sustain

future steel manufacturing research hub

Additional information for Early Career Researcher (ECR) Platform Call

Autumn 2020

Sponsored by:

UKRI Engineering and Physical Sciences Research Council

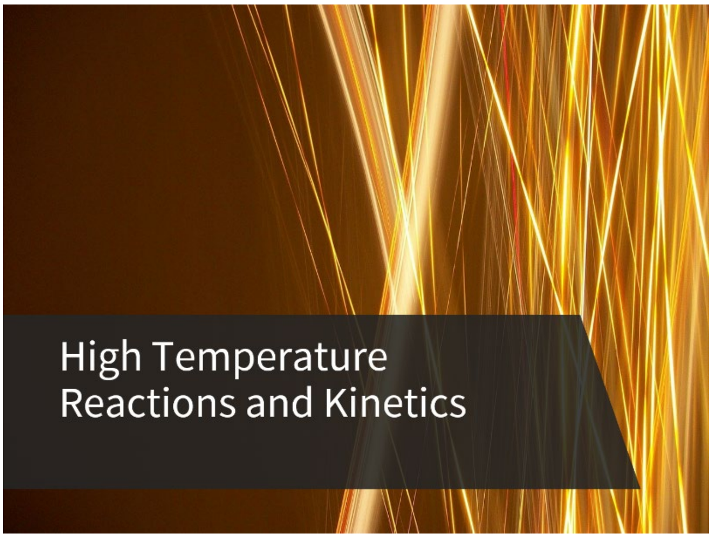
Academic Partners:

Swansea University Prifysgol Abertawe

The University Of Sheffield.

WMG THE UNIVERSITY OF WARWICK

Platform Scope

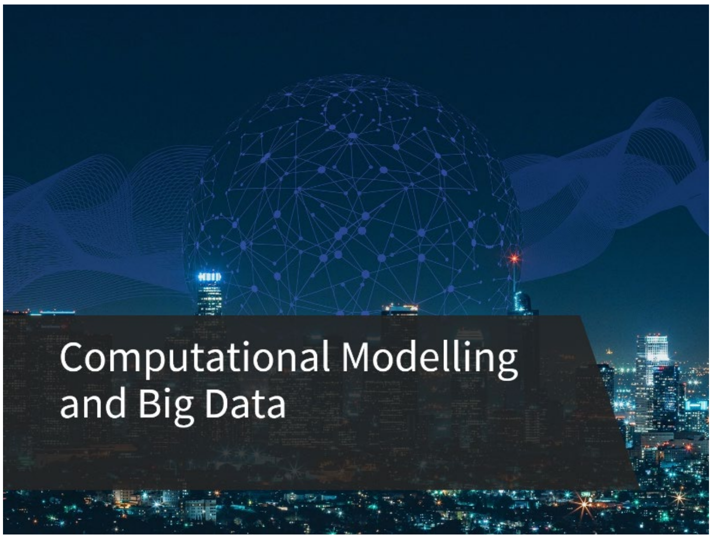


Scientific Lead:
Professor Peter Holliman
Swansea University

This challenge is open to TRL 0-1 ideas focussed upon the identification and development of novel fuel sources and reactors that could be used to replace existing fossil fuels or carbon fuel sources within all steelmaking routes. This includes the investigation of suitable domestic and/or industrial wastes, novel non-carbon based energy sources and the processing of new or existing materials to make them suitable for a particular process – e.g. physical properties such as strength, heat of combustion, auto ignition temperature and range and by-products of combustion. Ultimately the performance of such alternative fuels should be projected into an identified process route and assessed in comparison to the existing methods.

Investigation into alternative processes will also be considered that improve efficiency to existing combustion methods for producing hot metal or heating liquid steel if deemed step-change rather than an incremental improvement.

The proposed research can be simulation and/or practical experimentation.



Scientific Lead:
Professor Arnold Beckmann
Swansea University

Real Time prescriptive and predictive analytics in the context of Steel Manufacturing

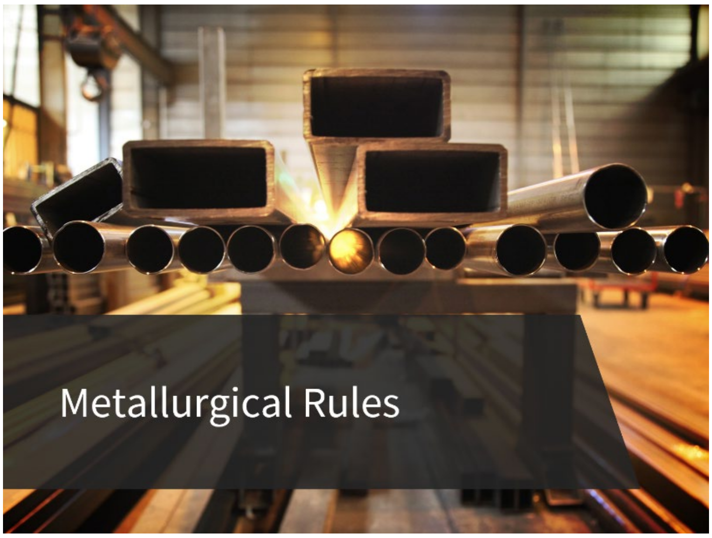
Computational modelling and Big Data play important roles in today's world, including the manufacturing of steel. The successful application of advanced analytics in the steel sector has been identified as an important step towards improving efficiency and competitiveness. One major goal is to achieve autonomous decision making. An essential step towards this goal is to enable prescriptive and predictive analytics capabilities in real time. It is believed that the latter requires a combination of different AI methods to be used, ranging from statistical (like machine learning) to symbolic ones (like rule-based systems involving ontologies).

The priority area in this year will consider low TRL (0-2) research focussed on advanced analytics approaches that leverage both statistical and symbolic AI technologies. The focus should be on the combination of such methods, and their potential for the steel sector.

Scientific Lead:
Professor Mark Rainforth
University of Sheffield

Microstructure determines the properties of steels. The improvements in in-line monitoring has led to steels with a much more predictable mechanical properties through tighter control of the microstructure. This is essential as steel specifications become more stringent with time. However, the complex interactions of the different microstructural attributes of steel means that we have a long way to go. Indeed, we still rely on empirical rules, for example, for predicting the effect of alloy composition (see 'Metallurgical Rules"). A long-standing issue is the length scale problem, with microstructural factors at the nm scale (e.g. manganese and carbon segregation) affecting the mechanical properties at the macroscopic scale. Our ability to quantify microstructure across the length scales has improved greatly in recent years, with the advent of new experimental techniques (such as high resolution, large area EBSD) and of new methods to analyse microstructures (e.g. machine learning techniques that can differentiate microstructures that the human eye cannot). There is a need to move towards quantifying the heterogeneities in microstructure that are driven by factors such as segregation and strain path differences. This must be an intelligent analysis of distributions, not just the generation of averages. The heterogeneities must be carefully correlated with the mechanical properties such that the effects are understood.

This challenge is aimed at low TRL (0-2) research focussed on characterisation and monitoring techniques that move forward our understanding of microstructural quantification, across the length scales and including an understanding of heterogeneities. This work can also feed into Scientific Challenge 4, Metallurgical Rules. Combined modelling and experimental approaches are particularly welcomed.



Scientific Lead:
Professor Claire Davis
University of Warwick

Metallurgical rules are essential underpinning concepts that support new alloy development and/or optimisation of process parameters. Metallurgists use many fundamental and empirical rules that have been developed bottom up from first principles or from analysis of experimental data with fitting parameters. There are opportunities to revisit some of the empirical rules utilising advanced computational power, increased characterisation resolution and fundamental understanding to minimise the use of fitting parameters and develop approaches that are more widely applicable. Advances in commercial and open access software means that new fields of research can be considered; for example, combined thermodynamic - thermomechanical modelling coupled with computational alloy design allowing new steel concepts to be considered.

The establishment of rapid alloy processing facilities means that these scenarios can then be validated. Production of high value steels requires tight control of processing and properties with narrow property ranges that need to be achieved. Accurate prediction and characterisation of microstructure, to include full distributions (e.g. grain sizes/precipitate sizes) rather than just average values, is required, particularly where non-uniform distributions occur. The advanced characterisation tools and modelling approaches available make this an achievable goal.

In this challenge low TRL (0-2) research focussed on developing understanding and applicability of the metallurgical rules underpinning steel compositional and processing design will be supported. Coupled modelling and experimental approaches are particularly welcomed.

Role of Scientific Leads (SLs)

The main role of the SLs is to direct and manage the scope of the Platform activity and mentor the Early Career Researchers (ECRs). The SLs will define annual priority areas (cross cutting themes) that address underpinning knowledge requirements for the Grand Challenge Research Activities (GCRA) to upskill staff, support career progression and ensure bi-directional knowledge transfer between academia and industry.

SLs will guide ECRs according to the Vitae Concordat and address the barriers therein through the completion of the project work and development of skills and experience.

SLs will identify and encourage existing research staff to produce applications for TRL 0-2 research within the Sustain GCRA to initiate the Platform and assign a suitable mentor from the SL cohort and senior members of staff. SLs may sponsor suitable candidates to facilitate this process.

Working with appropriate industrial contacts, the SLs will minimise the risk of reduced research efficacy and impact that is expected from ECRs by mentoring and advising throughout the idea generation, research and publication process.

Sustain KPI’s

<table>
<tr><th>Type</th><th>KPI</th><th>Aligned Ambition</th></tr>
<tr><td rowspan="4">Publication & Dissemination</td><td>Conference Publications</td><td rowspan="4">International Academic Leadership 2030</td></tr>
<tr><td>Journal Publications</td></tr>
<tr><td>Policy Publications and Briefings</td></tr>
<tr><td>Total Citations</td></tr>
<tr><td rowspan="4">Pathway to Manufacture</td><td>Patents</td><td rowspan="4">Double GVA by 2030</td></tr>
<tr><td>Investments</td></tr>
<tr><td>Traceable CAPEX</td></tr>
<tr><td>Productivity Enhancement</td></tr>
<tr><td rowspan="6">Outreach and Engagement</td><td>Sandpits</td><td rowspan="6">Responsible Innovation & International Academic Leadership</td></tr>
<tr><td>SUSTAIN Conference</td></tr>
<tr><td>Academic Engagements</td></tr>
<tr><td>New Spokes</td></tr>
<tr><td>Public Engagements</td></tr>
<tr><td>New Industrial Partners</td></tr>
<tr><td rowspan="3">Leverage</td><td>UKRI (RC) Competitively won</td><td rowspan="3">Sustainability & Impact</td></tr>
<tr><td>Innovate UK (Open)</td></tr>
<tr><td>Innovate UK (ISCF)</td></tr>
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