Materials Processing Institute

2nd Postgraduate Research Symposium on Ferrous Metallurgy

The latest academic thinking on Ferrous Metallurgy

Tuesday 26th February 2019

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

#Metallurgy

2019 Programme

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

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IOM3 The Institute of Materials, Minerals and Mining

Materials Processing Institute

Foreword

Welcome to the UK's second annual postgraduate research symposium on 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 interest in presenting at the symposium has been extremely strong. After some consideration it has been decided not to increase the length of the symposium in line with demand, but to continue in future years to focus on accepting the highest quality entries.

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 website 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. We are pleased that this year the symposium has been incorporated into the 150th anniversary celebrations of the Iron and Steel Society and the Institute of Materials, Minerals and Mining.

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, British Steel and Liberty and to Ron Deelen of British Steel, 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 and present next year, when the symposium will be held on 25th February 2020.

Chris McDonald
CEO, Materials Processing Institute

Programme of Events

10:00 - 10:20	Registration, Coffee and Networking
10:20 - 10:30	**Welcome and Introduction** *Chris McDonald, Chief Executive Officer, Materials Processing Institute*
10:30 - 11:50	**Session 1: Materials Performance** *Chair Session 1: Dr. Steve Ooi (Ovako Steel)* *1. Role of fracture toughness and wear mechanism in impact-abrasion.* *Presenter: Appa rao Chintha (University of Cambridge)* *2. Using deep neural network with small dataset to predict solidification cracking susceptibility of stainless steels.* *Presenter: Shuo Feng (University of Leicester)* *3. Aesthetic and performance enhancement of ZMA coated steels.* *Presenter: Amar Dhoj Malla (Swansea University)* *4. Comparison of Squats and Studs from different traffic environments.* *Presenter: Shaun Earl (University of Sheffield)*
11:50 - 12:10	**First Perambulation** Poster Exposition
12:10 - 13:10	**Session 2: New Materials Design** *Chair Session 2: Dr. Richard Thackray (University of Sheffield)* *1. Hot stage quasi in-situ analysis of the effect of titanium and manganese on static recrystallization of cold-rolled low carbon V and Ti-V bearing micro-alloyed steels.* *Presenter: Ishwar Kapoor (WMG, University of Warwick)* *2. Understanding the nano-oxide particle nature of irradiated oxide dispersion strengthened steels.* *Presenter: Thomas Davis (University of Oxford)* *3. Surface texture and visual appearance of packaging steel.* *Presenter: Stephen Jones (Swansea University)*
13:10 - 14:00	**Lunch and Networking** St. George's Den (Library 13:35-13:50) Poster Exposition
14:00 - 15:20	**Session 3: Materials Processing** *Chair Session 3: Professor Hongbiao Dong (University of Leicester)* *1. Direct observation of coal particle swelling.* *Presenter: Ian Moore (Materials Processing Institute)* *2. The single-stage production of low zinc pig iron nuggets from basic oxygen furnace dust using blast furnace dust as a reductant.* *Presenter: Daniel Stewart (Swansea University)* *3. A microstructural evaluation of the cleavage fracture of as-cast slabs, known as 'Clinking'.* *Presenter: Guy Khosla (Imperial College, London)* *4. TRansformation/TWinning Induced Plasticity (TRIP/TWIP) steels produced by additive layer manufacturing.* *Presenter: Hossein Eskandari Sabzi (Lancaster University)*
15:20 - 15:40	**Second Perambulation** Poster Exposition
15.40 - 16:00	**Awarding of Prizes by the Armourers and Brasiers' Materials Science Committee** 1. Best Paper and Runner-up 2. Best Poster 3. Best Pitch
16:00 - 16:40	**Keynote Speaker - Ron Deelen, Chief Marketing Officer, British Steel**
16:40 - 16:50	Vote of Thanks - Chris Vaughan, Technical Director, British Steel
16:50 - 18:30	Drinks Reception

Poster Exposition

The simulation of hydrogen in magnetic iron.
Edmund Simpson (Kings College, London)

Hydrogen embrittlement of automotive ultra-high-strength steels – Generation & diffusion of atomic hydrogen.
James Lelliott (Swansea University)

Atomistic simulations of BCC-Fe and ferrite.
Angel Alberto Izquierdo Sanchez (Newcastle University)

Galling in 316 stainless steel.
Samuel Rogers (Imperial College, London)

Nanoindentation as a method for phase mapping auto-tempered martensite and lower bainite mixed microstructure steels.
Cameron Bee (WMG, University of Warwick)

Galvanised UHSS for automotive BIW applications.
James Ayres (Swansea University)

Keynote Speaker

Prior to locating to the UK, Ron, a Dutch national, lived and worked in the Netherlands, Germany and Spain. Ron has an MBA from the Technical University of Eindhoven. He started his career as a management trainee with DAF trucks and then spent 18 years with fastener company Nedschroef in a variety of management positions.

Ron said: "My first taste for the steel industry was when I took up the role as Technical Director for long products manufacturer Saarstahl. I subsequently spent time with BOSAL, which makes steel products such as tow bars, as Divisional Director and was appointed President of Europe, Middle East and Africa at German manufacturer NORMA Group."

Ron Deelen
Chief Marketing Officer, British Steel

Prior to his current position, Ron was CEO of FN Steel in the Netherlands where he led the work to support British Steel's acquisition of the company in 2017.

Ron continued: "At British Steel, we live by 3 core values – pride, passion and performance.

"We take great pride in our heritage, our products, our people and what we're helping create. We're passionate about helping our customers succeed, making our business sustainable, protecting our communities and developing our people. And we're driven to achieve our best performance through production excellence.

"We're very proud to sponsor this year's symposium, which will help strengthen the links between our industry and academia. It's crucial to us that we invest in research that looks to the future and clearly considers the bigger picture of the issues facing the steel industry.

"We'll shortly be opening our new R&D facility at the Advanced Manufacturing Research Centre in Sheffield, which will help play a vital role in building stronger futures."

BRITISH STEEL

Organised by Materials Processing Institute with support from 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 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 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
Materials Performance

Dr. Steve Ooi
Ovako Steel

Dr. Steve Ooi is a Group Technical Specialist of Ovako Steel. A company that he joined recently after working at the University of Cambridge for 9 years. He obtained his BEng, MPhil and PhD from Swansea University. His work specialises in alloy and process design in the context of steels for complex engineering applications where component failure can lead to significant consequences. Much of his research has therefore been focused on critical components in aeroengines, automobiles, stress-cancelling welding alloys, deep-ocean structures and bearings. He holds three international patents for the ferrous alloy he designed.

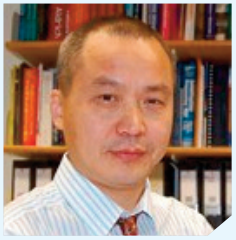
SESSION 2
New Materials Design

Dr. Richard Thackray
University of Sheffield

Dr. Richard Thackray holds a degree in Materials Science and a PhD in Metallurgy from Imperial College London. He 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 3
Materials Processing



Professor Hongbiao Dong
University of Leicester

Professor Hongbiao Dong received a First Class BSc degree and a Masters degree from University of Science and Technology Beijing and obtained his PhD in Materials Science from the University of Oxford in 2000. He joined the Department of Engineering at the University of Leicester in 2004 from Imperial College London, where he worked on modelling microstructure evolution in aero-engine turbine blades. Since October 2006 he has been awarded a Royal Society Industry Fellowship to conduct research at Rolls-Royce plc.

Role of fracture toughness and wear mechanism in impact-abrasion

SPEAKER / LEAD AUTHOR:
Appa rao Chintha

INSTITUTION:
University of Cambridge

OTHER AUTHORS:
Kati Valtonen - University of Tampere
Veli-Tapani - Kuokkala - University of Tampere
Giorgio Divitini - University of Cambridge
Saurabh Kundu - Tata Steel
H. K. D. H. Bhadeshia - University of Cambridge
Dr. Mathew Peet - University of Cambridge

ABSTRACT:
Steels for abrasion wear applications are currently developed to be harder through martensitic transformation. Although hardness generally improves the wear properties, real-life operation - such as in the case of lifting and excavation equipment - shows that other properties, such as toughness, may play a role. Due to the general variety of performance criteria that need to be met for applications, it is crucial to design materials with an optimised set of properties, thus requiring an understanding of the influence of each parameter on the final performance, as well as the interplay of different factors. Here the role of fracture toughness in increasing wear resistance is studied in impact-abrasion conditions, in an experiment that, for the first time, decouples toughness from microstructure and hardness-induced effects. An attempt was also made to understand the wear mechanism in impact-abrasion damage.

Using deep neural network with small dataset to predict solidification cracking susceptibility of stainless steels

SPEAKER / LEAD AUTHOR:
Shuo Feng

INSTITUTION:
University of Leicester

OTHER AUTHORS:
Huiyu Zhou - University of Leicester
Hongbiao Dong - University of Leicester

ABSTRACT:
Deep neural network (DNN) exhibits state-of-the-art performance in many fields including microstructure recognition where big dataset is used in training. However, DNN trained by conventional methods with small datasets commonly shows worse performance than traditional machine learning methods, e.g. shallow neural network and support vector machine. This inherent limitation prevented the wide adoption of DNN in material study because collecting and assembling big dataset in material science is a challenge. In this study, we attempted to predict solidification defects by DNN regression with a small dataset that contains 487 data points. It is found that a pre-trained and fine-tuned DNN shows better generalization performance over shallow neural network, support vector machine, etc. The trained DNN transforms scattered experimental data points into a map of high accuracy in high-dimensional chemistry and processing parameters space. Though DNN with big datasets is the optimal solution, DNN with small datasets and pre-training can be a reasonable choice when big datasets are unavailable in material study.

Aesthetic and performance enhancement of ZMA coated steels

SPEAKER / LEAD AUTHOR:
Amar Dhoj Malla

INSTITUTION:
Swansea University

OTHER AUTHORS:
James Sullivan - Swansea University
Nathan Cooze - Swansea University
Natalie Wint - Swansea University
Bakir Salgin - Swansea University
Shahin Mehraban - Swansea University
Tim Savil - Swansea University

ABSTRACT:
A combination of in-situ Scanning Vibrating Electrode Technique and Time-Lapse Microscopy were used to investigate the influence of additions of germanium (0.19-1.8 wt. %) to the corrosion performance of zinc-magnesium-aluminium alloy samples immersed in a 1 % (w/v) aqueous sodium chloride electrolyte. The addition of Ge resulted in the formation of Mg_2Ge crystals. An increased percentage of primary zinc and a corresponding decrease in the eutectic phase were also observed. Additions of 1.8 wt. % Ge resulted in a 57.88 % decrease in the mass loss, as measured by SVET. An initial increase in anodic activity, corresponding to a 0.075 V drop in Open Circuit Potential (OCP) was observed. A mechanism is proposed whereby Mg_2Ge crystals behave like a smart release vehicle of Mg^{2+} and that the enhanced corrosion resistance observed in the case of 1.8 Ge is thus suggested to results from the precipitation of protective MgO and $Mg(OH)_2$.

Comparison of Squats and Studs from different traffic environments

SPEAKER / LEAD AUTHOR:
Shaun Earl

INSTITUTION:
University of Sheffield

OTHER AUTHORS:
Katy Rankin - University of Southampton
Roger Lewis - University of Sheffield
Lindsey Smith - British Steel
Mark Rainforth - University of Sheffield

ABSTRACT:
Squats and studs are defects in railheads that share common features, but have different causes. This paper examined four squat and stud samples from three different traffic environments to compare features using μ-CT X-ray scans, surface and subsurface inspection. All defects contain similar superficial features, but the depth of subsurface damage varies. Some of the studs show branching of cracks that could continue to grow into transverse defects, breaking the rail. The three defects that were scanned would all be classed as studs, but their crack morphology varies, possibly because they are all from different traffic environments.

Hot stage quasi in-situ analysis of the effect of titanium and manganese on static recrystallization of cold-rolled low carbon V and Ti-V bearing micro-alloyed steels

SPEAKER / LEAD AUTHOR:
Ishwar Kapoor

INSTITUTION:
WMG, University of Warwick

OTHER AUTHORS:
Youngjun Lan - Tata Steel, Coventry Technology Centre
Arjan Rijkenberg - Tata Steel, Ijmuiden
Zushu Li - University of Warwick
Vit Janik - Institute for Future Transport and Cities, Coventry University

ABSTRACT:
In the present study, effect of titanium and vanadium carbide precipitates and manganese solute atoms on recrystallization behaviour of cold-rolled low carbon micro-alloyed steels is studied by annealing at different temperatures inside muffle furnace. Hot Stage quasi in-situ EBSD is carried out to understand the role of different textural components, alpha and gamma fibres during annealing. Average geometrically necessary dislocation (GND) density is evaluated at different annealing conditions to understand the recrystallization kinetics of alpha and gamma fibres. Site specific precipitate study under STEM on a FIB-lift out sample is carried out to understand precipitate distribution within ferrite matrix.

Understanding the nano-oxide particle nature of irradiated oxide dispersion strengthened steels

SPEAKER / LEAD AUTHOR:
Thomas Davis

INSTITUTION:
Department of Materials, University of Oxford

OTHER AUTHORS:
M. P. Moody - Department of Materials, University of Oxford
P.A.J. Bagot - Department of Materials, University of Oxford
M.A. Auger - Department of Materials, University of Oxford
D. E. J. Armstrong - Department of Materials, University of Oxford

ABSTRACT:
Ferritic steels will form the major structural elements for any future fusion and generation IV fission power station. Conducting neutron irradiation campaigns to such high damage levels is time consuming, expensive and induce radioactivity. As such ion implantation is preferred as at least the tool of 'first look' at new structural nuclear materials, such as Oxide Dispersion Strengthened (ODS, Fe-14Cr-3W-0.2Ti-0.25Y_2O_3) steel.

Atom probe tomography (APT) has been conducted on nanoindents themselves to determine the yttrium-oxide dispersion distribution. The APT data has provided essential information on whether the oxide particles were uniformly or non-uniformly distributed throughout the matrix. This thorough investigation has revealed an insight into how the dispersion distribution effects the hardness of the material under irradiation. The research suggests that for ODS steels to become an engineering alloy (where its mechanical properties can be predicted) is currently unattainable with a bimodal microstructure, and thus bimodal mechanical properties.

Swansea University
Prifysgol Abertawe

Surface texture and visual appearance of packaging steel

SPEAKER / LEAD AUTHOR:
Stephen Jones

INSTITUTION:
Swansea University

OTHER AUTHORS:
Dr. E. Jewell - Swansea University
R. Bröcking - Tata Steel
D.J. Wentink - Tata Steel

ABSTRACT:
The surface texture of packaging steel influences the functional behaviour of the final coated surface. Formability, appearance and damage resistance are all influenced by the surface texture of the strip. However, damage resistance and appearance are coupled functions. A good visual appearance gives poor damage resistance and vice versa. A well-designed surface texture would break this couple, giving a surface with high damage resistance and good appearance. This paper outlines the design of such a surface. Parameters which characterise the relevant functions are described. The roughness amplitude of a surface is related to damage resistance and the slopes of a surface are related to visual appearance. A surface is then simulated with features such that the surface slopes can be varied across a narrow range of roughness amplitude, meaning that visual appearance can be controlled while maintaining damage resistance. Current texturing technologies are capable of creating this surface design.

Direct observation of coal particle swelling

SPEAKER / LEAD AUTHOR:
Ian Moore

INSTITUTION:
Materials Processing Institute

OTHER AUTHORS:
Zushu Li - University of Warwick
Stephen Spooner - University of Warwick
Sridhar Seetharaman - Colorado School of Mines
Colin Atkinson - Materials Processing Institute
Jan van der Stel - Tata Steel
Stefan Born - Tata Steel

ABSTRACT:
The blast furnace–basic oxygen furnace integrated route will retain a strong contribution to global steel production throughout the current century, as such its continued improvement is desirable. Pulverised coal injection (PCI) is a key part of blast furnace ironmaking as it brings economic and environmental benefits. A thorough understanding of coal behaviour during PCI is necessary for optimised PCI operation. However, little is known about the effects of coal thermoplasticity on blast furnace performance. The high temperature confocal scanning laser microscope (HT-CSLM) provides a novel technique to evaluate the thermoplastic swelling properties of discrete coal particles. The maximum swelling ratio is shown to increase with increasing heating rate. Lighter particles are found to be more highly swelling, whilst the effect of particle size differed between coal types. A drop tube furnace (DTF) is used to 'scale-up' experiments by providing a heating environment closer to that of PCI.

The single-stage production of low zinc pig Iron nuggets from basic oxygen furnace dust using blast furnace dust as a reductant

SPEAKER / LEAD AUTHOR:
Daniel Stewart

INSTITUTION:
Swansea University

OTHER AUTHORS:
Andrew R Barron - Swansea University
David Thomson - Tata Steel Europe

ABSTRACT:
Zinc contaminated ferrous by-products are a challenge to recycle at an integrated steelworks due to zinc's deleterious effect on blast furnace performance. The Rotary Hearth Furnace (RHF) is considered the best available technology for zinc removal from contaminated by-products such as Basic Oxygen Furnace (BOF) Dust and Blast Furnace (BF) Dust, using carbothermal reduction to recover iron in the form of Direct Reduced Iron (DRI) and crude ZnO. DRI is of limited value due to its high gangue element content, due to the lack of slag separation within the process. The ITmk3 process allows from in-situ separation of iron and gangue in DRI within an RHF to produce pig iron nuggets from virgin ore using carbon as a reductant. In this study, pig iron nuggets of similar quality to the ITmk3 process were rapidly produced from BOF dust, using BF dust as a reducing agent and a siliceous flux at low residence times and realistic RHF temperatures.

A microstructural evaluation of the cleavage fracture of as-cast slabs, known as: 'Clinking'

SPEAKER / LEAD AUTHOR:
Guy Khosla

INSTITUTION:
Imperial College, London

OTHER AUTHORS:
Raza Sekha - Imperial College, London
Catrin Davies - Imperial College, London
Daniel Balint - Imperial College, London
Didier Farrugia - Tata Steel

ABSTRACT:
Clinking is the unstable, brittle, transverse fracture of continuously cast slabs of steel. The fracture can occur as the slabs are cooling after casting or in the reheat furnaces of the hot mill. Clinking is known to occur as a function of the composition and microstructure. In two grades sensitive to clinking, large columnar grains grown in the <100> direction. Tensile tests of flat plates look at how the interaction of large columnar grains influence the critical stress to fracture through conducting Digital Image Correlation on flat plate samples. Intergranular strains can be calculated and the critical fracture stress can be determined, which is then used to simulate crack initiation and propagation as a function of the microstructure size/orientation.

TRansformation/TWinning Induced Plasticity (TRIP/TWIP) steels produced by additive layer manufacturing

SPEAKER / LEAD AUTHOR:
Hossein Eskandari Sabzi

INSTITUTION:
Lancaster University

OTHER AUTHORS:
Pedro Rivera-Diaz-del-Castillo - Lancaster University

ABSTRACT:
TRansformation/TWinning Induced Plasticity (TRIP/TWIP) steels are amongst the most attractive advanced high strength steels (AHSS). In spite of their exceptional mechanical properties, elemental and processing costs limit their applicability. Additive Layer Manufacturing (ALM) is a good alternative to overcome some limitations of conventional production methods, as it allows complex shapes and decreases material waste, leading to reduced production costs, especially for low-volume components. In order to design TRIP/TWIP steels, chemical composition should be controlled to predict the activation of TRIP and TWIP mechanisms. This paper presents the advantages and disadvantages to be considered for such design. Micro-chemical segregation usually present in highly alloyed TRIP/TWIP grades can be reduced using ALM. However, high cooling rates in ALM lead to a high density of low-angle grain boundaries and fine microstructures that can suppress the activation of TRIP/TWIP mechanisms. This review aims to discuss the different ALM parameters affecting TRIP/TWIP capability.

The simulation of hydrogen in magnetic iron

AUTHOR OF POSTER:
Edmund Simpson

INSTITUTION:
King's College, London

ABSTRACT:
Hydrogen embrittlement is a complex problem that is still not fully understood, due to the multiple length and time scales involved; in order to extend this understanding, it is crucial to quantify the interaction of hydrogen with dislocations. Tight Binding is one of the simplest models that can be described as truly quantum mechanical and so has both the required scale and accuracy for these simulations.

The interaction between hydrogen and an isolated screw dislocation was probed at a range of applied strains and used to estimate the changing effects of hydrogen on screw dislocation mobility, such as enhanced kink pair formation, hydrogen drag on moving kinks and possible pinning point formation. In general, it was found that, with an increasing hydrogen lattice concentration, the regions of tension pass through the softening and hardening regimes of hydrogen effect earlier and to a greater degree than regions of compression.

Hydrogen embrittlement of automotive ultra-high-strength steels – generation & diffusion of atomic hydrogen

AUTHOR OF POSTER:
James Lelliott

INSTITUTION:
Swansea University

OTHER AUTHORS:
Professor Neil McMurray - Swansea University
Dr. Elizabeth Sackett - Swansea University
Professor Geraint Williams- Swansea University
Dr. Douglas Figueroa-Gordon - Tata Steel Strip Products UK, Port Talbot

ABSTRACT:
Increasingly, automotive manufacturers are utilising steels of increasing tensile strength to facilitate mass reduction through down-gauging. However, this tends to increase susceptibility to the hydrogen embrittlement phenomenon, which has been shown to be due to the interactions between the service (hydrogen generation) conditions, microstructure, applied stresses, and diffusion characteristics of atomic hydrogen.

The present work utilised potentiodynamic scans, scanning kelvin probe force microscope (SKPFM), time-lapse photography and scanning vibrating electrode (SVET) techniques, to characterise six different low-alloy strip steels according to their hydrogen generation (corrosion) qualities. It is shown that despite small chemistry and processing differences, there are significant differences in hydrogen generation activity (corrosion processes) between different low-alloy strip steels. Furthermore, it can be seen that the presence of pre-charged atomic hydrogen also affects the corrosion properties themselves by altering the breakdown potential of the steels, affecting different microstructures in different ways and potentially exacerbating issues faced.

Atomistic simulations of BCC-Fe and ferrite

AUTHOR OF POSTER:
Angel Alberto Izquierdo Sanchez

INSTITUTION:
Newcastle University

OTHER AUTHORS:
Alasdair Charles - University of Newcastle
Adrian Oila - University of Newcastle

ABSTRACT:
Most molecular dynamics simulations involving Fe-C ferrite (the solid solution of carbon in BCC iron) reported in the literature are actually carried out on pure iron.

This is probably because the carbon content in ferrite is very small (0.008 wt % at room temperature) and it is maybe assumed that its influence on results is not significant.

We performed deformation experiments at various strain rates and different temperatures using both, iron BCC and ferrite and our results show significant differences in the deformation behaviour of pure iron and the solid solution. At slower strain rates these differences are sufficiently large to indicate that using pure iron to represent ferrite is incorrect.

Galling in 316 stainless steel

AUTHOR OF POSTER:
Samuel Rogers

INSTITUTION:
Imperial College, London

OTHER AUTHORS:
David Dye - Imperial College, London

ABSTRACT:
Galling is a severe adhesive wear mechanism caused by high normal loads and interfacial shear forces and is often seen to occur in valves. This study investigated the effect of prior oxidation on the behaviour of galling for 316 stainless steel, a commonly used base material for galling resistant alloy development. A number of galling parameters have been investigated which show a reduction in galling damage as a result of the surface oxide. The magnitude of the galling scars has been linked with a change in size of a highly deformed subsurface region which has been named the tribologically affected zone (TAZ). The TAZ has been observed to undergo a different stress-state when compared with the bulk microstructure, likely as a result of the extreme shear in the interfacial region.

Nanoindentation as a method for phase mapping auto-tempered martensite and lower bainite mixed microstructure steels

AUTHOR OF POSTER:
Cameron Bee

INSTITUTION:
WMG, University of Warwick

OTHER AUTHORS:
Prof. Claire Davis - University of Warwick
Dr. Carl Slater - University of Warwick
Dr. Didier Farrugia - Tata Steel UK

ABSTRACT:
High strength and toughness is achieved in thick strip steels designed for the yellow goods market with mixed lower bainite and auto-tempered martensite microstructures. Different phase fractions arise due to differences in strip thickness and coiling temperatures affecting the mechanical properties. Distinguishing between these phases in low carbon steels is challenging due to their similarity in appearance, traditionally relying on visual identification from scanning electron microscope images. Nanoindentation has been used previously to characterise the properties of ferrite and martensite in dual phase steel.

The work presented extends this technique to characterise lower bainite and auto-tempered martensite; exploring the feasibility of phase mapping by quantitatively estimating phase fractions using the relative hardness of the individual phases. This method reduces subjectivity over current visual methods.

Initial results show that lower bainite and auto-tempered martensite can be distinguished, and phase mapping of ferrite/pearlite microstructures for proof of concept has been undertaken.

Galvanised UHSS for automotive BIW applications

AUTHOR OF POSTER:
James Ayres

INSTITUTION:
Swansea University

OTHER AUTHORS:
Dr. David Penney - Swansea University
Dr. Titou Minster-Blondeau - Tata Steel

ABSTRACT:
This project will look primarily at the effects that varying silicon levels has on the bake hardenability of dual phase steels, as well as the effects on other mechanical properties.

Further research will look at how silicon may also play a role in the liquid metal embrittlement (LME) of galvanised dual phase steels during resistance spot welding, an issue that is currently a major concern within the automotive industry.

2018 Symposium Highlights

BEST PAPER - WINNER

Simulation of hydrogen removal in the vacuum arc degasser

SPEAKER AND LEAD AUTHOR: Faris Karouni, University of Sheffield
OTHER AUTHORS: Professor Bradley Wynne, University of Sheffield
Professor Jesus Talamantes-Silva, Sheffield Forgemasters International Ltd
Stephen Phillips, Sheffield Forgemasters International Ltd

BEST PAPER - RUNNER-UP

In-situ time-lapse microscopy to elucidate the corrosion mechanism of Zn^3.8wt.%Al galvanising metallic coating; surface and cut-edge

SPEAKER AND LEAD AUTHOR: Callum Gallagher, Swansea University
OTHER AUTHORS: J Patel, CBMM Technology Suisse S.A.
E J Palmiere, University of Sheffield

BEST PAPER - RUNNER-UP

SVET-LI: A novel combination of scanning vibrating electrode technique and time-lapse imaging for studying the localised corrosion of sacrificial zinc coatings

SPEAKER AND LEAD AUTHOR: Rebecca Bolton, Swansea University

BEST POSTER - WINNER

Influence of composition and processing on strain ageing in high strength pearlitic wires

POSTER AUTHOR: Benjamin Jones, University of Sheffield
OTHER AUTHORS: W M Rainforth, University of Sheffield
S Hobson, British Steel

KEYNOTE SPEAKER

Bimlendra Jha
Chief Executive Officer, Tata Steel UK

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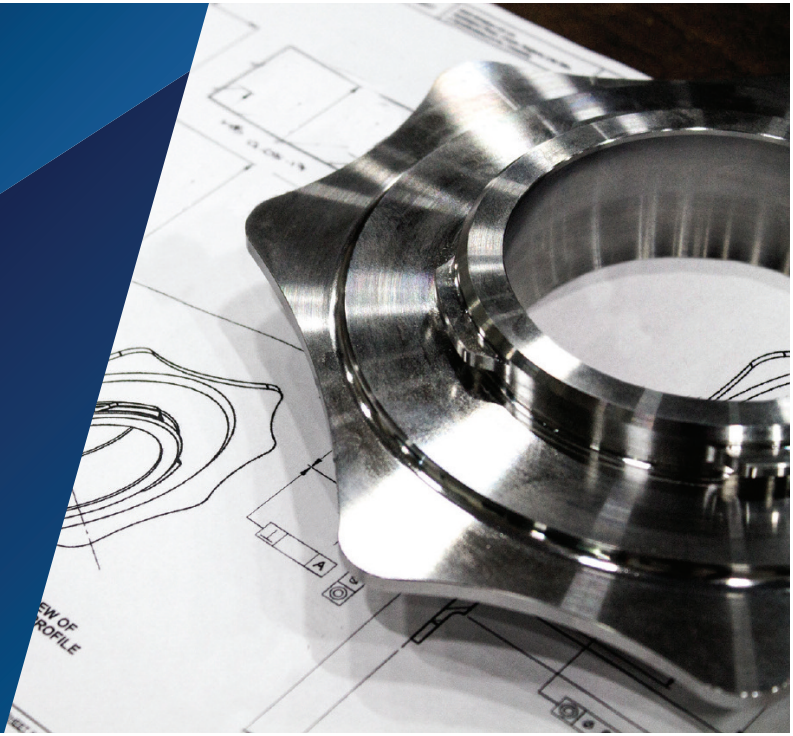

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Materials Processing Institute

Materials Processing Institute
Eston Road
Middlesbrough
TS6 6US
United Kingdom

+44 (0)1642 382000
academy@mpiuk.com
www.mpiuk.com/doctoral-academy-home.htm

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