seal kits and flow control Blast nozzles and hoses
Cabinet liners: inline and wall liners	Cabinet refurbishment is less common for airblast
Cabinet seals (hanging seals in pass-through machines)	Nozzle/Lance entry seals

Refurbishments common to both machine types include:

- Classifier screens: Check and replace with right size, as necessary.
- Control system: Replace circuits, outdated or discontinued components, and upgrade relay logics to PLC and pushbuttons to TouchScreen Operator Interfaces.
- Dust collectors: Refurbish or replace units so that they conform to safety standards. This is a very critical aspect to consider and will be discussed in a later section.

WHEN TO CONSIDER A REFURBISHED MACHINE

AGTOS GmbH operates two manufacturing facilities, one in Emsdetten, Germany and another in Konin, Poland. AGTOS manufactures quality wheelblast machines and refurbishes used machines. During my recent visit to their Poland facility, Thomas Herhold, one of their Sales Managers, directed me to an older AGTOS four-wheel plate and structural machine that had been brought in for refurbishment with the goal of adapting it to its new home in Mexico. AGTOS has been in business for almost 20 years and they are now seeing some of their earlier designs return for refurbishment. "We enjoy long-term relationships with our customers and the trust helps us make joint decisions on whether to procure new equipment or consider an AGTOS refurbished machine," said

Thomas Herhold, a Sales Manager at AGTOS GmbH, stands in front of an AGTOS refurbished machine.

Thomas. The decision matrix at AGTOS can be broken down as follows:

Economics: "In my experience, most companies consider a new machine if the repair or refurbishment costs on their existing machine exceeds 40% of the price of a new machine. However, even at this point, customers get involved in an additional step of sourcing a used machine that is newer than their existing machine and adding the cost of refurbishing it to bring it to the standards of a new machine. Most times, this refurbishment results in an almost new machine at a fraction of the cost of a new one," said Thomas.

Technology: "In a wheelblast machine, if refurbishing with newer wheels will increase your productivity and the lifetime of your wear parts, then it's worth the effort. The rest of the machine consists of the enclosure and reclaim system, which if in good condition, add to the justification of considering refurbishment. At AGTOS, we regularly refurbish competitors' machines with our blast wheels," added Thomas.

Though the pace of technological advancement is relatively slow in our industry, controls, pneumatics, and work-handling tools have experienced rapid development. If these advances could enhance the productivity of your existing process, it may be time to consider refurbishing your existing machine. Two such examples of advancements could be: (a) a vision system to monitor the process and increase safety, and (b) a used robot to ease labor costs by automating the handling.

Frequent Program Changes or Short-Term Programs: Customers, particularly Tier Two and Three in the automotive industry, need equipment to address process requirements for specific auto platforms. These machines may not find utility upon completion of the program since the part style is subject to change. Such projects are better served with a refurbished machine than a new one.

Prototype Manufacturing or Designing a New Process: Manufacturing facilities that develop prototypes regularly experiment with their processes. If the testing involves blast cleaning or shot peening, such facilities could consider a refurbished machine that offers a wide range of flexibility. For instance, a table-type machine with fixtures that allow a part to be placed flat, hung on a spinner, rotated on rollers, etc., will fit the bill. The refurbishment could include multiple wheel locations with wheels actuated as required to take advantage of different target angles. This machine will allow the user to develop the process without being locked into a new machine that might require the process to adapt to it.

These are some of the more common reasons to consider a refurbished machine. The next step is to create a list of criteria when considering a refurbished machine.

WHAT TO LOOK FOR IN A REFURBISHED MACHINE

Langtry Blast Technologies, based in Burlington, Ontario, Canada, specializes in new and refurbished wheel and airblast machines. Mike Langtry, the owner, had some interesting insights to share.

"We have seen some very good quality used machines come up for sale in the market. We typically buy a machine to refurbish and re-sell if we know of a customer interested in something similar. In broad terms, when looking at refurbished machines (or those that offer the potential for refurbishment), we look for design flexibility and a sound structure," he said. "We're also noticing an increased number of customers approaching us to refurbish their existing machines with controls, HMIs (Human Machine Interfaces) and process control components such as classifiers, pressure feedback loops and flow control devices to help them conform to Nadcap and other audits and specifications."

Design flexibility: "Plain and multi-table machines (both wheel and air type), spinner hangers and mesh-belts offer greatest possibilities for retrofit/refurbishment. If the available work envelope satisfies the potential application

requirements, adding a nozzle carriage or robot to target this envelope is relatively easy," Mike said.

Sound Structure: "Extensive cutting, welding and other modifications to the cabinet are never a good idea. If the refurbishment requires such changes, either to address the needs of the future project, or to compensate for a bad initial design, the refurbishment costs will be prohibitive. Look for a machine where you don't have to go about re-designing the basics such as the cabinet and reclaim systems. Also, pay attention to the capacity of the reclaim system to handle the increased shot flow if your refurbishment plans involve increasing throughput with a higher HP wheel or greater quantity of nozzles," he advised.

Safety: Due to new safety regulations that will apply to all newly installed machines, this discussion won't be complete without a note on safety. If refurbishment involves updating the safety system in the machine, one of the key elements to consider is its ventilation and dust collection. Components manufactured from metals such as aluminum and magnesium have the propensity to generate dust that is explosive. Some blast media also exhibit such properties. Current safety standards require updating the ventilation and dust collection systems with fire suppression and explosion protection features such as fire-retardant filters, rotary airlock valves, explosion vents, isolation and no-return valves. Such modifications could add up to a considerable investment requirement and very well exceed the cost of other refurbishment initiatives in the machine.

Brian McGillivray, the President of Vibra Finish in Mississauga, Ontario, manages a large contract blast cleaning business that employs over 20 new and refurbished machines. He adds to the above list with the following remarks: "When considering a used machine that needs to be refurbished, consider your in-house resources. Blast machines are maintenance prone and, whether new or used, it will benefit you to be self-reliant. Vibra Finish has a five-member maintenance team that's strong in tackling all technical aspects of blast machines," he said.

When discussing the possibility of refurbished machines for shot peening, Brian cautions us: "It all depends on how this machine was originally used—whether it was used for cleaning or peening. A cleaning machine will certainly need refurbishment in the process control department with flow control valves, a classifier, closed feedback loops for air pressure or wheel speed, and a definite upgrade to the control system. Bear in mind that the machine will still need to pass an audit, particularly if your plans involve peening aerospace components." This doesn't mean that refurbished machines are not a solution for shot peening. One must consider this option on the merits of each project.

ADVANTAGES AND LIMITATIONS OF REFURBISHED MACHINES

- When this article was written, the North American economy was in an expansion cycle. It isn't uncommon for manufacturers to quote lead times that exceed normal times by 25%. This brings us to one of the major advantages of refurbished machines—the majority of the design work, at least for the fundamentals of the machine, is already completed. All major blast machine companies dedicate a percentage of their resources to the refurbishment business and the lead time to refurbish a machine will be a fraction of the time to design and build a new machine. The cost factor doesn't need further elaboration.

- Obsolescence in advanced countries due to technological developments and/or the increase in labor costs result in old machines being sold to less developed markets, usually at bargain prices. However, the transportation cost and the cost of dismantling the machine are factors to consider. The machine's owner will seldom want to employ resources to dismantle the machine for the buyer.

- It is difficult to make a final recommendation on the benefits of a refurbished machine since this judgment is reliant on its upgrades. However, Brian McGillivray's comment on in-house resources is very important to consider. Unlike a new machine from a manufacturer and the leverage one might wield by squeezing out an extra year of warranty, refurbished machines may not come with such a luxury.

If your finishing operation fits into the criteria listed earlier in our discussions, exploring a used machine for refurbishment will be an educational experience. This might even give you the knowledge to negotiate the purchase of a new machine!

Spirit AeroSystems Unveils Fabrication Center of Excellence

SPIRIT AEROSYSTEMS recently unveiled the first of two centers of excellence, focusing on the fabrication of complex commercial and military aircraft parts. The facility, located on the company's headquarters campus in Wichita, Kansas, will accommodate new work in the global aerostructures market while also supporting current customer contracts.

Spirit AeroSystems' new Center of Excellence is located on the company's headquarters campus in Wichita, Kansas.

"We announced plans last year to invest and grow our fabrication capabilities to $1 billion, and this new Five-Axis Center of Excellence in Wichita is a step in achieving that goal," said Spirit President and CEO Tom Gentile. "New state-of-the-art machining in this facility further solidifies Spirit's fabrication and chemical processing capability, and will enhance our ability to win new fabrication work from both current and future customers."

The purchase and installation of new equipment in the 20,000 square-foot facility began in 2017, augmenting the company's existing capabilities as one of the world's largest fabricators of aerospace parts. Spirit offers customers a wide range of solutions including machining, skin and sheet metal fabrication and chemical processing.

"Our investment in fabrication capabilities through these Center of Excellence expansions builds our global competitive advantage for fabrication work," said Spirit Senior Vice President of Global Fabrication, Kevin Matthies. "The expansion in Wichita—and later this year in McAlester, Oklahoma—will allow us to be a true global leader in fabrication work with better quality and improved turn time."

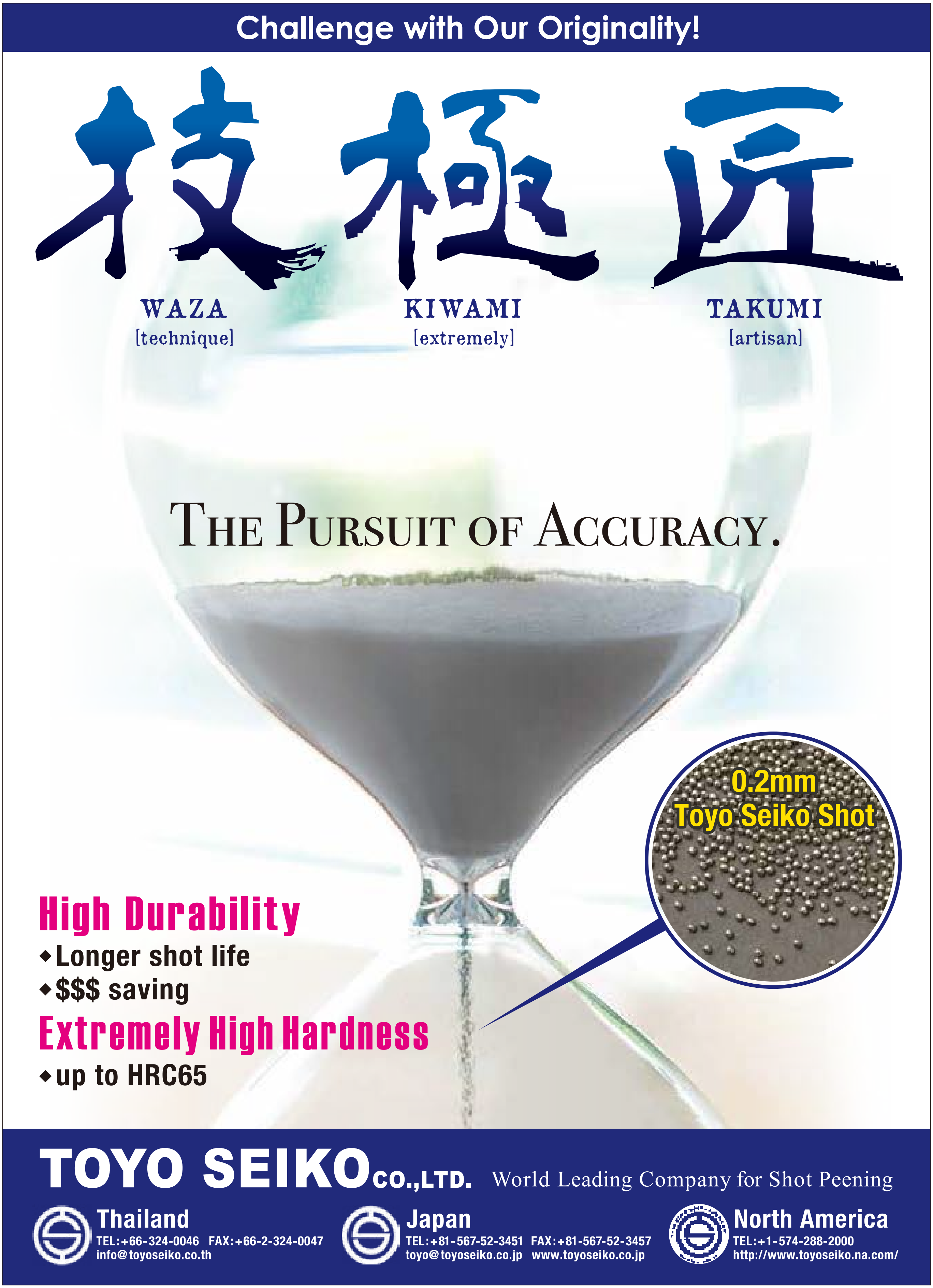
The new Five-Axis Center of Excellence in Wichita will utilize high-speed technology to specialize in large, complex soft metal parts for fuselage, pylon and wing structures.

Spirit's fabrication capability spans more than 2.6 million square feet and produces more than 38,000 parts daily. The company leverages one of the largest automated lines in the world to reliably offer high-volume and high-velocity processing.

The expansion plans follows Spirit AeroSystem's announcement in December 2017 that the company was adding 1,000 jobs at its Kansas facility. The growth is fueled by a number of factors: increasing production rates on existing commercial aircraft programs, growth in Spirit's Fabrication and Defense businesses and other new business pursuits. The announcement solidifies Spirit's presence in Wichita and Kansas for decades to come.

About Spirit AeroSystems
Spirit AeroSystems designs and builds aerostructures for both commercial and defense customers. With headquarters in Wichita, Kansas, Spirit operates sites in the U.S., U.K., France and Malaysia. The company's core products include fuselages, pylons, nacelles and wing components for the world's premier aircraft. Spirit AeroSystems focuses on affordable, innovative composite and aluminum manufacturing solutions to support customers around the globe. More information is available at www.spiritaero.com.

Spirit AeroSystems is a supplier to Sikorsy for the CH-53K helicopter. Sikorsky components are manufactured in the company's Wichita, Kansas facility.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Dr. N. Jayaraman and Doug Hornbach | Lambda Technologies Group

Eliminating Stress Corrosion Cracking: A Study on the Effects of Designed Compression

POWER PRODUCERS spend nearly $10 billion a year fighting corrosion, and that is only covering the United States. Stress Corrosion Cracking (SCC) can cause sudden, catastrophic and costly failures. Power facilities attempt to prevent SCC by using materials that are generally thought of as SCC resistant, like austenitic stainless steels and nickel-based alloys. Despite the general corrosion resistance, even some conditions of austenitic stainless steels and Ni-based alloys are susceptible to SCC. High-strength ferritic alloys can be susceptible to sulfide stress cracking. Many alloys are subject to other types of environmentally assisted cracking under the right conditions, namely a corrosive environment and tensile stress above a certain threshold.

In fact, stress corrosion cracking is one of the most serious metallurgical problems facing the power industry today. Because it can initiate slowly and progress undetected at stresses well within engineering design limits and typical operating conditions, the threat of SCC requires frequent costly inspections. If damage is found, as is common in high-stress areas, repair or replacement is in order, costing even more in parts, labor and downtime.

In another arena, sulfide stress cracking, along with hydrogen embrittlement, prevents the use of less-expensive high-strength carbon steel alloys in oil and gas recovery efforts of the petrochemical industry. Compounds like hydrogen sulfide and sodium chloride are commonly encountered downhole, creating sour environments that are the perfect breeding ground for corrosion. If any of these types of damage are not identified prior to cracks propagating to failure, they have the potential to cause oil spills and other environmental catastrophes, costing millions or even billions. Even with regular precautionary measures, the unpredictability of these damage mechanisms warrants a reliable, and preferably cost-effective, means of mitigation.

Traditionally, methods for mitigating these types of damage have been limited to applying coatings or expensive alternate alloys. While coatings certainly help, they can degrade over time, and remanufacturing a part using a different alloy is time-consuming and costly. Either method may only lead to a small improvement. Shot and needle peening have also been used, but with limited success due to the shallow depth of compression and the fact that a highly cold-worked surface is actually more susceptible to corrosion damage.

More recently, designed compression has been employed to completely eliminate SCC without changing the material or design. Applied using highly controlled surface treatments such as low plasticity burnishing (LPB®), engineers design a deep, stable layer of compression and apply it to the susceptible area(s) of a component. By putting the surface in high residual compression far below the tensile threshold for cracking, the potential for fracture from fatigue, stress corrosion or sulfide stress cracking is eliminated. As an added bonus, LPB in particular greatly enhances the surface finish of processed components, speeding up inspections when they are needed due to the ease of identifying damage.

Lambda Technologies, a company established as a leader in life extension technology and specializing in the understanding, measurement and control of residual stresses, initiated a study to evaluate the effects of LPB on mitigating SCC in welded stainless steel components. Type 304L and 316L stainless steel were chosen for the study due to their widespread application. Plate material conforming to ASME SA240 was machined and welded into test plates of approximately 4" x 4" x 0.5". Each specimen was welded and then subsequently LPB processed on half of the face. Welding was performed by a certified nuclear repair facility using a shielded metal arc welding (SMAW) process and weld filler metal E308 and 152 for the 304L and 316L plates, respectively.

X-ray diffraction residual stress measurements were made on the specimens to characterize the effect from welding and LPB processing as functions of both depth and distance across the welds. Figure 1 (page 20) shows the residual stress distribution as a function of distance and depth for a 304L sample in both the LPB treated and untreated regions. Tensile residual stresses on the as-welded side of the sample approach +100 ksi (+689 MPa). The LPB treatment produced deep compression with a magnitude of greater than –120 ksi (-827 MPa). These results confirm that the LPB treated halves of the specimens are in a state of deep residual compression, while the untreated sides are in tension and remain susceptible to SCC.

To explore the effects of LPB on SCC, the samples were exposed to boiling magnesium chloride above 120˚C in accordance with ASTM standards. After 100 hours of exposure, the untreated sides of all specimens exhibited severe hoop and radial SCC, in some cases completely penetrating through the half-inch thickness. The LPB treated

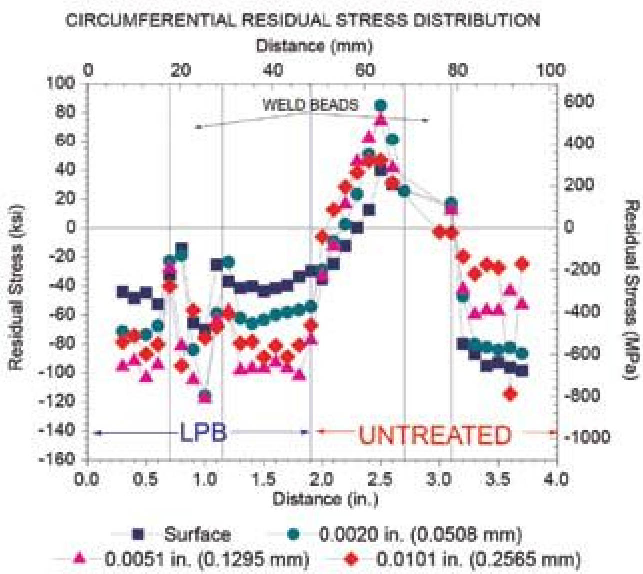

Figure 1: X-ray Diffraction Residual Stress Measurements of 304L Welded Specimen

areas contained no SCC and retained 100% of the initial compression induced by processing. Optical microscopy and fluorescent dye penetrant were used to inspect and confirm that SCC stopped completely at the LPB boundary, as seen in Figure 2.

Designed compression applied with LPB is a valuable tool in both the design and overhaul phases for equipment. As shown in this study, LPB can completely eliminate SCC in stainless steels and shows huge potential to aid in many industries. The work described in this article led to the development of an LPB system for the Department of Energy to process closure welds on nuclear waste containers. The vessels are designed to last thousands of years, but SCC threatened a drastically shorter life. Waste containers are

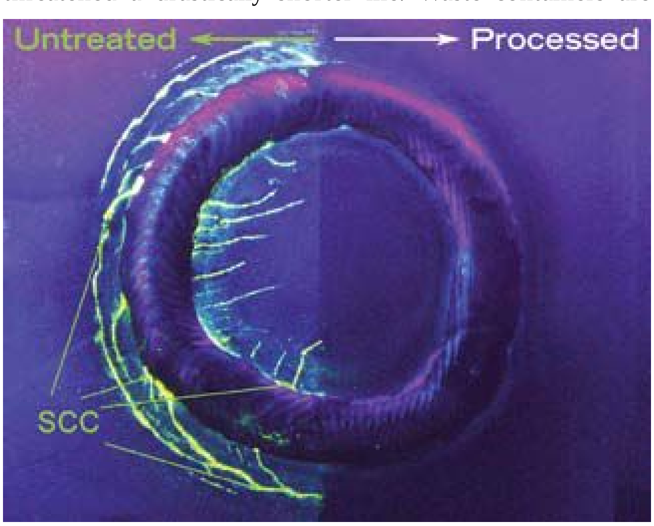

Figure 2: SCC Shown on Untreated and LPB Processed 316L Welded Specimen with Fluorescent Dye Penetrant

heat-treated to relieve stress before closure, but the final closure welded areas have high tensile stresses, serving as initiation points for SCC. Shown in Figure 3, LPB imparted a 12 mm depth of compression in the weld closure, completely eliminating SCC and ensuring safe usage for the required duration.

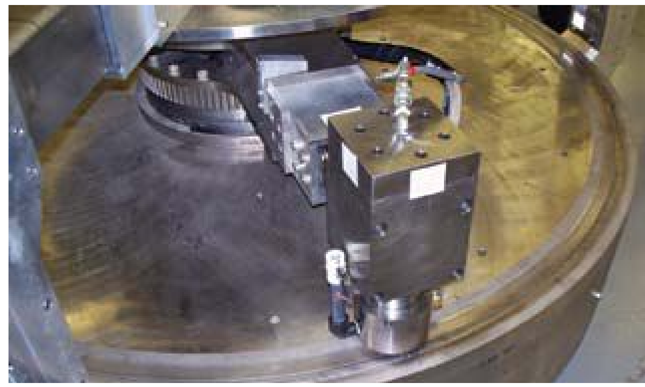

Figure 3: LPB Processing of Nuclear Waste Container Weld

The success of using designed compression to eliminate SCC and other forms of environmentally assisted cracking is not limited to stainless steel alloys. Because LPB drastically increases the damage tolerance of high-strength steels, the use of designed compression has allowed the petrochemical industry to employ materials like P110 steel, which has the strength to last in drilling conditions. Untreated P110 steel can fail from sulfide SCC in just a few hours despite its strength. LPB processed specimens lasted for more than 1,000 hours, when testing was finally discontinued. These results far exceed NACE standards and have allowed petrochemical engineers the ability to use much less expensive material while retaining all the benefits of its strength.

Designed compression applied with LPB is a valuable tool in both the design and overhaul phases for equipment. As a proven method of mitigating both SCC and corrosion fatigue in various components, LPB shows huge potential to aid in the power and petrochemical communities. As more deep wells and offshore resources are developed, and as the world's need for power continues to rise, this cost-effective surface enhancement method will be an invaluable tool to reduce operational costs, extend component life, and improve performance.

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ACADEMIC STUDY
Dr. David Kirk | Coventry University

Component Distortion
An Overview

INTRODUCTION

Every shot peener distorts components—if only in the form of Almen strips. They would be useless if they didn't distort! Distortion is caused by a combination of plastic deformation and induced residual stresses. Force, rigidity and bending moment determine the amount of distortion. This article aims to explain, for non-experts, how distortion in a shot peened component develops.

Shot peening is a cold-working process so that plastic deformation and residual stress development go hand in hand. Each imposed residual stress system must involve a balancing of both forces and bending moments. Force is the level of stress multiplied by the area over which it acts. It is important to distinguish between the magnitude of stress and the force to which it corresponds. Fig. 1 illustrates this basic relationship. Imagine a typical eating apple being suspended from a beam using wire of 1 mm^2 cross-sectional area. Assuming the apple imposes a force of 1N on the wire, then we have a system with a stress level of 1MPa induced into the wire ($1Pa = 1Nm^{-2}$). The wire is being strained by the applied force. Residual compressive surface stresses in peened components are generally in hundreds of MPa with core tensile stresses in tens of MPa. Note that it is forces that generate stresses—not the other way round. The distribution of residual stresses in a peened component depends upon the balance of forces and bending moments that are a consequence of the peening operation.

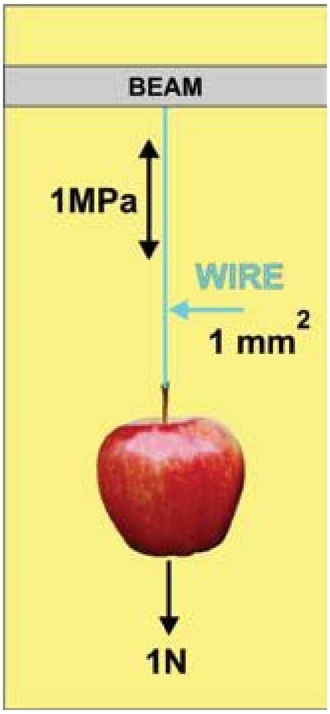

Fig. 1. Simple residual stress system.

Heyn introduced a simple spring model in 1912, purportedly as an aid to understanding balancing of residual stresses. A spring model has been introduced in this article to simulate the necessary balancing of forces and bending moments that must exist in a shot-peened component.

SYSTEMS OF FORCES AND BENDING MOMENTS

Stable, Balanced System

Fig. 2 represents a stable system. Imagine two compressed springs each pushing end blocks outwards with a force of 10N. These two forces are balanced by ten stretched springs symmetrically placed above and below the centerline and each pulling the end blocks inwards with a force of 2N. We now have a balanced, stable system of forces. There is no tendency for the two end blocks to move. The system of forces/bending moments is roughly similar to that in a strip that has been peened on both major faces by equal amounts. Peening would have induced equal compressive forces, F, on the upper and lower faces balanced by tensile force, 2F, acting on the core. This system is represented in fig. 3 which includes analogous springs.

Unstable, Unbalanced System

Fig. 4 represents a spring model of an unstable system. The model is the same as that shown as fig. 2 but with the lower,

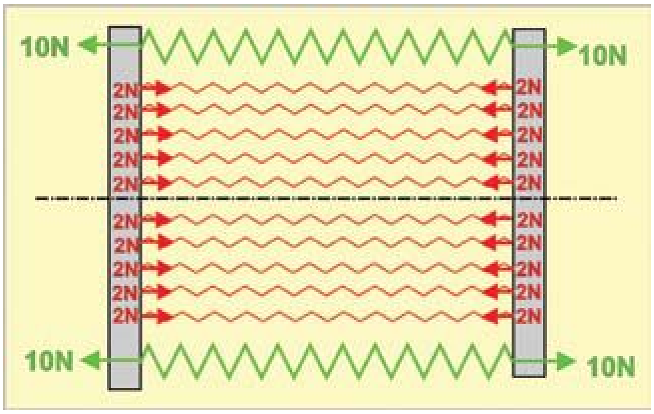

Fig. 2. Spring model of a stable, balanced, force/bending moment system.

compressed spring removed. Removing this spring gives an imbalance of both forces and bending moments.

Stable, Balanced System

In order to correct the situation of fig. 4, spring forces would adjust themselves to give the stable situation shown in fig. 5. The force in the remaining compressed spring is reduced. As the end blocks rotate about their axes, the forces change in the originally stretched springs. Those above the centerline increase whereas those below the centerline reduce with some eventually becoming compressive.

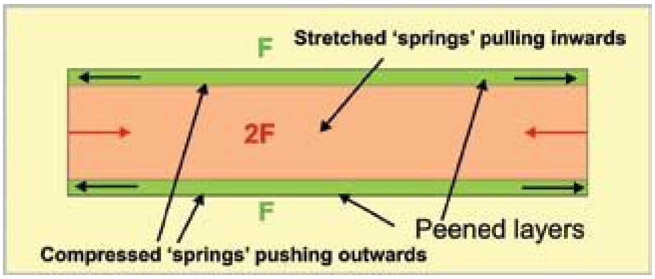

Fig. 3. Stable, balanced, force/bending moment system for a peened strip.

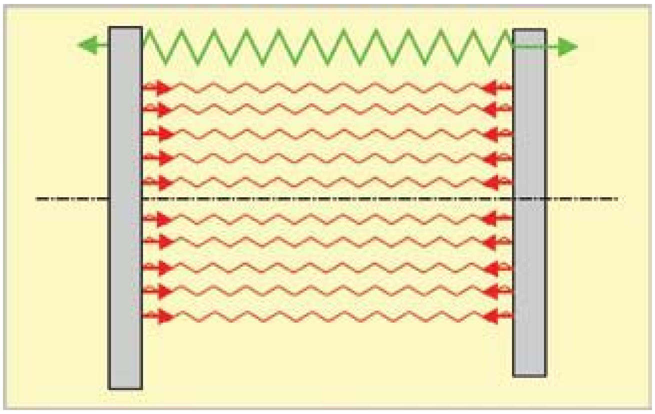

Fig. 4. Spring model of an unstable situation.

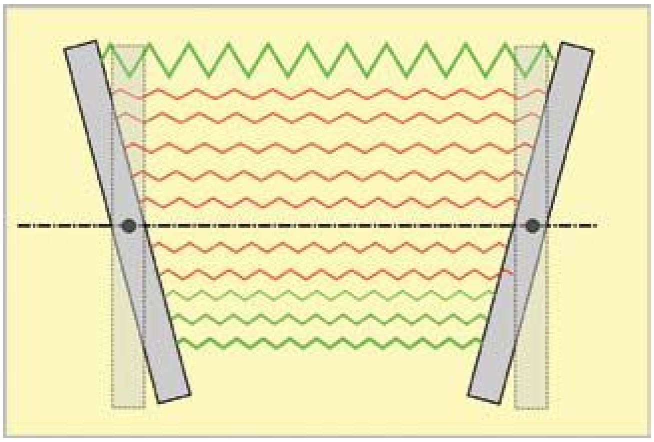

Fig. 5. Spring model showing adjustments needed to achieve a stable situation.

The equivalent peened situation to that of fig. 5 is shown in fig. 6. Strip bending is induced by the force, F, being exerted by the peened layer. This force is the product of residual stress level multiplied by the area over which it acts. Fig. 7 shows a typical distribution of residual stress in the surface region. Consider, as an example, that this distribution was from a peened Almen strip. Since the strip dimensions are well-known (19 mm x 76 mm) we can estimate the longitudinal and transverse compressive forces. Assuming an average stress of 240N mm^{-2} in the compressed surface layer we have the longitudinal force is some 19 mm x 0.5 mm x 240N mm^{-2} or 2280N, and the transverse force is some 76 mm x 0.5 mm x 240N mm^{-2} or 9120N.

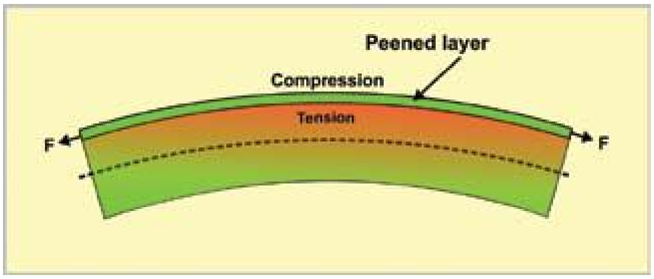

Fig. 6. Peened strip equivalent of Fig. 5.

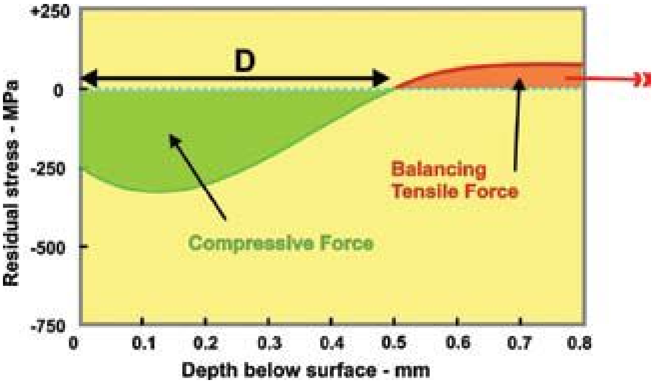

Fig. 7. Typical residual stress distribution near peened surface giving rise to compressive and tensile balancing forces.

DEVELOPMENT OF RESIDUAL STRESSES AND FORCES

Residual stresses and corresponding forces can only develop as a consequence of cold-working. By definition, hot-working is carried out at such a high temperature that the worked component self-anneals. Inhomogeneous cold plastic deformation is a necessary requirement for residual stresses and forces to develop. Shot peening is a process that involves cold-working of the surface of components. The plastic deformation involved is confined to the peened surface. This means that peening plastic deformation is "inhomogeneous". In effect, only the peened surface is plastically deformed.

There is a universal "Golden Rule" defining the sign of the residual stress that is induced by inhomogeneous plastic deformation:

The sign of the residual stress is the opposite of the sign of the inhomogeneous plastic deformation that caused it.

The "sign" of peening surface plastic deformation is positive (+) equivalent to tensile deformation. Applying the "Golden Rule," the resulting surface residual stress must be compressive (-).

We can think of peening as inducing surface residual stress forces that are the equivalent of compressed springs. The force in the "springs" increases with (a) the depth of the peened layer and (b) with the average stress in the peened layer.

The tensile surface plastic deformation of peening is the sum of numerous miniature surface movements. Fig. 8 is a simplified portrayal of the surface movement associated with an individual dent. The material present before denting, ABCA, is pushed sideways, i.e., parallel to the surface. This corresponds to tensile, (+), plastic deformation of the peened surface layer and therefore to a compressive residual force. The core material resists this outward movement requiring a balancing tensile force.

DUPLEX BENDING CAUSED BY PEENING

So far, only bending in one direction has been considered. Denting causes tensile stretching in the two directions defining the surface. The easiest way to appreciate this duplex bending is to consider a peened Almen strip as shown in fig. 9. Peening bends the strip by an amount corresponding to h1 parallel to the strip's major axis AB. A smaller amount of bending, h2, also occurs parallel to the strip's minor axis BC. Almen strip and gauge manufacturers would not be in business if this type of bending did not occur! It is also worth noting that peening must induce component distortion—to a greater or lesser extent—but more on that later.

DISTORTION AND RIGIDITY

Distortion will normally occur as a consequence of shot peening. The only exception will be if the operation is absolutely homogeneous; for example, if both major faces of an Almen strip were peened simultaneously using identical peening parameters. The extent of the induced distortion depends upon the magnitude of the bending force and the rigidity of the component.

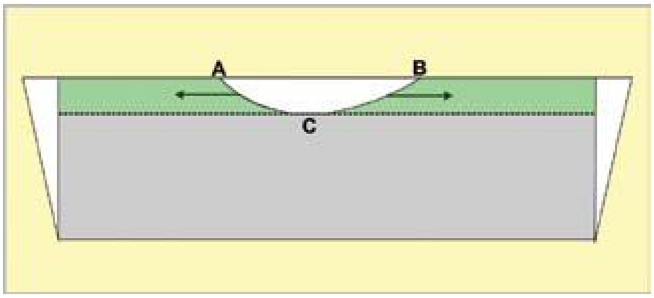

Fig. 8. Simplified portrayal of material movement caused by a dent.

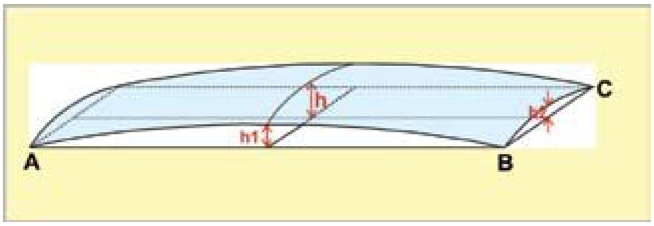

Fig. 9. Duplex bending induced by peening one major surface of an Almen strip.

Rigidity is determined by the geometry of a component's ***cross-section***. The difficulty of estimating component rigidity seems to increase exponentially with the complexity of its geometry. Some appreciation of the most important factors can be obtained by using a simple example. Consider trying to bend, using only fingers, a steel ruler as illustrated in Fig. 10. Common-sense/experience tells us that with this orientation the induced bending will be negligible. The ruler is exhibiting high rigidity. On the other hand, if we rotate the ruler through 90˚, bending will occur quite easily. The two orientations correspond to A and B in fig. 10.

The simplest relationship for rigidity, **I**, is that of a rectangular object. Its width, **w**, is multiplied by the cube of its thickness, **t**, and divided by twelve. Expressed as an equation:

$$\mathbf{I = w.t^3/12} \qquad (1)$$

Assume, for the sake of simplifying mental arithmetic, that the ruler's cross-sectional dimensions are 20 mm x 2 mm. For the orientation A shown in fig. 10, the width (normal to the page) is 2 mm and the thickness is 20 mm. Hence I = 2 mm x 20^3 mm^3/12 or 16,000 mm^4/12. Rotating the ruler through 90˚ to give orientation B means that the width now becomes 20 mm and the thickness becomes 2 mm. Hence I = 20 X 2^3 m^{m4}/12 or 160 m^{m4}/12. The "edgewise" orientation, A, therefore has a rigidity value 100 times as great as the "flatwise" orientation, B. This quantifies the difference in our ability to induce bending.

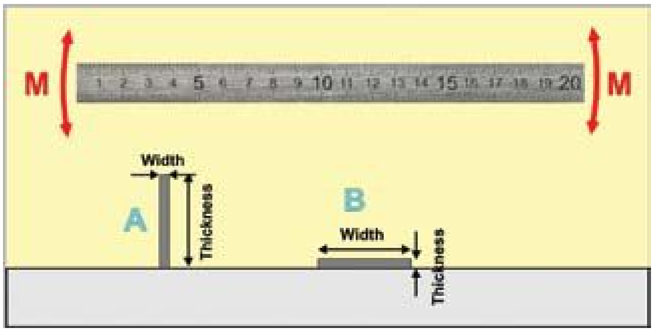

Fig. 10. Bending moment, M, being applied to a steel ruler.

The primary conclusion is that **thickness is the key factor in determining the onset of distortion** because rigidity is a function of the **cube** of thickness. As we know, an Almen N strip, being thinner, distorts much more than an Almen A strip when given the same amount of peening.

PLASTIC VERSUS RESIDUAL STRESS DISTORTION

As mentioned earlier, distortion is caused by a combination of plastic deformation and induced residual-stress forces. Fig. 11 illustrates the situation for a simple shape such as an Almen strip. The two contributions to deflection, plastic (pl) and residual stress (rs) are roughly equal. That ratio has been confirmed by noting the 50% reduction in arc height that occurs when stress-relief annealing has been applied to peened strips. Potential distortion estimated from residual stress force can be doubled to give a predicted total distortion value.

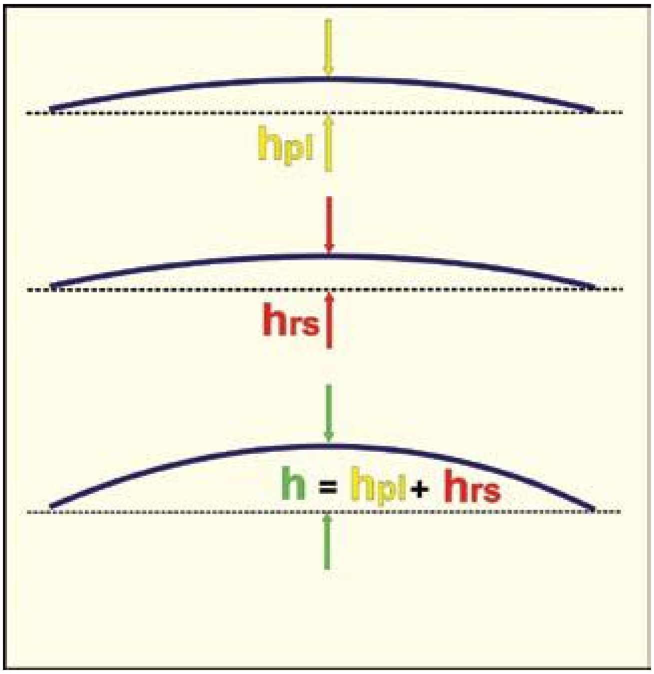

Fig. 11. Strip distortion components for peened Almen strips.

FACTORS CONTROLLING DISTORTION ARISING FROM RESIDUAL STRESS

Three factors control the amount of distortion induced by residual stress forces. These are: BENDING MOMENT, RIGIDITY and ELASTIC MODULUS. Increase of bending moment increases distortion whereas increases of rigidity and/or elastic modulus reduce distortion. This is illustrated schematically in fig. 12.

A quantitative relationship, familiar to mechanical engineers, exists that links the three factors:

$$1/R = M/(E \times I) \qquad (2)$$

1/R is the curvature induced by applying the bending moment, M, E is elastic modulus and I is rigidity. The larger the value of M/(E x I) the greater will be the induced curvature.

The relationship factors are illustrated in fig. 13 for a shot-peened strip. Note that bending moment, M, is a function of force, F, multiplied by strip thickness.

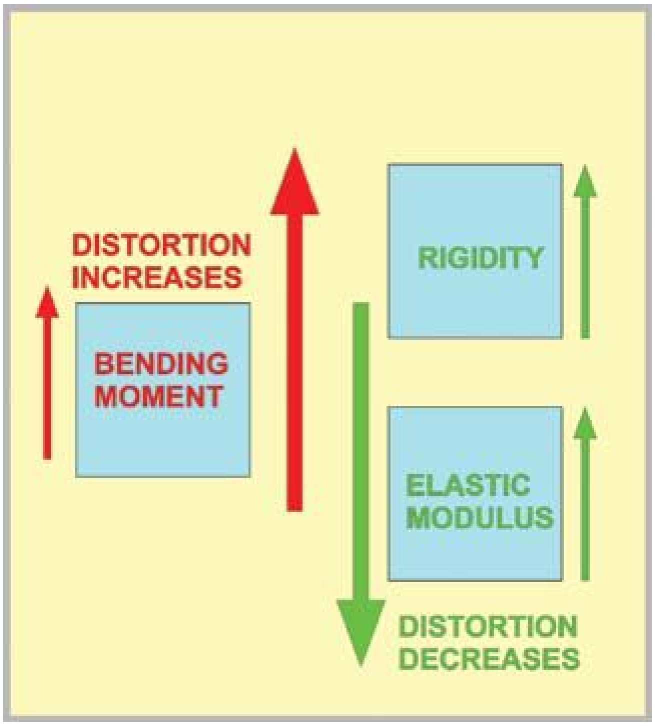

Fig.12. Factors controlling distortion.

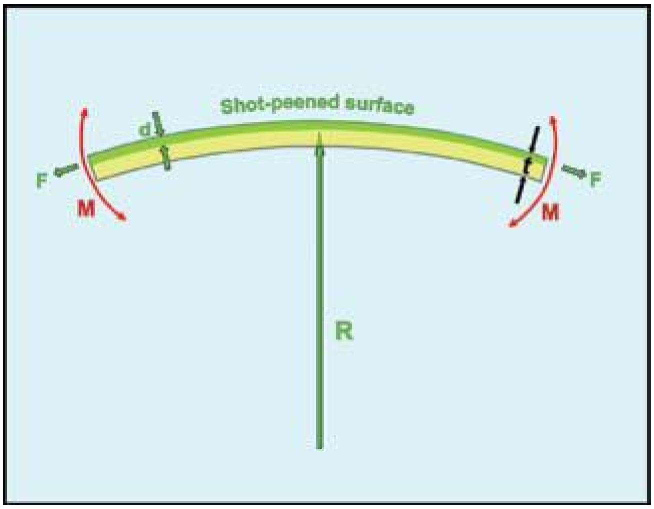

Fig. 13. Inter-relationship of factors affecting distortion of a strip.

1/R is called the "curvature" of the distorted object. The larger the value of 1/R the larger is the curvature and therefore the amount of distortion. Curvature is generally preferred to deflection as a quantitative measure of distortion because it is independent of the component's length. Imagine standing on a plank supported at its ends. If the plank was 10 m long the induced deflection would be much greater than if it was only 2 m long. Almen strips are a special case because they are always of a fixed length. Their distortion is quantified by the deflection from flatness—arc height. Distortion of an originally flat component can readily be measured using a feeler gauge set.

A very important conclusion can be deduced from equation (2). On the right-hand side, M is proportional to thickness and is being divided by rigidity, I, which is proportional to thickness cubed, see equation (1). Therefore one power of thickness cancels out. Hence:

Potential peening distortion, 1/R, is inversely proportional to the square of the component's thickness.

DISTORTION CONTROL

We must start by acknowledging that virtually every shot peening operation imposes some degree of distortion on a component. This distortion may be welcome as for Almen intensity measurement and for peen forming. On the other hand, if peening imposes an unacceptable level of distortion we must try to reduce it.

Available methods for reducing peening distortion are limited. Some that come to mind are as follows:

1. Reduce surface compressive force

This is the most obvious method—achieved by inducing a thinner deformed surface layer (by using smaller shot and/or peening intensity). The disadvantage is that the customer may insist that a specified thickness of deformed and compressed surface layer is required in order to optimise component performance.

2. Pre-machine component with reverse distortion

This is feasible if the peening distortion is very small (but still unacceptable) so that a tiny amount of pre-machining can be applied. Peening distortion then becomes peen-forming. The method would require that the peening distortion is highly reproducible and would rarely be recommended.

3. Post-peening machining

Some fine-finish machining operations could be postponed until after peening has been carried out—hence removing any distortion effect. This could be a useful technique.

4. Mild stress-relieving

Shot-peening improves service performance by a combination of surface work-hardening and a compressed surface layer. Mild stress-relieving would reduce the surface compression force without inducing a significant reduction of surface work-hardening.

5. Compressive strain peening

Tensile strain peening is a well-established process. Components such as railway wagon springs have the peening surface put into tension during peening. After peening the strain is removed, leaving higher levels of compressive stress in the peened surface. The opposite type of strain, compression, could be applied during shot peening. This would give a lower level of compressive stress in the peened surface, reducing distortion, but would preserve the depth of the work-hardened surface layer.

6. Modification of component design

This involves increasing component rigidity in regions affected by shot peening distortion.

DISCUSSION

This article, being an overview of distortion, has necessarily been superficial in many respects. Several of the contributory factors have been dealt with in much greater depth in previous articles in this series.

The spring model of residual force distribution is believed to be particularly useful for illustrating distortion generation.

For a given component, the most important factors controlling distortion are the compressive surface force generated by shot peening and the inherent rigidity of the component. It has been shown that the extent of distortion is inversely proportional to the square of the component's thickness. The potential for distortion of steel components can, for example, be predicted using the observed distortion of steel Almen strips (obtained during intensity measurements). For example, if the thickness of a rectangular component was ten times that of the Almen strip then component distortion, per 76 mm length, would be roughly one-hundredth of that measured for the strip.

Rigidity estimates can be used to explain the multiplication factors, 3.0 and 3.2, proposed for comparing intensity values derived from N, A and C strips.

The rigidity of complex component sections can be approximated by using the nearest textbook example. A mechanical engineer's specialised knowledge might, however, need to be employed.

Finally, we must accept that shot peening will inevitably induce distortion. Fortunately the degree of component distortion is usually insignificant. It may, however, be a required feature.


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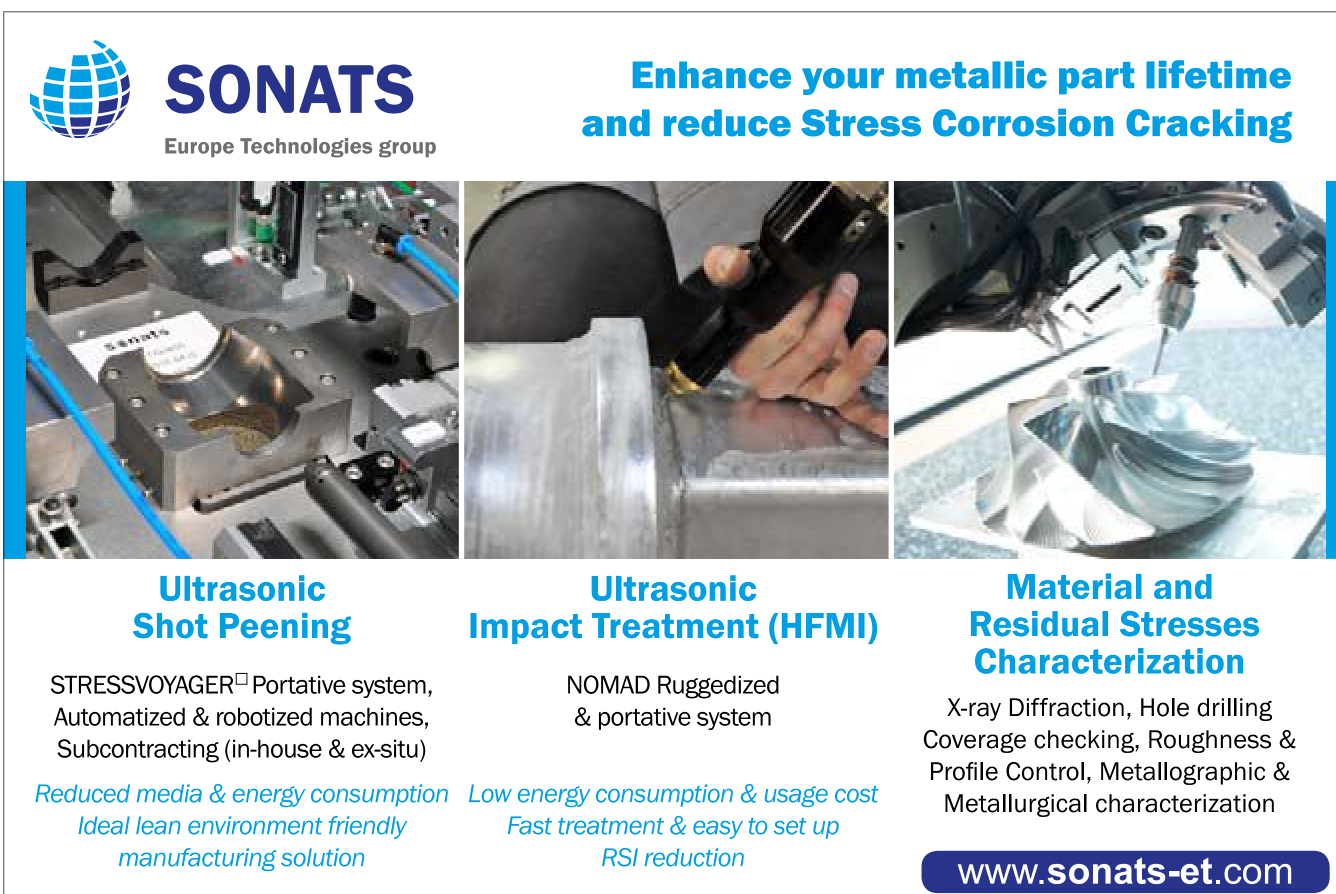
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On the Relationship of Surface Cold Work to Coverage in Shot Peening

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INTRODUCTION

Certainly, a desirable result of shot peening is creation of compressive residual stresses at the surface of a part and in near surface layers. Though often not known or seldom considered, cold work (CW) is also an inherent result of peening, and is fundamentally responsible for the creation of compressive residual stresses. Bombardment of the surface of a part by small spherical media creates plastic deformation, i.e., stretching of surface layers. Elastic resistance of underlying material, which is not plastically stretched by peening, results in compression in surface and near-surface layers. Also, not commonly known or considered is that CW can influence the stability of residual stresses from thermal exposure and mechanical applied stresses in service (Ref. 1). Discussion of this matter of residual stress stability is beyond the scope of this brief article. Readers, however, are encouraged to consult the reference supplied to determine significance to their parts and service life.

Considerable work at Lambda Technologies has been done on the subject of optimization of shot peening. Published in various places (Ref. 2 &3) and patented (Ref. 4) the work has been synopsized in a brochure available from Lambda (Ref. 5). See contact information for authors at the beginning of this article to obtain a copy of this brochure. The principal finding from peening optimization work by Lambda has been that optimum peening benefits in terms of residual stresses and fatigue strength result from peening to coverage levels less than 100%. Because CW is fundamental to residual stress creation in peening, the authors have chosen to study the relationship between CW and coverage. Incidentally, the possibility of a relationship between surface residual stress and coverage was also examined. Results are presented herein.

Specifically in this article, the authors will outline a method for cold work determination using x-ray diffraction (XRD) peak breadth and examine the relationship of CW to coverage in four diverse materials.

%CW XRD MEASUREMENT TECHNIQUE

Cold work is often expressed as a percentage (%CW) as related to the plastic strain involved. For example, 50% cold work is equivalent to a plastic strain of 0.50, 10% CW is 0.10 plastic strain, etc. Increase in %CW is manifested in XRD as an increase in diffraction peak breadth. An example of a diffraction peak profile and peak width is illustrated in Figure 1. Further discussion of measuring the %CW through the use of XRD is beyond the scope of this article, but is described in detail elsewhere (Ref. 6).

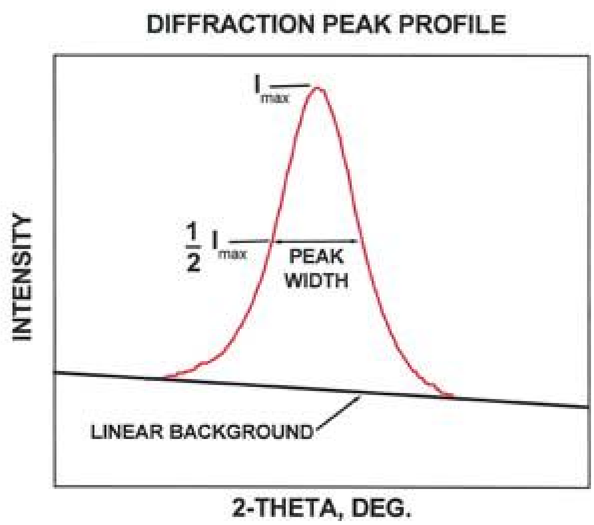

Figure 1. Graphic Illustration of FWHM Diffraction Peak Breadth Parameter

Surface values of %CW (and residual stress) can be determined non-destructively whereas determination of subsurface values require progressive layer removal to expose subsurface material for XRD measurements. Although subsurface data have been produced, the authors have confined this article to surface measurements to determine whether or not such information could be exploited as a nondestructive technique to determine optimum coverage.

RESULTS AND DISCUSSION

New information provided in this article (Figure 2) shows the relationship of surface %CW (from XRD peak breadth) to peening coverage in 4340 steel (39 HRC), Inconel 718 (STA), Ti-6Al-4V, and 7075-T6 Al respectively. Interestingly, for each of the four materials, surface %CW increases rapidly with


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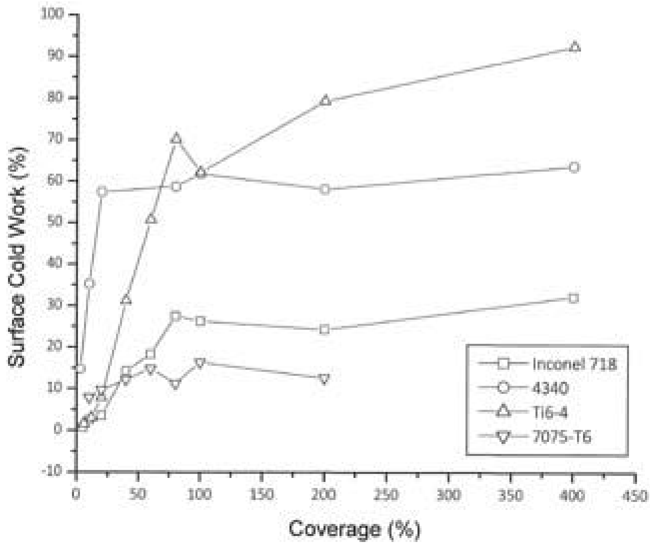

Figure 2. Relationship between Surface %CW from FWHM and Coverage for four materials

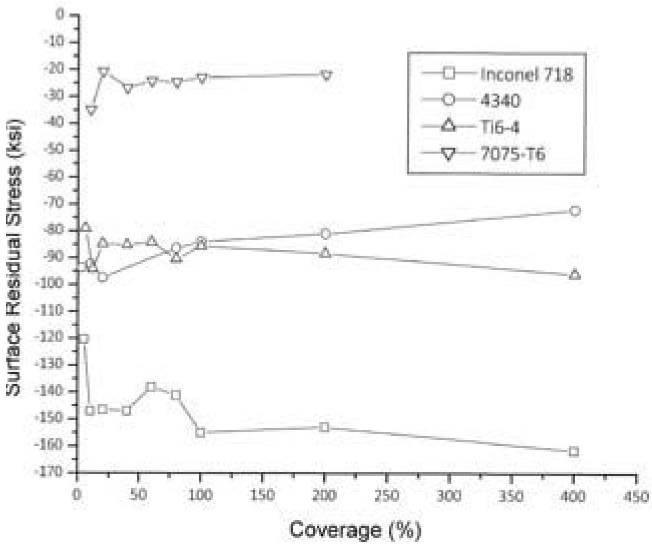

Figure 3. Relationship between Surface Residual Stress and Coverage for four materials

coverage and saturates at coverage values less than 100%. This is consistent with a previous finding that optimum peening coverage is also less than 100%. Interestingly, the saturation points for %CW for three of the four materials was very close to the 80% coverage level found as the optimum coverage level in previous studies. Potentially, therefore, monitoring of %CW at the surface may be useful as a technique for assessing peening quality. For the fourth material (4340 steel), the saturation point for surface %CW occurred at a coverage level considerably below the previously determined optimum.

The authors also examined the relationship of surface residual stress levels to coverage in the same four materials. Results are shown in Figure 3. This was done because surface residual stress levels are believed by other investigators to be useful as a nondestructive technique for determining peening quality. The trend in surface residual stress with coverage for each material appears to be unlike the trend in %CW with coverage. Except for very low coverage values, surface residual stresses for all four materials appear to be generally insensitive to coverage. There is no correlation of surface residual stresses with optimum coverage levels determined in previous work. Thus, it appears that nondestructive surface residual stress measurements will not be generally useful either to detect optimum peening coverage or as an index of peening quality.

SUMMARY

The relationship of surface %CW to coverage was explored for four diverse materials. In representative aluminum, nickel and titanium alloys, the saturation value of %CW appeared to coincide with an optimum coverage level of 80% as found in earlier investigations. For 4340 steel (39 HRC), there was no such coincidence, with the saturation %CW occurring at a coverage level significantly less than the 80% optimum level of coverage revealed in previous work. The relation of surface residual stress to coverage was also examined. No consistent correlation was found between surface residual stress and coverage in any of the four materials.

The practical benefits of optimized shot peening include up to a four-fold production rate improvement, reduced cost and media consumption (Ref. 2,3,4). The associated reduction in cold work minimizes surface damage and increases both the thermal and mechanical stability of the beneficial compressive layer. Because cold work is cumulative, practicing optimized peening can also extend the useful life of fatigue critical parts that are repeatedly peened in overhaul by reducing the increase in cold work with each cycle.

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Sinto America Group Companies Announces New Executive Vice President and Chief Operating Officer

SINTO AMERICA, INC. GROUP COMPANIES, which includes Roberts Sinto Corporation and SandMold Systems, Inc., announced that Michael Halsband has been appointed the companies' Executive Vice President and Chief Operating Officer effective September 11, 2017.

Halsband has extensive experience in engineering, project and program management, purchasing and supply chain management, sales management, organization development and systems integration in technological advanced companies.

Halsband holds a Bachelors, Masters, and Doctorate degrees in Mechanical Engineering and was born and raised in Germany. He has strong international experience having worked in Germany and for two large foreign global companies. His most recently was General Manager at ATS Assembly and Test in Wixom, Michigan, and also held management roles at Comau, Inc., and ThyssenKrupp.

Roberts Sinto Corporation and SandMold Systems, Inc. are a part of Sinto America, Inc., the North American group of companies, of Sintokogio, Ltd., a worldwide family of companies with an international reputation for excellence in the metal casting industry.

Sinto America, Inc. and its group of operating companies are dedicated to providing superior customer service by offering practical, cost-effective and technologically advanced equipment and solutions to a variety of industries throughout North America. Following Sintokogio's strategic direction, Sinto America focuses on four primary markets: Foundry, Surface Treatment, Material Handling and Environmental. Additional information about Sinto America is available at www.sintoamerica.com.

DAES Distribution Selected by Straaltechniek International as Distributor Partner

Netherlands-based innovators in shot peening and high-end blasting turnkey solutions turn to DAES for North America and Middle East regions

DAES Distribution LLC, a DAES Group company, is dedicated to serving the aerospace industry by offering the finest solutions on the market. The company announced that it signed a new commercial agreement with Straaltechniek International BV. Straaltechniek, a shot peening and high-end blasting technology leader, is headquartered in Oosterhout, The Netherlands. Straaltechniek products will be distributed by DAES to the aerospace industry in North America and the Middle East regions where DAES Group has strong established relationships.

Straaltechniek has served the aerospace industry for over 30 years, achieving outstanding results through their high levels of innovation. Their clients include companies such as Rolls-Royce, GE, Air France KLM, Turkish Airlines, South African Airways and Pratt & Whitney. Its robust portfolio ranges from a robotic shot peening machine to high-end blasting equipment.

"We are pleased to start this business relationship with DAES Distribution. This agreement fortifies our efforts to become a premier provider in the aerospace industry," said Marco Klijsen, Straaltechniek Managing Director. "The experience and capabilities of DAES makes them a strong partner and this new chapter is enabling us to extend our markets," stated Marco Klijsen.

Straaltechniek relies on a variety of resources to customize each project to reach the specific needs of OEMs and MROs while maintaining quality standards. Straaltechniek's strengths and competitive advantages are based on the combination of innovation, flexibility, adaptability, strategic planning, and high technology.

"This agreement between Straaltechniek and DAES Distribution will result in success for both companies," said Alan Codlin, DAES Distribution Chairman. "Straaltechniek solutions, are not only clear market leaders but their technology is also ideal for our industry, where metal fatigue is a critical issue. This strategic relationship will benefit our portfolio and enhance our client's success," added Codlin.

The 2018 Dodge Challenger SRT Demon

This press release caught our eye because it referenced shot peening, but we think it will be interesting to all car enthusiasts.

"ROADSHOW BY CNET" has named the high-performance drivetrain in the 2018 Dodge Challenger SRT Demon as the winner of the 2018 Roadshow Shift Award in the Driveline Technology of the Year category.

Designed, engineered and built for absolute drag strip domination, the limited-production 2018 Dodge Challenger SRT Demon is powered by a 840-horsepower, supercharged 6.2-liter HEMI® Demon V-8 engine, making it the most powerful muscle car ever and the world's fastest quarter-mile production car with an elapsed time of 9.65 seconds at 140 miles per hour, as certified by National Hot Rod Association.

To make all that horsepower and immense 770 pounds-feet of torque transfer to the pavement, Dodge//SRT engineers used a variety of proven drag racing strategies and several technology-firsts to build the first-ever production car to produce a front-wheel lift as certified by Guinness World Records.

"We saw some amazing innovations on the powertrain front this year, and this was a hotly contested category, but in the end, the Roadshow team couldn't resist the lure of the Demon," said Tim Stevens, editor-in-chief, Roadshow by CNET. "The power output is of course phenomenal, but it's the extent of the technology that really impressed us, like ducting the air conditioning to chill the intake air. It's a hell of a package."

"Our performance-minded designers and engineers worked tirelessly to shake the foundation of the entire performance car industry with the 840-horsepower Dodge Challenger SRT Demon," said Tim Kuniskis, head of passenger cars, Dodge//SRT, Chrysler and FIAT, FCA North America. "In the quest for domination at the drag strip, Dodge//SRT engineers reviewed and strengthened every piece of the drivetrain to ensure it provides the ultimate in performance and durability."

Updates include:

- Supercharged 6.2-liter HEMI Demon V-8 engine produces 840 horsepower and 770 pounds-feet of torque when equipped with available Direct Connection engine controller (first ever for production car) and fueled with 100+ high-octane unleaded fuel. Engine develops 808 horsepower and 717 pounds-feet of torque with 91-octane fuel
- Air-Grabber™ induction system includes the largest

The supercharged 6.2-liter HEMI® Demon V-8 in the 2018 Dodge Challenger SRT Demon is rated at 840 horsepower and 770 lb.-ft. of torque.

functional hood scoop (45.2 square inches) of any production car
- First-ever, factory-production car with TransBrake combined with Torque Reserve, to deliver the highest g-force acceleration of any production car
- After-Run Chiller (production car first) runs the cooling fan and the low-temperature circuit coolant pump after engine shutdown
- Award-winning and factory production car first SRT Power Chiller™ redirects air conditioning refrigerant to help cool compressed air entering the supercharged Demon V-8 engine
- Bilstein Adaptive Damping shocks have been tuned for drag racing, shifting as much weight as possible on the rear tires at launch for maximum traction. The weight transfer improves rear tire grip by 11 percent.
- Drag Mode Launch Assist (factory car first) uses wheel speed sensors to watch for driveline-damaging wheel hop at launch and in milliseconds modifies the engine torque to regain full grip
- Factory-installed, 315/40R18 Nitto street-legal drag radials for improved grip and 40 percent more launch force compared with standard SRT Challenger Hellcat tires
- Available narrow "front runner" wheels for use at drag strips to cut front-end weight and rolling resistance

The Dodge Challenger SRT Demon's driveline components were also upgraded to get all that power and torque to the rear wheels, on every run. Changes include:
- Upgraded prop shaft with a 15 percent increase in torque capacity. The prop shaft uses high-strength steel. Shaft tube thickness increases by 20 percent, and the stub shafts are heat treated for enhanced durability.
- The rear differential housing has 30 percent more torque capacity. The housing is made from heat-treated A383 aluminum alloy. New material for the gear set has higher fatigue strength, with a deeper case hardening depth **and two-step shot-peening manufacturing process to increase compressive residual stress.**
- The rear half shafts are larger in diameter; use a high-strength, low-alloy steel; and have 41 splines (up from 38), delivering a 20 percent increase in torque capacity. Eight-ball joints handle more torque, while reducing operating temperatures by more than 86 degrees Fahrenheit.

More about the 2018 Dodge Challenger SRT Demon

Production of the 2018 Dodge Challenger SRT Demon is limited to 3,300 vehicles—3,000 for the United States and 300 for Canada—with a U.S. Manufacturer's Suggested Retail Price (MSRP) of $84,995, including $1,700 gas guzzler tax, excluding $1,095 destination.

The Challenger SRT Demon is covered by FCA US LLC factory warranty, including three-year/36,000-mile limited vehicle warranty and five-year/60,000-mile limited powertrain coverage.

All 2018 Dodge Challenger SRT Demon owners receive one full-day session at Bob Bondurant School of High-performance Driving in the newly announced Dodge//SRT Bondurant Drag Racing School.

The Roadshow Shift Awards highlight the best in innovative, disruptive technologies and products in the automotive world. With cars becoming more complex as transportation and tech sectors converge, it's become harder for consumers to know what developments and products matter most for their lives. The Roadshow Shift awards cut through the confusion and the sizzle to recognize the most innovative and important developments in the car industry each year. Award winners aren't just class benchmarks, they're driving the industry towards a smarter, more sustainable and entertaining future.

About Dodge//SRT

Dodge//SRT offers a complete lineup of performance vehicles that stand out in their own segments. Dodge is FCA North America's mainstream performance brand, and SRT is positioned as the ultimate performance halo of the Dodge brand, together creating a complete and balanced performance brand with one vision and one voice.

For more than 100 years, the Dodge brand has carried on the spirit of brothers John and Horace Dodge, who founded the company in 1914. Their influence continues today. New for 2018, the 840-horsepower Dodge Challenger SRT Demon, the fastest quarter-mile production car in the world and most powerful muscle car ever, is taking the world by storm, along with the new 2018 Dodge Durango SRT, America's fastest, most powerful and most capable three-row SUV, and the 707-horsepower Dodge Challenger SRT Hellcat Widebody. These new SRT ultimate performance models join a brand lineup that includes the Durango, Grand Caravan, Journey, Charger and Challenger, including the 707-horsepower Challenger SRT Hellcat and the Charger SRT Hellcat, the quickest, fastest and most powerful sedan in the world.

7th International Conference on Laser Peening and Related Phenomena

June 17-22, 2018 • Singapore

THE CONFERENCE CHAIRMEN, Professor Michael Fitzpatrick with Coventry University and Professor Minghui Hong with the National University of Singapore, have announced that the 7th International Conference on Laser Peening and Related Phenomena (LSP 2018) will return to Asia, to the wonderful venue of Singapore, June 17-22, 2018. The 10th Anniversary conference will be hosted by the National University of Singapore (NUS), jointly organised with Coventry University, UK, through its Singapore Hub.

The conference will maintain its workshop-style approach of a single session and an emphasis on discussion and networking, with a focus on industrial problems and applications, alongside the basic phenomena of materials response and the development of laser systems for the future.

Industry leaders will display their products and services in an exhibit during the conference. LPS 2018 will provide a unique opportunity to meet with important vendors, and researchers from around the world.

The conference welcomed abstracts from the community with the following themes. The Conference Committee considered abstracts that fell outside the areas explicitly mentioned here, if they aligned with the overall aims of the conference series. In addition to papers that deal with applications from the core business of LSP in the aerospace and power generation industries, the committee was particularly interested in research into the use of LSP in marine, automotive, and medical industries.

1. Performance and lifing enhancement for engineering applications
   - Fatigue and fracture
   - Tribology, wear and erosion
   - Corrosion and stress corrosion
   - Forming and shaping
   - Repair or mitigation of damage
   - Life extension
2. Fundamental mechanisms and modeling
   - Plasma pulse modeling
   - Plasma/material interactions
   - High-strain-rate effects
   - Finite element and other computational methods
   - Fundamentals of residual stress generation
   - Material hardening and property modification
   - Microstructural characterization and modification
   - Phenomenological and eigenstrain techniques
3. Laser technologies and novel process techniques
   - High repetition-rate technologies
   - Pico- and femto-second laser systems
   - Compact and portable systems
   - High-power lasers
   - Micro-scale peening systems
4. Related and novel technologies
   - Multiple and combined surface treatments
   - Burnishing
   - Ultrasonic Nanocrystal Surface Modification (UNSM)
   - Surface Mechanical Attrition Techniques (SMAT)
   - Cavitation shot-less peening
   - Other novel techniques

The conference will be held on the engineering campus of the National University of Singapore. Singapore provides a wide range of cultural attractions, sightseeing, excellent cuisine, and a range of amenities for delegates and their partners. Shuttles will take participants to the conference hotels, and there will be a program of events around the conference, including a river cruise tour, networking events, and technical visits.

The conference hosts look forward to seeing you at the LSP2018 in Singapore. Please visit www.lsp2018.com for more information.

The conference will be held in the beautiful city of Singapore.

Kathy Levy | Associate Editor | The Shot Peener

Flow Control for an Older Machine

DAVE BARKLEY, the Shot Peening Training Director with Electronics Inc. (EI), occasionally gets questions on EI products from his students. He recently received an inquiry from a Senior Product Engineer with an aerospace company in Singapore. The company was told during an audit that they need media flow measurement on their shot peening machine. They were using Model 50 MagnaValves on a 25-year-old Pangborn machine. They asked Dave to recommend a Model 500 (the 500-P or 500-24) and a controller. The following is Dave's response—it may be helpful to others wanting to upgrade an older machine.

"The key thing to consider is that EI's AC products are meant to run on 120 Vac 60 Hz. A transformer is typically used to obtain the required voltage; however, a transformer does not change the AC frequency. Singapore's electrical system supplies power with the AC frequency of 50 Hz. Electronic circuits, designed for 60 Hz operations, run warmer when supplied with 50 Hz. This may cause the FC controller to overheat since the flow monitoring feature has more electronic circuitry than the Model 50 valves you are currently using. The ambient heat in your shop may intensify the issue."

"Several years ago, EI switched to the 24 Vdc power standard for their international customers that have power sources different than those in the US. Since 24 Vdc power supplies are common, it should be a simple addition if your control panel doesn't already have one. With this in mind, EI recommends a valve and controller from the 24 Vdc product line. Specifically, we suggest a 500-24 MagnaValve and a FC-24 controller for complete media control on your machine. These products also have more features and are less expensive than their 120 Vac counterparts."

"Please note: The flow monitoring feature requires more room inside the 500-24 MagnaValve and the valve is 2" (50.8 mm) taller than your current valves. You should explore the modifications necessary to fit them on your machine. If you choose the 24 Vdc products, please refer to their manuals for total amperage requirements when selecting a 24 Vdc power supply, or to confirm the amperage availability of an existing supply."

"I hope this helps with your selection and upgrade. I will be in Singapore, as I am every July, to conduct our annual training seminar and can visit if desired," added Dave.