The Iron and Steel Society

A Division of the Institute of Materials, Minerals and Mining

Iron and Steel Society Newsletter Issue 2, August 2020

Editorial from Laura Baker, Chair of the Iron and Steel Society

Dear members,

Welcome to the second edition of the Iron and Steel Society Newsletter. We, like many people across the world, have been learning to adjust to a 'new normal' in light of the unprecedented changes imposed by the coronavirus pandemic.

The iron and steel industry has been impacted heavily by the pandemic. Companies have had to reduce output as demand from our core customer base has declined, which has resulted in plants being idled across the UK. For those plants that have been producing, new working practices have had to be implemented to ensure the workforce are kept safe and any COVID-19 risk is minimised. Many academic institutions have had to close their doors during the peak of the pandemic, resulting in research being constrained to those activities that can be done from home. Thankfully, these institutions are beginning to open up again so we can look forward to a return to the first-class research facilities that we have in the UK. One of these, the Advanced Steel Research Centre at the University of Warwick, UK, is showcased in this edition of the newsletter.

Throughout this period, steelmakers and associated research institutions have provided materials for industrial health service waste bins, power generators for hospitals, manufactured hand sanitiser and developed mechanical ventilators. Steel companies are at the heart of the communities in which they serve and as such have had a critical role in supporting the national pandemic response and will play a vital role in rebuilding the post-pandemic economy.

Simon Blanchard producing hand sanitizer for Marie Curie Nurses
Photo kindly provided by *Materials Processing Institute*

Despite the challenges brought about by coronavirus, the Iron and Steel Society has not been idle. As you will read, while, unfortunately, we have had to postpone some events, most will still go ahead as we embrace the potential of virtual technology. We also remain active in British Standards committees and continue to publish the Ironmaking & Steelmaking journal which grows in strength every year.

Finally, a huge congratulations to all our award winners, every one of whom has been instrumental in contributing to technology management or driving the state of the art in iron and steel research and development.

Stay safe everyone

IOM3 Iron and Steel Society Awards 2020

Bessemer Gold Medal – **Professor David Worsley**, Swansea University

Awarded for sustained long-term interaction with the steel industry for over 25 years, focussing on research associated with the development of advanced, intelligent coating technologies primarily for steel but also with applications for other construction materials. Currently, Vice President, Innovation where he has been a major contributor to the university's growth as a key part of the UK steel R & D infrastructure.

Hadfield Medal – **Stephen Carey**, Liberty Speciality Steels

Recognised for a significant and continuing contribution to the production of extremely high quality alloy steels for a range of demanding applications, demonstrating an ability to see the bigger picture while maintaining excellence and attention to detail. Stephen has been actively involved at different stages of his career in remelting, speciality steelmaking, technical management and customer services. His expertise is highly regarded by leading global companies. At the same time, he is also recognised for his ability to support and nurture talent across the businesses he has worked in.

Thomas Medal – **Alan Scholes**, Materials Processing Institute

Awarded for a continuing contribution to the development and commercialisation of process technologies across the iron and steel sector, with involvement from laboratory and pilot scale studies through to industrial trials and plant commissioning. Alan continues to work closely with universities helping to bridge the gap between fundamental and industrial research, resulting in continuing active involvement in European collaborative projects as well as supporting clients on a global basis. He is a recognised technology and innovation leader across the industry.

Frank Fitzgerald Medal and Travel Award – **Dr Sarah Connolly**, Innovate UK

Awarded to an IOM3 member in the early stages of their career. At the time of her nomination, Sarah had an experimental and business development role at WMG, University of Warwick where she was part of the team running a small-scale rapid alloy prototyping steel production plant to assess potential new or modified steel grades. Throughout her career to-date, Sarah has been actively involved in public engagement and outreach activities organising showcase events and preparing case studies in her current position and helping with school liaison activities while studying for her DPhil at Oxford. Sarah has recently moved to a new role with Innovate UK as part of their Foundation Industries programme where she will gain increased awareness of Government and global steel sector strategies. Sarah plans to use the travel grant to attend the Future Steel Forum (Prague, late November 2020) to gain significant knowledge on the application of Industry 4.0 across the steel sector.

Adrian Normanton Medal – **Johan Martinsson, Björn Glaser & Du Sichen**, Department of Materials Science and Engineering, Royal Institute of Technology, Stockholm, Sweden

Awarded for their publicatio**n** - *The structure of foaming BOF-converter slag* which was considered the best technical paper on the topic of steelmaking, or casting published in *Ironmaking and Steelmaking (*2019, vol 46, No. 8, pp 777-781)

Williams Award – This medal is awarded for a paper of particular merit concerned with the manufacture and use of iron and steel. For 2020, it has been given for the paper - *Monitoring of less-common residual elements in scrap feeds for EAF steelmaking* – written by **Augusta Martinelli Miranda** (Department of Metallurgy and Materials, Federal University of Ouro Preto and REDEMAT, Ouro Preto, Brazil) and co-authors, as listed below.

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Augusta Martinelli Miranda[a], Paulo Santos Assis[a], Geoffrey Alan Brooks[b], Muhammad Akbar Rhamdhani[b], Andrea Fontana[c], Alister King[c], Gerald Sanders[c] and Gabriela Paula da Costa Moreira[a]

a Department of Metallurgy and Materials, Federal University of Ouro Preto and REDEMAT, Ouro Preto, Brazil;

b Department of Mechanical and Product Design Engineering, Swinburne University of Technology, Melbourne, Australia;

c Meltshop Department, Liberty Steel, Melbourne, Australia

Geoff Hale, Consultant to IOM3

Developments in UK Steel R&D Infrastructure

The Advanced Steel Research Centre at WMG, University of Warwick

At the Advanced Steel Research Centre (ASRC) we focus on research to develop new and improved steels and understand new processing technologies. Our researchers work on physical-chemical topics relating to iron and steel manufacturing and usage, tackling both fundamental and applied research from steelmaking, through to production and service.

Our work combines fundamental studies of scientific issues with applied problem solving with many of our projects being undertaken in collaboration with industry. We are also educating and developing our research students to meet the global need for highly trained engineers who understand issues of policy and the environment.

We are investigating the opportunities in new iron making technologies, new casting processes, increased use of recycled steel, in-line microstructural engineering, late stage differentiation of products and through process modelling. Alongside these, we also address product performance, optimisation and customer requirements. We are partners in the EPSRC Manufacturing Hub SUSTAIN, with Swansea and Sheffield Universities, which is focusing on Zero Waste, Carbon Neutral Iron and Steelmaking and Smart Steel Processing, and in the EPSRC-Tata Steel Prosperity Partnership Project on Rapid Alloy Processing (RAP).

Our Advanced Steel Research Centre houses cutting edge facilities, with a focus for in-situ examination, that our researchers use for their projects but is also available for external work:

- Manufacture new steel chemistries up to 7.5 kg using vacuum induction melting
- Assess processing stages from liquid metal – slag – gas interactions, to thermo-mechanical processing (hot/cold rolling and Gleeble simulations) to product properties
- Generate key thermal-physical-chemical mechanical data for models
- Conduct rapid alloy processing trials for chemistry and process variations
- Microstructual characterisation and high sensitivity chemical analysis across all length scales

The ASRC building and facilities were made possible by funding from the Engineering and Physical Sciences Research Council (EPSRC) and the Government's Local Growth Fund through Coventry and Warwickshire LEP.

Advanced Steel Research Centre, which opened in 2016

Steel casting (left) for small scale trials and in-situ observation of dendritic solidification of steel in the confocal laser scanning microscope (right) – video available at https://www.youtube.com/watch?v=_sCvdwFtljo

Contact details:

Head of the ASRC: Professor Claire Davis (Claire.Davis@warwick.ac.uk)

Microscopy and characterisation: Dr Geoff West (G.West@warwick.ac.uk)

Casting and thermo-mechanical processing: Dr Stephen Hewitt (S.Hewitt.2@warwick.ac.uk) and Dr Carl Slater (C.D.Slater@warwick.ac.uk)

Opportunities for general collaborative research in steel Dr Russ Hall (R.Hall.5@warwick.ac.uk)

Equipment usage access: Becky Doust (R.Doust@warwick.ac.uk)

ASRC website: https://warwick.ac.uk/fac/sci/wmg/research/steel_processing/

Steel Strategy Seminars

As a result of the continued COVID-19 situation, it has been decided that IOM3 events for the remainder of 2020 will be held online. The Iron and Steel Society Board had been planning events on Industry 4.0 and these will now take place as two webinars. The first one (planned for August) will focus on Industry 4.0 developments outside the UK with perspectives from Worldsteel, Europe, and Equipment and Technology suppliers. The second webinar will concentrate on the UK position – what is happening in the UK steel industry: state of readiness, barriers to implementation etc. The role of the Digital Catapult will also be discussed, together with available funding opportunities from UKRI.

Initial plans are in place for a seminar on Decarbonisation of the UK Steel Sector to be held in the first quarter of 2021.

Bessemer Day 2020

In response to the coronavirus pandemic and the uncertainty of when large groups will be able to meet physically, the Iron and Steel Society are planning to hold a virtual Bessemer Day, provisionally on Thursday 22 October. The day will consist of a Bessemer Master Class for young professionals and students working in the iron and steel sector, based around the broad theme – **Power to the people; democratisation and decarbonisation driven by coated steel products**. It is anticipated that the Master Class will cover the background to corrosion and electrochemistry and desire for longer life; manufacturing challenges in achieving metallic and organic coatings; synergies between materials with very different properties; functional coatings; demonstration and deployment; recovery of materials, reuse, and intelligent coatings.

A virtual awards ceremony to celebrate the achievement of the medal winners outlined above will be held after which Professor Dave Worsley, the Bessemer Laureate for 2020 will present the Sir Henry Bessemer Lecture – **Power to the people; democratisation and decarbonisation driven by coated steel products**

Further information will be circulated to Iron and Steel Society members later in the year, and the event will also be promoted by IOM3 via *Materials World*, on the website and using social media.

12th European Electric Steelmaking Conference – EEC2021
12-14 September 2021

This conference was due to be held in Sheffield from 16-18 September 2020. However, with the ongoing coronavirus pandemic, the event has been postponed and will now take place between *12 and 14 September 2021 at the same venue – The Diamond Centre, University of Sheffield, UK.*

The key aim of this 12th European Electric Steelmaking Conference is to provide a forum at which steelmakers, product specialists, and all other parts of the steel sector supply chain (including the academic community and research and technology organisations) can come together to share information and exchange knowledge on current and future developments across the broad spectrum of electric furnace steelmaking and its associated technologies.

The conference will have five principal technology-based themes each of which is outlined below:

Process Metallurgy of EAF Refractory & Synthetic Slag Raw Materials Optimisation Process Modelling	*Society and the Environment* Sustainable Steel Production Recovery of Process Wastes Zero Waste Strategies Materials Sustainability Compliance Case Studies/Disaster Management
Plant New Plant & Technology Plant Enhancement Technologies Greenfield vs Brownfield Site	*Energy* Long Term Energy Strategies Site Energy Management Melting Energy
Industry 4.0 Automation Big Data Systems Integration	

CIMM, GrafTech, Krakodlew, Lhoist, Liberty Speciality Steels, Luxmet and MPI have already committed to support the conference in 2021. Other sponsorship and exhibition packages are available. The programme will be structured so that there will be ample opportunities for sponsors and exhibitors to interact with conference delegates. To discuss sponsorship and exhibition opportunities at EEC 2021, please contact Sue Harris sue.harris@iom3.org.

The conference will be followed by tours to one of two special steel plants in the local area i.e. Liberty Speciality and Outokumpu Sheffield. These steelmakers produce a wide range of steel specifications from low carbon general machining steels to stainless and heat resisting alloy steels.

A series of three webinars outlining some of the topics to be covered during the conference have been scheduled. The first one on will take place on 16 September, with presentations on Industry 4.0 and Energy. Two further webinars will be held in November (Society and the Environment, and Process) and January 2021 (New Plant and Equipment, and a Conference overview). Further details will be added to the conference website at https://www.iom3online.org/eec2021.

Elimination of Mechanical Property Testing for Release of Steel Products

Many steel products are released to specified mechanical properties such as tensile strength, impact toughness, ductility and hardenability. Obtaining the relevant test coupons, machining the samples and carrying out the testing can be a time consuming and expensive operation. Furthermore the measured properties may not be representative of all the material supplied – for example in the production of strip, mechanical property test samples are often taken from the outer wraps of the coil which may have experienced different rolling conditions and coil cooling rates from the body of the coil.

The idea of omitting the testing step and releasing material to calculated properties is not new. Systems for calculating the hardenability of steels from chemical composition have been available, using the work of Grossman (1) since the 1950s and some rail steel standards (2) allow material to be released to tensile strength and ductility values calculated from regression equations based upon the chemical composition. In recent years great strides have been made in the development of predictive models. These include thermodynamic and kinetic models which allow accurate predictions of the phases present in steels. Finite element or thermomechanical models of hot rolling processes can be coupled with these to predict

microstructures in hot rolled products which can in turn be used with microstructure/property relationships to predict the product properties.

Steel companies have invested heavily in model development, primarily to aid alloy design and to improve process control. This has led to greater consistency of product properties, lower rejection rates and, with the elimination of testing, faster release of material to the customer. Models may be physically-based and these can be used over broad ranges of composition; they are especially useful for developing new compositions where existing data are not available.

For maximum accuracy statistical modelling is often preferred based on data from more restricted ranges of composition and processing parameters. This includes techniques such as linear regression, neural networks and increasingly artificial intelligence.

A further development of this approach is the use of advanced sensors to measure structure-sensitive parameters based on, for example magnetic or ultrasonic properties, which can then be related to final product properties. Great strides have been made in developing sensors which can operate reliably in the harsh environments found for example in hot rolling mills but they can also be used at room temperature on the final product (3).

As outlined above, the release of material to modelled properties benefits both the steel producer and the end users. However, just as the validity of mechanical properties measured by conventional testing is ensured by adherence to national and international testing standards it is important that systems are in place to ensure modelled property values are equally reliable.

With conventional testing the property will be measured using tightly controlled procedures whereas with modelled properties inputs and calculation procedures can differ widely. For maximum accuracy models must be tuned for a particular production site and details of the models may be considered commercially sensitive. A European standard is currently being developed to allow the validity of modelled properties to be demonstrated. This will lay out a procedure to specify what are the inputs and outputs to the models, how the predictions of the models are validated and how this validation is repeated periodically to ensure the continued validity of the predicted values. It is important to stress that the standard does not look at the detailed workings of the models it only looks at the inputs and outputs and ensures that the models are validated initially and periodically during use. In this way the ranges for the input data and final predicted property values for which the modelled properties are valid is clear.

The process laid down should permit producers and end users to have confidence material released to predicted property values using models developed and maintained by themselves or others. The new standard (4) is expected to be available towards the end of 2021. In order to make use of the benefits outlined above from the use of modelled properties to release material, it is important that potential users have in place the production equipment and robust validated models, together with the systems to demonstrate the continued validity of their predictions.

1. M.A.Grossmann, “Elements of Hardenability”, Cleveland (ASM), 1952
2. Railway applications – Track =- Rail: Part 1: Vignole railway rails 46 kg/m and above, BS EN 13674-1:2011)
3. https://www.emg-automation.com/fileadmin/content/automation/qualitaetssichernde_systeme/dokumente/IMPOC_brochure_EN_Rev00_01-2018.pdf
4. pr EN 10373 – Determination of the Physical and Mechanical Properties of Steels Using Models.

Peter Morris

peter.f.morris@virginmedia.com

Ironmaking and Steelmaking Journal

The journal is growing its number of submissions year on year. This is most encouraging and even in the recent few months there has been no apparent drop off in numbers. The bulk of the submissions originate from China, but there are indications of a progressive geographic spread. However, the Editors and the Publishers can increase their networking activities to increase this spread.

As at the time of writing this article, the Impact Factor for 2019 is not yet available, but there is no reason to suspect that it should not continue its rising trend. In 2016, a review paper on *Microalloyed Steels* authored by Prof. T.N.Baker of the University of Strathclyde in Glasgow received 8956 views on the journal website. At that time this was seen as being an exceptional level. However, a paper on *Sulphur Removal in Ironmaking and Oxygen Steelmaking* was published and has received the incredible number of 23,727 views to date. The authors were Frank Schrama, Elisabeth Maria Beunder, Bart Van den Berg, Xongxiang Yang, and Rob Boom, who had affiliations with TU Delft, Tata Steel, and Danieli Corus. Both were review papers, and it clearly shows the benefits of having available such material. Both those papers were subsequently recipients of the Williams Award by IOM3.

Within the last few months, the journal has been able to publish three themed editions – continuous casting, non-metallic inclusions, and blast furnaces. Each edition had approximately twelve papers on that topic. This can only be achieved when there are enough papers ahead of publication on the specific subject. Hopefully, this has met with the approval of the readership.

As editors we are keen to try different approaches but still retain the essential strengths of the journal. As readers of this article I would encourage those of you who can to seriously consider submitting your research or articles to Ironmaking and Steelmaking. In addition, if you have concepts which we could consider as review article subjects then we would be glad to consider them.

Taylor and Francis, the publishers, did stop printing journals in mid-April as a result of the COVID-19 situation. However, this was a temporary measure and printed copies are being distributed once more.

N.McPherson

Co-Editor

norriemcpherson1@hotmail.com

Contact us

Any comments regarding the content or format of the Newsletter are most welcome. Also we are happy to consider short articles on technical or commercial topics for inclusion in future editions

Please contact either Peter Morris (e - peter.f.morris@virginmedia.com) or Geoff Hale (e - geoffhaleiom3@gmail.com)