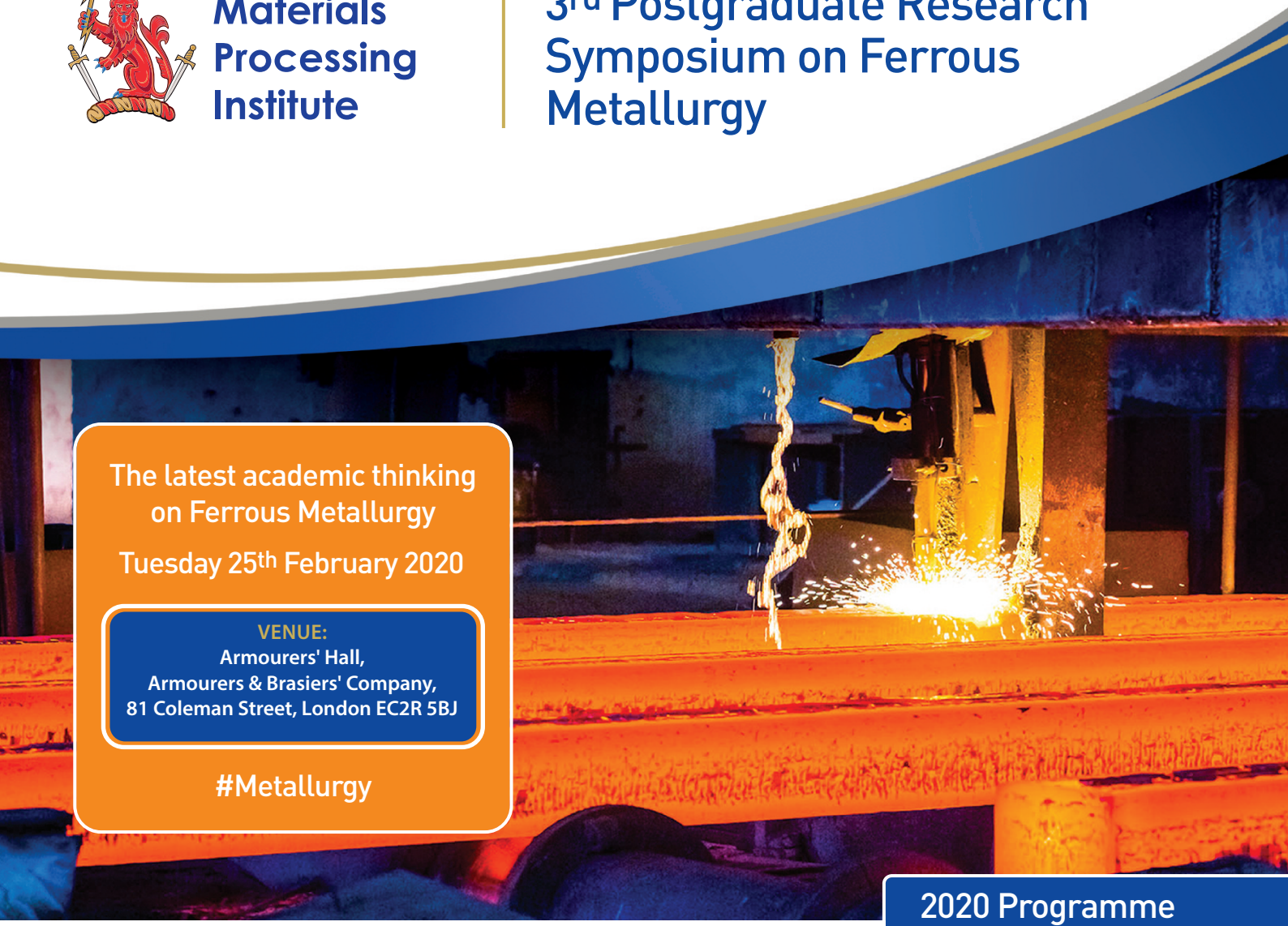
Materials Processing Institute

3rd Postgraduate Research Symposium on Ferrous Metallurgy



The latest academic thinking on Ferrous Metallurgy

Tuesday 25th February 2020

VENUE:
Armourers' Hall,
Armourers & Brasiers' Company,
81 Coleman Street, London EC2R 5BJ

#Metallurgy

2020 Programme

Main Sponsor: LIBERTY

Poster Display Sponsor: M2A MATERIALS AND MANUFACTURING ACADEMY

Drinks Reception Sponsor: Materials Processing Institute

Organised by:

Materials Processing Institute with support from Armourers and Brasiers' Company and the Iron & Steel Society of IOM3.

ARMOURERS & BRASIERS' COMPANY

IOM3 The Institute of Materials, Minerals and Mining

Materials Processing Institute

Foreword

Welcome to the UK's third annual postgraduate research symposium for ferrous metallurgy. The symposium showcases postgraduate research from across the country, bringing together a diverse range of students, academics and industrialists. The aim of the symposium is to allow PhD researchers and university departments from across the UK to showcase their research, inspire academics and research students to engage in the research challenges of the steel industry and to enable industry colleagues and academics to form strong and lasting networks. I am pleased to write that the symposium is now a firmly established part of the UK metallurgy calendar, with 2020 having our largest poster display and greatest number of registrations to date. As was the case last year, we were over subscribed for papers to present. In future years we will prioritise those applicants who have already presented a poster in a previous year.

The symposium has been organised by the Doctoral Academy at the Materials Processing Institute, an organisation dedicated to forging strong networks between the UK research and industrial community in ferrous materials. The academy is free to join for researchers, academics and industrialists. Benefits include access to bursaries, networks and research support. Details are available from the Institute web page at: www.mpiuk.com.

The great diversity of institutions involved in ferrous metallurgy research in the UK can be seen from today's programme. It is this diversity that makes the case for the symposium and for the same reason, strong, centralised institutions, such as the Materials Processing Institute, the Iron and Steel Society and the Company of Armourers and Brasiers, are more important than ever before. These three organisations have once again worked together to organise, fund and promote this event and remain committed to ensuring it continues as an annual fixture of international importance in the calendar of the UK materials research and the steel industry.

My personal thanks to the Master, Wardens and Company of Armourers and Brasiers, for their consistent and unstinting support of UK materials research, which includes the use of Armourers' Hall for the symposium today and the highly valued partnership and bursary scheme with the Materials Processing Institute. Thanks are also due to the Iron and Steel Society for their support of this event as co-organising partners and to our sponsors, Liberty Steel and M2A, and to Jon Bolton, for graciously agreeing to deliver the keynote address.

I hope that you will all enjoy the symposium today, find new opportunities for research and make new friends from across the community. Please do share your experience with friends and colleagues via social media and encourage others to attend the next Symposium on 23rd February 2021, where I am pleased to announce the keynote speaker will be Dr. Alexander Fleischanderl, Technology Officer Up-Stream and Head of Eco Solutions, Primetals Technologies.

Chris McDonald
CEO, Materials Processing Institute

Programme

10:00 - 10:30	Registration, Coffee and Networking
10:30 - 10:40	**Welcome and Introduction** *Chris McDonald, Chief Executive Officer, Materials Processing Institute*
10:40 - 11:40	**Session 1: Characterisation and Modelling** *Chair Session 1: Dr. Richard Thackray (University of Sheffield)* *1. A comprehensive model for the coupled modelling of MnS inclusion and macrosegregation.* *Presenter: Duanxing Cai (University of Leicester)* *2. Development of novel coatings for the reduction of high temperature oxidation in carbon steel conveyance.* *Presenter: James Grant (Swansea University)* *3. The application of machine learning in material research: An overview.* *Presenter: Shuo Feng (University of Leicester)*
11:40 - 12:00	**First Perambulation** Poster Exposition
12:00 - 13:00	**Session 2: Steel Property Measurement and Characterisation** *Chair Session 2: Gill Thornton (Liberty Powder Metals Ltd)* *1. Multi-scale characterisation of hot rolled AHSS for improved toughness and bendability.* *Presenter: Cameron Bee (University of Warwick)* *2. Effect of microstructure and test parameters on hydrogen permeation in ultra-high-strength steels.* *Presenter: James Lelliot (Swansea University)* *3. Effects of hydrogen on edge dislocation mobility in BCC iron by molecular dynamics.* *Presenter: Angel Alberto Izquierdo Sanchez (Newcastle University)*
13:00 - 14:00	**Lunch and Networking** Poster Exposition
14:00 - 15:20	**Session 3: Development of Steel Grades and Properties** *Chair Session 3: Professor Hongbiao Dong (University of Leicester)* *1. A best practice guide for welding of newly developed duplex stainless steel (UNS S82551) seamless pipes.* *Presenter: Kenta Yamada (University of Leicester)* *2. Investigating the elevated temperature deformation of iron-base hard facing alloys.* *Presenter: Benjamin Poole (Imperial College London)* *3. Revealing deformation mechanisms of FCC alloys at low temperature range: in situ neutron diffraction.* *Presenter: Lei Tang (University of Birmingham)* *4. Microstructural evolution of neutron irradiated T91 ferritic-martensitic steel in the advanced test reactor.* *Presenter: Thomas Davis (University of Oxford)*
15:20 - 15:40	**Second Perambulation** Poster Exposition
15.40 - 16:00	**Awarding of Prizes by the Armourers and Brasiers' Materials Science Committee** 1. Millman Scholarship 2. Best Presentation and Runner-up 3. Best Poster
16:00 - 16:40	**Keynote Speaker - Jon Bolton, Senior Adviser, Liberty Steel Group (UK)**
16:40 - 16:50	Vote of Thanks - Dr. Simon Pike, Technical Director, Liberty Steel UK
16:50 - 18:30	Drinks Reception

Poster Exposition

1. Exploring the effects of cryogenic treatment on engineering coating systems.
Christian Chiadikobi (University of Leicester)

2. Sulphur release from pulverised coal injection.
Chay Davies-Smith (Cardiff University)

3. Blister formation in high strength steels during hot rolling.
Rebecca Dewfall (Swansea University)

4. Robotic plasma processing vehicle chassis.
Adel Gani (University of Strathclyde)

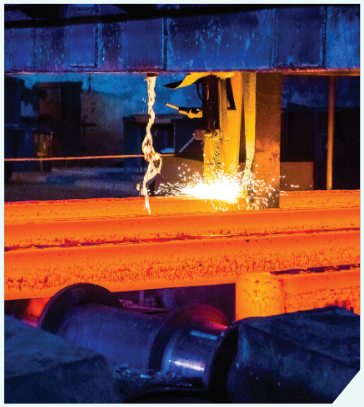
5. Evolution of carbides in high speed steel during heat treatment.
Yang Liu (University of Leicester)

6. Using rapid alloy prototyping to understand the effects of residual elements on a low alloy steel.
Caroline Norrish (Swansea University)

7. Understanding austenite stability in bearing steels - Influence of chemical composition and grain size.
Adriel Wong (University of Cambridge)

8. Rapid, accurate metallic iron analysis for ironmaking materials.
Daniel Stewart (Swansea University)

9. Development of high performance packaging steels.
Sean Bennett (Swansea University)



Keynote Speaker

Jon has held senior leadership positions in the steel industry across the UK, Europe and North America for more than thirty-five years and was previously the Chairman of UK Steel and co-chaired the UK Steel Council alongside the Secretary of State for Business and Industry, advising government and providing strategic leadership to the sector. In 2019 he was awarded The Bessemer Gold Medal, by the Institute of Materials, Minerals and Mining, in recognition of his outstanding contributions to the UK steel industry. He is a leading advocate for the importance of investment and renewal of the steel industry in a modern industrial economy.

Jon said: "The European steel industry is currently undergoing a transformation. Global competitive pressures are leading to consolidation, customers are driving product development and perhaps, most importantly, environmental imperatives are driving process changes and investment decisions. Only last October we announced an ambition to build on GFG's existing GREENSTEEL strategy to aim for net carbon neutral status by 2030 – placing Liberty Steel Group on a pathway to become the first carbon neutral steel company in the world.

I believe that managing existing assets and introducing new technologies, such as using hydrogen generated from renewable power to produce steel, combined with political and business resolve will help us realise the considerable commercial, economic and social benefits which arise from supporting a foundation industry such as steel. For that reason, we need the brightest and the best from industry, academia and government to collaborate and deliver the most cost-effective pathways to deliver a long-term sustainable future for this critical industry. That is why Liberty Steel Group is delighted to sponsor this symposium and engage with those who are leading the latest thinking in ferrous metallurgy."

Jon Bolton
Senior Adviser, Liberty Steel Group (UK)

LIBERTY

Organised by the Materials Processing Institute with support from the Armourers and Brasiers' Company and the Iron & Steel Society of IOM3.

Materials Processing Institute

The Materials Processing Institute is a research and innovation centre serving organisations that work in advanced materials, low carbon energy, digital technologies and the circular economy. The Institute provides a range of technology and R&D based services and consultancy to support industry, government and academia. It has expertise in materials, materials processing and energy, specialising in challenging processes, particularly those involving high specification materials, high temperatures and difficult operating conditions.

The Institute combines the expertise of world-leading scientists, metallurgists and engineers and it has been at the forefront of innovations and process developments for over 75 years. Extensive materials processing knowledge is supported by state-of-the-art facilities, including high specification laboratories, scale-up, prototyping, demonstration and production facilities.

The Doctoral Academy at the Institute links with industry and the UK academic research base to support postgraduate and EngD students specialising in materials science disciplines and the SME Technology Centre supports businesses with the development of new technologies and products.

ARMOURERS & BRASIERS' COMPANY

The Armourers & Brasiers' Company started life in 1322 as the medieval Guild charged with overseeing standards in the production of arms and armour. Over the centuries, its purpose has changed a number of times and it now exists primarily to promote materials science in the United Kingdom. It does this through its charitable giving and networking activities.

Materials Science is the modern discipline most closely aligned to the Armourers & Brasiers' ancient craft of working with metals and materials. The Company offers travel grants for research students working towards PhD or EngD to present their work at academic conferences, and grants for undergraduate students on Materials Science degree courses to help with the costs of industrial placements.

The Company exists also to maintain its historic home, Armourers' Hall, a scheduled ancient monument and Grade II listed building, on a site which it has occupied uninterruptedly since 1346.

IOM3 The Institute of Materials, Minerals and Mining

The activities of the Institute of Materials, Minerals and Mining (IOM3) encompass the whole materials cycle. IOM3 exists to promote and develop all aspects of materials science and engineering, geology, mining and associated technologies, mineral and petroleum engineering and extraction metallurgy as a leading authority in materials and mining.

The Iron and Steel Society is part of IOM3 and provides value and support to the iron and steel Industry and individual members with a particular interest in iron and steel, to promote exchange and development of technology. The Society supports the iron and steel industry and related industries within the supply chain by providing a focus for the exchange of knowledge on all aspects of steel production, processing and applications. The Society's activities encompass all professional, technical and educational aspects of the steel industry and whole supply chain as well as other strategic considerations of steel.

Chair of Sessions

SESSION 1
Characterisation and Modelling

Dr. Richard Thackray
University of Sheffield

Richard is a key member of the University of Sheffield's team for SUSTAIN - the EPSRC funded Future Steel Manufacturing Research Hub. He holds a degree in Materials Science and a PhD in Metallurgy from Imperial College London. Richard joined the University of Sheffield in 2003 as Corus Lecturer in Steelmaking, and his current research interests are related to the production of steel, including development of mould powders for continuous casting of steel, and the role of thermomechanical processing on inclusion behaviours.

Richard is also involved in a number of projects that look at aspects of sustainability in steelmaking, in particular, initiatives to reduce energy consumption in steelmaking, reuse/recycling of waste material, life-cycle assessment of critical elements in steel, and industrial symbiosis in the steel industry. Richard is past chair of the Iron and Steel Society of the Institute of Materials, Minerals and Mining, and a current member of the Sustainable Development Group and Casting Society.

SESSION 2
Property Measurement and Characterisation

Gill Thornton
Liberty Powder Metals Ltd

Gill has a degree in Material Science and an MBA from Warwick Business School. She has worked in the steel industry for 34 years in technical roles including R&D and on plants across the UK. Her most recent work was leading a 4 year multi partner UK government project on creating an advanced manufacturing supply chain for net shape and additive manufactured parts which address the demands of end-users. This has led to Liberty Steel starting a new business; Liberty Powder Metals to vacuum atomise a broad spectrum of high quality steel and nickel-based alloy powders, with bespoke chemistries to enhance properties where required, where her current role is the R&D Manager. Gill is a past president of the Cleveland Institution of Engineers.

SESSION 3
Development of Steel Grades and Properties

Professor Hongbaio Dong
University of Leicester

Professor Dong is internationally renowned for his work in modelling of metal processing, digital manufacturing, solidification and its application in casting, welding and additive manufacturing of metal. He is Research Chair of the Royal Academy of Engineering/TWI, Science Director of EPSRC CDT in Innovative Metal Processing, and Director of NISCO UK Research Centre. He successfully led a major EU-FP7 project on modelling of welding, was a recipient of the Metrology for World Class Manufacturing award and is a Royal Society Industry Fellow at Rolls-Royce Precision Casting Facility.

The research in his team aims to bring knowledge-inspired decision making to the production routes of high value-added components, such as single crystal aero-engine turbine components and deep-sea oil and gas transport systems.

A comprehensive model for the coupled modelling of MnS inclusion and macrosegregation

SPEAKER / LEAD AUTHOR:
Duanxing Cai

INSTITUTION:
University of Leicester

OTHER AUTHORS:
Jun Li, University of Leicester
Professor Hongbiao Dong, University of Leicester
Jianguo Li, Shanghai Jiao Tong University

ABSTRACT:
Modelling the growth of manganese sulphide (MnS) is important since it greatly impacts the steel property, however, previous models only simulated the growth of MnS based on dynamics without involving its interaction with macrosegregation.

In this study, a comprehensive model incorporating the formation kinetics of MnS with a microsegregation model is presented to model the interaction between MnS and macrosegregation. Classical nucleation theory and a diffusion-controlled growth model are applied to describe the evolution of MnS, which is fully coupled with a mixed three-phase solidification model. Some main features are taken into account: growth of columnar dendrite; nucleation, growth and sedimentation of equiaxed dendrite; columnar to equiaxed transition; thermosolutal convection and inclusion floatation.

Reasonable consistency of macrosegregation with experiment was obtained. It was shown that Mn and S are expelled from solid phase, enriching in liquid phase, meanwhile the temperature decreases, both of which supply the thermodynamic environment to MnS formation.

Development of novel coatings for the reduction of high temperature oxidation in carbon steel tubes

SPEAKER / LEAD AUTHOR:
James Grant

INSTITUTION:
Swansea University

OTHER AUTHORS:
Amit Das, University of Nottingham

ABSTRACT:
TATA Steel's low carbon steel conveyance tubes undergo a 900°C normalisation to remove an undesirable heat affected zone caused by high frequency induction welding. This reheating, however, generates significant surface conditioning issues and instigates severe processing inefficiencies due to the parent hollow's insufficient protection from high temperature oxidation.

This research will evaluate the kinetics of the scale grown by normalisation and will further characterise the key oxide layers; FeO, Fe3O4, Fe2O3, permeating on the steel surface. In addition, the research details the trailing of preventative coatings, such as silicates and phosphates, in high temperature environments which can reduce the quantitative thickness of scale by up to 37% and remove the influence of oxide spallation thereby improving product surface quality. Techniques for analysis and characterisation include Raman Spectroscopy, Energy-Dispersive Spectroscopy, Simultaneous Thermal Analysis and Scanning Electron Microscopy.

UNIVERSITY OF LEICESTER

The application of machine learning in material research : An overview

SPEAKER / LEAD AUTHOR:
Shuo Feng

INSTITUTION:
University of Leicester

OTHER AUTHORS:
Professor Hongbiao Dong, University of Leicester

ABSTRACT:
Data-based and data-driven machine learning can reveal hidden complex nonlinear relationships in archived data and has become an important complement to physical based methods in science.

This paper overviewed some popular models (e.g. tree-based models, conventional neural network, convolutional neural network, principal component analysis etc.) in machine learning and compared their pros and cons from the points of accuracy and interpretability. Examples of their typical applications in materials science were given, e.g. structured data regression; image classification; unsupervised data clustering; and data dimension reduction. The challenges (e.g. limited dataset size, imbalanced data distribution, etc.) of applying machine learning in materials research were discussed and some specific strategies (e.g. data augment, regularisation, visualisation, pre-training, etc.) coping with them were also given.

Multi-scale characterisation of hot rolled AHSS for improved toughness and bendability

SPEAKER / LEAD AUTHOR:
Cameron Bee

INSTITUTION:
University of Warwick

OTHER AUTHORS:
Professor Claire Davis, University of Warwick
Dr. Carl Slater, University of Warwick
Dr. Didier Farrugia, TATA Steel UK

ABSTRACT:
Advanced high strength steel strip used in the yellow goods sector needs high strength with good toughness and bendability. Local inhomogeneity is a key factor influencing bendability, of particular significance in the surface and sub-surface regions, which experience the greatest strain during bending. Inhomogeneities include inclusion distributions, mixed microstructures, compositional segregation and texture, which affect localised strain concentrations.

In this work multi-scale characterisation has been used to consider the role of compositional inhomogeneity, from solidification interdendritic segregation, in a tempered martensitic steel. Micro X-ray fluorescence mapping for Mn inhomogeneity has shown enriched bands in the hot rolled strip, and instrumented nano-indentation has quantified the associated local hardness distribution. SEM in-situ bend testing has been used to identify shear band formation and strain localisation in the surface/sub-surface regions and the relationship to the compositional inhomogeneity. The significance of the correlation between these factors is discussed in the context of processability.

Effect of microstructure and test parameters on hydrogen permeation in ultra-high-strength steels

SPEAKER / LEAD AUTHOR:
James Lelliot

INSTITUTION:
Swansea University

OTHER AUTHORS:
Dr. Douglas Figueroa-Gordon, Tata Steel Strip Products UK
Professor Hamilton N. McMurray, Swansea University
Dr. Elizabeth Sackett, Swansea University

ABSTRACT:
Effects of microstructure, charging potential and membrane thickness on hydrogen diffusion characteristics of two ultra-high-strength boron steels were assessed by means of permeation tests. Lattice diffusion was found to be dominant over the effects of irreversible trapping for both steels and conditions. High dislocation density was observed to lead to >40% lower diffusivity in the quenched martensitic microstructure than in the as received condition for both steels. It was also found that the higher hydrogen flux obtained from higher charging overpotential did not lead to significant differences in calculated effective diffusivity.

Newcastle University

Effects of hydrogen on edge dislocation mobility in BCC iron by molecular dynamics

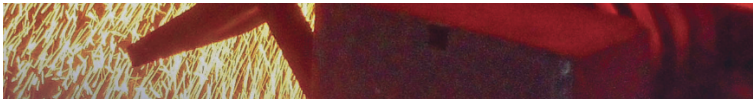
SPEAKER / LEAD AUTHOR:
Angel Alberto Izquierdo Sanchez

INSTITUTION:
Newcastle University

OTHER AUTHORS:
Dr. Adrian Oila, Newcastle University
Dr. Alasdair Charles, Newcastle University

ABSTRACT:
Hydrogen Enhanced Localised Plasticity (HELP) is one of the proposed theories to explain hydrogen embrittlement in iron and steel. According to the HELP model, hydrogen increases dislocation mobility resulting in softening of the affected specimen. Atomistic simulations, when designed correctly, can provide valuable insights into phenomena occurring at an atomic level.

In this work, a widely used embedded-atom method interatomic potential was used to study the effects of hydrogen and vacancies on the mobility of a periodic array of dislocations. It was found that at sufficiently high concentrations of solute hydrogen, the critical shear stress for dislocation movement is increased and the average glide velocity reduced, suggesting hardening in contrary to the HELP theory.



A best practice guide for welding of newly developed duplex stainless steel (UNS S82551) seamless pipes

SPEAKER / LEAD AUTHOR:
Kenta Yamada

INSTITUTION:
University of Leicester

OTHER AUTHORS:
Dr. Kasra Sotoudeh, TWI Ltd
Professor Hongbiao Dong, University of Leicester

ABSTRACT:
(New DSS) containing 25Cr-5Ni-1Mo-2.5Cu has been developed (UNS S82551) by Nippon Steel Corporation (NSC), which is intended for flowline application in slightly sour environments.

In this study, NSC and TWI are collaborating on a development programme aimed at establishing a best practice guide for welding of UNS S82551 pipe.

Reporting of this development programme will be divided into two major parts: the first (presented here) will evaluate alloy design and weldability of UNS S82551 pipe for flow line applications using NSC in-house developed welding procedure, which is based on industry recommended practice for welding DSS. Results presented will include tensile, toughness, corrosion and metallographic data for base metal and welds.

The second part will be reported as a next step, and will discuss the effect of welding conditions such as heat input and interpass temperature on intermetallic precipitation, microstructure, mechanical and corrosion properties.

Investigating the elevated temperature deformation of iron-base hard facing alloys

SPEAKER / LEAD AUTHOR:
Ben Poole

INSTITUTION:
Imperial College London

OTHER AUTHORS:
Professor Daniele Dini, Imperial College London
Dr. David Stewart, Rolls-Royce plc.
Professor Fionn Dunne, Imperial College London

ABSTRACT:
Cobalt-base hard facings are commonly used to protect contacting surfaces throughout the nuclear industry, but are a major contributor to operator radiation exposure. As such, replacement alloys are required with iron-base hard facings being the main candidate. However, iron-base hard facings have been unable to match the galling resistance performance of cobalt-base alloys at temperature relevant to light water reactor operating conditions (approximately 300°C), with the mechanisms underpinning this loss in performance unknown.

Two iron-base hard facings (Nitronic 60 and Tristelle 5183) are investigated using small-scale mechanical testing with the deformation characterised using digital image correlation and high-resolution electron backscatter diffraction techniques. The roles of microstructure, slip interaction and localisation, geometrically necessary dislocation evolution and hard carbide phases are examined in order to provide insight into the deformation of these alloys. This understanding of deformation is then related back to macroscale galling resistance.

Revealing deformation mechanisms of FCC alloys at low temperature range: in situ neutron diffraction

SPEAKER / LEAD AUTHOR:
Lei Tang

INSTITUTION:
University of Birmingham

OTHER AUTHORS:
Dr. Biao Cai, University of Birmingham

ABSTRACT:
Two athermal transformation processes, twinning and phase transformation, have been receiving huge interest due to the intriguing mechanical performance improvement and the possibility of overcoming strength-ductility trade-off they bring to some fcc-lattice-structured alloys, especially ferrous alloys. It is accepted that these two strengthening mechanisms are closed related to the formation and gathering of stacking faults, this means the stacking fault energy (SFE) plays a critical role in deciding the deforming microstructure and the corresponding mechanical behaviours. As the SFE of an alloy is closely related to its chemical composition and deformation temperature, we investigated two promising materials: a high entropy alloy and a high Mn steel via in situ neutron diffraction at a low temperature range (from 373K to 15K), hoping to reveal the relationship among SFE, strengthening mechanisms and the mechanical properties and shed a light on designing new high-performance materials serving at extremely low temperatures.

Microstructural evolution of neutron irradiated T91 ferritic-martensitic steel in the advanced test reactor

SPEAKER / LEAD AUTHOR:
Thomas P. Davis

INSTITUTION:
University of Oxford

OTHER AUTHORS:
Professor Michael Moody, University of Oxford
Dr Paul Bagot, University of Oxford
Dr. Maria Auger, University of Oxford, Univeridad Carlos III de Madrid
Professor Peter Hosemann, University of California
Professor David Armstrong, University of Oxford

ABSTRACT:
T91 ferritic-martensitic steel is a candidate for the uranium fuel cladding material of advanced nuclear reactors. Neutron irradiation is the driving force for microstructural and microchemical evolution which has detrimental effects on the mechanical performance. One of the defining microstructural features that results from neutron irradiation is the formation of Mn-Si-Ni rich nanosized precipitates. In this study, T91 steel has been neutron irradiated to 2.2, 6.65 and 8.8 dpa at 320C in the Advanced Test Reactor, Idaho National Laboratory (INL), USA. Atom probe tomography was conducted at the Microscopy and Characterization Suite (MaCS) located at the Center for Advanced Energy Studies, INL.

This presentation will report on the segregation of elements to dislocations, grain boundaries and the formation of Mn-Ni-Si clusters. Further, Cu clusters, alpha prime (>60% Cr at% ppts) were observed. This presentation will provide an insight into the evolution of solute evolution that results in this steel being embrittled.

UNIVERSITY OF LEICESTER

Exploring the effects of cryogenic treatment on engineering coating systems

AUTHOR OF POSTER:
Christian Chiadikobi

INSTITUTION:
University of Leicester

OTHER AUTHORS:
Dr. Rob Thornton, University of Leicester
Dr. Dave Weston, University of Leicester

ABSTRACT:
The purpose of performing cryogenic treatment on a material is to improve the mechanical properties e.g. toughness, hardness by causing permanent microstructural changes with little or no adverse effect within an as cast sample. Cryogenic treatment is a one-time treatment that involves lowering the cast to temperature typically below 193K (-80°C). Then soaked for a length of time, before raising back to the atmosphere.

In the literature, cryogenic treatments have been shown to be of great benefit for industry, improving cutting tool life, stopping power and life span of automobile brakes in high stress concentration. Nevertheless, for some applications, cryogenic treated materials are also coated for protection e.g. corrosion resistance etc. Although, this has been inconsistently characterised and reported for any given cast sample.

Therefore, it is of vital importance to explore the effects of cryogenic treatments on engineering coating systems through materials characterisation, mechanical and chemical testing techniques.

CARDIFF UNIVERSITY

Sulphur release from pulverised coal injection

AUTHOR OF POSTER:
Chay Davies-Smith

INSTITUTION:
Cardiff University

ABSTRACT:
Within the ironmaking process, the use of pulverised coal injection into the blast furnace is a well-established method of reducing costs and improving both output and energy efficiency. A negative effect of the replacement of coke with coal is the increase in the quantity of impurities entering the blast furnace. Increases in elements such as sodium, potassium, or sulphur can lead to increased slag volumes, modification of slag basicity, and an increase in the requirement for hot metal treatments.

The release of these elements from the coal in the raceway region of the blast furnace is of specific interest to this research. A drop tube furnace is used to produce similar conditions to those found in the raceway region. The rate of sulphur release in the simulated raceway is analysed. The effect of simultaneous injection of fluxes is investigated. Considerations for further work are discussed.

Blister formation in high strength steels during hot rolling

AUTHOR OF POSTER:
Rebecca Dewfall

INSTITUTION:
Swansea University

OTHER AUTHORS:
Dr. Soran Birosca
Dr. Vladimir Basabe

ABSTRACT:
Blister formation on variant high strength (HSS), high Mn steels was investigated. The HSS variants were oxidised in a thermo-gravimetric analyser (TGA) with the air velocity of 5.3cm over the temperature range of 750-1200°C. The oxidation conditions were selected to simulate hot rolling process where secondary and tertiary oxide scales can form. Experiments were mainly conducted in order to evaluate or establish exact blistering temperatures and formation mechanisms. Differing Mn and Si contents in HSS alloys were used to discern the influence of Mn on blister formation. The thermodynamics and kinetics of these reactions were shown to differ greatly between the two steels used, producing blistering regimes unique to each grade. This led to reconsideration of the standard industrial hot rolling temperature utilised for each HSS grades. Here, the blister mechanistic regimes and two distinctive formation modes were established for both SSH grades.

Robotic plasma processing vehicle chassis

AUTHOR OF POSTER:
Adel Gani

INSTITUTION:
University of Strathclyde

ABSTRACT:
The aim of this article is to understand if an automated plasma cutter can be used as an alternative tool instead of the traditional cutting methods e.g. circular and reciprocating saws. Our aim included how this would be beneficial within the automotive sector which involves primarily companies where the business focus is the conversion of vehicles. We will be looking primarily at a more efficient approach to the underbody chassis floor trimming stage during the conversion process which could eliminate challenges encountered during the cutting process using saws for instance, profiling issues, risk of injury, costing and time consumed. The study showed that using a robotic plasma arm could be the answer.

Evolution of carbides in high speed steel during heat treatment

AUTHOR OF POSTER:
Yang Liu

INSTITUTION:
University of Leicester

OTHER AUTHORS:
Professor Jing Li, University of Science and Technology Beijing
Professor Hongbiao Dong, University of Leicester

ABSTRACT:
In this paper, we investigated the as-cast microstructure and the evolution of carbides during heat treatment of electroslag remelted high speed steel.

The results showed that the element distribution is not uniform from the bottom to the top of the ingot, and carbides are found thick and to be connected into network. From the surface to the centre, the grain size increased gradually, and the eutectic ledeburite is thicker while the segregation is more serious. After the solution treatment, forging and rolling, carbides are completely spheroidal and dispersed in matrix. The average diameter of the carbides reduced to 1.28μm and the space distance reduced to 3.23μm. A uniformly distribution of spheroidal shaped carbides are achieved.

Using rapid alloy prototyping to understand the effects of residual elements on a low alloy steel

AUTHOR OF POSTER:
Caroline Norrish

INSTITUTION:
Swansea University

OTHER AUTHORS:
Richard Underhill, Tata Steel Europe
Carlos Llovo-Vidal, Tata Steel Europe
Professor Cameron Pleydell-Pearce, Swansea University
Professor Nicholas Lavery, Swansea University

ABSTRACT:
A global requirement to reduce environmental impacts could be achieved for steel by increasing the level of scrap steel. Whilst drastically reducing the overall carbon footprint of steel production, adding more scrap during production leads to increased quantities of residual elements such as copper, tin, chromium, molybdenum and nickel in the final product, some of which may have undesirable effects on the properties and processability of specific steel grades.

The effects of increasing levels of these elements are being investigated using a new rapid alloy prototyping method to prepare and process small specimens of laboratory prepared steel. This method allows many compositions to be investigated in a combinatorial fashion with relative ease compared to the traditional larger-scale alloy development methods. High throughput characterisation including hardness, tensile strength, optical microscopy and x-ray diffraction analysis are being used to understand the compositional-processing-property trends for these residual elements.

Understanding austenite stability in bearing steels - Influence of chemical composition and grain size

AUTHOR OF POSTER:
Adriel Wong

INSTITUTION:
University of Cambridge

OTHER AUTHORS:
Vikram Bedekar, The Timken Company
Rohit Voothaluru, The Timken Company
Enrique Galindo-Nava, University of Cambridge

ABSTRACT:
Austenite stability is an important consideration for the performance of bearing steels. Due to its metastable nature, austenite can mechanically or thermally transform into martensite. Its stability is influenced by several factors, including chemical composition and prior austenite grain size (PAGS). While austenite stability in through-hardened bearings has been studied extensively, similar studies in the case of carburised grades are not as widely reported.

This work presents results from investigations on the effect of austenitisation temperature towards the PAGS. The martensite start temperatures in selected carburised steels were measured from a dilatometer. The stacking fault energies of the steels were also calculated from a thermodynamic model to elucidate the influence of chemical composition. Based on the results, basic correlations on the effect of chemical composition and PAGS towards austenite stability have been established.

Rapid, accurate metallic iron analysis for ironmaking materials

AUTHOR OF POSTER:
Daniel Stewart

INSTITUTION:
Swansea University

OTHER AUTHORS:
Professor Andrew R Barron, Swansea University

ABSTRACT:
Determination of the metallic iron content of steelmaking materials such as direct reduced iron, revert materials and slags is critical for assessing their value in use. Accurate determination of the Fe^0 content of these materials using hotplate reaction with $CuSO_4$ is slow and labour intensive for industrial labs. The poster demonstrates the use of a DigiPREP system for greatly increased sample output for determining Fe^0.

Development of high performance packaging steels

AUTHOR OF POSTER:
Sean Bennett

INSTITUTION:
Swansea University

ABSTRACT:
The goal is to develop a grade of packaging steel with a high proof strength that can be cold rolled to a very thin gauge whilst securing good elongation in all directions to improve its formability. Finally, it must be cost effective to manufacture. Heating rates and soak temperatures during annealing have been studied. Furthermore, the effect of alloying elements has been studied.

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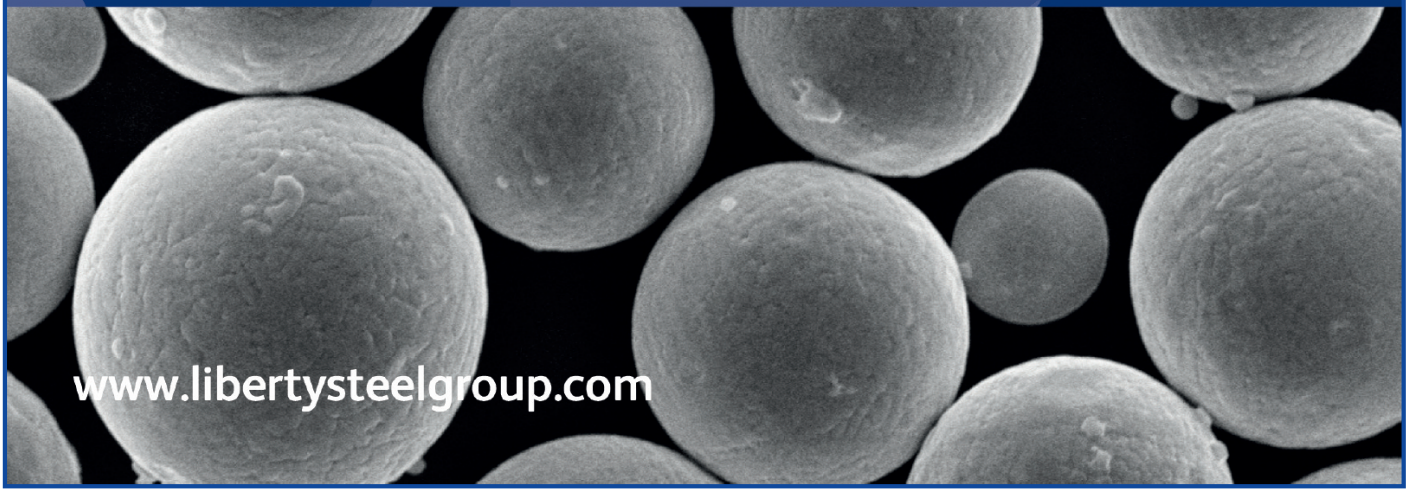

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