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DFARS, NIST SP 800-171, AND CMMC 2.0 COMPLIANCE

As a heat treater, complying with these Department of Defense certifications can be critical to your company's future.



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As industries continue to prioritize energy efficiency, compact design, and performance optimization, PCE is likely to play an increasingly pivotal role in shaping the future of heat-exchange technology.



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FROM THE EDITOR ///



It's getting hot at Heat Treat 2023!

It's finally here. And by "it," I mean Heat Treat 2023. If you're reading this, odds are you may be walking the show floor at this very moment. But, if you're not, here's what you're missing out on:

- » The return of ASM Materials Week, anticipating 6,000 attendees, 250 exhibitors, and 600 presentations.
- » Comprehensive technical programming, bringing together industry, academia, and government in the materials world to discuss advanced materials, applications, and technologies addressing a spectrum of emerging technologies in key growth market areas.
- » Annual ASM protocol events, including a leadership awards luncheon, awards dinner, annual business meeting, and all ASM board and committee meetings.
- » An exposition, featuring products, solutions, and demonstrations from major OEMs, materials suppliers, producers, and corporate partners.
- » Education courses with hands-on equipment and training.
- » Student/emerging professionals programming, competitions, and career recruitment center.

To keep things hot (hey, it's *Thermal Processing*; heat-treating puns are low-hanging fruit), our October issue sets the tone as the perfect primer for Heat Treat 2023. You might even run into some of our contributing authors or columnists right here on the show floor.

In our Focus section, our cover story from Joe Coleman looks at how complying with DFARS, NIST SP 800-171, and CMMC 2.0 certifications can be critical to a heat-treater's future.

Next up is an article from Jochen Kern where he discusses how photo-chemical etching is a perfect process for heat-exchanger production.

Our final Focus article is on the stretch-forming process and how it can create stronger parts, increase production, and reduce processing steps, but selecting the proper machine is essential.

In addition to those articles, we have a wealth of information in the form of our columnists and a plethora of news updates throughout the industry.

I hope your time spent at Heat Treat 2023 is productive and profitable, and remember that *Thermal Processing* is here to boost that success.

So if you're walking the floor in Detroit, be sure and stop by *Thermal Processing's* booth (#2238) and say hey. I'd love to talk about editorial opportunities, and our advertising representatives would be happy to discuss ways to take your message to the next level.

As always, thanks for reading!

KENNETH CARTER, EDITOR
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In the new Seco/Warwick furnace, the customer will execute vacuum heat treatment of titanium and its alloys and will perform vacuum carburizing processes for steel elements. (Courtesy: Seco/Warwick)

Racing supplier chooses Seco/Warwick solution

A European subcontractor for the automotive and racing industries, as well as a partner for teams participating in Formula 1 races, has bet on Seco/Warwick for the second time.

The order includes a Vector[®] vacuum furnace with 15 bar abs high-pressure gas quenching, and high vacuum (HV). The furnace will process engine and gear components for vehicles racing in the most important motorsport competitions.

This partner provides carburizing, and various heat-treatment services for titanium, aluminum, and precipitation hardening of alloys. These services must be of aviation quality within the most demanding timeframes required by European F1 teams.

In the new Seco/Warwick furnace, the customer will execute vacuum heat treatment of titanium and its alloys and will perform vacuum carburizing processes for steel elements. Titanium alloys are very strong materials, but at the same time soft and plas-

tic, which makes them difficult to machine. Low thermal conductivity and density creates an environment where the cutting material is subject to a strong thermal load and tends to harden. The Vector vacuum furnace is perfect for titanium heat treatment. The current order includes the furnace in exactly the same configuration as the first delivery.

“The second order for the same product means that the customer wants to increase processing capacity and at the same time prevent a production back-up,” said Maciej Korecki, vice president of the Vacuum Segment at Seco/Warwick. “The vacuum furnace system which will be delivered to England has numerous options such as cryogenic processing, convection, FineCarb[®] vacuum carburizing, pre-nitriding for PreNitLPC[®] carburizing technology or low-pressure carbonitriding LPCN. It is a very efficient and versatile solution with relatively small dimensions, which makes it suitable even for smaller hardening plants.”

Vector is a universal furnace. It works in many industries in more than 70 countries around the world. However, the purpose of this particular model will be unique. Carburizing and hardening of parts such as

gears for engines and transmissions for high-performance F1 sports cars is quite a rare production challenge compared to other typical products for which Seco/Warwick supplies its furnaces. The product is unique due to the characteristic modifications which are necessary to help effectively meet the customer's process requirements. These standards are very high. The goal is to make a product of the highest quality and reliability because the products work in motorsport which means the most demanding conditions.

Formula 1 is a unique combination of technology, speed, precision, and competition. Mercedes, Ferrari, Renault, and Honda teams currently compete in Formula 1. Beginning in 2026, two more manufacturers will join them — Audi and RB Powertrains/Ford. The FIA regulations specify in detail what material a part must consist of and how it must be manufactured. Titanium or titanium alloys are used for many engine parts and suspensions because they have high toughness, strength, and ductility, and are corrosion resistant. Formula 1 car components must be manufactured precisely and safely in both prototype and small series production. The fast research and development pace and the annual rule changes by the FIA present another challenge. Therefore, it is key for manufacturers of these parts to have a vacuum furnace which will ensure impeccable high-speed operation. And that's what Vector from Seco/Warwick is all about.

MORE INFO www.secowarwick.com

Castool Tooling upgrades with Nitrex equipment

Castool Tooling Systems, a division of Exco Technologies and a leading tooling provider to extrusion and die-casting companies, expanded its in-house capabilities by adding a Nitrex turnkey nitrocarburizing sys-



SEND US YOUR NEWS Companies wishing to submit materials for inclusion in Thermal Processing's Update section should contact the editor, Kenneth Carter, at editor@thermalprocessing.com. Releases accompanied by color images will be given first consideration.



Castool Tooling System's new pit-type nitrocarburizing furnace, a Nitrex model NX-1625 is capable of processing large workloads of up to 6,000 kg. (Courtesy: Nitrex)

tem. The large-capacity furnace is part of a significant investment project that saw several furnace OEM suppliers collaborating to outfit the New Market, Canada, facility with various pieces of heat-treating process equipment.

The new pit-type nitrocarburizing furnace, a model NX-1625 is capable of processing large workloads of up to 6,000 kg (13,200 pounds) with dimensions of 1,550 mm (61") in diameter and 2,500 mm (98.5") in height. The turnkey solution includes Nitreg[®]-C controlled nitrocarburizing and ONC[®] post-oxidation technologies with proven recipes to treat shot sleeves made of H13 tool steel effectively. These technologies improve the strength and longevity of the shot sleeves while also preventing distortion when used in high-temperature and corrosive environments. Furthermore, component post-finishing is eliminated, since after nitrocarburizing, treated parts retain their dimensional stability.

"Although Castool is a new customer from the equipment side of our business, they have been outsourcing nitriding to our heat-treating services for many years and have been impressed with the quality of service and customer experience," said Nikola Dzepina, Nitrex account manager. "The parent company of Castool, Exco, was also a terrific reference. They have been using an in-house Nitrex system since 2011 for nitriding extrusion dies. Our process expertise and strong

reference base were crucial factors in getting this order."

MORE INFO www.nitrex.com

Solar Manufacturing ships Mentor furnace to tool & die maker

Solar Manufacturing recently shipped a Mentor[®] vacuum furnace to a customer specializing in tool and die. The furnace will primarily be used to harden tool steels.

The customer has purchased a total of three furnaces from Solar Manufacturing and this is their first Mentor.

The Mentor features a graphite-insulated hot zone measuring 12" wide x 12" high x 18" deep, capable of operating temperatures up to 2,400°F, and a load weight capacity up to 250 pounds. The furnace includes the SolarVac[®] Essentials PLC-based control system with HMI/industrial PC using Wonderware supervisory software for recipe storage, alarm management, and data acquisition functions.

"For years, the heat-treaters have been requesting a compact, yet rugged furnace that would efficiently process smaller workloads," said Pete Reh, vice president of sales. "We have many Mentor customers who utilize these heat-treating furnaces for production

HOT.

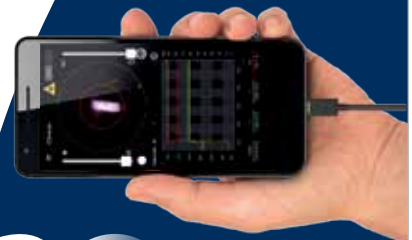


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The Solar Manufacturing Metor vacuum furnace is compact, yet rugged and efficiently processes smaller workloads. (Courtesy: Solar Manufacturing)

especially in additive manufacturing and medical industries.”

Solar Manufacturing designs and manufactures a wide variety of vacuum heat treating, sintering, and brazing furnaces and offers replacement hot zones, spare parts, and professional service.

MORE INFO www.solarmfg.com

Nitrex, Linde renew joint marketing agreement, expand

Nitrex and Linde have renewed and expanded their heat-treating focused joint marketing agreement. What started as a local agreement 13 years ago between Nitrex and Linde, formerly known as UPC-Marathon and Praxair, respectively, has evolved into

an international marketing agreement and now covers Europe and North America.

To date, Nitrex and Linde have worked together on more than 30 projects. By using their complementary offerings, they have upgraded essential equipment and have helped customers achieve quality results. Nitrex provides Linde customers with equipment and analyses to control first-rate gas atmospheres, thanks to its competence in the heat treatment and electrical fields, technical solutions, support, and world-class gas panels.

“Our competencies complement each other,” said Roman Grosman, national director of business development for Linde in the United States. “In the event that Linde’s heat-treatment clients require equipment that we do not offer, Nitrex can meet this need.”

“This continues to be a win-win relationship,” said Paul Oleszkiewicz, president, CPO & CSO of UPC-Marathon, a Nitrex company.

“We can supply Linde gas customers with process controls, and in turn, Linde offers a reliable gas supply network. We are both aiming for the highest quality, efficiency, performance, and a greener tomorrow and providing optimal service for our customers.”

MORE INFO www.nitrex.com
www.linde.com

Alumil S.A. integrates two Nitrex systems

Nitrex has successfully commissioned two nitriding systems for Alumil S.A., Greece’s largest extrusion company and the leading producer of architectural systems. With this collaboration, Nitrex further strengthens its global presence in extrusion profile manufacturing, demonstrating the industry’s confidence in Nitrex’s expertise to optimize die performance, increase the throughput of extruded profiles, and reduce overall tooling costs.

Catering to various sectors, including construction, automotive, energy, and more, and serving as a key exporter to Europe, the Middle East, and the United States, Alumil has started up two pit-type nitriding systems installed at separate locations. The first system, an NX-1215 model with a 3-ton load capacity, is operational at Alumil’s facility in Greece. The second system, an NX-620 furnace model with a 1.2-ton load capacity, is located at the company’s operation in Serbia.

The turnkey solution provided by Nitrex includes the exclusive Nitreg® technology, ensuring consistent and superior nitriding results. In anticipation of Alumil’s plans to expand manufacturing capacities in Greece, the system installed at this location has been specially sized up to accommodate future growth.

The decision to invest in Nitrex nitriding systems stemmed from Alumil’s need to replace outdated in-house nitriding equipment. Since the existing nitriders could not be upgraded, there were efficiency issues such as inconsistencies in nitriding uniformity and high gas consumption.

“Nitrex’s modern system design, advanced technology, and process capabilities positioned us as the ideal partner for Alumil’s

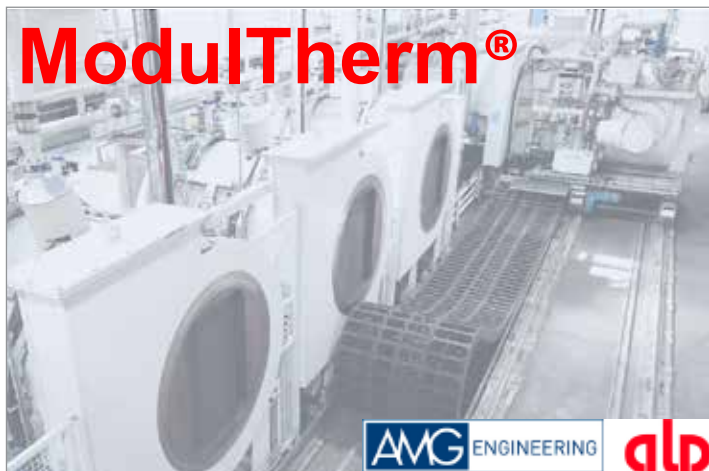


plant upgrade and growth requirements,” said Marcin Stoklosa, project manager at Nitrex. “The successful commissioning of the systems in Greece and Serbia reinforces Nitrex’s steadfast commitment to delivering innovative solutions that enhance application performance and are tailored to meet the specific needs of our customers. It also solidifies our position as the preferred choice for advanced nitriding solutions in the extrusion industry.”

The nitriding system in Serbia was installed in October 2022, followed by the installation in Greece in November 2022.

MORE INFO www.nitrex.com

Alumil has started up two pit-type nitriding systems installed at separate locations. The first system, an NX-1215 model with a 3-ton load capacity, is operational at Alumil’s facility in Greece. The second system, an NX-620 furnace model with a 1.2-ton load capacity, is located at the company’s operation in Serbia. (Courtesy: Nitrex)



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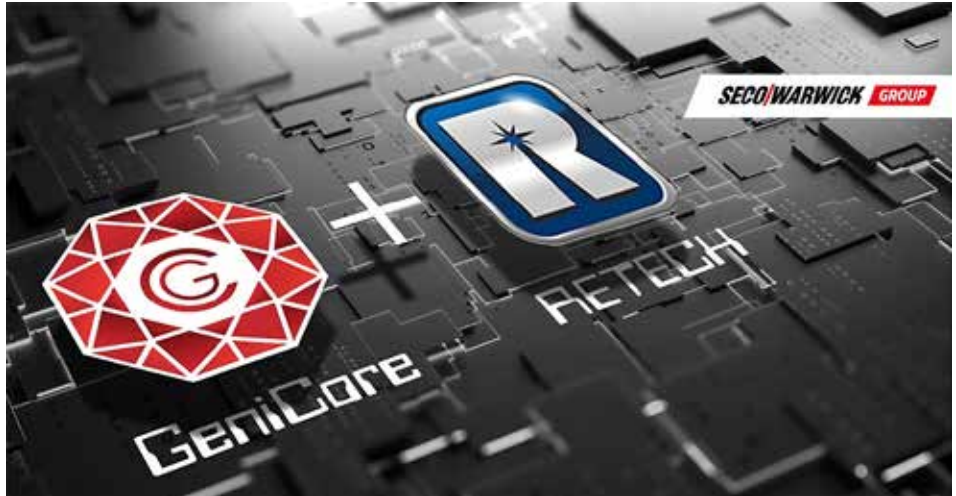
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Retech, Genicore team on spark plasma sintering

Retech, an American subsidiary of the Seco/Warwick Group, has established cooperation with GeniCore, a company dealing in composite materials engineering. Thanks to the cooperation, Retech will expand its offer in powder metal processes with spark plasma sintering.

The spark plasma sintering (SPS) process bonds materials using a combination of pressure and thermal energy applied to materials in a mold. It resembles hot pressing, but the SPS process consumes far less energy and, most importantly, can bond a broader range of materials into novel composites unachievable by other processes.

The “spark” in spark plasma sintering is more of a powerful pulse of electric current that passes directly through the material in



In cooperation with GeniCore, Retech will expand its offer in powder metal processes with spark plasma sintering. (Courtesy: Seco/Warwick Group)

the mold form while it is under pressure. To withstand the heat and pressure, the molds are made of graphite, which is machined into a negative shape. As the material is com-

pressed in the mold while under vacuum, a pulse of direct current is passed through the material, producing the high temperatures necessary for sinter bonding to occur. The



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current pulse heats the material via Joule heating rather than radiant, applying the heat only where needed, thereby using less energy than traditional hot pressing or sintering methods.

“As the global leader in vacuum metallurgical equipment, bringing SPS into our repertoire and representing its capabilities is a win for Retech, GeniCore, and our customers,” said Earl Good, Retech systems managing director and president.

GeniCore’s pioneering advancement in SPS technology is in their direct current (DC) electric pulse switching, enabling the most precise DC waveform control in the emerging SPS industry — including each pulse’s current, duration, and spacing. Generating square pulses of under one millisecond, and even precisely programmable square-pulse packets, delivers tremendous energy directly into the materials being consolidated. This precision pulse control, in turn, breeds the greatest precision in sintering, resulting in uniform consolidation

with minimal grain growth.

GeniCore has developed multiple SPS systems, called U-FAST (Upgraded Field Assisted Sintering Technology), each one optimized for specific applications.

Many SPS applications are already employed in manufacturing, and the broad spectrum of SPS capabilities and applications are still being researched and discovered. GeniCore SPS processes are being used by manufacturers and research institutions alike, including a national laboratory, NASA, and the large EU industrial engineering company.

“The GeniCore mission is to deliver superior value to our customers through innovative SPS technology,” said Marcin Rosiński, GeniCore CEO. “Cooperation with Retech gives us the honor to serve discerning and distinguished customers in the North American market.”

Retech is one of the leaders in powder metallurgy, constantly seeking innovations. The partnership with GeniCore and the

opportunity to offer spark plasma sintering technology will be another boost for development.

MORE INFO www.secowarwick.com
www.retechsystemsllc.com

Siemens Energy chooses clean Seco/Warwick furnace

Siemens Energy, a recognized manufacturer of gas turbines and other energy technologies, has chosen an eco-friendly vacuum furnace from Seco/Warwick with high-pressure gas hardening (6 bar abs.) and high vacuum (HV) for one of its production facilities.

This solution will execute efficient and ecologically clean processes in a high vacuum range. Thanks to the use of a system consisting of a dry pump, an efficient Root’s pump, and five Oerlikon/Leybold turbomo-



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molecular pumps, the furnace will meet the partner's restrictive requirements.

Another operating advantage of the Vector is the metal heating chamber, which prevents direct heat loss to the vacuum chamber's wall and ensures very high process purity. The efficiency is also influenced by the ability to conduct the heating and cooling process at 6 bars with two gases (nitrogen or argon). The furnace has metal screen insulation and metal heating elements.

"While Vector is our standard product, this particular model has numerous options which will ensure a truly high standard, i.e., soldering processes with extraordinary cleanliness for oxidation-sensitive alloys," said Maciej Korecki, vice president of the Vacuum Segment at the Seco/Warwick Group. "In addition, thanks to the inverter control, the customer will be able to switch on the optimal cooling power in the appropriate process segment. The great advantages also include low heat losses and good temperature distribution in the metal heating



Siemens Energy has chosen an eco-friendly vacuum furnace from Seco/Warwick with high-pressure gas hardening and high vacuum for one of its production facilities. (Courtesy: Seco/Warwick)

chamber. The vacuum furnace has numerous options such as directional cooling, dew point sensors, and isothermal quenching to increase its versatility. This is our first order from a Siemens Energy production facility,

but in the past, we have supplied equipment to gas turbine manufacturers. Gas turbines can run on a variety of gases, including hydrogen. Green hydrogen, as an energy carrier without a carbon footprint, will gradu-

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Flow Meters	Nitrogen, endo, natural gas, air
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Max Temp	1450°F
Working Dim's	36" wide x 72" deep x 36" high
Power	480 V, 3-Phase, 60 Cycle, 40 Amp
Max Fuel Demand	1000 CFH, 800,000 BTU
Controls	SSI controls



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ally increase its market share not only in the energy industry, but also in other economic sectors, contributing to gradual decarbonization of the atmosphere. Seco/Warwick wants to be part of the energy transformation process and to support the green technology development, which is why this contract is so important to us.”

Vacuum furnaces use vacuum created by air evacuation as the protective atmosphere for the heat-treated part surfaces. The vacuum furnace’s main advantage lies in its operational versatility and the ability to carry out processes traditionally carried out in atmospheric furnaces. Differences in the vacuum furnace construction as well as the method of conducting the processes minimizes both media consumption and emissions to the environment, making the vacuum furnace itself a SECO/ECO solution when compared to traditional atmosphere furnaces.

Vacuum heat treatment’s eco-friendly features include:

» Perfect part surface quality (without

additional operations).

» No intercrystalline oxidation (no additional mechanical treatment).

» No need to use protective gases (lower costs and emissions).

» Minimal consumption of process gases (cost savings).

» Minimum time for atmosphere preparation and conditioning (saving time and costs).

» Zero startup and shutdown time, work on demand (saving time, costs).

» No open flame, no risk of fire or explosion (safety).

» Clean process, no part washing required (reduced environmental pollution).

» Low heat and by-product emissions (limited global warming effect).

» Environmentally friendly (zero pollution).

» Zero CO2 emissions (carbon footprint reduction).

MORE INFO www.secowarwick.com

Renishaw Central platform offers data-driven solution

Renishaw Central is a new smart-manufacturing data platform that collects, presents, and initiates accurate process and metrology data. The platform connects to measurement devices across the manufacturing process and provides valuable insights that manufacturers can use to analyze, identify, predict, and correct process errors before they occur.

Renishaw’s new Central manufacturing connectivity and data platform is poised to transform the productivity, capability, and efficiency of manufacturing operations. The new data-driven manufacturing solution brings the power of connectivity to the machine shop floor, resulting in highly efficient, productive operations with optimized processes, reduced downtime and

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Renishaw Central, the smart manufacturing data platform, connects multiple machines and devices across the shop floor. (Courtesy: Renishaw)

minimized waste. Renishaw will demonstrate how Central delivers the factory of the future at the Quality Show, October 24-26 in Rosemont, Illinois, and at WESTEC, held at the Long Beach Convention Center in Long Beach, California November 7-9. The exhibit (booth #1027 at Quality and #2045 at WESTEC) will feature Renishaw's Central platform, and other smart manufacturing solutions, including the Renishaw Equator™ gauging systems.

Renishaw Central collects metrology, status, and alarm data from connected devices across the shop floor. Devices include additive manufacturing (AM) systems, on-machine measurements systems, shop floor gauging, and coordinate measuring machines (CMMs). With insight into the process performance of each workstation, manufacturers have a better understanding of where to take corrective measures. In unattended processes, the status of devices can be monitored remotely. If any errors occur, they are detected and displayed within the

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Central platform's dashboards or other third-party applications.

"The platform operates on-premises, allows shop administrators to own their data, and ensures that process control is automated without depending on an internet connection," said Brandon Golab, machine tool product manager at Renishaw Inc. "Connectivity, consistency and control drives confidence and, in turn, the development of future factory concepts."

The Quality Show is a three-day trade show dedicated to connecting quality manufacturing professionals with process improvement vendors. WESTEC is part of the Manufacturing Technology Series that includes EASTEC, SOUTHTEC, and HOUSTEX. The Renishaw exhibit for both shows includes examples of essential process control routines, along with the latest advancements for precision component measurement.

Renishaw provides solutions for tool setting, broken tool detection, component set-

up, in-cycle gauging and first-off component inspection, with automatic offset updates.

MORE INFO www.renishaw.com

ANCA's FX7 ULTRA offers new accuracy for small tools

With exceptional accuracy and quality, ANCA's FX7 ULTRA takes small tool manufacturing to new heights.

"The FX7 ULTRA introduces cutting-edge technologies that revolutionize precision grinding for small tools down to 0.1mm diameter," said Darren Fox, ANCA product manager. "If you produce tools such as ball-nose, corner radius endmills, and complex or intricate profile tools, then this machine is for you."

New software, hardware, and design features significantly improve surface finish,

accuracy, and controlled runout, ensuring batch consistency from the first ground tool to the last. These advancements ensure that the FX7 ULTRA is the go-to solution for precision grinding in industries that rely on small tools, including electronics, telecommunications, medical devices, aerospace, automotive, diemold, and general machining.

Features of the FX7 ULTRA include:

- » One nanometer control system.
- » New servo control algorithm for smooth motion.
- » System and mechanical upgrades enhance stiffness and rigidity.
- » In-process measuring, balancing and runout compensation for consistent accuracy.
- » Motor Temperature Control (MTC) – ANCA's patented innovation.
- » Specialist training support from ANCA engineering experts on how to grind perfect cutting tools.

The FX7 ULTRA not only grinds tools faster than other machines, but also produces tools with both finer surface finishes and

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Designed for small tools, the new FX7 ULTRA is the latest game-changing innovation in ANCA's premium ULTRA machine range. (Courtesy: ANCA)

greater accuracy — which means superior tool performance and quality.

“The ULTRA technology has enabled production of high-quality small tools with the capability to grind down to a size as small as 0.1mm,” Fox said. “The nanometer control enables micro-adjustments for smoother axis movement resulting in optimal tool geometry, ensuring superior cutting performance and surface finish. These advancements will have a significant impact across the entire tool range, enabling precise and efficient grinding operations for a variety of applications.”

“Our customers who supply to industries where intricate and precise machining operations are paramount are always striving for the best quality tools, and now they can stay ahead of the game with the FX7 ULTRA,” said Pat Boland, ANCA co-founder. “After years of dedicated research and development, the FX7 ULTRA is set to revolutionize the way we manufacture small tools.”

MORE INFO www.anca.com

Seco/Warwick to deliver furnace for jet components

Seco/Warwick will deliver a vertical vacuum furnace to the leader among companies pro-

viding leading-edge repair and maintenance services for jet engines.

The system has been designed to carry out clean brazing processes in high vacuum as efficiently as possible, ensuring the highest protection of the treated part surfaces. The solution will be used to process jet engine components.

The German partner carries out comprehensive repairs of technologically advanced jet engines. The company also has a research center which develops innovative repair techniques for various types of components and entire engines. The group employs several thousand qualified employees in various locations around the world and is a leader among companies repairing and providing full-service MRO for jet engines. The purchase of a vertical vacuum furnace will improve production processes and significantly increase the commercial heat treater's efficiency.

Seco/Warwick has provided vacuum furnaces to companies in the aviation industry for decades. This vast experience is the result of vacuum furnaces operating with above-average quality. The furnaces operate superbly in even the most demanding industries. Seco/Warwick furnaces produce parts for most top passenger, commercial, and military aircraft. Seco/Warwick furnaces for aviation are executed in accordance with the AMS2750F standard in the second (II) class.

“Aviation is an important sector for us and

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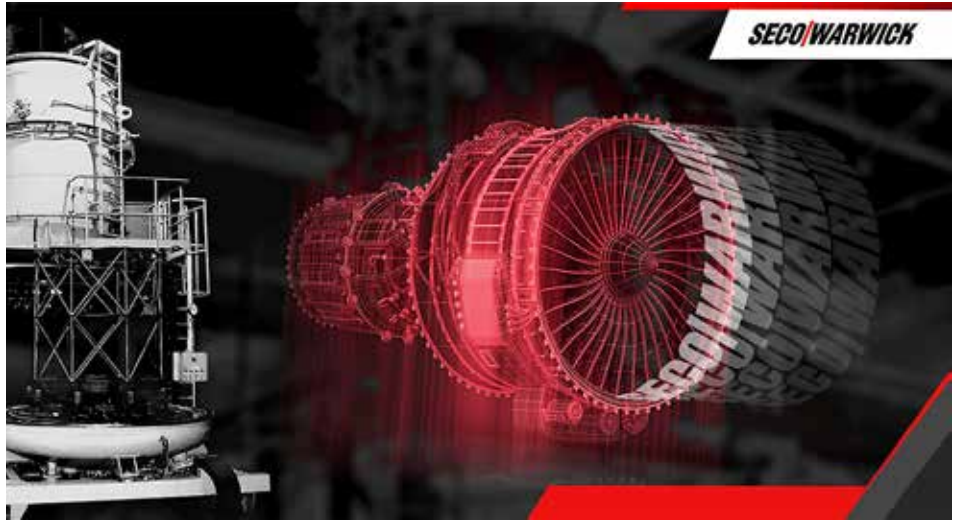
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one of the key industries where we supply industrial furnaces,” said Maciej Korecki, vice president of the Vacuum Segment, in the Seco/Warwick Group. “We perfectly know its needs — high-quality results for above-average requirements. Our solutions are already working for this partner in central and eastern Europe.

However, this will be the first delivery for the German branch. The vertical vacuum furnace is the answer to the challenges of annealing and brazing larger aviation components. The furnace cooling system provides precision cooling rate control for the parts in process, which is crucial in the aviation industry. Compactness, economy, and intuitive operation are the advantage of this product.”

Seco/Warwick has already supplied vacuum solutions to aviation component manufacturing plants on all continents.

The solution ordered by this partner belongs to the family of vertical vacuum furnaces, enabling vacuum heating and gas cool-



Seco/Warwick has supplied vacuum solutions to aviation component manufacturing plants on all continents. (Courtesy: Seco/Warwick)

ing under pressure up to 1.5 bar abs. Thanks to the internal cooling gas blower as well as the internal heat exchanger, the furnaces are compact and do not require much space in

the hardening room. Graphite insulation and wide heating elements ensure long-term and reliable operation in industrial production conditions.

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This versatile furnace is adapted to carry out the following processes: brazing, degassing, annealing, solution heat treatment, aging, and tempering. During cooling, the cooling gas circulation with the use of the nozzle blowing system optimizes and ensures excellent uniform cooling of the treated parts. As is the Seco/Warwick standard, the furnace is also equipped with a dew point sensor, thanks to which the phenomenon of water vapor condensation and, consequently, the possibility of the processed load surface oxidation is eliminated.

MORE INFO www.secowarwick.com

Plant in Spain buys third Seco/Warwick furnace

One of the largest service hardening plants in Spain has purchased a Vector® vacuum furnace from Seco/Warwick. It will be the third Seco/Warwick solution for this partner.

The client has been cooperating with Seco/Warwick for many years, along with Arrola, who provides service support to the Spanish market on behalf of the Seco/Warwick Group. Local service is one of the reasons why Seco/Warwick was chosen. On the Iberian Peninsula, customer service is provided by Arrola, and this local support is praised by this service hardening plant, a long time Seco/Warwick customer.

“We are happy to have a local partner who knows our furnaces very well and is close to our customers,” said Maciej Korecki, vice president of the Vacuum Segment of the Seco/Warwick Group. “Arrola understands customer expectations and has been providing comprehensive services to our partners for years. It is a very good and convenient system that works efficiently. Thanks to local support, we can propose a comprehensive offer including fast support.”

The furnace on order will increase the company's efficiency when hardening larger-dimension elements. The solution will join the machine park in which there is already one Vector vacuum furnace, and a two-chamber furnace with an oil quench manufactured by Seco/Warwick.

“The Vector will enhance and increase the hardening processing capacity and will

improve process efficiency,” said Korecki. “The advantage of this product is a large working space (900x900x1200) with the capacity to adjust to an oversized load, utilizing the advantages of a circular heating chamber. This is the golden measure for many service hardening plants.”

The vacuum furnace ordered by the hardening plant enables efficient processes to be carried out under vacuum, in both medium and high ranges. This is possible thanks to a system consisting of a dry mechanical pump, efficient Roots pump, and a diffusion pump. The process efficiency is also influenced by using the option for cooling at 15 bar. Moreover, due to the inverter control, it is possible to precisely control the cooling rate. Thanks to the use of an inverter to control the gas blower, there are no electrical network overloads associated with starting the engine, and the energy efficiency is improved. Thus, the customer avoids increased charges related to electricity. The Vector on order is adapted to the aviation standard and will also perform

production for this demanding industry.

Other great advantages of the furnace include low heat losses and good temperature distribution in the heating chamber, equally resistant to rapid wear. The vacuum furnace will be equipped with numerous options such as convection, directional cooling, and isothermal quenching.

Vacuum furnaces use vacuum (vacuum created by air evacuation) as the protective atmosphere for the heat-treated part surfaces. The vacuum furnace's main advantage is its versatility and the ability to carry out processes traditionally carried out in atmospheric furnaces.

Differences in the vacuum furnace construction as well as the method of conducting the processes minimizes both media consumption and emissions to the environment, making the vacuum furnace itself a SECO/ECO solution when compared to traditional atmosphere furnaces.

MORE INFO www.secowarwick.com

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Okuma debuts next-generation CNC machine control

The leadership team at Okuma America Corporation announced the launch of the company's next-generation machine control for its expansive line of CNC (computer numeric control) machine tools. The new control—the Okuma OSP-P500—is the company's latest innovation within its OSP control line which dates back to 1963. Leveraging the OSP line's 60-year history, coupled with today's digital transformation technologies, the OSP-P500 is designed to enhance user experiences and fully optimize modern manufacturing operations.

The OSP-P500 is designed with today's high-speed, high-accuracy manufacturing operations in mind. The new control comes standard with dual-core computer processors which provide increased levels of machine

processing power by enabling multiple processes to operate simultaneously. This results in reduced cycle times per machined part and shortened production run times. The dual-core processors also provide redundant operations, thus ensuring uninterrupted machining operations.

Most notably, the OSP-P500 is fully equipped with Digital Twin Technology, a technology that enables high-precision machining simulations to be created on a computer, while also providing real-time data feedback loops from the operational machine tool to the simulating computer. This feature allows operators to use real-time data to mirror exact machine tool functions and behaviors to optimize performance.

The OSP-P500 is designed with the user in mind. Built on a Microsoft Windows, open-architecture platform, coupled with on-board conversational programming capabilities, the OSP-P500 is among the easiest machine controls to program on the mar-

ket. Additionally, new ergonomic features, including screen tilt and swivel capabilities, allow for comfortable machine operation by all operators.

As modern manufacturing practices become more reliant on digital data collection, assessment, and transfer, the need for data protection is paramount. The Okuma OSP-P500 is designed with robust protective features to manage data exposure risks, including, tamper-proof protection; whitelisting of the machine's API; anomaly detection; required operator identification and authentication; and regularly scheduled software and data back-ups.

In addition to its smart, cutting-edge machining performance capabilities, the OSP-P500 is also designed with the environment in mind. The new control comes standard with Okuma's proprietary ECO suite plus technology, a collection of digital features that monitor, control, and perfectly balance energy consumption with optimal machining performance.



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Notable features of the OSP-P500 CNC control:

- » Two sizes: 15" screen or 21.5" screen based on machine size.
- » Space-saving, modern design.
- » Ergonomic tilt and swivel capabilities.
- » QWERTY keyboard.
- » Full-color touchscreen.
- » Pulse handle options available.
- » Windows-based operating system.
- » Open architecture platform for integration to Apps on Okuma App Store.

The OSP-P500 made its Western-hemisphere debut at the Gosigerfest event in September. It will be available for purchase in the Americas beginning in the Fall of 2023 on select Okuma machine tool models. The new control will become available on a wider variety of Okuma models throughout 2024.

MORE INFO www.okuma.com/cnc-osp-p500

Ceratizit will tackle multiple materials at SOUTHTEC

Shop readiness was top of mind when Ceratizit planned their line-up for SOUTHTEC 2023, October 24-26. In booth #1509 at the Greenville, South Carolina, show, the company will feature innovative cutting tool solutions that prepare shops of all sizes to machine a broad spectrum of materials and improve sustainability.

"We listen to our customers," said Dan Cope, executive vice president of Cutting Tools, Ceratizit USA. "Shops of all sizes are faced with machining a variety of materials or new materials to stay competitive, and we are meeting the challenge with them."

For turning, Ceratizit will highlight indexable inserts and the KOMtronic U-axis system. With common steel turning operations in mind, Ceratizit's standard coated-carbide

ISO-P steel insert grades are highly engineered for increased productivity and feature advanced substrates and geometries.

From Ceratizit's X7 Line of indexable inserts, the company's CTPX710 and CRPX715 are designed specifically for difficult to machine materials. The X7 Line turning grades are next generation, high-performance substrates that offer outstanding performance when machining steel, stainless steel, superalloys, and non-ferrous metals.

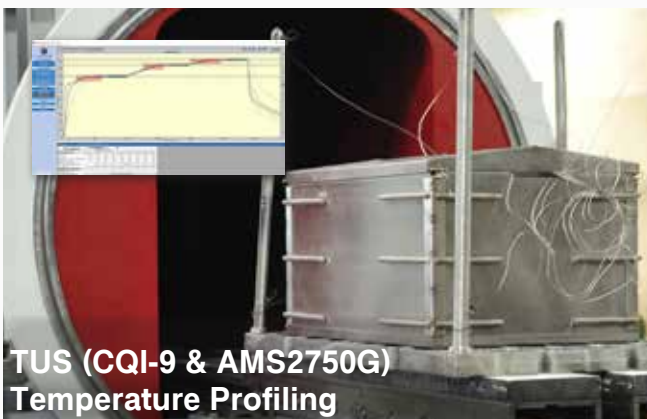
Both ISO-P and X7 Line inserts are reinforced with an AlTiN-based coating applied by the company's proprietary Dragonskin coating technology. The microstructure of the coating has been optimized to resist heat, less tool wear, and process security.

For non-rotationally symmetrical parts, Ceratizit's freely programmable KOMtronic U-axis system makes any turning and contouring operation possible. When combined with custom-made front tools and the optimum selection of inserts, the system successfully performs contours in bores as well as

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UPDATE /// HEAT TREATING INDUSTRY NEWS

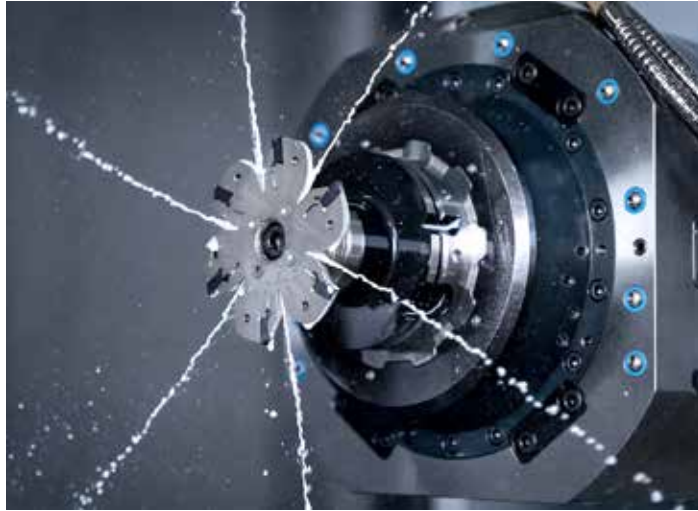
external machining operations. Additionally, the system allows shops to use standard machines.

SOUTHTEC guests seeking milling solutions can visit Ceratizit's booth for insert grades to machine heat-resistant superalloys (HRSA), slot milling cutters, and solid carbide end mills.

Ceratizit's CTC5245 and CTC5240 inserts also include Dragonskin coating technology and were specifically developed for milling applications of nickel-based and titanium-based alloys respectfully. The inserts cross-over to other HRSA materials as well, including Inconel.

The MaxMill Slot-SX is a milling cutter system that closes the gap of milling tools with indexable inserts to machine steel, stainless steel, cast iron, non-ferrous and HRSA. Internal coolant holes ensure optimum chip control.

Ceratizit's P007 and P556 solid carbide end mills are protected with the Dragonskin coating and built for roughing and finishing for a



The MaxMill Slot-SX is a milling cutter system that closes the gap of milling tools with indexable inserts to machine steel, stainless steel, cast iron, non-ferrous and HRSA. Internal coolant holes ensure optimum chip control. Ceratizit will feature it at SOUTHTEC. (Courtesy: Ceratizit)

wide range of applications. The tools provide a high value-to-performance ratio, an H6 shank tolerance, unequal index, and variable helix. Additionally, the four flute P007 and five flute P556 designs will set the stage for new products Ceratizit has planned in 2024.

"It is our responsibility on behalf of our customers to look to the future," said Cope. "We will bring that forward thinking to the show in October." ❧

MORE INFO www.cuttingtools.ceratizit.com

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HeatTreat 2023 is heating up!



HeatTreat 2023 is October 17-19 in Detroit, Michigan. It is co-located with IMAT 2023 and the Motion+Power Technology Expo. (Courtesy: Shutterstock)

HeatTreat 2023 is October 17-19 in Detroit, Michigan. It is co-located with IMAT 2023 and the Motion+Power Technology Expo and is expected to cover many topics of interest. This is the 32nd ASM Heat Treating Society Conference and Exhibition.

At press time, there are about 125 papers from international heat-treating professionals.

Core programming from ASM Affiliate Societies, including the Heat Treating Society, will serve as the backbone of IMAT technical sessions. More than 600 academic and industry presentations from leading scientists, researchers, and industry experts will cover topics including additive manufacturing, materials behavior and characterization, phase stability, and reaction kinetics.

There are numerous student/emerging professionals initiatives, including free college student registration, the Fluxtrol Student Research Competition, and the ASM Heat Treating Society Strong Bar Student Competition. This is an opportunity for young professionals and students to meet international heat-treating experts. Several courses by ASM HTS or AGMA will be available.

The technical program is available at www.asminternational.org/heat-treat/technical.

28TH IFHTSE CONGRESS

November 13-16, 2023 | Yokohama, Japan

The 28th IFHTSE Congress is sponsored by the Japanese Society for Heat Treatment. It will be November 13-16 in Yokohama, Japan. This

wide-ranging conference offers participants the opportunity to network and hear papers on a wide ranging series of topics, including thermal processing of steel, surface hardening additive manufacturing, and modeling and simulation of industrial processes.

The technical program can be found at jsht.or.jp/ifhtse2023/IFHTSE2023Program.html.

The technical program contains 107 oral presentations in four parallel sessions, with 67 poster presentations. On Wednesday afternoon of the conference, a panel of leading international experts will discuss the challenges and trends in heat treating and surface engineering.

The Tom Bell Young Author Award will be given for the best paper from a young author presented at the Congress. The recipient will be invited to participate for free at the next IFHTSE Congress, including travel and accommodation.

Two more young authors will receive the “IFHTSE Congress Scholarship,” which covers the attendance fee at the next IFHTSE Congress in Cleveland, Ohio.

More information at www.ifhtse.org/about-us/awards.

Plenary lectures include:

»Jian Lu, City University of Hong Kong Shenzhen Research Institute, China. “Recent development of Surface Modification: from Nanostructure to Supra-Nanostructure.”

»Marcel A.J. Somers, Technical University of Denmark, IFHTSE

Executive Committee member. “Nitriding and nitrocarburizing; an interwoven braid of science and innovation.”

Keynote Lectures

» Imre Felde, Obuda University, Hungary, IFHTSE Treasurer. “Biomimetic methods and AI technics assisting Heat Treatment processes.”

» Roger Lumley, AW Bell, Australia, and La Trobe University, Australia. “A study on the homogeneity of plastic deformation and its importance to tensile ductility in Al-Si-Cu-Mg (C355) investment castings.”

» Massimo Pellizzari, University of Trento, Italy, IFHTSE Vice President. “Heat Treatment for Additive Manufacturing.”

» Toshihiro Tsuchiyama, Kyusyu University, Japan. “Microstructure control of a medium manganese steel by combined interrupted quenching and inter-critical annealing.”

» Rainer Fechte-Heinen, IWT and University of Bremen, Germany. “Quenching and Distortion.”

» Koji Takahashi, Yokohama National University, Japan. “Effects of laser peening on the very high cycle fatigue strength of additively manufactured maraging steel.”

More information on the 28th Congress at jsht.or.jp/ifhtse2023/index.html.

IFHTSE MEDAL FOR PROF. MICHEL JEANDIN

The Executive Committee has awarded the IFHTSE Medal to Professor Michel Jeandin of MINES ParisTech, MAT-Centre des Matériaux in France.

The citation reads:

“In recognition of his life-time contributions to Materials Science and the dissemination of knowledge, especially in Surface Modification Technologies such as the development of Cold Spray technology and next-generation surface coatings.”

Jeandin has made seminal contributions to the field of surface engineering, especially in the areas of thermal spray coatings and in cold spray applications. Jeandin graduated as an engineer from Lyon Central School (France) in 1977 and defended a Ph.D. thesis at Paris Mining School in 1981 on the subject, “The liquid phase sintering of superalloys.”

Jeandin’s main contribution was thermal spraying, which is the

basis of his worldwide reputation. This relates to the cold spray process, as he was a pioneer and had deep and continuous involvement in the study of the process from its very beginnings about 25 years ago. The work done by Jeandin led to more than 400 publications, most of which were in the field of surface engineering and heat treatments. Among them, no less than 177 were published in refereed international journals, and five consisted of invited chapters of reference books (e.g., for cold spray and laser shock processes). Moreover, 20 patents and one registered trademark have also been credited to Jeandin.

SURFACE ENGINEERING PIONEER XU BINSHI

IFHTSE Fellow Xu Binshi passed away this year. He was long engaged in the research of maintenance and remanufacturing engineering and was a pioneer of surface engineering in China. He covered widespread fields such as plasma spraying, brush plating, thermal barrier coatings, replacement materials, lubrication, anti-wear, and anti-corrosion layers. He won numerous awards and prizes and was appointed academician of the Chinese Academy of Engineering in 1995.

The citation of his 2004 IFHTSE Fellowship read: “In recognition of the exceptional foresight demonstrated by his early recognition of the critical importance of surface engineering in what has proved to be the spectacular industrial and economic development of China.”

SPOTLIGHT ON MEMBERS

The Research Institute of Sweden

RISE Research Institutes of Sweden is Sweden’s research institute and innovation partner. Through international collaboration with industry, academia, and the public sector, RISE works to ensure the competitiveness of the Swedish business community on an international level and contribute to a sustainable society. With almost 3,300 employees, RISE engages in and supports all types of innovation processes. RISE is an independent, state-owned research institute, which offers unique expertise and more than 130 testbeds and demonstration environments for future-proof technologies, products, and services.

IFHTSE is a federation of organizations not individuals. There are three groups of members: scientific or technical societies and associations, universities and registered research institutes, and companies.



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INDUSTRIAL HEATING EQUIPMENT ASSOCIATION

IHEA grows its sustainability and decarbonization initiatives



IHEA's Sustainability & Decarbonization webinar series focuses on carbon producing heating processes and provides methods to optimize their efficiency.

With the popularity and success of this summer's Sustainability & Decarbonization webinar series, the Industrial Heating Equipment Association (IHEA) announces an expansion of the series with 11 new sustainability webinars through 2024.

"With interest very high regarding sustainability and reducing carbon emissions and greenhouse gases, the IHEA board of directors feels there is a strong need to continue providing valuable information that will assist our industry in navigating sustainability issues," said IHEA Executive Vice President Anne Goyer.

The series will continue to be offered on the third Thursday of every month with an occasional exception for holidays.

IHEA's Sustainability & Decarbonization webinar series focuses

on carbon producing heating processes and provides methods to optimize their efficiency and thereby reduce their carbon emission intensity. The webinars cover the various scopes of carbon emissions and the methods to determine your site, or specific equipment, carbon footprint. IHEA is pleased to add critical subject matter to its educational calendar.

The IHEA board of directors determined the webinar topics that are critical, and IHEA members have volunteered to develop the content and deliver the webinars. IHEA will be adding details for each webinar so be sure to check back often for additional information. To register for the webinars, go to www.ihea.org/sustainabilitywebinars.

SEMINAR DATES AND TOPICS

» **October 19, 2023:** How to Get Grants to Become Environmentally Sustainable, Lakeview Consulting.

» **November 30, 2023:** The European Approach, WS Thermal Process Technology Inc.

» **January 18, 2024:** Introduction to Hydrogen, Karl Dungs Inc.

» **February 15, 2024:** Carbon Capture & Storage (Sequestration), Dry Coolers Inc.

» **March 21, 2024:** Hydrogen Basics, Honeywell Thermal Solutions.

» **April 18, 2024:** Making Decisions - Gas vs. Electric, Surface Combustion.

» **May 16, 2024:** Today's Existing Technology for Carbon Reduction, Bloom Engineering.

» **June 20, 2024:** Understanding Carbon Credits & Net Zero, Surface Combustion.

» **July 18, 2024:** Industry Adoption: US Codes & Standards, Karl Dungs Inc.

» **August 15, 2024:** Renewable Fuels, Karl Dungs Inc./Advanced Energy.

SUSTAINABILITY & DECARBONIZATION RESOURCES

In addition to the webinar series, IHEA has been developing and expanding a variety of initiatives relating to sustainability and decarbonization in the industrial heating equipment industry. Recently IHEA President Brian Kelly of Honeywell Thermal Solutions said, "IHEA is taking a leadership role because we see this will be an ongoing and changing landscape for the industry for years to come. With the collective expertise of our membership, we feel that we can provide information, education, and guidance to help everyone navigate what is sure to be a challenging environment."

"In the end, we want IHEA to be a resource to help our entire industry in their sustainability journey as it will be a long and winding road that will be different for everyone," he said.

The first initiative was to develop a sustainability area on the IHEA website that features the foundation of information the industry needs. This section of the IHEA website will evolve as time goes on. Content and resources will be added on a regular basis, and visitors will always find something new that will be of value. To access this information, go to www.ihea.org/sustainability. The first three items under Sustainability on the website include:

Frequently Asked Questions: The Frequently Asked Questions (FAQ) section on IHEA's Sustainability page will be an evolving list of answers to the most popular questions asked today. Visitors are encouraged to submit their own questions that will be answered by industry experts. If you don't see a question you need answered, complete the FAQ submission form at the bottom of the page, and the question and answer will be added to the website.

Glossary of Terms: Hoping to alleviate much of the confusion involved in sustainability and decarbonization discussions, the glossary provides a quick review of commonly used sustainability and decarbonization terminology. This section on the IHEA website will evolve as the initiatives grow.

Resource List: The IHEA Resource List is a growing collection of important resources to help the industry find a wide variety of information related to sustainability and decarbonization. It includes links to websites that IHEA members have found useful.

IHEA FALL SEMINARS

IHEA's fall seminars will be October 31 and November 1. IHEA will offer the Combustion Seminar and the Safety Standards and Codes



IHEA SUSTAINABILITY INITIATIVES

Seminar at the Embassy Suites by Hilton – Cincinnati RiverCenter. These popular technical seminars have adapted to industry needs and include content on hydrogen and decarbonization.

There will be a combined tabletop exhibition and reception Tuesday, October 31. Attendees from both seminars will have the opportunity to speak with company representatives and learn more about the products and services discussed in the classroom. Member companies benefit by connecting with attendees from both seminars during the tabletop exhibition and reception.

There's still time to register. Details and registration information are at www.ihea.org/Fall23.

IHEA CALENDAR OF EVENTS

OCTOBER 8-10

IHEA Combustion Seminar

Indiana Convention Center | Indianapolis, Indiana

OCTOBER 8-10

IHEA Safety Standards & Codes Seminar

Indiana Convention Center | Indianapolis, Indiana

OCTOBER 8

IHEA Induction Seminar

Indiana Convention Center | Indianapolis, Indiana

OCTOBER 15-NOVEMBER 26

Advanced Process Heating | On-Line Distance Learning Course

NOVEMBER 13-14

Powder Coating & Curing Processes Seminar | Henderson, Nevada

The Chemical Coaters Association International and the Industrial Heating Equipment Association's Infrared Division are presenting this day and a half introduction to Powder Coating & Curing Processes Seminar, which will include classroom instruction and hands-on lab demonstrations.

For details on IHEA events, go to www.ihea.org/events

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Material models can show the capability of simulating the complicated age-hardening process with respect to precipitate formation, growth, and coarsening.

Heat treatment process modeling development for age-hardenable alloys

Age-hardenable alloys, such as some aluminum alloys, maraging steel, and nickel-based alloys, get their strength not from quenching but from the precipitation that occurs during the aging or tempering process. While the types of precipitates are different for each alloy, the mechanism is similar. During aging, alloys come out of the base matrix of the material and combine to form nano-scale precipitates; these precipitates strengthen the material by blocking the path of any dislocations that may form and travel through the grain. The general heat treatment of these materials includes a solution treatment to dissolve any precipitates that have been formed, quenching to maintain the solid-solution matrix, and an aging or tempering step to allow the precipitates to nucleate and grow. Higher temperatures aid in precipitation, but temperatures too high will coarsen the precipitates, reducing their strengthening effect. Modeling this phenomenon can be challenging due to the precipitates having different rates of formation and coarsening at different aging temperatures; the large range of temperature the material undergoes during heat treatment; and the effect these precipitates have on the mechanical properties of the material such as ductility, yield strength, and hardness. An analytical model is needed to predict the microstructural evolution during the solution treatment, quenching, aging, with respect to precipitate formation, growth, and coarsening.

SOLUTION TREATMENT

Solution treatment of age-hardenable alloys includes heating the material to a sufficient temperature and holding to decompose and dissolve the precipitates into the matrix. The temperature has a significant effect on the rate and completeness of the solutionizing step, with higher temperatures speeding up the process. However, grain growth at higher temperatures is a concern. As with most heat treatments, a balance point between furnace time and grain size is needed. With modeling, one can predict the time required at temperature to ensure all the precipitates are dissolved, but an accurate material model is required for the kinetics of decomposition. Data for the solution treatment kinetics can be gathered from isothermal holds at an array of solution temperatures and measuring the subsequent hardness, or by in-situ X-ray diffraction techniques. Figure 1 shows the results of the solution treatment model that was developed for 6061 aluminum. The plot shows the volume fraction of precipitates, initially at 2.5 percent, over time at a range of temperatures from 490°C to 570°C. At 490°C, the decomposition of precipitate A is slow and, after an hour hold, over 1 percent of precipitates remains undissolved. In contrast, holds at 550°C and 570°C begin to dissolve the precipitate much faster and the solution treatment is numerically complete after an hour of holding time.

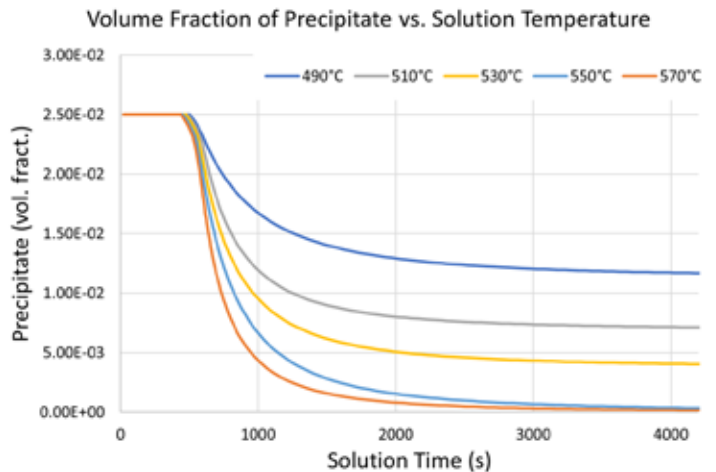


Figure 1: Simulation results for the volume fraction of precipitate A vs. solution time at temperatures ranging from 490°C -570°C.

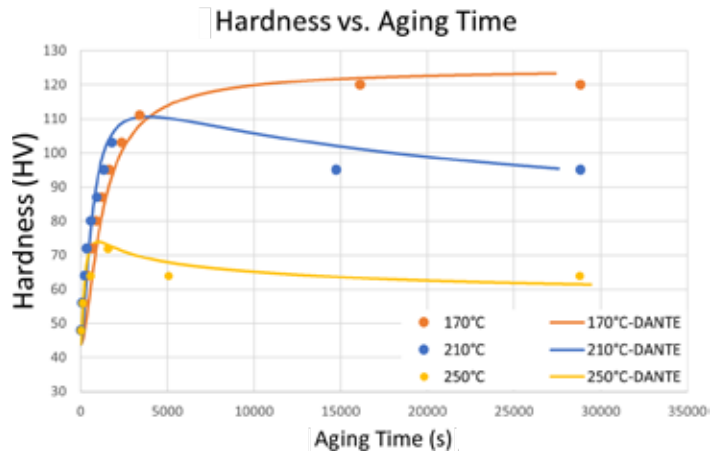


Figure 2: Hardness vs. aging time for selected temperatures: 170°C, 210°C, and 250°C, experimental vs simulation.

AGING

After solution treatment and quenching, age-hardenable alloys are subjected to temperatures below the solution treatment temperature and held for long periods of time to allow the alloys to precipitate and form the main hardening phases. There exists a Goldilocks zone in temperature where the precipitates are allowed to diffuse and combine but not coarsen excessively, which would reduce their hardening potential. For modeling, data is required over a large temperature range as precipitation can occur while the part is transitioning through these temperatures. Figure 2 shows Vickers hardness results versus aging

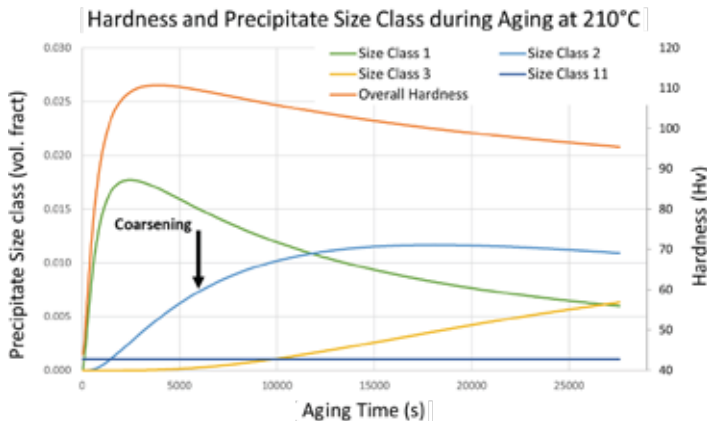


Figure 3: Hardness and size class volume fraction vs. aging time at 210°C.

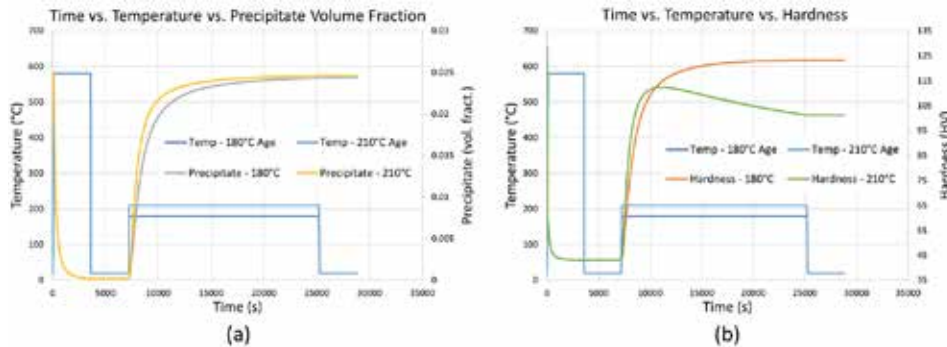


Figure 4: Time vs. temperature plots for aging at 180°C and 210°C vs. predicted volume fraction of precipitates (a) and hardness (b).

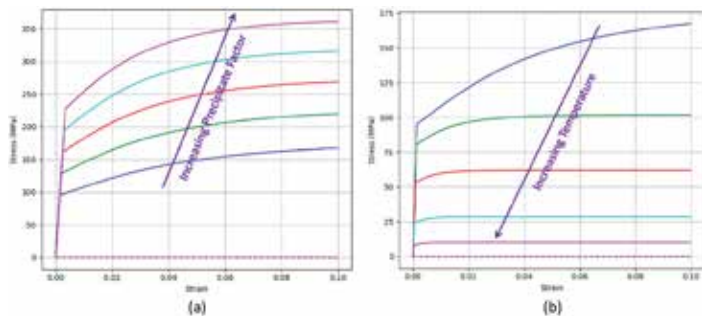


Figure 5: Stress vs. strain plots for increasing precipitate factor (a) and increasing temperature (b).

time for three temperatures for 6061, both experimental and simulated. Artificial aging at 170°C provides a slow and steady increase in hardness over time with a peak hardness occurring at the end of the process. At 210°C, peak hardness occurs early in the process and coarsening of the precipitates causes a reduction in hardness over the remainder of the processing time. At 250°C, the coarsening of the precipitates overshadows the formation of precipitates, and the hardness never reaches peak values, illustrating an extremely overaged condition. Typically, aging would not be performed at this temperature due to the rapid coarsening of precipitates. However, it is important to include the kinetics for this temperature, as a bulky part will cool from solution treatment more slowly in the core, often causing this overaged condition before the part ever sees the aging step.

An effective analytical model for age-hardenable materials must track the size of these precipitates through the process of formation, and coarsening. DANTE uses a size class to define the precipitation and coarsening, with 11 different classes the precipitates can evolve through. When precipitates form, they begin as size class one, and if the temperature is high enough or time long enough, they coarsen to

size class 2, and so on to size class 11. These size classes are two-fold in that they track the actual size of the precipitates and are used to adjust the mechanical properties in real time during the simulation. Size class 11 precipitates contribute very little to the hardness and subsequent mechanical performance of the alloy. Figure 3 shows the size class evolution and its effect on the hardness of 6061 at 210°C. When the aging starts, we can see the volume fraction of size class 1 precipitates rise with the overall hardness. As size class 1 begins to coarsen to size class 2, the overall hardness begins to decrease, and so on as size class 3 forms.

Putting all this work on solution treatment and precipitate nucleation and coarsening together completes the precipitate phase kinetics. Figure 4 shows two time-temperature plots for a simulated solution treatment, quenching, and artificial aging process at 180°C and 210°C. Figure 4(a) shows the volume fraction of precipitates during the process, while Figure 4(b) shows the hardness during the process. Figure 4(a) shows that while the rate of formation of precipitates is faster in the 210°C aging than the 180°C aging, they both end up with about the same volume fraction after aging. Figure 4(b) shows that despite the same volume fraction of precipitates, the hardness is much lower in the 210°C aged simulation due to the coarsening of the precipitates.

MECHANICAL MODEL

The final piece to modeling age-hardenable materials is the mechanical model to account for the stress/strain response during heat treatment. These parameters are used to simulate the in-process and residual stress states and the distortion from the heat-treatment process. An effective mechanical model must include effects from temperature, strain, strain rate, and precipitates including coarsening. Using the previous work with coarsening and hardness, a factor is used to account for the influence that precipitates have on hardness, and thus mechanical performance. This factor is applied to DANTE's internal state variable plasticity model, and is used to describe the yield, hardening, and recovery during heat treatment. Figure 5 shows this general stress/strain relationship with increasing precipitate factor (a) and increasing temperature (b). In general, the more contribution the precipitates have to hardness, the higher the yield strength, and as the temperature rises, the yield strength is reduced. Coarsened precipitates will have less of an influence on hardness.

CONCLUSIONS

The material models implemented in DANTE successfully showed the capability of modeling the complicated age-hardening process consisting of predicting the microstructural evolution during the solution treatment, quenching, aging, and with respect to precipitate formation, growth, and coarsening. While this work showed examples using 6061 aluminum, the models developed can be used for any age-hardenable alloy, including precipitation hardened stainless steel, maraging steel, and nickel-based alloys. ☞

ABOUT THE AUTHOR

Jason Meyer joined DANTE Solutions full time in May 2021 after receiving his Master's degree in mechanical engineering from Cleveland State University. His main responsibilities include marketing efforts, project work, and support and training services for the DANTE software package and the DANTE utility tools. Contact him at jason.meyer@dante-solutions.com.



Rapid cooling from elevated temperature tempering, while not affecting tensile properties, can substantially improve toughness, elongation, and reduction in area.

Cooling rate after tempering

In this column, I will discuss the effect of cooling rate after tempering.

INTRODUCTION

During heat treatment of steel, the process is generally austenitize, quench, and temper (Figure 1). The heat-up rate during austenitization is typically not critical as long it does not cause any distortion from unequal heating. In earlier articles, I have shown that the quench rate is critical to achieve the desired mechanical properties, and a microstructure of nearly 100 percent martensite.

The tempering operation is critical to transform the martensite to tempered martensite, and to relieve residual stresses. There are several variables that affect microstructure and the mechanical properties of a tempered steel:

- » The composition of the steel, including alloying elements.
- » Tempering temperature.
- » Tempering time.
- » Cooling rate from the tempering temperature.

In this article, I am strictly talking about the cooling rate from the tempering temperature.

Tempering temperature is obviously the most important variable. The tempering temperature controls the size and distribution of the carbides formed. In general, the higher the temperature, the softer the part. In alloy steels, besides the Fe₃C carbides found in carbon steels, additional alloy carbides will be formed. This makes alloy steels harder than plain carbon steels at the same tempering temperature.

The toughness of a steel is improved by higher tempering temperatures. However, a drop in toughness occurs in the 230 to 370°C (450-700°F) temperature range. This temperature range is the “blue brittleness” range [1], where a characteristic blue-tinted oxide forms on the part during tempering.

Temper embrittlement occurs when the steel is tempered between 450 and 600°C (840 and 1,110°F). The cause of temper embrittlement is thought to be associated with impurity segregation at the grain boundaries. These impurities are often arsenic, antimony, and phosphorus [2]. Manganese and chromium can also migrate to grain boundaries along prior austenite grain boundaries, resulting in embrittlement [3]. Fracture morphology is often intergranular.

COOLING RATE AFTER TEMPERING

Looking at a typical iron-carbon phase diagram, in the temperature region commonly used for tempering, there are no changes in microstructure. It is a two-phase region of strictly ferrite and carbide. When you look at a Continuous-Cooling-Transformation diagram for steels, it only shows the reactions for transforming to martensite, bainite, or pearlite. There is no region for transformation to tempered martensite. This implies that there is no change in microstructure regardless

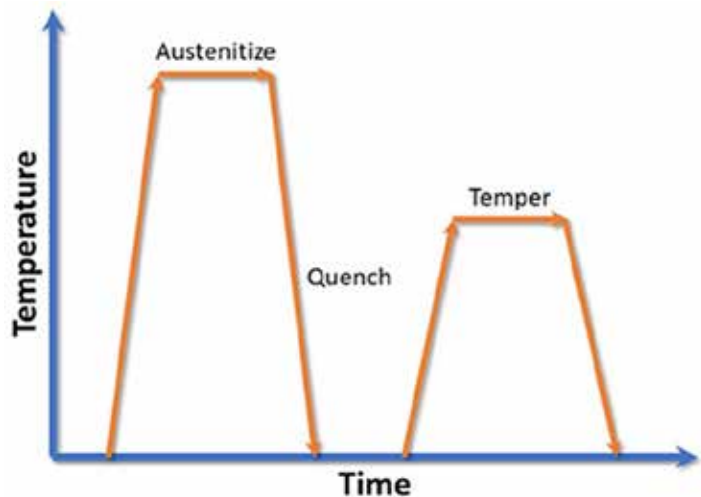


Figure 1: Schematic representation of the heat treatment of steel.

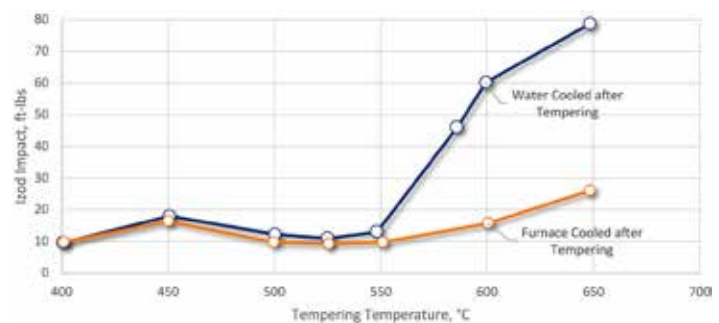


Figure 2: Effect of cooling rate on the impact properties of a 0.35%C-1.05%Cr-3.44%Ni steel exposed to either furnace cooling or water quenching after tempering [4].

of cooling rate after tempering.

Testing of samples cooled at different rates after tempering showed no difference in the tensile strength of the parts. However, toughness, measured by impact testing (Charpy or Izod), is decreased when cooled slowly through the temperature range of 600 to 450°C (1,110 to 840°F). For steels containing chromium and other carbide-forming elements, this is especially true [2]. Other measurements of ductility, such as elongation or reduction in area, may also be reduced when slow cooling through this temperature range. This is shown in Figure 2.

Slow cooling through this temperature region allows migration of impurities to the grain boundaries or allows the formation of carbides at grain boundaries. This effect is especially apparent in chromium-nickel steels or chromium-manganese steels [5] [6] [7]. One additional



The toughness of a steel is improved by higher tempering temperatures. However, a drop in toughness occurs in the 230 to 370°C (450-700°F) temperature range.

disadvantage to slow cooling through this temperature range is the growth of oxide scale. Rapid cooling also minimizes the formation of adherent oxides.

Often, temper embrittlement can be reversed by retempering above the embrittlement temperature (>600°C or 1,110°F), followed by rapid cooling to remove the embrittlement effect [7]. The time required depends on the quantity of impurities present [8].

CONCLUSIONS

In this article, we have described the beneficial effect of rapid cooling from elevated temperature tempering. Tempering in the temperature range of 450 and 600°C (840 and 1,110°F), or when slow cooling (furnace or air-cooling) through this temperature range, can allow impurities such as phosphorus, antimony, or tin, to segregate to grain boundaries. Strong carbide formers, such as chromium, can precipitate at grain boundaries, reducing toughness. Rapid cooling through this temperature range, while not affecting tensile properties, can substantially improve toughness, elongation, and reduction in area.

Should you have any comments regarding this article, or any suggestions for future articles, please contact the author or editor. ✉

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ISSUE FOCUS ///

CERTIFICATIONS / AEROSPACE APPLICATIONS

DFARS, NIST SP 800-171, AND CMMC 2.0 COMPLIANCE



With the escalating threat of cyberattacks, the DoD has prioritized addressing cybersecurity threats and protecting sensitive information, including controlled unclassified information (CUI) and federal contract information (FCI). (Courtesy: Shutterstock)

As a heat treater, complying with these Department of Defense certifications can be critical to your company's future.

By **JOE COLEMAN**

As a heat treater, if you are providing services or products to a Department of Defense (DoD) contractor, a downstream supplier, or fall anywhere within the DoD supply chain, you are most likely affected by certain DoD mandates.

Discussions around DFARS compliance, NIST SP 800-171 implementation, and cybersecurity within the federal defense contracting space is becoming increasingly prevalent. Although it seems like the conversation has just recently gained steam, the DFARS mandate has been around longer than most people realize.

In this article, you will be provided the answers to the most common questions regarding how heat treaters can position themselves for additional business by becoming compliant, remaining compliant, and improving overall cybersecurity health.

WHO NEEDS TO BE COMPLIANT

With the escalating threat of cyberattacks, the DoD has prioritized addressing cybersecurity threats and protecting sensitive information, including controlled unclassified information (CUI) and federal contract information (FCI). The DoD is requiring all contractors, subcontractors, and suppliers to comply with DFARS 252.204-7012. Don't take a chance at losing your current DoD contracts and losing future business because you're not compliant. Compliance is not an option if you fall within the DoD supply chain and the Defense Industrial Base (DIB).

If you have or are pursuing any contracts that include DFARS Clause 252.204-7012 requirements, you are already required to be compliant with NIST SP 800-171, including the major provisions of what is required in CMMC 2.0.

SOME CYBERSECURITY STATISTICS

Heat treaters implementing effective cybersecurity practices are particularly challenged today because there are more devices (including mobile devices) than people, and attackers are becoming more innovative. Cybersecurity is the practice of protecting systems, data, networks, and programs from digital attacks (web/cloud-based). These cyberattacks are usually aimed at accessing, changing, or destroying sensitive information; extorting money from users; or interrupting normal business processes and procedures. This is why the government is pushing for enhanced cybersecurity more than ever before. You need to be sure you and your customers' critical data and systems are protected and secured.

Here are some statistics from 2022 on how cybercrime affects SMBs (small to mid-sized businesses):

- » Less than 50 percent of SMBs have a cybersecurity plan in place.
- » Cyberattacks have increased by nearly 600 percent since the beginning of the pandemic in 2020.
- » 58 percent of cyberattack victims are small and mid-sized businesses.
- » Major data breaches cost businesses an average of \$4.35 million in 2022 ... each.
- » 60 percent of small companies close their business within six



The DoD is requiring all contractors, subcontractors, and suppliers to comply with DFARS 252.204-7012. (Courtesy: Bluestreak Consulting)

months after a major security breach.

» 55 percent of ransomware attacks involve companies with fewer than 100 employees.

» 95 percent of cybersecurity breaches are a result of human error (the weakest link).

» About 236 million ransomware attacks occurred globally in the first half of 2022.

Cyberattacks continue to increase day by day, minute by minute. For your business to survive, you need to implement the NIST security control requirements and “harden” your security position now — before something goes wrong.

WHAT IS DFARS 252.204-7012?

What are the DoD compliance requirements for members of the DIB? The Defense Federal Acquisition Regulation Supplement or DFARS is a set of cybersecurity regulations that defense contractors must follow to be awarded new DoD contracts and to keep current contracts.

Originally implemented in 2016, DFARS 252.204-7012 requires safeguarding and “adequate security” of covered defense information (CDI), which also includes CUI, by implementing the guidelines found in NIST SP 800-171.

DFARS 252.204-7012 further requires contractors, subcontractors, and suppliers to follow certain procedures in the event of a cyber incident, including reporting the incident to the government and providing access to systems. Lack of DFARS compliance will result in

the loss of current and future contracts. As a result, this can also hurt the organization's reputation. And, as you already know, bad news travels faster than good news.

WHAT IS NIST SP 800-171?

NIST SP 800-171 is a National Institute of Standards and Technology Special Publication that provides recommended requirements for protecting the confidentiality of CUI in non-federal organizations or businesses. Defense contractors, subcontractors, and downstream suppliers must implement the recommended 110 controls contained in NIST SP 800-171 to demonstrate their provision of adequate security to protect the sensitive information and CUI included in their defense contracts, as required by DFARS 252.204-7012. If a manufacturer is part of a DoD, General Services Administration (GSA), NASA, or other federal or state agencies' supply chain, the implementation

There are 17 Controls in Level 1, and they are based on what is found in the Federal Acquisition Regulation FAR 52.204-21. This is a good starting point for organizations just beginning to implement cybersecurity measures, or who have limited resources.

Level 1 certification is required for companies that handle Federal Contract Information (FCI) but aren't considered part of the critical infrastructure, which includes most businesses and government agencies.

Level 1 is NOT for any business that processes, stores, or transmits CUI in any way. If you handle CUI, a Level 2 certification is a minimum requirement.

CMMC Level 2: Advanced Cyber Hygiene

Level 2 builds on the cybersecurity hygiene practices of Level 1 and requires additional measures to be put in place.

Level 2 is similar to NIST SP 800-171 and includes 110 practices. Some of the practices focus on access control, incident response, risk management, physical security, and system and information integrity. If you have any doubt about whether you handle CUI (or will in the future), Level 2 certification is recommended.

CMMC Level 3: Expert Cyber Hygiene

Level 3 is the highest level of CMMC certification and requires the most stringent security measures. Level 3 is based on NIST SP 800-171 and adds additional practices from NIST SP 800-172. The extra practices focus on more sophisticated detection and response capabilities, information protection, and system-hardening requirements.

Level 3 certification is required for the same types of companies that need Level 2 certification, but who also handle CUI in the most sensitive or higher security assurance of DoD contracts. Organizations required to comply with CMMC Level 3 certification are assessed by the federal government's Defense Contract Management Agency. Assessment

process details for Level 3 are still being developed at this time.

THE DFARS INTERIM RULE

On September 29, 2020, the DoD published the DFARS interim rule 2019-D041, Assessing Contractor Implementation of Cybersecurity Requirements, effective November 30, 2020. These new clauses are an extension of the original DFARS 252.204-7012 clause that has been required in DoD contracts since 2018.

The interim rule consisting of DFARS Clauses 252.204-7019, 252.204-7020, and 252.204-7021 implements the NIST SP 800-171 DoD Assessment Methodology and the Cybersecurity Maturity Model Certification (CMMC) Framework. The interim rule requires contracting officers to take specific action before awarding contracts, tasks, or delivery orders, or exercising an option period of extending the period of performance on existing contracts, on or after November 30, 2020.

DFARS 252.204-7019 CLAUSE: NOTICE OF NIST SP 800-171 DOD ASSESSMENT REQUIREMENTS

All DoD contractors in the DIB and their supply chain must complete a self-assessment using the DoD's NIST 800-171A Assessment



NIST SP 800-171 Rev. 2



No.	Control Family	ID	Controls	Objectives
3.1	Access Control	AC	22	70
3.2	Awareness & Training	AT	3	9
3.3	Audit & Accountability	AU	9	29
3.4	Configuration Management	CM	9	44
3.5	Identification & Authentication	IA	11	25
3.6	Incident Response	IR	3	14
3.7	Maintenance	MA	6	10
3.8	Media Protection	MP	9	15
3.9	Personnel Security	PS	2	4
3.10	Physical Protection	PE	6	16
3.11	Risk Assessment	RA	3	9
3.12	Security Assessment	CA	4	14
3.13	System & Communications Protection	SC	16	41
3.14	System & Information Integrity	SI	7	20
			110	320

NIST SP 800-171 is a National Institute of Standards and Technology Special Publication that provides recommended requirements for protecting the confidentiality of CUI in non-federal organizations or businesses. (Courtesy: Bluestreak Consulting)

of the security requirements included in NIST SP 800-171 is a must.

NIST SP 800-171 requirements consist of 14 specific security control families. Within the 14 security control families, there are 110 separate controls and, within those controls, there are 320 individual control/assessment objectives, all of which need to be met to become 100 percent compliant.

WHAT IS CMMC 2.0?

CMMC stands for Cybersecurity Maturity Model Certification. It combines the controls from NIST SP 800-171 and from other sources, depending on the level of certification. This is a new model that will replace NIST SP 800-171 and will be enforced by the DoD. What is the difference? The new CMMC 2.0 contains three levels of certification, which will give the contractor a score that will determine their ability to bid on certain contracts.

CMMC Level 1: Foundational Cyber Hygiene

The most basic level of security, Level 1, requires the implementation of basic cybersecurity hygiene practices such as password management and keeping systems up-to-date with security patches. This level is intended for small businesses with minimal risk to their data.



Heat treaters implementing effective cybersecurity practices are particularly challenged today because there are more devices (including mobile devices) than people, and attackers are becoming more innovative. Courtesy: Shutterstock)

Methodology and generate a points-based score. If the self-assessment score falls below 110, contractors are required to create a POAM (plan of action with milestones) and indicate by which date the security gaps will be remediated and a score of 110 will be achieved as part of the Supplier Performance Risk System (SPRS). At the time of contract award for a DoD contract containing the new 7019 clause, a DoD contracting officer will verify that a score has been uploaded to the SPRS.

DFARS 252.204-7020 CLAUSE: NIST SP 800-171 DOD ASSESSMENT REQUIREMENTS

Along with the 252.204-7012 and 252.204-7019 clauses, the 252.204-7020 clause is approved for use in all DoD contracts. This new clause requires contractors provide the government with access to its facilities, systems, and personnel when it's necessary for the DoD to conduct or renew a higher-level assessment. The higher-level assessments are the medium and high assessments. The self-assessment conducted as part of the 252.204-7019 clause is called a basic assessment.

A medium assessment is conducted by DoD personnel and will include a review of your system security plan (SSP) and how each of the requirements is met to identify any language that may not adequately address the security requirements.

A high assessment is conducted by DoD personnel onsite at the contractor's location and will leverage the full NIST 800-171A to determine if the implementations meet the requirements by reviewing evidence and demonstration such as recent scanning results, system inventories, baseline configurations, and demonstration of multi-factor authentication and/or two-factor authentication.

Along with that, this rule also requires contractors flow down their requirements from 252.204-7019 to their subcontractors and suppliers. Just as the DoD may choose not to award a contract due to noncompliance, you may not be able to use a subcontractor or supplier in your downstream due to their noncompliance.

DFARS 252.204-7021 CLAUSE: CYBERSECURITY MATURITY MODEL CERTIFICATION (CMMC) REQUIREMENTS

This DFARS clause establishes CMMC into the federal regulatory framework. This requires CMMC is to be included in all contracts, tasks or orders, and solicitations, with very few exceptions.

The level of CMMC required will be determined by the DoD and

added to the request for proposal (RFP/RFQ). Contractors must maintain the appropriate CMMC level for the duration of any contract, and the requirements must be flowed down to their subcontractors and suppliers. The CMMC certification is required at the time of contract award.

CONSEQUENCES OF FAILING TO COMPLY WITH DFARS 7012 & NIST SP 800-171

Heat treaters willing to move forward with these cybersecurity initiatives by the DoD will have an overwhelming impact on the DoD supply chain and their business. Many heat treaters within the U.S. who will not embrace the mandatory requirements will result in the few who do become compliant being awarded the contracts by the DoD or their contractors.

Poor cybersecurity practices can result in hacking, potentially losing your data and your customers' critical data, being attacked by malware, viruses, and ransomware resulting in significant damage to your business, and you losing customers, not to mention being liable for all losses and paying significant fines.

This is neither a fast nor inexpensive process. NIST SP 800-171 compliance can take from between nine to 12 months. Achieving CMMC 2.0 certification can take between 12 to 18 months. So, starting now is very important.

CAN YOU AFFORD COMPLIANCE?

With the huge push for cybersecurity by the government, certain cost-sharing and funding sources have been identified who may cover a large percentage of the costs associated with these critical cybersecurity projects. Bluestreak Consulting™ can provide more information during the free consultation meeting, if interested. ☎

ABOUT THE AUTHOR

Joe Coleman is the cyber security officer at Bluestreak Consulting™ and Bluestreak | Bright AM™. Coleman is also CMMC RP (Registered Practitioner) certified. He has more than 35 years of diverse manufacturing and engineering experience. His background includes extensive training in cybersecurity, a career as a machinist, a machining manager, a lead manufacturing engineer, and an early additive manufacturing (AM) pioneer. For more information, contact Coleman at joe.coleman@go-throughput.com or 513-900-7934.



PHOTO-CHEMICAL ETCHING A PERFECT PROCESS FOR HEAT EXCHANGER PRODUCTION

Photo chemical etching (PCE), also known as chemical milling or photo-etching, is a precise and versatile manufacturing process that involves selectively removing material from a metal sheet using chemical reactions. (Courtesy: micrometal Etching Group)

As industries continue to prioritize energy efficiency, compact design, and performance optimization, PCE is likely to play an increasingly pivotal role in shaping the future of heat-exchange technology.

By JOCHEN KERN

Heat exchangers play a crucial role in various industrial applications, from power generation and automotive systems to HVAC systems and aerospace technology. The efficiency and performance of heat exchangers are directly related to their design and manufacturing methods. One manufacturing process proven to be ideally suited for producing high-quality heat exchangers is photo-chemical etching (PCE). This innovative technique offers numerous advantages over traditional manufacturing methods, addressing key challenges while paving the way for innovative heat-exchanger designs.

ADVANTAGES OF PHOTO-CHEMICAL ETCHING FOR HEAT EXCHANGERS

PCE, also known as chemical milling or photo-etching, is a precise and versatile manufacturing process that involves selectively removing material from a metal sheet using chemical reactions. When it comes to producing heat exchangers, this method presents several notable advantages.

For example, heat exchangers often require intricate and complex geometries to enhance heat-transfer efficiency. PCE excels in producing intricate patterns, fine details, and complex shapes that are difficult to achieve with conventional methods such as stamping or machining. This allows engineers to design heat exchangers with optimal fluid flow paths and heat-exchange surfaces.

In addition, PCE provides exceptional dimensional accuracy and consistency across large production runs. This is crucial for heat exchangers, as even slight variations in geometry can significantly affect heat-transfer performance by, for example, altering fluid flow patterns and surface interactions, leading to changes in convection, conduction, and radiation mechanisms. With minimal variation in tolerances, heat exchangers manufactured through the PCE process ensure reliable and predictable performance.

Heat exchangers must also withstand various operating conditions, including temperature, pressure, and corrosive environments. The temperature at which heat exchangers operate, for example, directly affects the material used to make them due to its influence on thermal expansion, mechanical strength, and corrosion rates, determining the material's durability and performance under specific conditions. Extreme temperatures can lead to thermal stress, material degradation, and potential failure. PCE works with a wide range of metals, including stainless steel, copper, aluminum, and titanium. This flexibility allows engineers to select materials best suited for the specific application's requirements, ensuring durability and longevity.

Finally, the ability to create intricate patterns and surface textures through the use of PCE improves heat-transfer efficiency. For example, heat-transfer efficiency can be enhanced by creating intricate surface patterns and textures that promote turbulence and disrupt laminar

flow, thereby increasing convective heat-transfer coefficients. These engineered surface features amplify fluid mixing and boundary layer disruption, facilitating more effective heat exchange between the fluid and the solid surface, all of which contribute to improved overall heat exchange performance.

CHALLENGES IN ALTERNATIVE MANUFACTURING PROCESSES

While PCE offers significant advantages, alternative manufacturing processes present several challenges when it comes to producing heat exchangers.

Conventional methods like stamping, welding, and machining are constrained by their limited ability to create intricate and complex geometries, resulting in suboptimal fluid flow patterns and less effective heat exchange surfaces in heat exchangers. As a consequence, the overall performance of these heat exchangers is diminished. Additionally, these techniques struggle to reproduce intricate internal passages and features essential for efficient heat transfer and fluid dynamics.

Traditional manufacturing processes are also susceptible to tolerance variations caused by factors such as tool wear, thermal expansion, and machine inaccuracies. These inconsistencies can detrimentally affect heat-exchanger performance by disrupting precise geometries and altering flow pathways. Suboptimal tolerances can impede proper fitment of components, hinder uniform fluid distribution, and hinder efficient heat transfer, ultimately compromising the overall effectiveness and reliability of the heat exchanger, and posing a challenge in maintaining consistent efficiency across a production batch.

As discussed, certain heat-exchanger designs demand materials with specific properties to endure extreme conditions. However, the limitations of traditional manufacturing methods can restrict the range of materials that can be effectively used. Many traditional techniques are optimized for specific materials and may struggle to handle newer, unconventional materials or those with unique properties required for specialized applications. This restrictiveness hampers the ability to tailor material choices to suit specific heat-exchanger requirements, limiting the design's overall performance, efficiency, and suitability for diverse operating conditions.

Finally, conventional manufacturing procedures, sometimes involving multi-step processes such as cutting, shaping, and welding, tend to extend production timelines and increase costs due to their inherent complexity and sequential nature. Each additional step requires specialized equipment, skilled labor, and quality checks, leading to longer lead times and higher costs. Moreover, the need for coordination among various processes can introduce delays and increase the risk of errors, further contributing to the overall time and cost overhead when making heat exchangers.



PCE allows for the precise combination of different metals and materials within a single heat-exchanger unit. (Courtesy: micrometal Etching Group)

INNOVATIONS IN HEAT EXCHANGE DESIGN AND MANUFACTURE WITH PCE

The adoption of PCE for heat-exchanger production opens up exciting avenues for innovation in design and manufacturing. Firstly, PCE enables the creation of micro-channels with intricate geometries. These micro-channels facilitate efficient heat transfer by increasing surface area and promoting turbulence, leading to highly compact and efficient heat exchangers. This innovation is particularly valuable in applications where space is limited, such as in electronics cooling or aerospace technology.

Second, engineers can use PCE to design and manipulate surface textures that enhance fluid flow and heat-transfer efficiency. By strategically creating patterns that promote turbulence and disrupt laminar flow, they can optimize convective heat-transfer coefficients and improve overall heat exchange. This customization of surface patterns to match specific applications enables heat exchangers to achieve elevated heat-exchange rates, resulting in heightened performance and increased efficiency tailored to the precise operational requirements.

PCE also allows for the precise combination of different metals and materials within a single heat-exchanger unit. This opens the door to creating hybrid heat exchangers that leverage the strengths of various materials while mitigating their weaknesses, enhancing overall durability and performance.

Also of critical importance, the rapid prototyping capabilities of PCE empower engineers to swiftly test and iterate heat-exchanger designs. With PCE, engineers can efficiently create intricate surface

patterns and textures, allowing for the rapid production of prototype heat exchangers with varying geometries. This rapid iteration process enables engineers to assess performance, fluid dynamics, and heat-transfer efficiency more effectively, leading to quicker design refinements and a streamlined development cycle. This accelerates the development process and facilitates the exploration of innovative concepts, ultimately leading to optimized designs.

CONCLUSION

In the realm of heat-exchanger production, PCE stands out as a revolutionary manufacturing process that addresses many challenges faced by traditional methods. Its ability to create complex geometries, maintain tight tolerances, and work with a wide range of materials makes it an ideal choice for producing efficient and innovative heat exchangers. As industries continue to prioritize energy efficiency, compact design, and performance optimization, PCE is likely to play an increasingly pivotal role in shaping the future of heat exchange technology. 🔥



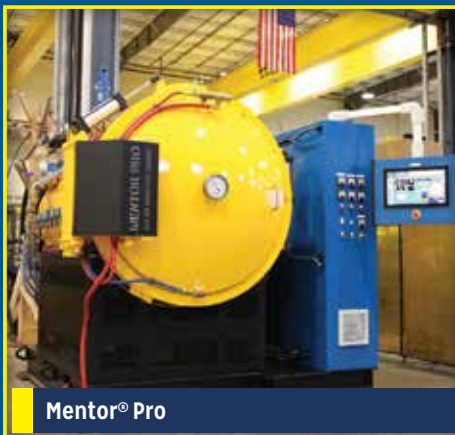
ABOUT THE AUTHOR

Jochen Kern is Head of Sales & Marketing, micrometal Etching Group. micrometal GmbH (incorporating HP Etch and Etchform) specializes in the industrial production of highly precise metal components. The companies etch a huge range of metals and deliver customer-specific, clean, complex components, free of stress and burrs. For more information, go to www.micrometal.de.

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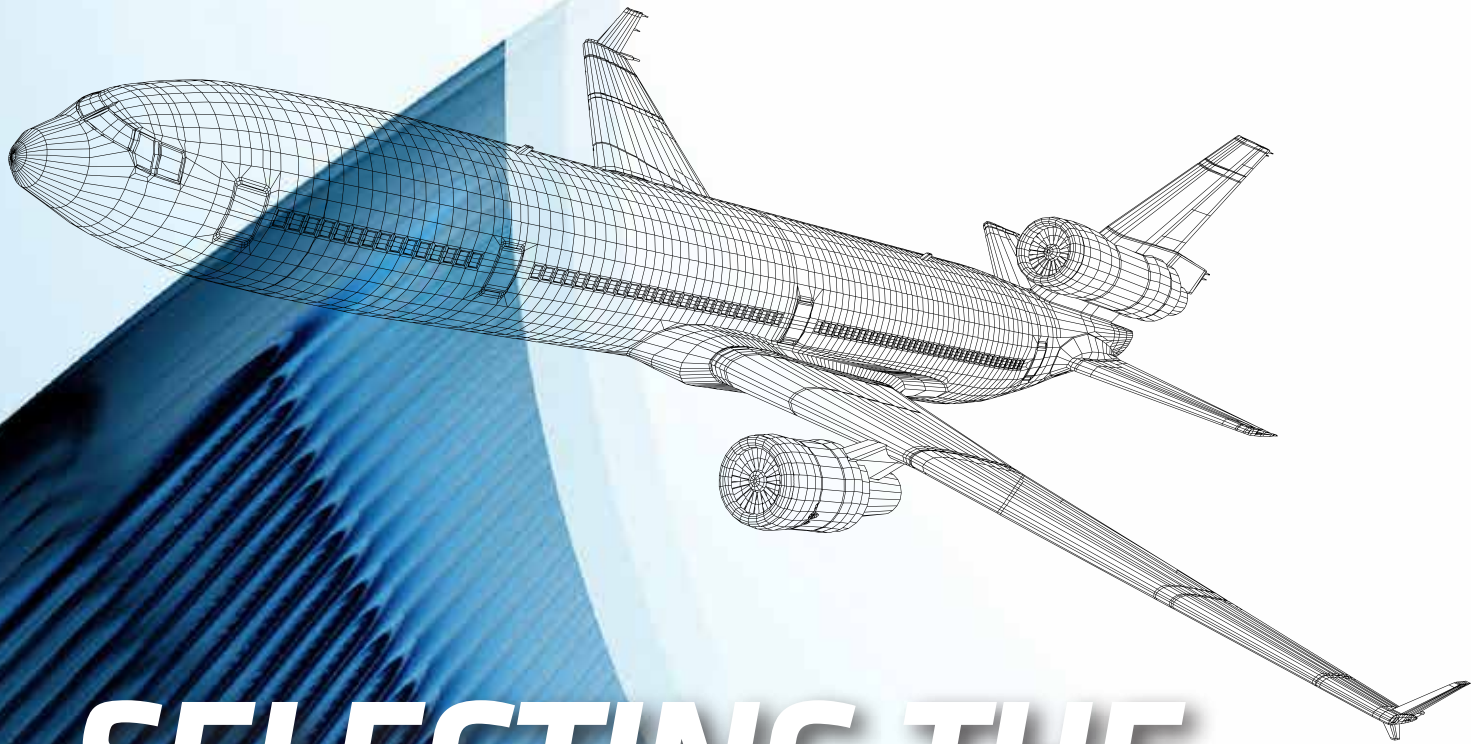


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***SELECTING THE
RIGHT STRETCH
FORMING
EQUIPMENT***

The stretch forming process can create stronger parts, increase production, and reduce processing steps, but selecting a machine with best-in-class capabilities is essential.

By DEL WILLIAMS

F

or manufacturers, striving to increase profitability while expanding their capabilities and improving their processes, adding stretch forming to their repertoire may be the answer.

Stretch forming is a unique process where material such as steel, stainless steel, aluminum, or even titanium is stretched beyond its yield point and simultaneously wrapped around net shaped dies. Forming sheet or extruded material using this method essentially shifts the neutral axes of a part to the perimeter of the die, resulting in a smooth, wrinkle-free contour that closely retains the shape of the die, improves the mechanical properties, and eliminates many post process steps used to attain dimensional accuracy.

Initially developed as an efficient means to produce components with complex curved profiles in the aircraft industry, stretch forming is now widely used for similar components in automotive, aerospace, construction, rail, and rocketry.

“As part producers seek to expand their capabilities, many have approached us with new stretch forming applications. Combining modern CNC technology with our precise digital die mapping technology and historically robust machine structure provides for the finely tuned automated motion control necessary to maintain constant strain in the part throughout the cycle, all resulting in industry leading dimensional stability,” said Dave Gardner, senior mechanical engineer at Erie Press Systems, a company that manufactures custom-engineered hydraulic presses for applications including metal forming, stretch forming, composite compression molding presses, cold extrusion, and forging. Park Ohio acquired Erie Press Systems in 2020 and is now a part of Ajax-CECO-Erie Press (ACE), the largest forging equipment supplier in North America, with over a century of experience in custom designing and building presses and forming machines.

Manufacturers that are unfamiliar with stretch forming as well as those with special requirements often require guidance to select equipment that meets their specific needs.

Drawing on Erie Press’s decades of experience in aerospace applications and ACE’s century of fabricating machinery, Gardner covers the basics of stretch forming and provides tips for selecting equipment that can help to maximize product quality, reliability, and productivity.

STRETCH FORMING BASICS

According to Gardner, stretch forming machines may be classified into three primary design types, depending on the client’s intended production requirements: Sheet stretch forming machines are used to produce complex curved sheet metal parts such as exterior panels and leading edges on aircraft, high-speed trains, RVs, buses, and commercial rockets. Extrusion stretch forming machines are used to produce extruded structural components with complex cross sections and curved profiles such as stringers and support beams for aircraft, skeletal components for locomotive, buses, transportation structures, and various curved shapes used in the elevator and archi-

tectural (building) industry. High-speed, high-volume stretch forming machines are generally reserved for forming extrusions in automotive or other high production applications.

Each design type classification can be further broken down into a series of machines with specialized features better suited for producing specific types of parts.

“Due to the wide range of features and options that are available, we work with our clients to develop the technical details of a machine that will fully meet their unique production requirements,” Gardner said.

Stretch forming offers numerous advantages, including the ability to accurately form complex shapes while maintaining the part’s total volume. Once the component is stretched into the yield state, less force is required to wrap the part around the die than with other forming methods. Part cost is substantially reduced by the ability to form accurate and repeatable components with little wasted material and, in most cases, a scuff-free quality finish that doesn’t require dimensional or cosmetic improvement. Additionally, the process induces work hardening in many materials, which increases strength while reducing internal residual stress and spring back as compared to conventional bending operations.

From Gardner’s decades of machine design experience in various applications, he advised that clients consider the purchase of stretch forming machines with these important qualities:

STRUCTURAL INTEGRITY AND LONGEVITY

Stretch forming is not a high impact process, but forces involved can be more than 3,000 tons in some aerospace applications. High-quality stretch forming machines with very precise motion control and the ability to digitally map the contour of the die with respect to the forming axes will form the part with nearly constant strain throughout the process and create very precise, consistent parts for many decades. Consequently, it is important to select a machine with these features to extend its accuracy, longevity, and reliability.

“Machines with inherent compliance (deflections) or off-line programming systems that only approximate the die profile in respect to the axes positioning system cannot assure constant strain in the process, often leading to inaccurate or non-repeatable part production,” Gardner said. “Lighter construction machines with weak or bolt together frames are simply not designed to hold up to extended use.”

Selecting a stretch forming machine with a robust, heavy frame, and properly designed connection points to the die table is therefore essential to ensure decades-long accuracy and reliability. ACE has systematically improved the structural integrity of its core design since acquiring the Hufford and Sheridan Grey design rights in 2001, many of which have been in production since the 1940s.

For sheet stretch forming equipment, it is particularly important to maintain a rigid structural frame to ensure accurate, consistent part creation.

“If you want to form accurate parts with a high degree of repeat-



High-quality stretch forming machines can create very precise, consistent parts. (Courtesy: Ajax-CECO-Erie Press)



Stretch forming is now widely used in the automotive industry as an efficient means to produce components with complex curved profiles. (Courtesy: Ajax-CECO-Erie Press)

ability, you need to minimize compliance, that is deflection, from the machine structure,” Gardner said.

However, this is an issue in machines with “optimized” construction, which tend to allow greater deflection during the stretch forming process. ACE’s robust structure is complemented by stiff connection points between moving machine members, which provide a system that reduces the total deflection throughout the forming cycle. The result is a process that is more precise and accurate, with predictable part quality.

SUPERIOR CONTROL

Stretch forming operates within the material conditions between the yield point and its ultimate strength. Commonly, high-temper materials have a narrow operating band to form above the yield point and do not exceed its ultimate strength. Precise motion and force control of the process is a vital consideration in machine selection if you expect to consistently achieve repeatable part production.

“A perfectly envisioned stretch forming cycle would include the ability for the machine to monitor the strain rate within the part as force increases along its axis, capture the strain when the part

transitions slightly above the yield point of the material, and form the part with nearly constant strain throughout the forming cycle,” Gardner said.

Practical limitations that affect a forming cycle include variations in the materials cross section, variations in the mechanical properties within the part (or batch of parts), dynamic deflections in the machine structure, discrepancy in the machines axes controls to properly adjust for the contour of the die, and even the ability to program a precise profile path that duplicates the contour of the die.

Gardner pointed out that attaining finer control of the stretch forming process is imperative to automated part production and achieves two important aims.

“First, it regulates the forming process so you can operate within a tighter band between the yield strength and the ultimate strength of the material to reduce part breakage,” he said. “Secondly, it allows the machine to very accurately approximate constant strain within the part by comparing its measure length to the applied axial force once it transitions into the yield state. In this way, the yield stress in the part and the length of the part remains consistent through the forming process.”

CONTROL SYSTEM UPGRADES

Most of the sophistication in today's stretch forming machines involves control system improvements for axes positioning systems, hydraulic force control, part programming, and ease-of-use for operators.

In ACE's stretch forming presses, for instance, the OEM simplifies operation by incorporating touchscreen, menu-based human machine interfaces (HMIs) to automate the forming cycle. Traditional stretch forming machines that employ manual controls require highly specialized operators that make intuitive adjustments during the cycle to achieve acceptable results.

Utilization of the HMI approach facilitates automated production, reliability, and consistency while greatly reducing broken or out-of-tolerance parts. Modern, high-quality control systems for stretch forming machines include automatic yield point detection systems, the ability to automate the programming process, monitor the forming process, contain machine diagnostic protocols, and have advanced safety systems for operator protection.

Along with the standard features listed earlier, ACE offers a two-pronged approach to provide forming predictability with integrated part programming. Standard supply includes an easy-to-use and highly accurate, proprietary automated part programming system that uses the machine axes to digitally map the profile and synchronize axes positioning during a simulated forming cycle with the die installed on the machine. Additionally, off-line programming software is offered that contains modules for FEA-based forming feasibility studies, spring back prediction to aid die design, machine collision detection, and that is capable for two-way communication with the machine for off-line part programming.

"Traditionally, spring back is a problem when forming tempered parts," Gardner said. "Our software predicts these reactions based on actual material properties at the time of forming. Spring back values are used to make virtual die geometry adjustments, and the feasibility study is duplicated until simulations indicate accurate parts are produced. Our beta version is provided with the latest machine we sold, which is a sheet stretch forming press."

Gardner explained the need for die customization in the extrusion stretch forming machine process:

"Certain types of alloyed material, particularly some grades of extruded aluminum, will age harden at room temperature in a relatively short amount of time," he said. "Processing these parts directly from the annealing furnace, before age hardening occurs, will improve the consistency of the formed profile. Age hardening after they have been formed usually will not affect the dimensional stability of a properly racked part."

Forming aluminum closer to the "zero" temper condition (or annealed condition) results in a consistent process that will more closely adhere to the net shape of the die, according to Gardner.

"A lot of our clients will form tempered aluminum extrusions, say up to a T4 temper condition, but tempered material retains some amount of residual stress during the forming process, and the die must be designed to accommodate some degree of spring back," he said. "So, you will have some spring back when forming tempered material, but certainly a lot less than witnessed in normal bending operations."

OPTIONS TO SPEED PRODUCTION

Manufacturers often seek options to speed the stretch forming pro-

cess. However, expediting the process generally involves part or tool handling, not part forming, according to Gardner.

"If the part forming process is too fast, particularly on sheet material, L der lines (surface markings) occur on the surface from unwanted elastic flow of the material caused by improper strain control," he said. "These normally will have little effect on the profile of the sheet but are an undesirable visual effect, so you can only form as fast as the material will allow."

To facilitate faster, higher-rate production, ACE offers options for automated part loading/unloading and improved tool change systems in their stretch forming machines.

For example, extrusion stretch forming machines may use fixed dies rigidly mounted to the die table and jaw inserts that are manufactured specifically to grip the unique shape of the extrusion being formed. Machines furnished with the standard balanced lifting brackets allow complete tooling changes in about 30 minutes by



Stretch forming is now widely used in the aerospace industry as an efficient means to produce components with complex curved profiles. (Courtesy: Ajax-CECO-Erie Press)

experienced operators. Automating the process will reduce the complete change out times to about five to 10 minutes, depending on the machine size.

Adding to the challenge of selecting options, certain manufacturers may need to frequently perform complete tooling changes due to short production runs and may benefit significantly from automating the tool change system. Other manufacturers have very high production quantities of the same part and may receive greater benefit from automating the part loading systems.

"To speed production for both short and long production run manufacturers, we can accommodate complete or partial automation for tooling or part changing systems," Gardner said. "Generally, we expect the lost time of these non-production related events to decrease by 60 to 75 percent when compared to standard, non-automated processes, depending on the unique requirements of each specific application."

Whether manufacturers are new to stretch forming or seasoned industry veterans that simply want to extend their capabilities, thoughtful selection of a machine specifically engineered to satisfy their unique requirements will result in the most robust, reliable, and cost-effective solution for expanding their capabilities and improving their processes. ♣

ABOUT THE AUTHOR

Del Williams is a technical writer based in Torrance, California. For more information, go to www.AjaxErie.com

COMPANY PROFILE ///

HONEYWELL SMART ENERGY AND THERMAL SOLUTIONS

SUSTAINABILITY SOLUTIONS FOR COMMERCIAL AND INDUSTRIAL THERMAL APPLICATIONS

Honeywell's Thermal Solutions provides safer burner management systems to allow sequencing of burner fuel delivery, flame safety, fuel air ratio and limit operation. (Courtesy: Honeywell)

Honeywell Thermal Solutions provides systems and solutions that help markets transitioning to a sustainable future.

By **KENNETH CARTER**, Thermal Processing editor

Thermal processing touches almost all parts of everyday life — from the mundane to the critical.

And as companies around the world work to ensure a sustainable future for that world, the experts at Honeywell take pride in offering products and services designed for that important goal.

“What keeps me happy and excited about the business is the role that we can play in the future of the world and make sure that we help our clients move to a more sustainable future with all the solutions that we have,” said Hamed Heyhat, president of Honeywell Smart Energy and Thermal Solutions.

PROVIDING A WIDE RANGE OF SOLUTIONS

And Honeywell’s portfolio of solutions is wide and varied, constantly evolving to serve an ever-changing landscape.

“Honeywell is one of the biggest — if not the biggest — companies active in heat treatment, providing solutions for fuel delivery, burners and also control systems,” Heyhat said. “We are very active in process control and heat-process control as part of our portfolio, but we have a full range of products from different valves and parts and equipment that deliver the fuel to where you want to run the heat process all the way to state-of-the-art high-class burners for different industries. And, of course, the control systems that we offer are used for safety and reliability of the systems and for the performance and efficiency of those systems.”

In short, Heyhat said no company in the market has a portfolio that comes close to rivaling Honeywell’s.

“We can go from A to Z for heat processing, and we’re working with many OEMs and end users and even go and deliver projects for them,” he said. “We have whole engineering solutions that we put together, readily build and test, and we ship them to different facilities.”

Those systems can be brand new or a retrofit of existing systems already on the market, according to Heyhat.

“We also deal with almost every market vertical in the industry — from food and beverage all the way to complex chip manufacturing,” he said. “Thermal process and heat process are part of almost every single vertical — from car manufacturing to chip manufacturing, to food and beverage, to glass, to textile — you name it.”

WORKING FOR A SUSTAINABLE FUTURE

As more companies strive for a more carbon-neutral future, it has become a major goal of Honeywell to make sure those needs are met, according to Heyhat.

“We call ourselves future shapers,” he said. “That comes with how we invest with innovation and solutions that will solve real customer

and market problems. When you take that philosophy into what we are doing internally, you can see the exact same thing. As the world is moving to more sustainable solutions, we are leading the energy transition with our customers by focusing on high efficiency burners. We have some of the most efficient burners in the world. We work a lot on multi-fuel burners. We are one of the few companies worldwide that can offer burners capable of switching between natural gas and hydrogen from zero to 100 percent live.”

This function becomes essential when the thermal process needs to be managed in order for the outcome in the heat chamber to remain consistent, according to Heyhat.

“You can basically switch between one (fuel) to the other as the thermal process is going on,” he said. “That comes with a lot of knowledge and know-how that we developed for more than 100 years on our teams. It’s very important.”

FUEL AVAILABILITY

It essentially boils down to the availability of fuels, and the key is not just being able to switch between one and the other, but how to keep



With the most comprehensive selection of industrial burners and heat exchangers in the industry, Honeywell can create unique solutions for any thermal application. (Courtesy: Honeywell)

the heat-chamber output constant, according to Heyhat.

“If you are heating in a glass manufacturing plant or heating in a food and beverage plant or you are in a paint booth of a car manufacturer, the switch between one fuel to the other fuel will change the thermal characteristics of the heat chamber, so it becomes necessary to manage the transfer between one and the other fuel to make sure that the output of the heat chamber is constant,” he said. “You don’t change the painting quality when you are switching from hydrogen to natural gas and back and forth.”

Ideally, hydrogen is often preferred, but only if blue or green hydrogen is available in the area for the reduction of carbon emissions, according to Heyhat.

“What is important is you want to make sure the output will stay



Honeywell Thermal Solutions supports every step of automotive paint finishing application with the equipment, technology, and expertise to help you ensure high product quality and safe, reliable operation. (Courtesy: Honeywell)

constant and the quality of what you get out of the heat chamber and thermal process is fixed; it's not changing," he said. "That's where we're investing to make sure we understand how we do the switch."

CUSTOMER RELATIONSHIPS

Also important is how Honeywell has formed a special partnership with its customers for the advancement of sustainable ideas, according to Heyhat.

"We have solutions, and as such, we join forces with our customers to help them to move to a more sustainable future," he said. "That is the goal of Honeywell's thermal solution business. It's not just, say, we have burners burning natural gas. We know natural gas is part of the transition. There is no future with zero natural gas between now and 2050 where everybody's talking about more sustainable heating. So, we actively invest and work with customers to make burners with natural gas more efficient with what we call clean combustion, where we have low NOx and low emission burners and extra low emission burners."

With those innovations in place, more efficiency means less use of the natural gas needed to achieve the same result, according to Heyhat.

"You are basically reducing the byproducts by high efficiency, low emission, low NOx burners," he said. "Meanwhile, we are also investing in all the dual fuel systems from fuel delivery to control to basically a type of gas that you want as fuel like 100 percent hydrogen. We are also actively looking into and investing in electrification and

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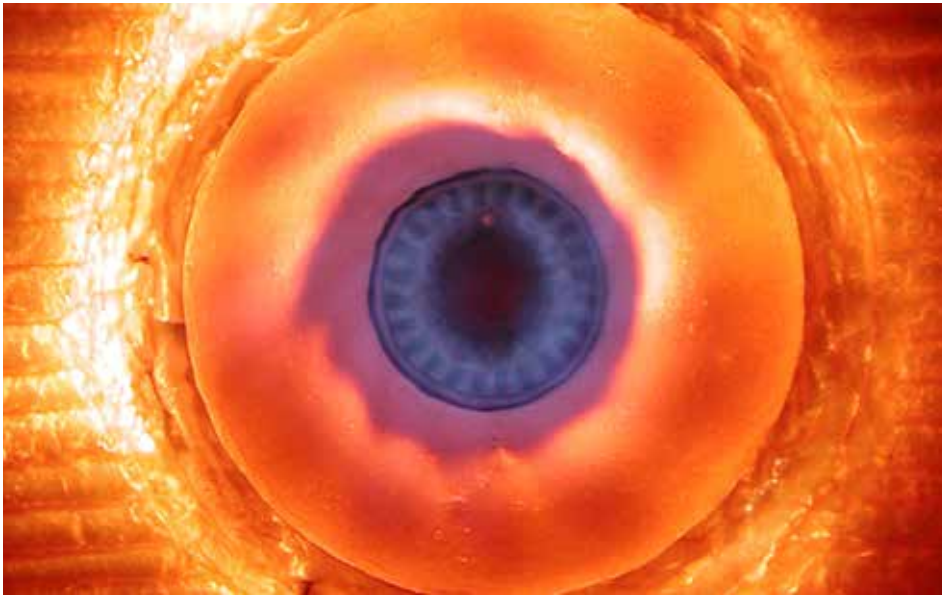
"Controlling the heat process was invented by Honeywell and then commercialized over decades, and we are still doing that."

electrical heating. We see the future being hybrid. There's not one fuel or solution that will take a dominant position in the market. As we move forward, we believe in creating flexibility for our customers to choose, based on the cost of energy and the different fuels and solutions that they have available, to basically define the most optimum solution. That can be a mix of electric heating, hydrogen, and natural gas in the same location."

PROCESS CONTROL

In addition to having products that can burn more efficiently, Honeywell is also involved in how those processes are managed, according to Heyhat.

"With our knowledge of thermal process, we are getting into energy management and heat process management," he said. "It's not just having a burner that would burn one or the other fuel or electric burners, but how you can have a layer of analytics and soft-



Honeywell has some of the most efficient burners in the world – capable of switching between natural gas and hydrogen from zero to 100 percent live. (Courtesy: Honeywell)



Honeywell Thermal Solutions offers a wide range of equipment for the food and beverage industry, offering direct fired and indirect fired solutions, ensuring the highest product quality, consistency, and safety standards. (Courtesy: Honeywell)

ware and digital solutions on top that would ultimately help the customers safely operate their systems, secure their output, while being sustainable and reducing the carbon footprint they have in their process. That is how we see ourselves, and that's where we are innovating and investing a lot of money on the future of heat and thermal process."

With more of its customers eyeing a more sustainable future, Heyhat said Honeywell will be heavily investing in retrofitting existing systems, so the question is how can Honeywell continue to engage its customer base to offer solutions to tackle that objective?

"That's where we are engaging with the end user and have an active participation with them," he said. "We talk with them. They come to us, because we have extensive test facilities and labs that we can experiment with different things. We build experimental heat chambers to make sure that we design the ultimate solution properly for

them. We are not developing our solutions in a vacuum in our R&D centers. We believe in the power of collaboration in the industry, and that is how we are basically engaging with our end user to jointly develop solutions that would fit the goals they have."

THE R&D PROCESS

In that vein, Honeywell either has a solution for a customer that's already been developed, or Heyhat said the company will provide a collaborative solution.

"We engage them in our R&D process," he said. "If there are things that nobody has and we didn't think of it or there are some special needs, we don't say, 'No, we don't have it.' We get engaged with them, and we make sure we develop those solutions that would help them to drive the business plan they have and the sustainability plan they have. It's a different type of sell. It's not like I have a bunch of products, and I go, 'Hey, buy X or Y from me.' It's listening to the customers. It's a type of farming sell where you go and seed something and make sure you get the results over time with the customer, developing the solutions that fit their purpose."

ACTIVE INVOLVEMENT

With a history that stretches over a century and a constantly evolving portfolio that now involves aerospace to utilities to oil and gas, the company has come a long way since it began producing hot water heat generators in 1906. But what has remained key to Honeywell's success is being consistently active in innovation, according to Heyhat.

"Controlling the heat process was invented by Honeywell and then commercialized over decades, and we are still doing that," he said.

And that is something Heyhat said shows no signs of stopping.

"We are developing R&D centers in different parts of the world, from Europe to the Far East to the U.S., and we are engaging with customers to actively develop custom-made solutions for those customers," he said.

Digitalization is also expected to be a large part of Honeywell's future development, according to Heyhat.

"We are well-positioned for that, because it will become more and more complex to run the process," he said. "Switching between different solutions is going to be a norm on a daily basis. And you will need that digital layer and the software and analytics to help you optimize the process and run it based on different targets. It could be a cost optimization or carbon footprint optimization, and things might change with the introduction of a carbon tax and other incentives or regulations in the market. We are going to see a heavy focus on sustainability and those hybrid solutions. That's where we can play an important role in the industry." 🌿



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Q&A /// INTERVIEW WITH AN INDUSTRY INSIDER



SUSAN HEINAUER /// REGIONAL SALES MANAGER /// THERMAL PROCESSING

“I am thrilled to be a part of the Thermal Processing team, and I am looking forward to working with existing and new advertising partners.”

Thermal Processing welcomes its newest sales representative to its staff, Susan Heinauer. She has more than 20 years of experience in sales and promises to bring her unique style and acumen to making sure advertisers get the best possible exposure with our readers.

What about the industry and heat treating in particular gets you excited?

I have worked in several different industries. My media sales career began in industrial thermal processing with *Industrial Heating*, *Process Heating* and *Process Cooling*, and I have really enjoyed it. I like the customers. One thing that I've noticed, and I enjoy, is working with different types of people. You have large corporations, but then you have family-owned companies. There's such a wide spectrum of folks that you work with that add some variety. In some cases, you work with the people who founded the company, so they have a different perspective.

Technological advancements over the years have kept the heat-treating industry on the cutting edge of improved productivity and energy efficiency to meet the industry's changing needs.

What part of your sales background has most prepared you for interacting with the heat-treat industry?

After almost 20 years in media sales in the industrial thermal processing industry, I've worked with a variety of companies from large corporations to family businesses. The heat-treating industry includes companies of all sizes, market segments, and regions and I welcome the challenge to learn my client's needs and work with them to achieve their goals.

You use analogies you developed with other companies to demonstrate how you've helped them in the past?

Yes, but, of course, you still have to tailor your proposal to what the client's needs are. There's a lot of fact-finding, and also, some companies just want branding, and some companies are all about leads. In many cases, a comprehensive integrated plan maximizes marketing efforts.

What do you do to try to convince a company that they need to increase their advertising visibility?

In my experience, it's really finding out what that potential advertiser is looking for. I have to really take their lead and work from there.

With so many companies seeming to be reducing or eliminating

their marketing staff, do you find it more of a challenge to get their attention? And how do you get their attention because of that?

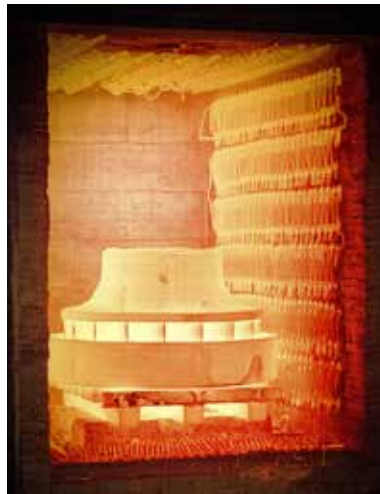
Well, it's difficult, and it's a challenge, but it boils down to persistence. Just stay with it. I don't know how many times I've been told, "Thank you for staying on me because I really wanted to do this. I just didn't have time." My very last email might start with, "I'm sorry to be a pest, but I know you are busy, so just want to check with you one more time."

At this month's HeatTreat 2023 show, what do you hope to accomplish while you're there?

Some of the clients that I've been assigned are new to me, so I'm going to introduce myself. Everyone knows *Industrial Heating* where I did work, and I know many exhibitors and their history with *Industrial Heating*. But since the nature of sales is often by phone or email, I am excited to meet clients in person and have already set up some appointments. I look forward to meeting as many exhibitors as possible to see how *Thermal Processing* can fit into their marketing plans.

Any particular types of companies that you hope to talk to while you're at HeatTreat?

Everyone — starting with all my clients that are on my list assigned to me, I want to introduce myself and talk about how happy I am to be able to walk up and hand people an issue and show them the outstanding quality of *Thermal Processing's* print magazines.



In addition to that, are there any other ways you would present *Thermal Processing* as a must destination for their ads?

Well, the quality of the editorial, of course. That would go along with handing an issue to people who may not be familiar, although I'm sure most people are. It's selling the brand as a whole, and all the different platforms we offer from digital and print magazines and then website and e-blasts. There are many other opportunities to work together, for example, as potential editorial contributors, which is always a good way to begin a great relationship. Bottom line is that I am thrilled to be a part of the *Thermal Processing* team, and I am looking forward to working with existing and new advertising partners. ♣

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