Metalcasting Industry Research

AFS is involved in several research partnerships funded through government funding and industry contributions and other means. Support of research is critical for North America to maintain a strong, vibrant, healthy and continually advancing metalcasting industry. AFS participates in these projects by securing industry partners and providing technical management and oversight.

Current research funding partnerships include:

- Advanced Casting Research Center (ACRC), which is part of the Metal Processing Institute (MPI) at Worcester Polytechnic Institute (WPI).
- US Department of Defense (DOD), Defense Logistics Agency (DLA) Castings Solutions for Readiness (CSR) Program and Innovative Casting Technology (ICT) Program, both funded through the American Metalcasting Consortium (AMC).
- The National Network for Manufacturing Innovation (MANUFACTURING USA) and the four current AFS involved consortium: (America Makes—National Additive Manufacturing Innovation Institute, Lightweight Innovations For Tomorrow—LIFT, which was formerly called Lightweight and Modern Metals Manufacturing Innovation—LM3I, Digital Manufacturing and Design Innovation—DMDI, and Clean Energy Smart Manufacturing Innovation Institute—SMLC CESMII).

AFS Funded & Monitored Research

AFS directly funds research projects from allocation of a portion of the annual dues paid by AFS Corporate Membership. The current AFS Funded Research Projects are described below.

Improving Dimensional Accuracy of Castings from Silica Sand Molds

Coordinators: Sairam Ravi, University of Northern Iowa and the AFS Cured Sand & Aggregate Committee

The rules of thumb concerning dimensional changes from pattern to final casting are not accurate enough to predict actual casting dimensions. Metalcasters will usually require several trial castings and pattern revisions before they meet the customer's dimensional accuracy requirements. This also causes design engineers to add extra machine stock, which inflates the cost of every cast part produced from silica sand molds and cores. Typical machining for castings may cost as much as five to seven times what the original casting costs. This often makes it more economical to produce machined parts from rolled alloy rather than castings. Computer simulations that predict final casting dimensions based on the properties of the molding aggregates can help in solving this issue while providing sustainability to silica sand molding.

Objectives are to validate existing dimensional accuracy code through simulation and measurement of production parts, refine codes as needed to match non-constrained core conditions, determine high temperature retrained strength of PUCB and PUNB cores and adjust code to compensate for casting solidification constraints, and conduct foundry validation trials in iron for constrained casting dimensions.

The research is being conducted at University of Northern Iowa (UNI) and is by the New Generation Sand Consortium (NGS) and AFS Cured Sand & Aggregate Committee. Those wishing more information about the project or how to participate can contact the PI Sairam Ravi at ravis@uni.edu or the AFS Technical Department (technicalassistant@afsinc.org).

Influence of Core Variables in Semi-Permanent Mold Dimensions

Coordinators: Dr. Paul Sanders, Michigan Technological University and AFS Permanent Mold Practices Committee

Casting shape, core materials (sands and resins) and the methods used to make and remove sand cores will influence the final dimensional shape and repeatability of a semi-permanent mold casting. Rather than understanding or predicting the dimensional variance in a casting, a common practice has been to either allow sufficient tolerance in the design to accommodate the unknowns. Foundry and design engineers often rely on "rules of thumb," previous experience with similar parts, or a hopefully understanding customer who will change the drawing to accommodate the actual result of the initial runs.

The "rule of thumb" for permanent mold castings is to use .006 inches/inch (mms/mm) shrinkage factor for tooling construction. Actual instances of .003 to .010 shrink factors have been observed. The shrink factor used on the sand core is typically

built to .010 in/in with instances from .008 to .013 observed in practice. These various process and tooling variables often lead into initial tooling questions that have a lot of anecdotal-based opinions in the industry, and little published data.

Objectives are to make cold box and shell cores using multiple resin levels, dimensionally scan cores and analyze data analysis. Pour castings and analyze the cast part to establish a deviation from perfect shape map. The project will evaluate the significance of experimental factors such as core type, resin level, knockout time and dimensional metrics and assess metal shrinkage, core deflections and resultant residual stresses and strains. The goal is to develop physical calculations to predict dimensional changes and develop guidelines for shrinkage factor as a function of process variables.

The work is being monitored by AFS Permanent Mold Practices Committee. Those interested in more information about the project or how to participate can contact the PI Paul Sanders at sanders@mtu.edu or the AFS Technical Department (technicalassistant@afsinc.org).

Prediction and Control of Distortion in Permanent Molds

Coordinators: Dr. David Schwam, Case Western Reserve and AFS Permanent Mold Committee

Permanent molds are subjected to high thermal stresses and are prone to distortion. Each casting cycle introduces heat into local areas of the mold, increasing the temperature and creating severe thermal gradients. Most of the mold material stays in the elastic deformation region and returns to the original dimensions upon cooling. However, in some parts of the mold the compressive surface stresses may exceed yield, resulting in permanent, plastic deformation. Other metallurgical events are also in play as the mold distortion occurs over many casting cycles where time at temperature is an issue.

This is primarily a computational effort supported by experimental data. In this study, finite element modeling will be used to identify the sources of mold distortion and also to explore methods to minimize mold distortion. Computer software will be used to assess both thermal stress and the change in microstructure that will occur due to time and temperature for the hot face of the mold cavity.

A permanent mold will be obtained from participating companies along with the CAD used to fabricate it. The geometry of the used mold will be captured with a laser scanner (CWRU). Computer simulations of stress and distortion will be conducted by Dante Solutions to identify sources of mold distortion, and predictions for the specific mold will be compared to the laser scanned model.

This project is being monitored by the AFS Permanent Mold Practices Committee. Those wishing more information about the project or how to participate can contact the AFS Technical Department (technicalassistant@afsinc.org).

Prefiring Time/Temperature Effect on Investment Shells Thermos-Mechanical Properties

Coordinators: Dr. Mingzhi Xu, Missouri University of Science & Technology, and AFS Investment Casting Committee

Investment shells are typically prefired before being poured. In the steel industry, the prefiring temperature is generally high enough to trigger some amount of devitrification of the amorphous silica constituent in the shell molds. Different foundries have their own prefiring temperature/time profiles which result in different amount of devitrification, thus affecting the thermo-mechanical properties of the shell molds. Estimating thermal properties from handbook data without considering the phase changes during the process is usually inaccurate. Applying thermal property values from commonly used simulation software database without carefully considering the difference of prefiring regime will often not represent the reality.

The ultimate objective of this project is to come up with a kinetic model that predicts the thermo-mechanical properties of silica-based investment shells.

The work is being monitored by AFS Investment Casting Committee. Those wishing more information about the project or how to participate can contact the PI Mingzhi Xu at mxu@mst.edu or the AFS Technical Department (techni calassistant@afsinc.org).

Air Sampling Method for OSHA Silica Compliance

Coordinators: Robert Scholz, TRC Environmental and AFS EHS Committee

OSHA's new worker exposure standard for respirable, crystalline silica requires that foundries limit exposure during work shifts to about one-half the concentration level of the previous Permissible Exposure Limit (PEL). Meeting this strict standard will necessitate that foundries refine their ability to identify and address root causes of exposure. Unfortunately, the method of averaging silica exposure over the work shift does not provide a basis for pinpointing those activities that have the greatest impact on overall average exposure levels. Real-time monitoring of silica concentrations could provide the needed diagnostic capability. However, this method is only in the developmental stage at this time. Instruments are commercially available to measure the concentration of silica-bearing respirable particulate matter (RPM). If real-time RPM measurements can be correlated with its silica content in a foundry situation, the needed capability for diagnosing the root causes of exposure could be made available to foundries. The goal of the project emanating from this proposal is to develop a procedure for providing the needed correlation in a wide variety of foundry process operations.

The work is being monitored by AFS Health and Safety Committee. For more information, contact the PI Robert Scholz at racholz@trcsolutions.com or the AFS Technical Department (technicalassistant@afsinc.org).

Quantify Casting Quality Through Filling Conditions

Coordinators: Dan Hoefert, Eck Industries and AFS Aluminum and Light Metals Committee

Today, predicting the actual filling damage that oxides may cause to a casting remains largely based on theory, experience and speculation. In the past decade, great strides have been made in simulation capabilities. Heat transfer data and computational fluid flow have been combined to do a wonderful job of predicting porosity and mechanical properties. Filling concerns such as excessive filling velocity, eddies and other turbulent conditions can also be noted with simulation software. However, simulation software does not take the chemical reaction of oxide formation into account. Filling results only offer an indirect indication of the potential oxide damage, with no effect to the predicted porosity or mechanical results. As such, serious pitfalls can exist when it comes to interpreting simulation results.

Without correlating filling concerns related to oxide damage, misleading simulation results can be predicted. If a gating design includes well-placed feeders and chills, but includes turbulent filling conditions, simulation can falsely predict excellent soundness and mechanical properties, despite the filling damage noted indirectly by viewing the filling results. As foundries look for competitive ways to tool and fill castings, this confusion can tempt a foundry to choose a more turbulent-fill gating design if the simulation results predict quality advantages over a more tranquil-fill gating design. This project is intended to help answer these difficult questions with meaningful data that can be used to quantify these concerns.

The project is being monitored by AFS Aluminum & Light Metals Division. Those wishing more information about the project can contact the PI Dan Hoefert at Dan.Hoefert@eckindustries.com or the AFS Technical Department (technicalassistant@afsinc.org).

Evaluation of Alternative Aggregates for Use in Green Sand Systems

Coordinators: Jerry Thiel, University of Northern Iowa

The lower cost of silica sand and its relatively high refractoriness make it a viable and economical choice for green sand systems, with millions of tons of silica sand used every year. However, a new rule by Occupational Safety and Health Administration (OSHA) considerably toughens the use of silica sand in a foundry. The regulation will require foundries to implement extensive engineering controls, which will be cost prohibitive for small- to medium-sized metalcasting facilities. One possible solution for foundries will be to utilize a non-silica aggregate in their green sand systems. This will minimize or eliminate the respirable crystalline silica, in addition to the large capital cost associated with engineering controls mandated in the new regulations. Little research has been conducted in the use of alternate non-silica aggregates in a green sand system, and these materials need to be characterized and tested for ensuring good results when bonded with a bentonite clay.

It is the intent of the project to determine what limitations non-silica aggregates have in the replacement of silica sand and then to educate the industry in these areas. The work is being monitored by AFS Technical Department. Anyone interested in more information about the project can contact the PI Jerry Thiel at thiel@uni.edu or the AFS Technical Department (technicalassistant@afsinc.org).

Alternative Granular Media for Green Sand Casting

Coordinators: Dr. Sam Ramrattan, Western Michigan University

The new Occupational Safety and Health Administration (OSHA) regulations limiting exposure to respirable crystalline silica have renewed interest in alternatives to silica sand which can withstand the heat of metalcasting and the rigors of repetitive reuse. Foundries have used alternative materials for decades. Chromite, zircon, olivine and carbon sands have each been successfully used to solve operating problems and thus have developed their specific niches in the foundry materials inventory. However, there are several other materials that are candidates for replacing silica sand, such as fused alumina, sintered bauxite and ceramic sands. Compositions and shapes could be readily tailored for a metalcasting process with overall recycling (reclamation) affording sustainable materials management.

This study examines materials that are readily available as alternatives to silica sand from a functionality perspective and evaluate their effectiveness for green sand casting.

Status Update: The work is being monitored by AFS Technical Department. Anyone interested in more information can contact the PI Dr. Sam Ramrattan at sam.ramrattan@wmich.edu or AFS Technical Department (technicalassistant@afsinc.org).

Metalcasting Industry Funded & Monitored Research

American Metalcasting Consortium/ Defense Logistics Agency Funded Projects

Innovative Casting Technology (ICT) Program

AFS, as part of the AMC, has secured a contract funded through the US Department of Defense, Defense Logistics Agency, Defense Supply Center Philadelphia and the Defense Logistics Agency (DLA), Ft. Belvoir, VA. The group of projects is under an AMC program entitled Innovative Casting Technology. The new project is an enhancement of previous AMC efforts and is called Casting Alloy Data Search (CADS).

Casting Alloy Data Search (CADS)

AFS through AMC/DLA has developed a very effective web-based tool called Casting Alloy Data Search (CADS) for the design engineers and ICME professionals, which has been used for over five years by the foundry industry and accessible through their Web site. CADS needs to further expand to accommodate more ICME relevant data generation for optimization and more accurate predictions, such as thermo-physical and thermo-mechanical properties required for process simulation, beyond casting alloys, for example, molding materials. The goal of this research project is to enhance the current CADS and create an additional module of CADS for the nonmetallics, such as molding and core materials being used in the sand casting process and populate by generating and validating data useful to the ICME professionals.

CADS is developed in partnership with Product Development & Analysis (PDA).

Castings Solutions for Readiness (CSR) Program

AFS, as part of its efforts in the American Metalcasting Consortium (AMC), has secured contracts funded through the US Department of Defense, Defense Logistics Agency, Defense Supply Center Philadelphia and the Defense Logistics Agency (DLA), Ft. Belvoir, VA. The group of projects is under an AMC program entitled Castings Solutions for Readiness (CSR). The two AFS projects are enhancements of previous AFS AMC efforts. One project is called Cast High-Integrity Alloy Mechanical Property Standards (CHAMPS), and the other project is called Casting Standards and Specifications.

CHAMPS Project—Additional Alloy Design Data

The goal of the CHAMPS Statistical Properties Project is incorporation of material property design data into the Metallic Materials Properties Development and Standardization (MMPDS) handbook, which replaced Mil-Handbook 5, so that this material can be specified and used to design and manufacture flight critical components in military and civilian aircraft. In this project, a consortium of qualified foundries produced investment cast test specimens, AFS coordinated the mechanical testing and submitted the data for statistical analysis and approval by MMPDS. The benefit to DLA is that the development of statistical-based property data will permit the use of castings across a broader range of applications. Component designers and engineers at the DLA will be able to make casting conversion decisions with assurance using validated statistical data on tensile, compressive, shear and bearing properties from the FAA recognized source, MMPDS Handbook. The outcome of the MMPDS project will be cast A&B design property allowables (highest confidence level) for the tested alloys to allow aerospace design engineers to specify castings without using design safety factors.

AFS worked with its own Investment Casting Technical Committee (4L) and the Investment Casting Institute (ICI) technical committee to develop the MMPDS properties for 17-4 and 15-5 PH investment cast steel. Working groups created melt practices, test casting gating and rigging, investing practices, heat treatment parameters and testing protocol. A special casting test plate was designed for extracting test specimens and also attached as-cast coupons. These plates were cast and then tested for the various MMPDS properties, including tensile properties. Microstructural evaluations were also performed. The attached test coupons were also tested for fatigue properties. Testing is now completed, and the results have been submitted to MMPDS for inclusion into their database. For more information, contact Steve Robison, AFS Sr. Technical Director, 847/824-0181 × 227 or stever@afsinc.org.

Casting Standards and Specifications

Accessing state-of-the-market technical, specification and training materials for castings is challenging. AFS is working to provide current and qualified information in a network friendly form to users of castings via the Casting Standards and Specifications project. The effort includes both archival and recent technical information in searchable databases. Specifications and standards are summarized, and the user is guided in their application. Tutorials covering the fundamental design concerns are also presented. The development of an online material design property database will greatly enhance the ability for the next generation of component designer to create the lightest weight and most efficient parts quicker and at lower cost. These tools facilitate more effective and efficient procurement to both DoD and industry in the support of weapon systems. Along with data from various AFS research projects, AFS has also incorporated the USAMP Light Metals Materials Database properties and strain life fatigue data for CGI Grade 400 and a high-alloy Class 40 Gray Iron into the AFS Casting Alloy Data Search (CADS) onto the AFS design Web site. This is an outstanding resource for those needing validated mechanical properties that design engineers need to make the most efficient components. The work planned under the current CADS project has recently been completed. The following alloys have been added to the database: Class 25E Gray Iron; Ductile Iron EN-GJS500-07 (lower hardness version of 80-55-06) for 1 and 3 inch section thickness; HiSiMo Ductile Iron; 1 and 2 inch section Aluminum E357, with specimens coming from the previously completed CHAMPS E357 project; an aluminum Al4Si with samples produced in both sand and permanent mold for 535 and sand mold for A206; (3) cast steel grades (WCB, 4330 and 8630) with material secured from various sources; and Solution Strengthened Ferritic (SSF) Ductile Iron (500 grade). The latest project includes a database of sand properties for sand molds. For more information, contact Steve Robison, AFS Sr. Technical Director, 847/824-0181 × 227 or stever@afsinc.org.

Manufacturing USA: National Network for Manufacturing Innovation

Manufacturing USA

The National Network for Manufacturing Innovation has a public name: *Manufacturing USA*. A total of fourteen manufacturing innovation institutes have been established with AFS involvement with four. These manufacturing institutes are public–private partnerships that each has distinct technology focus areas but works toward a common goal to secure the future of manufacturing in the USA through innovation, education and collaboration. Through *Manufacturing USA*, industry, academia and government partners are leveraging existing resources, collaborating and co-investing to nurture manufacturing innovation and accelerate commercialization. Each institute is designed to be a public–private organization that provides vision, leadership and resources to its members.

America Makes—National Additive Manufacturing Innovation Institute

America Makes is the National Additive Manufacturing Innovation Institute. As the national accelerator for additive manufacturing (AM) and 3D printing (3DP), America Makes is the nation's leading and collaborative partner in AM and 3DP technology research, discovery, creation and innovation. Structured as a public–private partnership with member organizations from industry, academia, government, non-government agencies and workforce and economic development resources, its mission is to innovate and accelerate AM and 3DP to increase our nation's global manufacturing competitiveness. AFS is partnering with Youngstown Business Incubator (YBI) who has been named a recipient of funds from America Makes for the research project "Accelerated Adoption of AM Technology in the American Foundry Industry." Along with YBI, Youngstown State University (YSU), ExOne, Humtown Products and the University of Northern Iowa (UNI), the project team for "Accelerated Adoption of AM Technology in the American Foundry Industry" will support the transition of binder jet AM to the small business casting industry by allowing increased access to the use of binder jet equipment and the development of design guidelines and process specifications.

The first AFS ad hoc division on Additive Manufacturing has just gained approval to operate as its own division. The Additive Manufacturing division has three committees: 3D Sand Printing, 3D Hard Tooling and 3D Investment Cast Tooling.

The second AFS Additive Manufacturing for Metalcasting conference is scheduled for September 10–13, 2018, in Louisville, KY.

Lightweight Innovations for Tomorrow—LIFT

The Lightweight and Modern Metals Manufacturing Innovation—LM3I—has been renamed LIFT (Lightweight Innovations for Tomorrow) and is headquartered in downtown Detroit. LIFT is led by Ohio-based EWI (Edison Welding Institute), a company that develops and applies manufacturing technology innovation within the manufacturing industry. AFS is part of a 60-member consortium that will pair leading aluminum, titanium and high-strength steel manufacturers with

universities and laboratories pioneering new technology development and research. "The long-term goal of the LIFT LM3I Institute will be to expand the market for and create new consumers of products and systems that utilize new, lightweight, high performing metals and alloys by removing technological barriers to their manufacture," the White House said. The Institute will seek to achieve this through leadership in pre-competitive advanced research and partnerships across defense, aerospace, automotive, energy and consumer products industries. The White House noted that lightweight and modern metals are utilized in a vast array of commercial products, from automobiles, to machinery and equipment, to marine craft and aircraft. "These ultra-light and ultra-strong materials improve the performance, enhance the safety, and boost the energy and fuel efficiency of vehicles and machines," the White House said. The Institute will advance the state of processing and fabrication technologies for lightweight and modern metals by facilitating the transition between basic/early research and full-scale production of associated materials, components and systems. AFS will champion the role of the metalcasting industry as a key metals manufacturing sector in this effort, with two initial projects being started in the casting area, one on thin-walled ferrous and the other on thin-walled nonferrous castings. The thin-walled ferrous project is near completion.

Digital Manufacturing and Design Innovation—DMDI

The idea behind the Institute is that manufacturing is being transformed by digital design, which replaces the draftsman's table with the capacity to work and create in a virtual environment. AFS feels the establishment of a Digital Manufacturing and Design Innovation (DMDI) Institute will increase the successful transition of digital manufacturing and innovative design technologies through advanced manufacturing, create an adaptive workforce capable of meeting industry needs, further increasing domestic competitiveness, and meet participating defense and civilian agency requirements. This project will benefit the US manufacturing industry by providing resource, focal point and network for resolving technical barriers currently limiting the application and integration of digital manufacturing and innovative design technologies. As it relates to the metalcasting industry, the use of these technologies will assist in the more rapid development and production of lighter weight metalcast components for military, energy, transportation and commercial applications. This can allow for design innovation via part consolidation and near net shape capabilities of metalcasting, the weight reduction potential of such materials as magnesium, aluminum, titanium and next generation ferrous metals, and the improved quality and productivity of advanced casting processes, this unique program can make significant strides toward production of high-integrity, complex cast components and advance our manufacturing base. The Institute will also be a resource for training our workforce from manual labor to more highly skilled and technical jobs.

Clean Energy Smart Manufacturing Innovation Institute (CESMII)

The Smart Manufacturing Leadership Coalition (SMLC) has been selected to lead the new Clean Energy Smart Manufacturing Innovation Institute (CESMII) in partnership with the Department of Energy. The winning coalition, headquartered in Los Angeles, California, brings together a consortium of nearly 200 partners (one of which is AFS) from across academia, industry and nonprofits. The emphasis will be on smart sensors and digital process controls to improve efficiencies in US advanced manufacturing processes. On February 22–23, 2017, SMLC launched, in partnership with DOE, Clean Energy Smart Manufacturing Innovation Institute (CESMII). CESMII is a national network of Regional Manufacturing Centers (RMCs) each focused on local relationships with opportunities for national impact in the areas of technology transfer and workforce development. The power of the network is cross-linking resources, capabilities and expertise across business, workforce and technical focus areas, leveraging each region's unique industrial environments. The regions include the California, Gulf coast, Southeast, Northeast, Midwest and Northwest.

AFS Information Services

Casting Process and Alloy Assistance

The AFS Web site offers assistance for casting design engineers in selecting the best casting process for a potential component and also provides casting alloy property data on many commonly used alloys. The Web site provides casting users, design engineers and purchasers with relevant and accurate information on casting capabilities and properties, providing easily accessible and retrievable information from a single site. The alloy data can be quickly exported to a spreadsheet or FEA tools. The Casting Alloy & Process Selector and the Casting Alloy Data Search are located on the AFS Web site, http://www.afsinc.org/, under the "Casting Buyer" tab. For more information, contact Steve Robison, AFS Sr. Technical Director, 847/824-0181 × 227 or stever@afsinc.org.

Casting Facility Directory

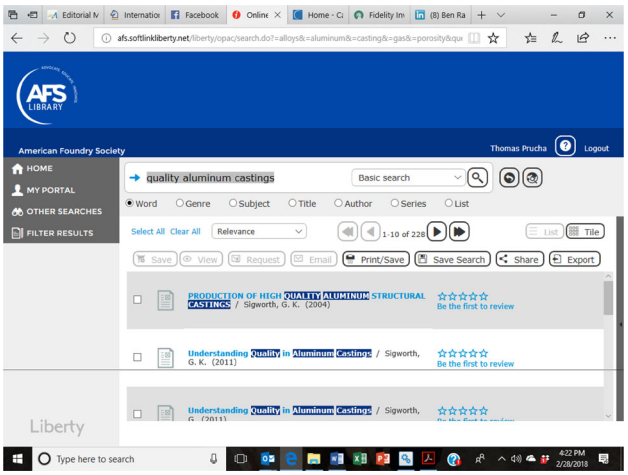
The AFS Directory of Metalcasters is also available to the public on the AFS Web site. The site provides a directory of North American metalcasters in a single source. Potential casting

buyers can search by metal, alloy, casting process, casting size (weight) and US state to locate a casting provider that meets their needs. The Metalcasters Directory is located on the AFS Web site under the "Resource Tools" menu or can be accessed directly at, http://www.afsinc.org/metalcasterdirectory/index.cfm. For more information, contact Steve Robison, AFS Sr. Technical Director, 847/824-0181 × 227 or stever@afsinc.org.

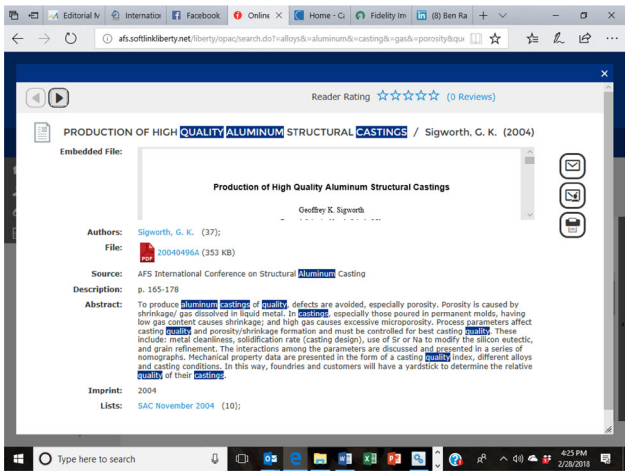
CastingConnection

CastingConnection is an online private social professional network environment to connect, engage and share critical industry information and best practices in real time. Through the Open Forum and sites devoted for our special interest groups, members can gather to network via a comprehensive member directory, participate in focused discussion groups and access and share useful and informative documents and media in all formats. Visit https://castingconnection.afsinc.org.

Library



The AFS new online library database serves the needs of the metalcasting industry for current and historic metalcasting information. AFS is continuing to electronically archive the full *AFS Transactions* series using nondestructive scanning technologies. The project is nearing completion, with many *AFS Transactions* fully electronically archived and web searchable, from the very first edition (published in 1896) to the present. Located at www.afslibrary.com, the Web site houses a large collection of metalcasting reference material. For more information, contact AFS technical assistant, 847/824-0181 × 246, technicalassistant@afsinc.org.



AFS has launched a new program that offers industry-specific training, information and education for metalcasters in a web-based format for a single access fee. The e-learning program will give subscribing organizations full access to online modules for formal staff training on a wide variety of metalcasting topics. Individual e-learning modules also are available a la carte. More information and a video demonstration are available at www.afsinc.org/elearning.

AFS Technology Transfer

122nd AFS Metalcasting Congress

More than 2000 metalcasting professionals and casting buyers are expected to attend the AFS 122nd Metalcasting Congress, scheduled for April 3–5, 2018 at the Fort Worth TX convention center. The event will feature more than 200 exhibits, keynote presentations, technical presentations and AFS Institute courses. The education sessions will provide casting personnel opportunities for personal and professional development through three days of practical advice, the latest technology advancements, new process and material developments and foundry case studies. Education sessions will cover cast metals and processes, as well business- and management-related issues. The AFS Hub will be a dedicated area on the show floor for connecting with AFS staff and other attendees. The HUB features the AFS Bookstore, The AFS Institute and Member Services, Industry Media Resources, a Makerspace and the Casting of the Year Display. For more information on Congress, contact Metalcasting Congress coordinator Pam Lassila at 847-824-0181 × 240, or plassila@afsinc.org.

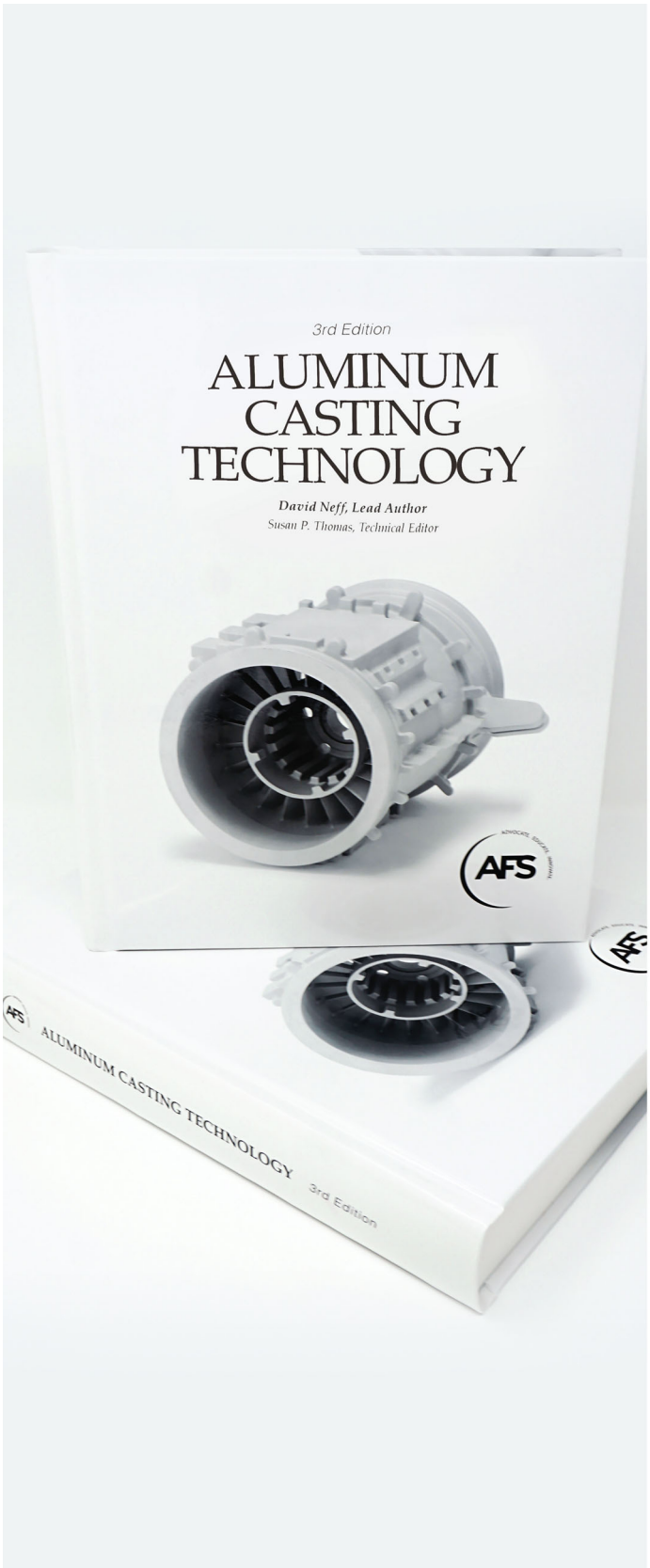
Conferences and Workshops

AFS is hosting a series of webinars to help foundries move toward compliance with the upcoming new regulations on respirable silica exposure. The webinars will cover many issues relating to compliance with the new standard, including alternate non-silica molding media, silica testing, medical testing and other issues. AFS has also scheduled monthly "members-only" webinars covering a wide range of technical

issues. For more information, contact the AFS technical assistant, 847/824-0181 x246, technicalassistant@afsinc.org, or visit the AFS Web site.

AFS is offered an extended program of educational opportunities covering all aspects of metalcasting including aluminum casting, iron casting, EHS issues, additive manufacturing, government issues and marketing. These educational events are scheduled to provide relevant and practical information to improve productivity and profitability for metalcasting facilities. The list below shows the complete schedule for AFS technical and management education events and listing of upcoming AFS events. For more information, contact the AFS technical assistant, 847/824-0181 × 246, technicalassistant@afsinc.org, or Sr. Technical Director Steve Robison at 800-537-4237 × 227, stever@afsinc.org.

- May 1–2, 2018; **AFS Cupola Workshop,** Waupaca, WI
- May 8–9, 2018; **AFS Stormwater Seminar**, Columbus, OH
- May 15–16, 2018; **AFS Government Affairs Fly-In**, Washington, DC
- August 20–21, 2018; **AFS Cast Iron Inoculation Conference,** Louisville, KY
- September 10–13, 2018; **AFS Additive Manufacturing for Metalcasting**, Louisville, KY
- September 16–18, 2018; **AFS Foundry Leadership Conference**, Amelia Island, FL
- October 7–8, 2018; **AFS Advanced Air Seminar**, Warrensville Heights, OH
- October 9–11, 2018; **AFS 30th EHS Conference**, Warrensville Heights, OH
- October 10, 2018; **Advanced Cupola Concepts Seminar,** Coshocton, OH
- November 5–7, 2018; **AFS 2018 Aluminum Casting Conference**, Knoxville, TN
- December 11–12, 2018; **AFS Marketing Conference**, Rosemont, IL



ALUMINUM CASTING TECHNOLOGY

3rd Edition

Lead Author: David Neff
Technical Editor: Susan P. Thomas

We are excited about this third edition of **Aluminum Casting Technology.** It brings together and expands the time-honored information on casting **aluminum alloys, their properties, and best practices,** as well as groundbreaking **new developments** from the last 25 years. **Color images** are used to illustrate and illuminate each chapter.

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