4th Annual Australia & New Zealand Steel Symposium 2022
7 November 2022, Melbourne, Australia

Editors

Geoffrey Brooks
Isis Ignacio

Organising Committee

Geoffrey Brooks
Leonard Woods
Andrea Fontana

We wish to thank the main sponsor for their contribution to the success of this symposium.
Symposium Program
(Monday, 7 November 2022)

8.30 - 9.00  Registration in EN615 – Engineering Building

9.00 - 9.10  Welcome by Andrea Fontana (Liberty GFG)

Session 1  Chaired by: Andrea Fontana (Liberty GFG)

9.10 - 9.35  01 – (Virtual) Handling the Future Dearth of H₂ and DRI Quality Iron Ore - Sara Hornby, Global Strategic Solutions

9.35 - 10.00 02 – The Use of Hydrogen in Ferroalloy Making - Oleg Ostrovski, University of New South Wales

10.00 - 10.25 03 – Physical Chemical Limits to Using Hydrogen in Iron and Steelmaking - Geoffrey Brooks, Swinburne University of Technology

10.25 - 10.50 04 – Technology Readiness Level and CO₂ Reduction Potential of Green Steel - Shahabuddin Ahmmad, Swinburne University of Tech.

10.50 - 11.05  Coffee/Tea Break in EN 612 (Staff Kitchen)

Session 2  Chaired by: Oleg Ostrovski (University of New South Wales)

11.05 - 11.15 05 – Overview of the Victorian Hydrogen Hub (VH2)– Gordon Chakaodza – Victorian Hydrogen Hub

11.15 - 11.40 06 – Green Iron Ore - Mark Pownceby, CSIRO Mineral

11.40 - 12.05 07 – Hydrogen Reducibility of Iron Ore Sinters – Isis Ignacio, Swinburne University of Technology

12.05 - 12.30 08 – Simulation of Burden Experience in a Hydrogen Enriched Blast Furnace - Nathan Barret, University of Newcastle


12.55 - 1.30  Lunch in EN 612 (Staff Kitchen)
**Session 3**  
Chaired by: Israel Murgas (Liberty GFG)  

1.30 - 1.55  
10 – Estimation of Zone Temperature Profiles in a BOF - **Nirmal Madhavan, Swinburne University of Technology**

1.55 - 2.20  
11 – Use of Sound to Measure Slag Foaming in the BOF – **Jason Heenatimulla, Swinburne University of Technology**

2.20 - 2.55  
12– Capability Improvement of the Rail Head Hardening Process at the Whyalla Steelworks - **Israel Murgas & Navjeet Singh, Liberty Primary Steel (Whyalla)**

2.55 - 3.10  
Coffee/Tea Break in EN 612 (Staff Kitchen)

**Session 4**  
Chaired by: Geoff Brooks (Swinburne University of Technology)  

3.10 - 3.35  
13 – Nb Effect on the Austenite Grain Size and Elongation of as-Rolled Microalloyed Rail Steel - **Israel Murgas & Larisa White, Liberty Primary Steel (Whyalla)**

3.35 - 4.00  
14 – Assessment of Metals Extraction Processes on Mars – **Akbar Rhamdhani, Swinburne University of Technology**

4.00 - 4.25  
15 – Thermal Decomposition of FeO from Silicate Ores - **Matthew Shaw, Swinburne University of Technology**

**End of Symposium**
Handling the Future Dearth of H₂ and DRI Quality Iron Ore

S. Hornby
Global Strategic Solutions

With the world H₂ availability anticipated to be only 4% to 11% of worldwide requirements by 2050 and “DRI quality iron ore” becoming increasingly unavailable, the steel industry needs to consider alternatives to “the Global Remediation Solution” - H₂ reduced DRI EAF steelmaking. GHG emissions could be significantly reduced in perhaps several less capital-intensive ways and reduce the significant techno-socio-economic impact of BF/BOF mill conversion and closure. This presentation will consider more intensive BF tuyere injection, charging of HBI (where low-grade iron ores can be tolerated) to both the BF and the BOF, and carbon capture and use (CCUS). These actions would increase productivity, decrease coke rates & GHG/Te hot metal, and improve BF cooling. Use CCUS would reduce GHG by 40% now and, when H₂ is available, by 80% which is effectively the level achieved by scrap fed EAFs. Low-grade iron ore reduction in the DRPs and further processing options will also be considered.

Dr. Sara Hornby
Founder and President at Global Strategic Solutions

Sara received her BSc (Hons) Metallurgy and her British Steel Corporation (BSC) sponsored PhD in Industrial Metallurgy at Sheffield Hallam University, UK. Her UK cupola foundry, R&D, and Steelmill (Firth Brown Tools and BSC) experience provided a good basis for her N. America career which began with >17 years with air Liquide. This was followed by technology company management positions (Tenova Goodfellow, Midrex Technologies Inc., Linde Gases, Inteco PTI, TMS International) leading finally to her own consulting company, Global Strategic Solutions, Inc. Sara holds 5 patents, has published over 127 papers, seminars and courses internationally and was the 2020 recipient of both the AIME AIST Benjamin F. Fairless Award and the AIST EF technical committee’s John Bell Award. She is an AIME Oral History participant, an interviewee for the Women in Steel books and is the Institute of Metals, Mining and Material’s (IoM3’s) 2022 Hadfield Medal recipient.
The paper considers reduction of manganese oxides by hydrogen to MnO and carbothermal reduction of manganese, chromium and titanium oxides in hydrogen. MnO can be processed further to metallic manganese in the electrolytic process. Direct reduction of stable metal oxides (manganese, chromium, titanium, silicon and other oxides) to the metallic state requires very high H₂ to H₂O ratio, which can be achieved by the carbothermal reduction in hydrogen. Carbothermal reduction in hydrogen can be implemented at lower temperatures in the solid state with potential advantages over conventional reduction of oxides from molten slags.
Physical Chemical Limits to Using Hydrogen in Iron and Steelmaking

G. Brooks
School of Engineering
Swinburne University of Technology

Hydrogen has distinct properties that greatly affect its application to iron and steelmaking operations. The gas’s low density and very low boiling point greatly influences storage options. The combustion behaviour of the gas has several important differences to natural gas, such as a higher flame temperatures and low energy density (on a volume basis), which in turn has follow on effects to application in steelmaking operations. Hydrogen can readily reduce iron oxide but the thermodynamics of the reaction favour reduction at high temperatures (>800 °C). The endothermic nature of the reactions means that controlling heat distribution in ironmaking furnaces is an important consideration in process design. The kinetics of reduction are generally fast (in comparison with CO) but particularly fast above 1100 °C. The high cost of hydrogen also provides an incentive to limiting its usage in ironmaking to what is required for reducing iron ore and using other energy options for process heat requirements.

Professor Geoff Brooks
Swinburne University of Technology

Geoff has published over 250 papers on fundamentals aspects of iron and steelmaking, has been invited to speak at many leading Universities around the world and has worked closely with steel companies in Europe, Asia and North America. He is currently a Professor of Engineering at Swinburne University of Technology. Geoff has been previously an Associate Professor at McMaster University in Canada and a Senior Lecturer at University of Wollongong. In 2013, Geoff was awarded the prestigious John Elliott Lectureship Award by the AIST (Association for Iron and Steel Technology), USA. He was also awarded the 2018 EPD Distinguished Lecturer by the TMS. Geoff and research collaborators have also been awarded a number of international awards such the 2015 MetSoc Award, 2015 Marcus Grossman Award ASM and 2020 Williams Award IOM3. He is a fellow of the Institute of Materials, Minerals and Mining.
Technology Readiness Level and CO₂ Reduction Potential of Green Steel

M. Shahabuddin¹, ², Geoffrey Brooks¹, ², Muhammad Akbar Rhamdhani¹, ²

¹Victorian Hydrogen Hub (VH2), Swinburne University of Technology, Hawthorn 3122 VIC, Australia
²Fluid and Process Dynamics (FPD) Group, Department of Mechanical and Product Design Engineering, Swinburne University of Technology, Hawthorn 3122 VIC, Australia

Steel industries emit 2.6 Gt CO₂, accounting for 7.0% of the global CO₂ emission. There has been a global effort to reduce the carbon footprint from this heavy industry through technological innovation. This study reports the technology readiness level (TRL) and CO₂ reduction potential of such low-carbon/green steel technologies based on the data available in the open literature. We classify green steel technologies into three major categories based on using CCUS, hydrogen, and direct renewable electricity. It is found that the TRL for the technology based on the application of CCUS in blast furnaces and smelting reduction lies between 7 to 9, while a TRL of 5 to 7 and ≤5 for hydrogen and direct electrifying technologies on a scale of 9. The CO₂ reduction potential of CCUS-based technologies is at a maximum of 80%, while ≥95% using the other two.

Dr. Shahabuddin Ahmmad
Swinburne University of Technology

Dr Shahabuddin is a Senior Research Fellow at Swinburne University of Technology, Australia. Previously he worked as a Research Fellow for Hydrogen Energy and waste material recycling projects at Federation University and the University of New South Wales. Shahabuddin’s current research focus includes application of hydrogen in heavy industries such as iron & steel manufacturing, including technoeconomic and life cycle assessment (LCA). He received his PhD in Chemical engineering from Monash University and MPhil from The University of Adelaide.

To date, Shahabuddin has published 50 research articles, which have received about 2,700 citations. Shahabuddin also works as an editor/guest editor/topic editor for various journals. Dr Shahabuddin is a certified material professional (CMatP) in Materials Australia and a member in Engineers Australia and the Institution of Chemical Engineers (IChemE).
Overview of the Victorian Hydrogen Hub (VH2)

G. Chakaodza
Victorian Hydrogen Hub

Gordon Chakaodza is Director of the Victorian Hydrogen Hub (VH2) at Swinburne University of Technology. He specialises in bringing together industry, research, community, and government to undertake transformative work in the development and adoption of new technologies. To date, Gordon has worked in senior leadership roles across multiple sectors in both Australia and overseas.

Working closely with the VH2 team, industry partners as well as Swinburne academic staff, Gordon and team have launched and operationalised the VH2 program with a goal of making it a nationally recognised centre of hydrogen development excellence.
Green Iron Ore

M. Pownceby
CSIRO Mineral Resources

Transitioning from coal-consuming blast furnaces to green hydrogen-based DRI processes is a key step in the global steel sector’s decarbonisation pathway. Insufficient supply of suitable high-grade (>66% Fe)* ores is however a significant challenge with head grades declining as high-quality, easy-to-mine resources are exhausted, and increasing reliance on below water table and problematic, low-grade ore types. Mineral processing (beneficiation) underpins efficient and sustainable steel production and is essential to securing high-quality raw material for green steel production. While in-ground resources cannot be changed, technical market knowledge supported by fundamental research into geometallurgical and unit process understanding can improve long-term value optimisation. This presentation discusses the impacts of low-grade ore types on decarbonising the iron and steelmaking industry and considers potential forward pathways.

*4% above the benchmark index and ~5-6% above the grades of major Pilbara iron ore producers.

Dr. Mark Pownceby
Senior Principal Research Scientist, CSIRO Mineral Resources

Dr Mark Pownceby is a Senior Principal Research Scientist with CSIRO's Mineral Resources Business Unit where he leads the Iron Ore Geometallurgy team. He has >25 years experience in iron ore and his major activities involve ore characterisation, beneficiation and understanding the complex mineral assemblages formed during the sintering of iron ores. He has made significant contributions to fundamental studies of iron ore. In particular, Mark and his colleagues have brought a strong scientific understanding to the sintering behaviour of iron ores through high temperature x-ray diffraction and determination of important chemical equilibrium data for these systems.
Iron and steelmaking have a significant contribution in producing greenhouse gases and there is a worldwide push towards decarbonising the process. One of the approaches to reduce CO₂ emissions is to use hydrogen in the blast furnace (BF) as reductant gas. However, hydrogen reduction is an endothermic reaction, bringing changes to the temperature distribution in the BF. Therefore, understanding iron ore sinter mineralogy and reducibility under hydrogen atmosphere is essential to optimise the process. In this presentation, the latest knowledge on hydrogen reduction of iron ore sinters were discussed, especially focusing on magnetite sinters and how to improve their reducibility.

Isis Ignacio
PhD Candidate, Swinburne University of Technology

Metallurgical Engineer graduated from Universidade Federal Fluminense, Brazil, in 2015. Currently, Isis is a final-year PhD candidate at Swinburne University of Technology, Melbourne, Australia. Her research investigates the mineralogy and its influence on strength, reducibility, and porosity of iron ore sinters, in partnership with CSIRO. She also works as researcher in the Direct Reduced Iron Fundamentals Project in collaboration with Swinburne University and Calix, where she investigates their zero-emissions iron process ZESTY.
Simulation of Burden Experience in a Hydrogen Enriched Blast Furnace

Nathan Barrett¹, Subhasish Mitra¹, Damien O’Dea², Paul Zulli³, Sheng Chew⁴, Tom Honeyands¹

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²BHP, 480 Queen St, Brisbane, QLD, 4000, Australia.
³University of Wollongong, Northfields Ave, Wollongong NSW 2522, Australia.
⁴BlueScope, Coke & Ironmaking Technology, Port Kembla, NSW 2505, Australia.

The blast furnace remains as the primary source of hot metal for the steel industry. Modern blast furnaces operate primarily on coke – which acts as a fuel, source of reducing gas and provides a permeable internal structure. Enrichment of the blast furnace using hydrogen has been proposed to supplement carbon monoxide as a reducing gas. To aid the transition to hydrogen enriched blast furnace ironmaking, this study presents the conditions experienced by the burden during its descent in a simulated blast furnace with hydrogen injection. Particular consideration is given to the radial distribution of gas compositions, and translation of determined conditions to experimental burden characterisation techniques.

Nathan Barrett
PhD Candidate, University of Newcastle

I am a Chemical Engineering graduate in the final year of my PhD with the Centre for Ironmaking Materials Research (CIMR) based at the University of Newcastle. My project is focussed on the utilisation of Australian lump ores in future hydrogen-enriched blast furnace operations, and the interactions that occur in the cohesive zone between lump iron ore and sinter. This project has involved both theoretical modelling and experimental techniques to understand and characterise burden behaviour.

Kenji Taira¹, ²

¹Monash University
²Nippon Steel Corporation

Temperature history in the sinter bed determine the quality of sinter pellets, but there are limited reports on the experimentally determined temperature distribution in the sinter bed. This study experimentally investigates two-dimensional temperature distribution in the sinter bed and its time variation by scanning thermocouples during combustion. The comprehensive data on the temperature distribution enabled numerical validation of the reaction. The time course profile of the flame front speed (FFS) was visualized at each radial position. Rietveld analysis of sinter samples showed a clear correlation between the temperature history during the reaction and the mineral phases.

Dr Kenji Taira
Researcher, Monash University

Dr Kenji Taira is a visiting researcher at the Department of Chemical and Biological Engineering of Monash University. He has been working for Nippon Steel, the world’s 5th largest steel company, since graduating from The University of Tokyo. Kyushu University granted him a Ph.D. His research interest includes catalysts for flue-gas treatment and H₂ production, and biomass and waste usage in the steel industry. The Iron and Steel Institute of Japan awarded him for his work on in situ monitoring techniques. He is the first author of 15 papers (ACS nano, J. Cat., etc.) and ~30 patent applications.
Estimation of Zone Temperature Profiles in a BOF

N. Madhavan¹, G.A. Brooks¹, M. A. Rhamdhani¹, B.K. Rout² and A. Overbosch²
¹Department of Mechanical Engineering and Product Design Engineering, School of Engineering, Swinburne University of Technology, Hawthorn, Australia
²Tata Steel, The Netherlands

In a Basic Oxygen Furnace (BOF), the reactions are believed to take place in various localised zones such as steel bath, slag, hot spot, and emulsion zone. Therefore, a distinct temperature profile can exist across different zones. The present study integrates the refining profiles into the heat transfer model to estimate the temperature profiles at hotspot, slag, and steel bath zones in a BOF. The results highlight that the hot spot temperature ranges from 1900 to 2090 °C, with a peak value of around 2300 °C observed during the middle of the blow. In the case of the steel bath and slag zone, the slag temperature was predicted to be lower than the hot metal temperature at the initial phase of the blow; thereafter, the slag temperature becomes greater than the hot metal temperature. The availability of more time-based plant data could be used to improve and refine these models.

Nirmal Madhavan
PhD Candidate, Swinburne University of Technology

Nirmal Madhavan is a Ph.D. candidate at the Swinburne University of Technology and holds a Master's degree in Fluid and Thermal Engineering from the Indian Institute of Technology (IIT). His research interests include understanding the processes at high temperatures. His Ph.D. research is focused on developing a mathematical model for understanding heat transfer aspects in the oxygen steelmaking process in collaboration with Tata Steels, The Netherlands. Apart from research, he also worked in different roles as a Design Engineer at Infosys Engineering Limited and Assistant professor at Mar Baselios Engineering College. He was one of the candidates selected in 2016 as a Senior Engineer to work for the coveted warship and Scorpene class submarine builders under the Ministry of Defence, India. His research interest includes understanding the heat transfer aspects of oxygen steelmaking, high-temperature computation, porous media combustion, energy storage techniques, and sustainable technologies.
Use of Sound to Measure Slag Foaming in the BOF

Jason Heenatimulla$^{1,2}$, Geoffrey Brooks$^{1,2}$, Michelle Dunn$^{1,2}$, David Sly$^{1,2}$, Rod Snashall$^{3,2}$ and Wang Leung$^{3,2}$

$^1$Swinburne University of Technology, Hawthorn, Australia  
$^2$ARC Research Hub for Australian Steel Innovation, University of Wollongong, Wollongong, Australia  
$^3$BlueScope Steel Limited, Australia

Sound or acoustic data have been used to control slag foaming in the BOF since the 1970s and has been an important tool for steelmakers. The main goal of existing sonic meters (sound sensor) is to provide enough information to operators to avoid the BOF slag foam from overflowing (slopping) during the blow. The accuracy of these meters in obtaining real time measurements that may correlate with the extent of slag foaming during the blow is unclear. This review describes previous research carried out using cold models and plant data focused on these issues. Also discussed is an overview of current research at Swinburne designed to better understand the fundamentals of sound in slag foam that should lead to an improved analysis of plant data with higher accuracy.

Jason Heenatimulla
PhD Candidate, Swinburne University of Technology

Jason Heenatimulla is a young Mechanical Engineer, who graduated from Swinburne University of Technology in 2020 with a Bachelor’s (Honours) degree. His final year research was on the sound analysis of ingot casting which interested him in sound and the steel making industry. His undergraduate studies helped gain a deeper understanding on signal analysis, metallurgy, and physical modelling.

Jason is currently a PhD student at Swinburne University of Technology in collaboration with the Steel Research Hub and BlueScope Steel. His research focuses on the acoustic analysis of the oxygen steelmaking process, to determine an accurate method of measuring slag foam heights in the BOF.
Capability Improvement of the Rail Head Hardening Process at the Whyalla Steelworks

Israel Murgas & Navjeet Singh
Steelmaking Department, Liberty Primary Steel, Whyalla Steelworks

The Whyalla Steelworks produces as-rolled rails and head hardened rails for the Australian market, as per AS1085.1:2019. The head hardened rails are produced by using an offline heat treatment process. Part of the rail head is heated first by two consecutive inductors to full austenisation and then rapidly cool down by an accelerated and controlled cooling system featuring compressed dry air. This process is capable to meet AS1085.1:2019 minimum tensile and hardness requirements only if the rail chemistry is controlled within a very tight carbon equivalent window. Therefore, to improve the head hardening process capability trial heats were microalloyed with Ti and some of the Ti-microalloyed rolled rails were processed through the Head Hardening Plant at both standard and modified air flow rate. It was found that the effect of Ti nitrides on pinning austenite grain boundaries resulted in an increased in elongation between 1 to 2 %. On the other hand, an increase in flow rate from 1600 Nm³/hr to 1800 Nm³/hr resulted in an increase of about 20 MPa in tensile strength and of 20 to 30 Vickers in the hardness measured at 10 mm from the running surface.

Israel Murgas
Metallurgical Engineer, Whyalla Steelworks
Metallurgical Engineer, University of Santiago, Chile
Master of Sciences – University of NSW, Australia
5 years as a Lecturer at University of Santiago, Chile
33 years at the Whyalla Steelworks working on Rolling Mills and Steelmaking processes
Main work in product/process development and Process Control

Dr. Navjeet Singh
Process Engineer, Whyalla Steelworks
Navjeet Singh joined Steelmaking technology team as a process engineer in November 2021. His focus is on caster quality and product development. Prior to joining the Steelmaking Technology team, Navjeet completed his PhD in materials engineering from the University of Wollongong. His PhD project was focussed around the development of a new 862 MPa yield strength steel for BlueScope Steel Ltd. His research career involved designing, thermo-mechanical processing and understanding of the microstructure-mechanical properties relationship of steels. His expertise is in sample preparation, reconstruction and data analysis of optical microscopy, SEM, EBSD, TEM and APT. His interests also include tensile sampling, Vickers micro-hardness and impact test work. Navjeet holds a Bachelor of Metallurgy and Material Engineering, as well as his PhD completed in 2020.


**Nb Effect on the Austenite Grain Size and Elongation of as-rolled Microalloyed Rail Steel**

Israel Murgas and Larisa White  
Steelmaking Department, Liberty Primary Steel, Whyalla Steelworks

Rail grades produced within Australia have been limited to the as-rolled and heat-treated (head hardened) C-Mn grades since commencement of rail production at the Whyalla Steelworks. In response to the increasing performance requirements placed upon rails in both freight and passenger sectors, a new intermediate strength rail grade has been developed, based on microalloying additions of V and Nb. The aim was to have an as-rolled rail with minimum values of 1100 MPa and 9% for tensile strength and elongation, respectively. The strength of the steel is a function of the chemistry and pearlite interlamellar spacing while the elongation is dependent on the prior austenite grain size for a given chemistry. To understand the effect of Nb on austenite grain size laboratory and plant trials were carried out. For the lab trials, as cast rail bloom samples were heated in a muffle furnace to achieve full austenitisation and then water quenched to facilitate measurement of prior austenite grain size. As expected, it was found that Nb has a beneficial effect on controlling the austenite grain size during the steel reheating, with grain size being 100 microns smaller than in rails without Nb. Controlled rolling of the rail blooms was used for the plant trials and samples were cut from the hot rails at the hot saw and water quenched to facilitate measurement of prior austenite grain size. It was found that by using controlled rolling an increase of 1% in elongation from 8.2 to 9.2% could be achieved.

**Larisa White**  
Process Engineer, Steelmaking, GFG – Liberty Primary Steel Whyalla  
Larisa White is a process engineer in the Steelmaking technology team, mainly based in refractories. In her previous role at the Steel Products department at LPS, she was responsible for customer quality and product development, including development work around 300 L15 grade steel for low temperature applications. Larisa held a management position in Operations as a shift manager, and later managed the Reheat Furnace and its team. Before joining Steel Products, Larisa rotated through assignments at the Iron Duke mines and Concentrator plant, Pellet Plant and Blast Furnace as part of the OneSteel cadet program commencing back in the late 2000’s. Larisa holds a Bachelor of Engineering - Metallurgy (Hons) from the University of South Australia.
Assessment of Metals Extraction Processes on Mars

M.A. Rhamdhani¹,², D.C. Nababan¹, R.Z. Mukhlis¹, M.G. Shaw¹,², M. Humbert¹,²
¹Fluid and Process Dynamics (FPD) Group, School of Engineering
²Space Technology and Industry Institute
Swinburne University of Technology, Melbourne, Australia

In situ resource utilization (ISRU) is an integral approach for further exploration and settlement on Mars, especially in providing metals for structural and construction. From the perspective of metal extraction through the pyrometallurgical process, both Mars’ atmosphere content and pressure are beneficial. Carbon, which can be drawn out from the CO₂ in the atmosphere, can potentially be used to extract metals from Martian soil. Thermodynamically, the low pressure of Mars’ atmosphere can lower the minimum reduction temperature of the metals. This current study provides a systematic analysis supported by the thermodynamic calculations on the different potential routes for extraction of metals from Mars’ soil (which contains 19.2 wt.% of FeO) at 7 mbar pressure, to simulate the Mars atmospheric pressure. An Ellingham diagram has been developed to give a base principle of various metals’ reducibility. It was found that the reaction of 100 g regolith with 9.5 g carbon at 1120 °C and 7 mbar produces liquid iron alloy with a conversion rate is up to 99.9%. The detailed equilibrium calculations of the carbothermic reduction of Martian regolith have generated a generic process flowsheet which includes minimum four-unit operations, i.e. reduction reactor, CO generation unit (such as the MOXIE process), condenser/heat exchanger unit, and agglomerator/pelletizer unit.

Professor M Akbar Rhamdhani,
Swinburne University of Technology

Professor M. Akbar RHAMDHANI is currently the Director of Fluid and Process Dynamics (FPD) Group at Swinburne. Akbar is a Professor in Extractive Metallurgy and Metals Recycling in Swinburne University of Technology, Australia. Akbar obtained his PhD from McMaster University Canada in Materials Science and Engineering. Akbar’s research focuses on advanced metal/material refining and impurities removal (e.g. in steel, aluminium, magnesium, silicon, nickel, and minerals); development of new processes for metal production with low carbon footprint; decarbonisation of metallurgical processes; metals extraction and recycling from secondary and urban resources; solar metallurgy; and astrometallurgy.
Thermal Decomposition of FeO from Silicate Ores

Matthew Shaw¹, Geoffrey Brooks¹, Akbar Rhamdhani¹, Alan Duffy², Mark Pownceby³
¹ Material and Product Design Engineering - Swinburne University
² Space Technology and Industry Institute - Swinburne University
³ Mineral Resources - CSIRO

Vacuum metallurgical processes can provide a lower temperature route to the extraction of FeO and Fe from silicate ores. Current work on the use of vacuum in off-earth resource extraction has potential to be applied in terrestrial steel-making applications. Operation of pyrometallurgical processes under high vacuum conditions reduces the temperature requirements of reactions resulting in a gaseous product. The current work presents thermodynamic modelling of the effect of reactor pressure on the thermal decomposition of FeO from mineral feedstocks. Basic laboratory demonstration of the sublimation and deposition of FeO under vacuum conditions heated using concentrated solar-thermal energy is also presented.

Matthew Shaw
PhD Candidate, Swinburne University of Technology

With a background in the mining industry as an extractive metallurgist, Matt loves the challenge of operation in extreme environments. Moving from industry into research Matt is finalising his PhD focusing on the topic of astrometallurgy, metal extraction in space.