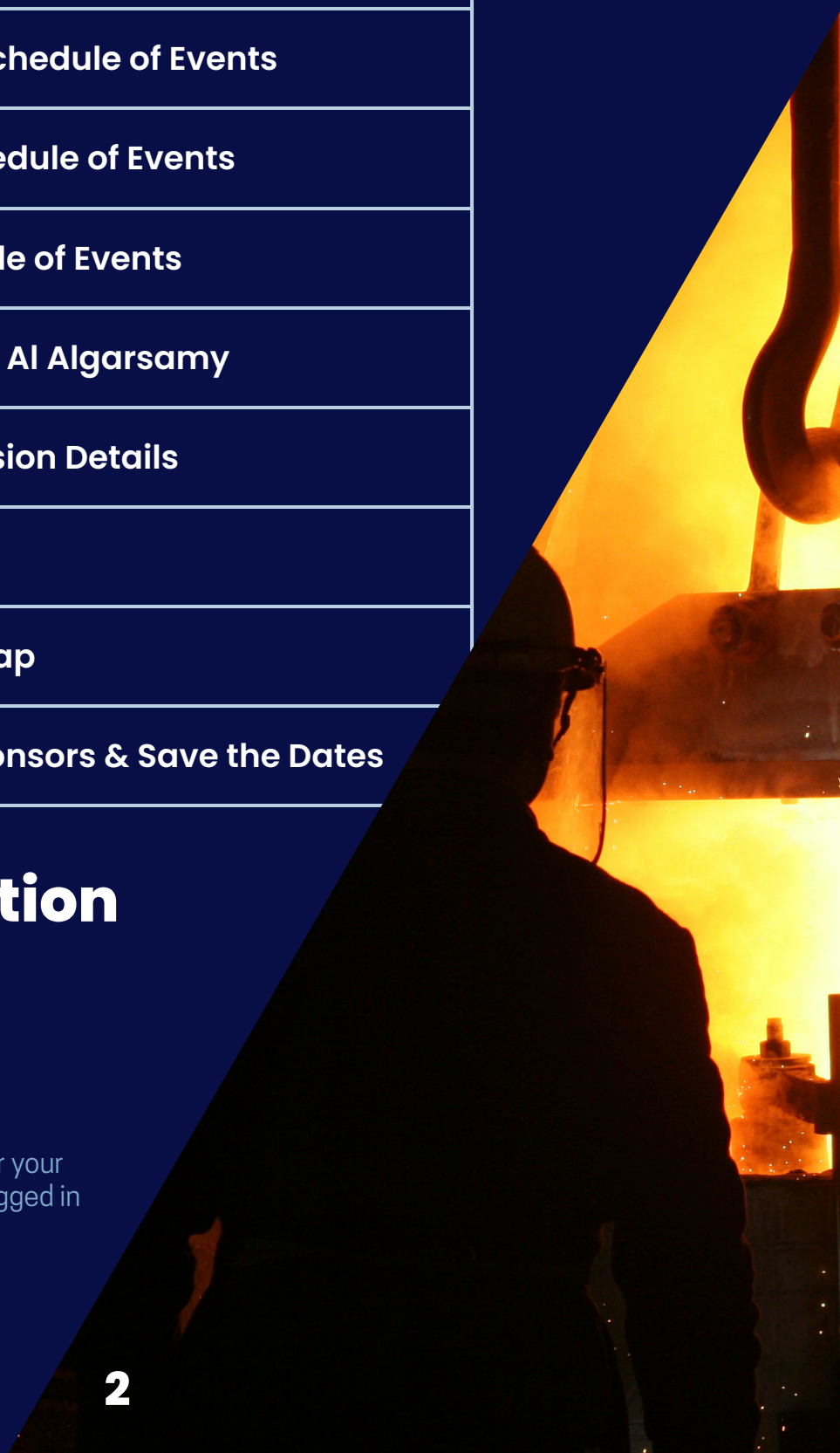
2023 7TH KEITH MILLIS SYMPOSIUM

OCTOBER 17TH - 20TH

Thank you for joining the Ductile Iron Society and your industry peers for excellent technical sessions and networking opportunities.

THE HILTON
CROWNE PLAZA ATLANTA
PERIMETER AT RAVINIA

TABLE OF CONTENTS



Wi-Fi Information

Wi-Fi Name

IHG ONE REWARDS

Instructions

For guests staying at the hotel, enter your room information and you will stay logged in for the duration of your stay.

For guests not staying at the hotel, enter the access code: **801584**.

TUESDAY 10/17
SCHEDULE OF EVENTS

9:00 AM - 12:00 PM	Research Committee Meeting Maplewood Room
1:00 PM - 2:30 PM	Marketing Committee Meeting Maplewood Room
1:00 PM - 2:30 PM	Membership Committee Meeting Azalea B Room
1:00 PM - 2:30 PM	Program & Publications Committee Meeting Camellia Room
1:00 PM - 2:30 PM	University Relations Committee Meeting Azalea A Room
3:00 PM - 5:00 PM	Metal Casting Forum Maplewood Room
6:00 PM	Cocktail Hour Camellia Room

WEDNESDAY 10/18
SCHEDULE OF EVENTS

Technical sessions will be held in the Dunwoody Suite.

7:00 AM	Registration Opens
8:00 AM	General Sessions Begin
8:00 AM	Welcome Eric Nelson, DIS President, Eric Nelson Consulting, LLC
8:10 AM	Keynote Address-Industry: “Thoughts & Insight on Ductile Iron and CGI for Ground Transportation Applications” Andrew Halonen, Mayflower Consulting, LLC
8:50 AM	Development of an Austempered Ductile Iron Unimog 3 Point Linkage Power Lift Arm Arron Rimmer, ADI Treatments Ltd, West Bromwich, West Midlands U.K.
9:30 AM	Advances and Considerations in the Prediction of Abnormal Graphite Formation in Ductile Iron Konstantin Nikolov, Magma
10:10 AM	Break

10:25 AM	Graphite Spheroids: The Place Where They Are Born Ramón Suárez, Azterlan
11:10 AM	Graphite Spheroids: The Way they Grow Doru Stefanescu, The University of Alabama and The Ohio State University
12:00 PM	Lunch & Trivia
1:15 PM	The Effects of MgFeSi and Inoculant Selection on Microstructure and Mechanical Properties of Varying Section Size Ductile Iron Castings Trevor Beach, Betz Industries
1:55 PM	Interaction Between Boron and Pearlite Stabilizers in Spheroidal Graphite Irons Leander Michels, Elkem Silicon Products
2:30 PM	The Role of Mn, Cu and Sn in Spheroidal Graphite Irons: Pearlite Formation Mechanism Andreas Bugten, Norwegian University of Science and Technology (NTNU)
3:00 PM	Break
3:20 PM	Effects of Titanium and Cerium Addition on Grain Size and Mechanical Properties of Ductile Iron Castings Jingjing Qing, Georgia Southern University

4:00 PM	AI/ML Driven Metamodels for the Ductile Iron Foundry Process Engineers in an Industry 4.0 Environment Jiten Shah, Product Development & Analysis (PDA) LLC
4:45 PM	Adjourn
6:00 PM	Cocktail Hour La Grotta Restaurant (Lower Level)

THURSDAY 10/19 SCHEDULE OF EVENTS

Technical sessions will be held in the Dunwoody Suite.

7:00 AM	Registration Opens
8:00 AM	General Sessions Begin
8:00 AM	Keynote Address-Academia: “How to build a Metalcasting Program from the Ground-up, Georgia Southern University Story” Mingzhi Xu, Georgia Southern University
8:30 AM	Improvement of High Temperature Performance of High Si SGI by Al Alloying and Optimizing Micro-Structural Dispersity Simon N. Lekakh, Missouri University of Science and Technology

9:10 AM	Comparison of Ba and Ca Additions on the Thermochemical Properties of Ductile Iron Slags, and Effects on MgFeSi Treatment Efficiency and Final Microstructure **Cathrine Hartung, Elkem Silicon Products**
9:50 AM	Break
10:05 AM	Impact of Quenching and Aluminium On B2 Superstructure Formation In Solid Solution Strengthened Ferritic Ductile Cast Iron Betto David Joseph, Foundry Institute, RWTH Aachen University
10:45 AM	Primary Austenite Morphology and Tensile Strength in CGI for Different C Contents, Cooling Conditions and Nodularity Vasilios Fourlakidis, Department of Materials and Manufacturing - Jönköping University
11:25 AM	Dendritic Austenite in Compacted and Spheroidal Graphite Iron Björn Domeij, Department of Materials and Manufacturing - Jönköping University
12:05 PM	Lunch
1:15 PM	CGI Global Update **Steve Dawson, SinterCast**

1:45 PM	Thermal Analysis of Ductile Iron - A New Way to Predict the Mechanical Properties Johannes Schüssler, RWTH Aachen University
2:25 PM	How Well Controlled is Your Foundry Process? Rebecca Ward, Impact NDT, LLC
3:00 PM	Break
3:20 PM	XRD-Analysis of the Correlation of Stacking Fault Formation and the TRIP-effect in ADI Felix Stieler, TU Clausthal
4:00 PM	Prediction of Cross-Section-Dependent ADI Microstructures by Experimental Heat Treatment Simulation Patrick Lachart, TU Clausthal
4:45 PM	General Session Adjourns
6:30 PM	Cocktail Hour Dunwoody Suite
7:30 PM	Dinner Banquet Dunwoody Suite

FRIDAY 10/20
SCHEDULE OF EVENTS

Technical sessions will be held in the Dunwoody Suite.

8:00 AM	General Session Begins
8:00 AM	Inoculation effects on Mass Effect in Ferritic Spheroidal Graphite Iron Castings with Heavy Section Satoshi Yamamoto, Daiwa Heavy Industry Co., Ltd, Hiroshima, Japan
8:40 AM	Shrinkage Investigation of Ductile Iron Castings Anhua Yu, Ward Manufacturing LLC
9:20 AM	Break
9:40 AM	Ductile Iron Fade Sampling Campaign James Cree, Grede-New Castle
10:20 AM	Molten and Semi-Solid Gravity Die Casting in Ductile Iron Castings Haruki Itofuji, I2C Technology Institute
11:00AM	High Modulus Ductile Iron Alloy Design and Characterization (Tentative) Shane Anderson, Materials Technology
11:40 AM	Symposium Adjourns

Remembering Al Algarsamy

May 15, 1941 - August 23, 2023

The Ductile Iron Society was sad to hear of the passing of Al Algarsamy. Our sincere condolences go out to his family and friends.

Al Alagarsamy was a legend of the DIS. Al, Prem Mohla, and PH Mani were known to sit attentively during presentations and bring their questions as soon as the floor was open. Their challenge was based on curiosity and helping to create a greater understanding for the larger group on whatever the subject might be. Al was a teacher and coach and took those skills to many DIS member foundries following his retirement. Al had an amazing breadth of foundry knowledge and could effectively impart that knowledge regardless of the receiver's background.

- DIS President, Eric Nelson

TECHNICAL SESSION DETAILS

Keynote Address-Industry: "Thoughts & Insight on Ductile Iron and CGI for Ground Transportation Applications"

Andrew Halonen, Mayflower Consulting, LLC | 10/18 8:10 AM

A look at commercial truck and light duty automotive, in both electric and IC engine powertrains including applications of CGI and ductile iron with emphasis on innovations and new opportunities. A spotlight of ductile iron in suspensions & brakes. In addition, this presentation provides inspiration and insight on how to improve foundry competitiveness for future generations via AI, promotion, and connecting with our youth.

Development of an Austempered Ductile Iron Unimog 3 Point Linkage Power Lift Arm

Arron Rimmer, ADI Treatments Ltd, West Bromwich, West Midlands U.K. | 10/18 8:50 AM

This presentation summarizes the investigation of the conversion of an 11-piece steel fabrication to an ADI casting. It was a collaborative effort involving the component manufacturer, foundry, machinist, local university, and an ADI heat treater. A number of design concepts were developed, with the final, significantly stronger, ADI design being compared to the fabrication using FEA analysis. The resulting conversion, at similar weight and cost, eliminated the failures that were experienced in the fabricated components in addition to reducing the production lead-time.

Advances and Considerations in the Prediction of Abnormal Graphite Formation in Ductile Iron

Konstantin Nikolov, Magma | 10/18 9:30 AM

Graphite degeneration in the form of abnormal formations such as chunky graphite and graphite flotation may appear in some castings. Influencing factors such as, melt composition and foundry process, can have adverse effect on mechanical properties. Utilizing virtual DOE we can test these inputs, analyze the impacts, and use the resulting data to steer the course of our decision-making power.

Graphite Spheroids: The Place Where They Are Born

Ramón Suárez, Azterlan | 10/18 10:25 AM

In the same way that a building needs a solid foundation to remain firm and stable, graphite requires proper nucleation sites to precipitate and grow in the right way. Phenomena that occur during the solidification process will determine the nature of the nuclei (non-metallic inclusions), as the topology of the land will establish the quality of a construction. Their presence will define the nucleation potential of the melt, being highly influenced by a multitude of variables such as the base metal composition, the graphite spheroidization treatment, or the inoculation process. A good knowledge of the formation of these particles will help provide control of the formation of graphite. Silicates, oxides, sulfides, carbides and nitrides were found acting as nuclei for graphite depending on the solidification conditions.

Graphite Spheroids: The Way they Grow

Doru Stefanescu, The University of Alabama & The Ohio State University | 10/18 11:10 AM

Graphite spheroids are one of the most intriguing forms of aggregation of graphite. They can be found as natural graphite in meteorites and volcanic rocks (metamorphic graphite caused by exposure to heat and pressure in the earth's crust), and in man-made materials such as steel and cast iron, but also in pyrolytic graphite, in carbon nanosheets obtained through vapor deposition, and others. While growth of graphite has been studied in depth during the last decades, the understanding of its physics continues to evolve as modern investigating equipment pushes the knowledge horizon. The complexities of the solidification of cast iron and its dependency on undercooling, a function of the cooling rate and of the nucleation potential, are discussed in conjunction with the asymmetric eutectic coupled zone. A sequential chart summarizes the various stages of graphite aggregation, as the graphite begins growing in contact with the nucleus at the beginning of solidification till it reaches its final crystallography at room temperature. It sets the basis for an in-depth analysis of the multi-mechanisms involved in the growth of graphite in cast iron during solidification and the subsequent solid-state transformation, with emphasis on compacted and spheroidal graphite. It discusses the significance of turbostratic graphite that appears mostly, but not only, at the nucleus/graphite interface and in the initial stages of graphitization, as revealed by recent electron microscopy studies.

The Effects of MgFeSi and Inoculant Selection on Microstructure and Mechanical Properties of Varying Section Size Ductile Iron Castings

Trevor Beach, Betz Industries | 10/18 1:15 PM

A presentation of the results of testing combinations of 3 MgFeSi alloys with 4 inoculant alloys. The goal was to determine if the mechanical properties could be improved in heavy section ductile iron. Samples from separately cast test bars up to the center of a 10 inch section were analyzed. The resulting microstructures were also reviewed to determine potential factors contributing to the variation in mechanical properties.

Interaction Between Boron and Pearlite Stabilizers in Spheroidal Graphite Irons

Leander Michels, Elkem Silicon Products | 10/18 1:55 PM

Boron (B) is used to increase the hardenability of steels. Therefore, steels containing B have commonly been used for hot stamping of automobile parts since the 1980s. Steel scrap is often added to the metal charge of cast iron to reduce the carbon footprint and lower the costs of the material. However, trace levels of B are reported to have detrimental effects on the microstructure of ductile iron. These detrimental effects include the promotion of carbides, and the promotion of ferrite in pearlitic ducitle iron. Ductile iron with a fully pearlitic matrix is preferred for applications that require high strength and good wear resistance. The most frequently employed pearlite-promoting elements in SGI are manganese (Mn), copper (Cu), and tin (Sn). In this presentation we investigate the effect of B in the microstructure of ductile iron when added together with the pearlite promoters, Mn, Cu and Sn.

The Role of Mn, Cu and Sn in Spheroidal Graphite Irons: Pearlite Formation Mechanism

Andreas Bugten, Norwegian University of Science and Technology (NTNU) | 10/18 2:30 PM

Most spheroidal graphite irons (SGI) have a matrix consisting of ferrite, pearlite, or a mix of the two. To achieve the desired matrix composition, pearlite promoters such as Mn, Cu, or Sn, are added to the molten metal. Among these elements Sn is the most potent pearlite promoter. However, each has a different impact on the solidification, graphite precipitation, eutectoid transformation and ultimately the final structure of the material. Research has shown that B promotes ferrite in fully pearlitic grades where Cu and Mn were used to promote pearlite. The present work investigates the effect of B in SGI with additions of Sn, Cu and Mn, and the effects of varying amounts of the different pearlite promoters on the matrix composition.

Effects of Titanium and Cerium Addition on Grain Size and Mechanical Properties of Ductile Iron Castings

Jingjing Qing, Georgia Southern University | 10/18 3:20 PM

Fineness of microstructural constituents in the metallic alloys affect their mechanical properties. This study sought to determine the effects of selected levels of titanium, cerium and aluminum on the fineness of microstructural constituents within ductile iron. A hypoeutectic iron was studied. Cerium additions in the amounts of 0.01 wt.% and 0.03 wt.%, titanium additions in the amounts of 0.02 wt.% and 0.04 wt.%, and aluminum addition at the amount of 0.02 wt.% were tested. The influences of the selected additions were determined using three methods: direct secondary dendrite arm spacing (SADS) measurement, liquidus recalescence analysis, and tensile testing. The results of the study showed that at above a critical value, cerium refined the SADS effectively within a distance of 22 mm from the casting bottom surface, whereas for the locations with slower cooling rates, Ce did not refine microstructure and impaired elongation. Titanium had an adverse effect on refining the microstructure when Al containing inoculant was used. Addition of Al was found effective at achieving a refined microstructure and improved mechanical properties. The inclusion composition and number density change as a result of alloy additions were measured.

AI/ML Driven Metamodels for the Ductile Iron Foundry Process Engineers in an Industry 4.0 Environment

Jiten Shah, Product Development & Analysis (PDA) LLC | 10/18 4:00 PM

Design and manufacturing of high performance ductile iron sand castings is a multi-variant complex process with many uncertainty involved. As a result, in spite of a well-controlled operation and an experience workforce, iron foundries in a production environment do face sporadic shrinkage and lots with nonconforming properties requirements, resulting in scrap or rework. A framework and methodology consisting of AI (Artificial Intelligence) and ML (Machine Learning) tools, coupled with ICME (Integrated Computational Materials Engineering) and process simulation tools to quantify uncertainty (UQ) will be presented. Metamodels, both predictive and prescriptive in near real time will be presented with results .

Keynote Address-Academia: "How to build an Metalcasting Program from the Ground-up, Georgia Southern University Story"

Mingzhi Xu, Georgia Southern University | 10/19 8:00 AM

The presenter and his wife joined Georgia Southern in 2018, back then there was only a small aluminum foundry at the university used for teaching, and it was in rough shape. After five years, Georgia Southern now has a vertically-integrated foundry that can design castings and alloys, melt and pour a wide range of metals, mold with different processes, perform various heat treatment, and conduct chemical/mechanical/metallographic analysis with state-of-the-art technologies. This foundry now serves over 200 students yearly and has seen research grants over $800,000. The presenter will share the story, and highlight some activities during this transformation.

Improvement of High Temperature Performance of High Si SGI by Al Alloying and Optimizing Micro-Structural Dispersity

Simon N. Lekakh, Missouri University of Science and Technology | 10/19 8:30 AM

High alloyed by Si cast iron with spherical graphite (SGI) has a unique combination of mechanical properties at room temperature and high oxidation resistance at elevated temperature. The performance of this cast material can be improved by precise alloying and by the development of a desired micro-structural dispersity, aterm is used to describe the heterogeneity of sizes of structural constituencies within the microstructure. This is done by using an effective melt inoculation in combination with an optimal cooling rate during solidification. There is consensus in metal-casting community that high micro-structural dispersity is desirable for good mechanical performance of high Si SGI at room temperature. However, it could not be a case for high temperature application. In this study, static high temperature oxidation of heavy (100 mm), medium (18 mm) and thin (5 mm) wall castings from two SGI (base, referred to as SiMo and alloyed by 3% Al (SiMoAl) were investigated. The different trends were observed in the base SiMo and alloyed SiMoAl SGI. The ways for improving high temperature performance by optimizing micro-structural dispersity were suggested based on determined trends in surface degradation.

Comparison of Ba and Ca additions on the Thermochemical Properties of Ductile Iron Slags, and Effects on MgFeSi Treatment Efficiency and Final Microstructure

Cathrine Hartung, Elkem Silicon Products | 10/19 9:10 AM

The present study investigated the effect of two common cover materials, steel, and FeSi, on the Mg-treatment efficiency and final iron quality. Both cover materials were used in a tundish treatment process in a ladle with a pocket. The FeSi cover material had a controlled level of Ba to provide inoculation support in addition to helping condition the slag in the treatment ladle. Ba-containing inoculants are often referred to as fade resistant. Thermochemical (CALPHAD) evaluation was done on the slag removed from the treatment ladle to determine if the slags generated with the two cover materials were different in behaviour due to the introduction of Ba. The inoculation was also done with a Ba-containing, and the holding time effect was evaluated.

Impact of Quenching and Aluminium On B2 Superstructure Formation In Solid Solution Strengthened Ferritic Ductile Cast Iron

Betto David Joseph, Foundry Institute, RWTH Aachen University | 10/19 10:05 AM

Solid-solution-strengthened ferritic ductile iron (SSFDI), proves to have a better ratio of tensile strength to elongation than conventional ductile iron grades. This applies up to a maximum silicon content of 4.3 wt%, beyond which it leads to an abrupt decrease in ultimate tensile strength and elongation at fracture. During solidification of high silicon ductile iron, negative segregation of silicon occurs and the highest silicon concentration is observed near the graphite nodules. This high silicon concentration leads to long range ordering of iron and silicon, and this ordering results in formation of superstructures like BCC_B2 and D03. The presence of super structures restricts the mobility of dislocations and leads to abrupt fracture of the material. This research focuses on the investigation of silicon homogenization by the addition of aluminium and heat treatments to avoid the formation of brittle iron-silicon superstructure. Thermodynamic–kinetic simulations as well as experimental investigations including, variation in alloy composition and quenching are performed. The results provide a promising understanding to control the micro-segregation of silicon in ductile cast iron based on heat treatments and alloy composition.

Primary Austenite Morphology and Tensile Strength in CGI for Different C Contents, Cooling Conditions and Nodularity

Vasilios Fourlakidis, Dept. of Materials & Manufacturing, Jönköping University | 10/19 10:45 AM

Compacted graphite iron (CGI) is a good option for the cylinder blocks and heads in heavy duty engines due to their well-balanced thermal and mechanical properties. In this work a re-melting technique has been utilized for the production of CGI with different nodularity (10 and 20%), C contents (CE=3.5, 3.8, 4.2) and under different solidification and cooling rates. The employed experimental parameters had a sizeable influence on the morphology and fraction of the inter-dendritic structure and resulted to ultimate tensile strength (UTS) that range between 335 to 456 MPa and 371 to 521 MPa for the 10 and 20% nodularity, respectively. The result shows that the UTS is linearly related to the solidification time and the microstructural parameter that express the scale length of the inter-dendritic region. Different CE and nodularity provide different relationships between UTS, solidification time and microstructure. The studied microstructural parameters can be incorporated in an empirical model for the prediction of the UTS.

Dendritic Austenite in Compacted and Spheroidal Graphite Iron

Björn Domeij, Dept. of Materials & Manufacturing, Jönköping University | 10/19 11:25 AM

During the early solidification of cast irons austenite tends to freeze dendritically. This has importance for various casting defects and the development of graphite and the eutectic. While dendrites normally merge with the eutectic austenite and transform into ferrite or pearlite, they leave noticeable traces in the final material. A measure of the dendrite microstructure structure has been shown to affect properties in gray and compacted graphite irons. This presentation reviews selected research work within this topical area.

CGI Global Update

Steve Dawson, SinterCast | 10/19 1:15 PM

With the united will of international governments, media, compliant industry and consumers, passenger cars are destined for electrification. The only question is the speed. But where are the trucks going? Full-size pick-ups are currently navigating the onset of electrification, but the initial results are mixed. Wall Street loves it; the heartland hates it. In the Super Duty sector, OEM's continue to inject billions into long term manufacturing facilities to extend the timelines on the profitable internal combustion engines that finance their electrification programmes. Even California's newest proposals include provisions for Super Duty diesels. And, with growing concerns for range, total cost of ownership and recharging time and infrastructure, long haul heavy duty trucks are beginning to contemplate alternative fuels in parallel with alternative powertrains. The debate is evolving from engines to energy. The presentation will provide an outlook for automotive powertrains in the US, Europe and Asia, and therefore, an outlook for the future demand for cast iron cylinder blocks and heads.

Thermal Analysis of Ductile Iron - A New Way to Predict the Mechanical Properties

Johannes Schüssler, RWTH Aachen University | 10/19 1:45 PM

Thermal analysis is characterized by the recording and evaluation of the temperature curve over time. Due to the correlation between transformation temperatures and chemical composition, thermal analysis is used to determine the carbon and silicon content. Furthermore, the aim is to be able to predict mechanical properties by thermal analysis. However, all current prediction methods refer to the cooling conditions in the investigated casting area and do not allow any transfer to other cooling conditions. There is a lack of a direct and automatic prediction of the mechanical properties from the thermal analysis before casting and transfer to other cooling conditions. For this study, cooling curves from the last 10 years at the Foundry Institute at RWTH Aachen University were evaluated and correlated with the mechanical properties from castings with three different thermal modules.

How Well Controlled is Your Foundry Process?

Rebecca Ward, Impact NDT, LLC | 10/19 2:25 PM

Relying on scrap rates alone to assess process control in the foundry can be deceiving. Depending on the inspection method used, it is possible to sort grossly non-conforming parts while still allowing a wide window of acceptance, masking a process that is out of control. Modern methods of Acoustic Resonant Testing (ART) allow for detailed data logging of both part weight and resonant frequency peak data. Monitoring these two factors at the lot level can give foundry members insight onto how consistent their process is both within a single date code and across multiple date codes.

XRD-Analysis of the Correlation of Stacking Fault Formation and the TRIP-effect in ADI

Felix Stieler, TU Clausthal | 10/19 3:20 PM

The mechanical properties of ausferritic ductile iron (ADI) are strongly influenced by the ability of the austenite to undergo martensite formation. Strain-induced martensite formation occurring under the right circumstances results in transformation induced plasticity (TRIP) that improves ductility and strength. TRIP has been shown to depend on the austenite's stacking fault energy (SFE), which describes the crystals micromechanical behaviour. In austenitic FeMnAlSi TRIP-steels, TRIP as a reaction to mechanical load only occurs for SFE <20 mJ/m². For carbon-stabilised austenite as in ADI, the relationship between stacking faults, mechanical properties and martensitic transformation has not yet been established. To investigate the TRIP-effect in ADI, unalloyed ADI with 3.43 wt% C, 2.52 wt% Si and 0.21 wt% Mn was ausferritised and subjected to tensile tests at temperatures between -180 °C and 200 °C. The amount of martensite produced by thermal and mechanical activation, crystalline microstrain and stacking fault density were measured on deformed and undeformed regions of the specimen by XRD and the resulting SFE calculated.

Prediction of Cross-Section-Dependent ADI Microstructures by Experimental Heat Treatment Simulation

Patrick Lachart, TU Clausthal | 10/19 4:00 PM

Heavy section [KH1] Austempered Ductile Iron (ADI) components may contain pearlitic or mixed microstructure (mixture of pearlite and ausferrite) in their centres besides ausferrite. As a result, mechanical properties are not homogeneously distributed over the thicknesses of the components. The oversizing of the components therefore leads to unnecessary material expenses in foundries. In order to avoid the complex manufacturing process of heavy section ADI components and subsequent investigations, preliminary tests were performed with smaller test samples. Here, temperature-time-curves were detected during heat treatment at different depths. Material samples of the customized composition were heat treated in a dilatometer under the same heat treatment conditions according to different sections of the cast component. A variation of the quenching rates was conducted to investigate the influence on the mixed microstructure formation and ratio of pearlitic and ausferritic microstructures. A comparison of the conventionally heat-treated and dilatometer produced microstructures proved the successful application for heavy section parts and enables microstructure predictions with small samples only.

Inoculation effects on Mass Effect in Ferritic Spheroidal Graphite Iron Castings with Heavy Section

Satoshi Yamamoto, Daiwa Heavy Industry Co., Ltd, Hiroshima, Japan | 10/20 8:00 AM

The effect of inoculants was confirmed to improve the mass effect of ferritic spheroidal graphite iron castings with heavy section. In the first series of tests, primary inoculation was performed simultaneously with the spheroidizing treatment, followed by the addition of post inoculant, and the effectiveness of this method was evaluated in the terms of nodule count and mechanical properties. In the first series of tests, six inoculants were evaluated in separately cast test samples, For the second part of the evaluation and Fe-Si-Ca-Zr and Fe-Si-Ca-Ba① were selected. In the second series of tests, these inoculants were used and evaluated by cast on test samples with the wall thickness of 40 and 70 mm. The results showed that possibly change to Fe-Si-Ca-Zr provided the greatest increase in the nodule count. Tensile properties of samples post inoculated Fe-Si-Ca-Zr showed almost the same values for tensile strength, proof stress, and elongation at 40 mm and 70 mm wall thickness. In impact tests, differences in absorbed energy were observed in samples with the wall thickness of 70 mm, with Fe-Si-Ca-Zr having the highest absorbed energy. Therefore, the Fe-Si-Ca-Zr inoculant is an effective post inoculation for reducing mass effect. Also, the factors were discussed through EPMA analysis of inoculants.

Shrinkage Investigation of Ductile Iron Casting

Anhua Yu, Ward Manufacturing LLC & Michael Whaley, Grede | 10/20 8:40 AM

It has been a challenging mission to assure Ductile Iron castings meet customer Internal Soundness specifications with acceptable process capability in the automotive industry and get approval in new model launch processes. Shrinkage conditions were investigated in the new program launch stage. Several factors were investigated including carbon equivalent, carbon levels, silicon levels, molten iron preconditioners and other additives. This study investigated shrinkage size by taking digital photos and measuring each shrinkage indication size by sophisticated software comparing to the size limits from the customer Internal Soundness Specification. Thermal analysis technique was also utilized to evaluate iron conditions to correlate shrinkage tendency. Statistical tools were applied to determine whether the factors in this investigation truly affected casting shrinkage characteristics. High process capability (Ppk) values have been achieved by adopting optimal process parameters and using proper additives, and the program was launched successfully. Additional studies also have been conducted to confirm Ductile Iron meets customer specification including mechanical properties, microstructure, impact property, and casting hardness at all conditions.

Ductile Iron Fade Sampling Campaign

James Cree, Grede-New Castle | 10/20 9:40 AM

This paper will present results of a thorough evaluation of the effects of (1) 'plain' thermal analysis (TA) cup design/geometry (square vs. round), (2) 'before' and 'after' paper cup inoculation of plain TA cup, (3) inoculant type, and (4) inoculant dosage on the resultant TA metrics and microstructure characteristics as quantified by image analysis metallography of treated and inoculated ductile iron. Since production castings have near-infinite shapes and sizes, there is often a large variation in the types and dosages of inoculants employed by ductile iron casting producers. Thus, the evaluations of this paper are important in quantifying the proportions of gage variation (discriminating capability) for all independent and interactive combinations of the foregoing four predictor variables. That is, the gauge variation for any combination of predictor variables must be sufficiently low to make any valid assessment(s) of them having significant effects on the responses of TA metrics and microstructure characteristics. Further analysis was done in probing for any significant correlations between TA metrics and the ultrasonic velocities and quantified microstructure characteristics of both mold-cooled and water-quenched coupons after casting, with presentation of results for the significant correlations. The logical progression from the results reported on in this study of production samples having nodularities exceeding 90% is to do the same evaluations on samples collected from a fade campaign at the end of a week's production by which the sampling would be done every five minutes over the course of the four or five hours after the weekly production ends. That will provide us with adequate samples for rigorously covering the gamut from high to low nodularities.

Molten and Semi-Solid Gravity Die Casting in Ductile Iron Castings

Haruki Itofuji, I2C Technology Institute | 10/20 10:20 AM

Permanent mold (PM) and semi-solid (Rheo) casting in ductile iron castings (DIC) were tried and the microstructure was targeted to be chill free in the as-cast condition. De-nitrification was conducted for understanding the solubility properties of nitrogen in base molten iron and re-nitrification was strictly avoided during molten treatment by the Mg alloy. As a result, the production of chill free steering knuckle castings was possible using both casting methods in the as cast condition. The knuckle castings also contained no shrinkage cavities.. The solidification time by semi-solid die casting was shorter than that of the general permanent mold die casting. It took approximately one third the time. The castings had ultra-fine spheroidal graphite which was mostly less than 10μm in nodule size. The graphite structure obtained by semi-solid casing method was finer and more uniform than those of the other casting methods. The tensile strength in castings with both casting methods was approximately 1.3x greater than minimum requirements and all elongation values greater than the 10% minimum. It was concluded that free nitrogen (NF) promoted the formation of ledeburite structure in PM gravity die casting and chill could be avoided by controlling the NF content in Mg-treated molten iron as low as possible.

High Modulus Ductile Iron Alloy Design and Characterization (Tentative)

Shane Anderson, Materials Technology | 10/20 11:00 AM

Ductile iron is an attractive material for use in vehicle powertrain components such as crankshafts due to its high castability along with a good combination of strength and ductility; however, the amount of graphite in the microstructure of current ductile iron alloys results in a substantially lower elastic modulus than steel, which prevents its use in stiffness-limited applications such as lightweight crankshafts. The primary factors affecting the elastic modulus of ductile iron are graphite volume fraction and graphite nodularity. In this work, an alloy design strategy is presented for a castable, high strength, ductile iron with an improved elastic modulus. Crankshafts are cast and characterized with respect to microstructure, tensile properties, and elastic modulus in the as-cast condition. The presentation will review the approach taken to produce high modulus ductile iron, the casting trials, and how the test casting will be characterized and tested. The actual results will not be available by the time of the KMS.

ATTENDEE LIST

Aalberts surface technologies Connor Montgomery
Aalberts surface technologies Dr. Kathy Hayrynen
Aalberts surface technologies Jeremy Lipshaw
ADI Treatments Ltd Arron Rimmer (Speaker)
Allied Mineral Tim Hoyt
Allied Mineral Products, LLC Jim McMinn
Allied Mineral Products, LLC Ben Hunsicker
American Castings Jason Morgan
Ariel Corporation Mostafa Sharifi
AY DOKUM MAK. SAN. TIC. AS. Erkin Koc
AY DOKUM MAK. SAN. TIC. AS. Hakan Oker
Azterlan Susana Mendez
Azterlan Ramón Suárez (Speaker)
Baker Manufacturing Julia Scruton
Betz Industries Tedd Sheets
Betz Industries Trevor Beach (Speaker)
Cadillac Castings John Gatewood
Carpenter Brothers Chris Forster
Carpenter Brothers, Inc Jay Morrison
Caterpillar Riley Kerestes
Charter Manufacturing Christopher Heczko
Daiwa Heavy Industry Co., Ltd Satoshi Yamamoto (Speaker)
Ductile Iron Society Claira Stollfus
Ductile Iron Society Laura Gustafson
Ductile Iron Society Michelle Ring
DIS Alumni Group Richard B. Gundlach (Speaker)
Dotson Company, Inc. Ashley Folden-Ecker
Electric Controls and Systems, Inc Zach Meadows
Elkem Andreas Voll Bugten (Speaker)
Elkem Annie Villenueve
Elkem Materials, Inc. Matt Liptak
Elkem Materials, Inc. Mark Weber
Elkem Materials, Inc. Rob Logan
Elkem Silicon Prod. Dev. AS Cathrine Hartung (Speaker)
Elkem Silicon Products Leander Michels (Speaker)
Elkem Silicon Products Tony Carrascosa
Elkem Silicon Products Mike Riabov
Eric Nelson Consulting, LLC Eric Nelson
Ferroglobe JP Kramer
Ferroglobe Phil Frerking
Georgia Southern University Audrey Lowery (Student)
Georgia Southern University August Rautmann (Student)

Georgia Southern University Gaylan Bri Beasley (Student)
Georgia Southern University Evan Carter (Student)
Georgia Southern University Mingzhi Xu (Speaker)
Georgia Southern University Jingjing Qing (Speaker)
Georgia Southern University Noah Brack (Student)
Georgia Southern University Xander Bowen (Student)
GIW Industries, Inc. Harry Tian
Grede James Cree (Speaker)
Grede Mike Whaley (Speaker)
Green Packaging, Inc. Wayne Siefert
HA International Matteo Pesci
HA International Svetlana Dodik-Pelja
Hickman, Williams & Company Brian Johnson
Hickman, Williams & Company Jeremy McLimans
Hickman, Williams & Company James Csonka
Hodge and Elyria Foundry Michael Forsha
I2C technology Institute Haruki Itofuji (Speaker)
Impact NDT Rebecca Ward (Speaker)
Inductotherm Michael Fanz-Huster
Inductotherm Corporation Mike Looby
JÖNKÖPING UNIVERSITY Vasilios Fourlakidis (Speaker)
Jönköping University Bjorn Domeij (Speaker)
Larpen Metallurgical Service Sean Marek
Larpen Metallurgical Service Mike Mutton
Lightspeed Concepts, Inc. Daniel Shirkey
MAGMA Foundry Technologies Vadim Pikhovich
MAGMA Foundry Technologies, Inc. Konstantin Nikolov (Speaker)
Martin Foundry Products David Flores
Materials Technology Shane Anderson (Speaker)
Mayflower Consulting, LLC Andrew Halonen (Speaker)
Meritor, Inc. Jason Sieber
Metal Morphasis LLC Thomas Prucha (Program Chair-Speaker)
Metal Technologies, Inc. Kramer Pursell
Metal Technologies, Inc. Lenny Basaj
Midvale Industries Tim Gilbreath
Miller and Company Audrey Howley
Miller and Company Ryan Hughes
Miller and Company Gary McComas
Miller and Company Ken Way
Miller and Company Peter Kim
Minéraux Mart Inc. Martin Mandeville
Minéraux Mart Inc. Steve Larose
Missouri University of Science and Technology Dr. Simon Lekakh (Speaker)
Neenah Foundry Ryan Foley
Oshkosh Corporation Vladimir Vega-Valer
Penticton Foundry, LTD. Brian Bendig
Penticton Foundry, LTD. Ryan Morcombe
Poitras Foundry Ltd. Angelick Dama
Poitras Foundry Ltd. Claude Masse
Poitras Foundry Ltd. Nic Stephanian

Primetrade, Inc. Brandon Kacko
Product Development & Analysis (PDA), LLC Jiten Shah (Speaker)
Productora de Hierro Maleable, S.A. De C.V. Gabriel Trujillo Martinez
Profound Alloys Luke Dix
Proterial Group Company Pete Guidi
Rio Tinto Iron & Titanium Yujiao Zou
Rochester Metal Products Corp. Craig Sederholm
RWTH Aachen University Johannes Schüssler (Speaker)
RWTH Aachen University Betto David Joseph (Speaker)
Saint Gobain Morgan Kent (New Member)
SELEE Corporation Robert Appling
SELEE Corporation Jason Lachance
SELEE Corporation Michael Feldmeier
SELEE Corportation Darshan Khatavkar
SinterCast, Inc. David Gilson
SinterCast, Inc. Steve Dawson (Speaker)
St Marys Foundry Erik Stephens
St. Marys Foundry Karl Warsinski
TU Clausthal Felix Stieler (Speaker)
TU Clausthal Patrick Lachart
University of Alabama Doru Stefanescu (Speaker)
Vald. Birn A/S Stephanie Nielsen
Vald. Birn A/S Morten Larsen
Vald. Birn A/S Matheus Paes
Vald. Birn A/S Stefan Hessels
Ward Manufacturing Anhua Yu (Speaker)
Washington Mills Hennepin, Inc. Chris DeRosa
Washington Mills Hennepin, Inc. Kevin Birdwell
Washington Mills Hennepin, Inc. Adam Epperson
Waupaca Foundry, Inc. Jason Bush
Waupaca Foundry, Inc. Jacob Gerdt
Winnebago Foundry Grant Wightman

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CONFERENCE MAP

Lobby Level Map

Lower Lobby Level Restaurant Map

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2024 SAVE THE DATES

Ductile Iron Production Seminar (DIPS)

SPONSOR THE EVENT!

JANUARY 29TH-30TH

North East Indianapolis (Fishers)

Research Committee Meeting
January 31st

Ductile Iron Society Spring Meeting

TOUR HOSTED BY JOHN DEERE

JUNE 3RD-6TH

Hilton Garden Inn
Cedar Falls, Iowa