BAOSTEEL-AUSTRALIA
JOINT RESEARCH AND DEVELOPMENT CENTRE

annual report 2012–13

BAOSTEEL

The University of Queensland
AUSTRALIA

UNSW
THE UNIVERSITY OF NEW SOUTH WALES

MONASH University

University of Wollongong

contents

mission and vision

The mission of the Centre is, through an enduring partnership, to engage in exploring and developing new knowledge and technologies within selected areas of particular significance for Baosteel's longer term, strategic development and business activities. The Centre is functionally located within the School of Chemical Engineering, Faculty of Engineering, Architecture and Information Technology (EAIT), the University of Queensland.

The purpose of the Centre is to create an internationally recognized Centre of excellence in the research area by harnessing and developing existing and emerging talent within the participant institutes to fulfil the mission of the Centre.

The specific aims of the Centre incorporate:

- Conducting strategic research supporting Baosteel's business interests, in approved priority themes including innovative materials, new energy, resource utilization and advanced environmental technologies.
- Providing strategic consultancies and technical advice for Baosteel's long-term and sustainable development.
- Promoting application of innovative technologies and development of new, high value and low carbon products in Baosteel.
- Providing a platform for Baosteel to access the international technical and personnel recruitment marketplace.
- Strengthening the academic/technical exchange between Baosteel and Australian universities and providing access to other innovations within these universities which may be of interest to Baosteel.

Board Chair's Message

Since it was launched in April 2011, the Baosteel-Australia Joint Research and Development Centre (BAJC) partnership has established a number of research collaborations between researchers at our partner institutions and BaoSteel.

We are proud of the progress the BAJC (the Centre) has made over the past two years in collaboration with Queensland, New South Wales, Wollongong and Monash Universities, and with Baosteel development engineers and practitioners.

In all our activities, the Centre strives to balance three main goals:

- creating value for Baosteel through innovation and technology
- developing the professional capacities of the individual researchers and engineers associated with the Centre
- Establishing close collaborative bonds between Australia and China.

We have made significant headway in all three areas.

This past year has seen something of a transition for the Centre. We have grown from a 'start-up' operation to a fully functioning (though still growing) entity.

A total of 23 individual projects are now either under way, or scheduled to start in 2014.

The first 12 projects are all now about half-way through their research phase and their potential impacts are beginning to emerge. A further 7 projects were launched at the start of this year (2013), and 5 more projects have been sanctioned to commence in 2014.

Many of the Centre's projects have attracted additional funding. For example, all 7 applications by Centre researchers and their associated project teams for Australian Research Council Linkage grants have been successful. This is a remarkable 100% success record! This outstanding result confirms the BAJC Technical Advisory Committee's rigorous internal project assessment process, and gives an independent 'vote of confidence' and validation of the creative, innovative and technical value of the projects and their investigator teams.

This 2012-13 Annual Report documents the achievements of the past year, and there is much to be proud of.

A full review of the Centre is scheduled for next year (2014). This review will highlight the immediate and tangible benefits arising from the Centre's activities, and it will guide our future development and evolution.

The Centre is well-served by Baosteel's generous research and development endowments. We are also the beneficiaries of the unstinting and enthusiastic support of the BAJC Board, Technical Advisory Committee, and management team, and the community of eminent researchers and engineers in China and Australia who propose and undertake technical work on our projects. Based on their commitment to engagement and success, we look forward with confidence to growing the BAJC as a national and international Centre of excellence in steelmaking research and development, and a valuable resource for technical collaboration between Australia and China.

Director's Report

This annual report celebrates BAJC's second year of operations, and describes the Centre's research and development programs and other activities. There are now 21 distinct projects supported through BAJC, with a further five projects scheduled to commence in January 2014. These projects cover Resources utilization, new metallurgical processes, Light metals, Energy materials and Environmental technologies, and engage the attention of a large number of research engineers.

In the year 2012-13, the Centre has 9 projects running through to the end of 2016, with approved funding of about $4m in cash and over $4.7m in-kind. More than 20 academic and research staff, and 5 PhD students are engaged on these projects. Projects also receive funding and support through Cooperative Research Centres, the Australian Research Council grants programme, state governments and a number of Australian companies.

We are especially proud that the BAJC co-chair Prof Max Lu was honoured in early 2012 with a top Chinese accolade for "distinguished and sustained contributions to collaboration with China in science and technology", presented by Chinese President Hu Jintao, Premier Wen Jiao Bao and vice premiers Li Keqiang and Liu Yandong.

A particular feature over the past year has been the extensive technical collaborations that have grown between research engineers at our partner universities, and their industry colleagues and application specialists at Baosteel. All of the project teams have visited their counterparts in Baosteel, and many have hosted technical experts from Baosteel at their laboratories in Australia.

As part of these exchanges, Australian groups in the Baosteel Talent Development Institute have presented a number of short courses. Arising from this exchange process, Prof Michael Ferry of the University of New South Wales (UNSW) has been appointed as a part-time Baosteel Professor, and Dr Wanqiang Xu (also of UNSW) as a Baosteel part-time Teacher.

A number of projects are now into their second year of development and several of these are reaching higher levels of 'technology readiness'. The next key step towards the implementation of their outcomes is plant trials and validation at Baosteel facilities. These are activities which require considerable planning and co-ordination, and I expect this will become an important part of the Centre's work over the next period.

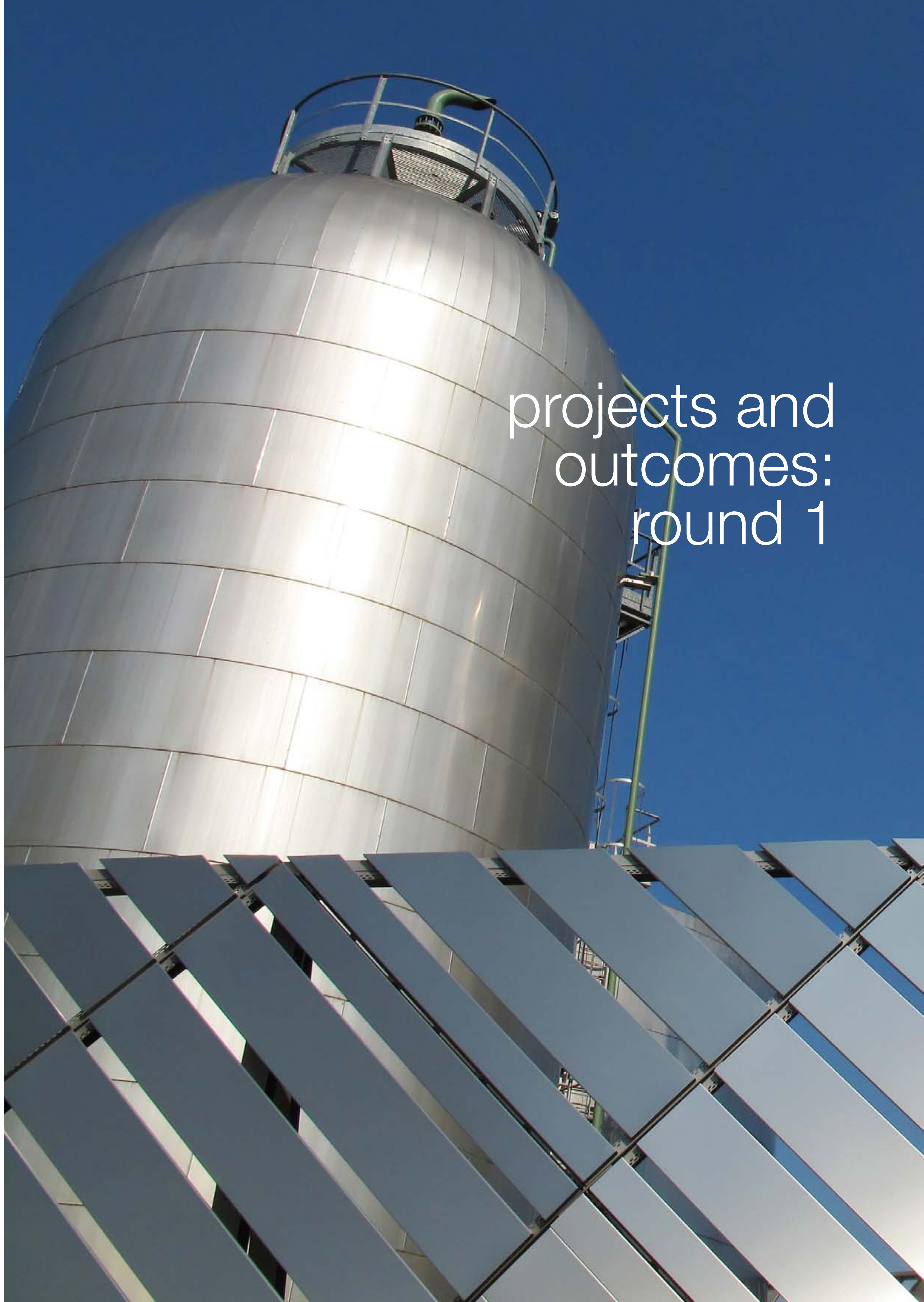
BAJC enjoys strong support at the most senior levels from its participants. For example, the Vice Chancellor of the University of Queensland (UQ) led a delegation including UQ's Vice President (Research), Vice President (International) and Deans of Engineering and Science met with Baosteel's Chairman, Mr Leijiang Xu, and senior company management to discuss the further development of relationships between the BAJC and Baosteel..

The inaugural two-day BAJC Symposium, held in Brisbane in December 2012, attracted over 70 participants who delivered presentations on the progress and outcomes of various projects.

The second Symposium is in planning for January 2014, and will be held in Melbourne.

BAJC Symposium provides an important opportunity for us to catch up with our colleagues, gather and share knowledge, and make and renew the friendships and interactions which inspire and motivate the individual technical and personal development of everyone associated with the BAJC.

The 2014 BAJC Symposium will also continue the process of building connections with our corporate collaborators, and establishing further productive links and partnerships to the benefit of both Australia and China.



projects and outcomes: round 1

project title

Ethanol from blast furnace offgas (via ARC-L project – Nano and micro-scale engineering of MoS_2-based catalyst for conversion of syngas to ethanol)

project leader

Dr Jorge Beltramini, ARC Centre of Excellence for Functional Nanomaterials, AIBN, University of Queensland

project BALP1100

principal researchers

Professor Victor Rudolph, Associate Professor Geoff Wang, Dr Jiuling Chen, School of Chemical Engineering, University of Queensland; Professor Max Lu, DVCR UQ, Dr Muxina Konarova, Dr Fenqiu Tang, ARC Centre of Excellence for Functional Nanomaterials, AIBN, University of Queensland

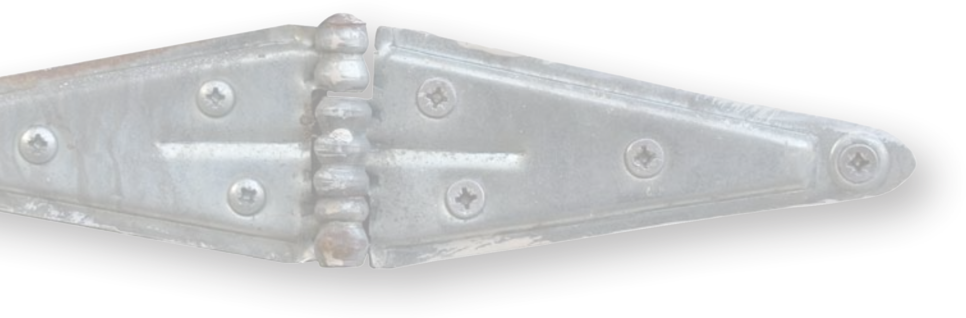
OBJECTIVES AND BENEFITS

Steel-making produces large quantities of residual H2 and CO, which can be converted into value-added commercial ethanol if problems achieving suitably high yields, selectivity and product market value are overcome. This project addresses these issues through innovations directed at: (a) high selectivity through new catalyst development; (b) very close control of the reaction temperature using high thermal conductivity, geometrically structured catalyst support; and (c) microchannel reactor architecture for high throughput. It promises to enable Baosteel to convert syngas into commercially–viable ethanol for use as a petrol substitute, offering significant new opportunities in the global transport fuel market.

HIGHLIGHTS AND ACHIEVEMENTS

2012/2013

- Synthesised and tested catalysts using various procedures and tested these in a small fixed bed reactor. A high performance catalyst (good conversion, good selectivity) has been identified and stability tests (on clean, simulated syngas) show no loss of activity over several hundred hours of use. The catalyst performance exceeds that of the standard precious metal catalysts conventionally proposed for syngas to ethanol. A patent application is in preparation.
- Work has commenced on aggregating the nano-sized catalyst into granular forms suitable for mini-channel reactor use.
- Proposed reactor configurations have been modelled and a suitable architecture developed and the experimental testing design completed. Items for the reactor are awaiting delivery and fabrication of the apparatus has commenced.



project title

innovative approaches to investigating the formation of thin-gauge metallic strip directly from the molten state

project leader

Professor Michael Ferry, School of Materials Science and Engineering, University of New South Wales (UNSW)

project BA110001

principal researchers

Drs Wanqiang (Martin) Xu, Kevin Laws and Zakaria Quadir

OBJECTIVES AND BENEFITS

Metallic sheet production has an estimated annual global market of over US$1 trillion in the construction, automotive, packaging, aircraft and aerospace industries. This project seeks to identify more efficient processes to manufacture high-quality sheets from metals and alloys of specific interest to Baosteel.

The research uses a powerful substrate immersion technique, coupled with twin roll casting (TRC) trials, to investigate the effect of key processing parameters on the development of as-cast structures and reduce defects in various types of metallic strips.

HIGHLIGHTS AND ACHIEVEMENTS

July-August 2012

- Examination of results so far and conduct further work on the mechanisms of defect formation in strip-cast low carbon steels.
- Dr Wanqiang Xu visited Baosteel Research Institute and carried out research on the origin of various defects in twin roll cast low carbon steels produced at the Baosteel Plant.

September-December 2012

- Dr Xiufang Wang of the Baosteel Research Institute visited UNSW as a Visiting Fellow and conducted a detailed study with Dr Xu on the effect of processing variables on the microstructure and texture of strip-cast medium carbon steel produced in Baosteel's twin roll casting pilot plant.

November - December 2012

- Professor Ferry delivered a short course on "Direct strip casting of alloys" to the Baosteel Talent Development Institute.
- Dr Xiufang Wang rated as one of BAJC's best-performing Baosteel Visiting Fellows.
- Professor Ferry selected as a part-time Baosteel Professor, and Dr Xu selected as a part-time Baosteel teacher (2013-15).

December 2012

- Attended BAJC conference to give update on progress of project

January 2013

- Technical report by Xu, Wang and Ferry on defect formation in strip-cast low carbon steels completed for Baosteel.
- Application approved for 3-year ARC Linkage funding grant covering project activities from 2013-15. The ARC Linkage grant includes Deakin University as a collaborating institution.

February 2013

- Dr Xu delivered a short course on "EBSD and its applications" to the Baosteel Talent Development Institute and conducted consulting work and training with Baosteel researchers and engineers.

June 2013

- Following four previous technical meetings at Baosteel, there was a further meeting between the Baosteel strip casting team and UNSW researchers where a detailed work plan was devised for designing high strength strip cast low alloyed low carbon steel.
- Professor Ferry and Dr Xu attended the Baosteel 2013 Biennial Conference where Prof. Ferry gave a keynote presentation entitled: "The application of 3D-EBSD in the study of deformed and annealed metals".

project title

Study of homogenisation and recrystallization effects in forged Ti-64 ingot and research in powder HIPping (Hot Isostatic Pressing) of Ti-64 powder

project leader

Professor Xinhua Wu, ARC Centre of Excellence for Design in Light Metals, Monash University

project BA110002

principal researchers

Professor Chris Davies, Dr Colleen Bettles, Dr Kun Yang, Dr Chao Voon Samuel Lim, Dr Aijun Huang (Baosteel), Dr Jifeng Sun (Baosteel)

postgraduate student

Kai Zhang

OBJECTIVES AND BENEFITS

This project aims to improve the homogeneity of Ti-6Al-4V (Ti-64) forged ingot and to study the industrial scale of HIPping Ti-64 powder. For the forged ingot research, experimentation and modelling will be employed to investigate the thermo-mechanical process effect on the recrystallization behaviour and homogeneity of largeTi-64 ingot. To study the powder HIPped Ti64, the mechanical properties of HIPped Ti-64 material will be evaluated based on different HIPping conditions. This study also seeks to develop know-how to achieve fatigue properties equivalent to forged ingots. By developing higher-quality Ti -64 alloys that are cheaper to produce, the project promises potential weight savings of more than 500 kg in commercial airliners, with manufacturing cost reductions of up to 50 per cent.

HIGHLIGHTS AND ACHIEVEMENTS

August 2012 – current

- Characterised forged billet made by one cogging/ forging sequence, and commence characterisation for another sent in June 2013.

September 2012

- Held project meeting with Baosteel in Shanghai, China.

October 2012 – June 2013

- Simulated upset forging and cogging processes using DEFORM 3D, gained understanding of critical parameters of these processes.

December 2012

- Attended BAJC conference to give update on progress of project.

February 2013

- Conducted preliminary meeting with Baosteel in China to plan full-scale forging trials.

March-June 2013

- Completed characterisation of cast ingot.

March 3-7 2013

- Presented an oral report entitled Effects of Processing Parameters on Macrozone Formation in Ti-6Al-4V Alloy (Kai Zhang, X. Wu, C. Bettles, C. Davies, A. Huang), to the TMS 2013 conference, San Antonio, USA.

May – June 2013

- Characterised the morphology of baseline Ti-64 powder from one alternative supplier. Will do similar characterisation for powder from another supplier and Baosteel in August 2013.

May 2013 - Current:

- Conducting further research to optimise processing steps for forging and cogging, in preparation for planned full-scale forging trials by Baosteel.

project title

Development of highly formable magnesium sheet

project leader

Professor Jian-Feng Nie, Department of Materials Engineering, Monash University

project BA11003

principal researchers

Professor Chris Davies, Associate Professor Nick Birbilis, Zhuoran Zeng, Xiaojian Xia

research fellow

Dr Mingzhe Bian

postgraduate student

Mr Zhuoran Zeng, Mr Xianjian Xia

OBJECTIVES AND BENEFITS

This project aims to deliver a cost-effective magnesium alloy with superior formability and thermo-mechanical processing parameters, to fabricate stronger, highly-formable and corrosion-resistant magnesium sheet at near room temperatures with satisfactory environmental performance and coatability. The research will characterise and evaluate micro-alloyed Mg-Zn-Gd, Mg-Zn-Ca and Mg-Ca-Zn materials, produced under different alloy compositions and thermo-mechanical processing conditions. This project will help Baosteel make value-added lightweight magnesium sheet products for use in the automotive, rail transport and computer industries. It will advance Australia's research capacity, and promises to boost international demand for Australian magnesite.

HIGHLIGHTS AND ACHIEVEMENTS

December 2012

- Attended BAJC conference to give update on progress of project.

January-June 2013

- Research into casting and hot-rolling ingots of Mg-Zn-Ca alloys, and characterising microstructures and properties of magnesium sheets.
- Continued research on corrosion, and electrochemical experiments, as part of a study of magnesium alloyed with additions of Ca, Gd, Sr, Zn and Zr in binary, ternary, quarternary and quinternary additions for the development of a master model. Study included testing of alloys B1, B2, B3, B4, B5, B5-2 and B7 and a selection of custom Mg-Zn based ternary alloys.
- Submitted detailed technical report on project activities conducted in the first quarter of 2013.
- Modification of alloy compositions was conducted for the further enhancement of the formability and other mechanical properties of magnesium sheets, and a patent was planned for this work.

April 2013

- Dr Mingzhe Bian joined the Monash University project team as Research Fellow. He holds a PhD on deformation behaviours of Mg alloys from Seoul National University.

21-14 May 2013

- Zhouran Zeng gave a talk at the International Workshop on Processing-Microstructure-Mechanical Properties of Magnesium Alloys, held in Spain.

project title

Scalable production of graphene-based bulk nanomaterials for advanced energy storage

project leader

Professor Dan Li, Department of Materials Engineering,Monash University

project BA11006

principal researchers

Professor George Simon, Dr Zhe Liu

research fellow

Dr Yanzhe Wu (January-December 2012)

postgraduate student

Zhiming Tian

OBJECTIVES AND BENEFITS

This project aims to address the industrial challenges inherent in the cost effective and scalable production of graphene, and its bulk assembly for use in high-performance energy storage devices. Its key technical objectives include the exfoliation of graphite into corrugated graphene sheets; the processing of exfoliated graphene into thin films; and the assembly of graphene thin films into new- generation energy storage devices. The project will develop patentable new technologies for the emerging and highly-profitable energy storage market, providing Baosteel with an opportunity to open up a new portfolio of high value-added products for the clean energy sector.

HIGHLIGHTS AND ACHIEVEMENTS

December 2012

- Developed a prototype integrated continuous process including effective delivery of exfoliation energy, solution phase stabilisation and the prevention of post-exfoliation aggregation.
- Attended BAJC conference to give update on progress of project

June 2013

- Conducted tests of new approaches to increase the yield of exfoliation, including testing of graphite from different sources and solvents.
- Proposed a new evaluation strategy to analyse the yield of exfoliated graphite.

project title

Process modelling and analysis of iron-making processes for improving energy efficiency in Baosteel

project leader

Dr Aibing Yu, Laboratory for Simulation and Modelling of Particulate Systems (SIMPAS), University of New South Wales (UNSW)

project BA11009

principal researchers

Dr Shibo Kuang, Dr Qinfu Hou, Dr Yansong Shen (APDI)

postgraduate student

Mr Zhaoyang Li

OBJECTIVES AND BENEFITS

This project aims to understand and model the fundamentals governing the multiphase flow and thermo-chemical behaviour in iron-making processes including blast furnace (BF) and COREX. It will (I) develop and validate computer models to reliably describe BF and COREX iron-making processes, (II) investigate the effects of key variables related to raw materials, operational and geometrical conditions, and (III) formulate and test strategies for the design, control and/or optimisation of BF or COREX iron-making processes under different conditions. By answering fundamental questions about BF and COREX, and identifying strategies to control problems, the outcomes may lead to industrial benefits such as an extended life campaign, better operational control, decreased fuel consumption, improved productivity, and reduced CO2 emissions.

HIGHLIGHTS AND ACHIEVEMENTS

July 2012

- Successfully attracted ARC LP leverage grant including financial support from ARC and Rio Tinto.

December 2012

- Attended BAJC conference to give update on progress of project.

July 2012-May 2013

- Progress on BF and COREX processes includes: (I) The BF model study shows that Baosteel 2# BF has the potential of 10 kg/tHM coke reduction based on current operational and material conditions. The effects of operational parameters including blast temperature, top pressure and oxygen enrichment on BF flow and performance have been quantified under the ranges provided. (II) COREX research has investigated some geometrical (AGD), operational and material properties such as the rotational speed of screw and cohesive force between particles in a full-scale Reduction Shaft model. Strategies have been identified to improve the cohesive solid flow in the Reduction Shaft. A model has been developed for the Melter Gasifier part of the COREX process, for application to Baosteel conditions when the parameters are available.

project title

Waste heat recovery from steelworks using advanced thermo-electrical (TE) materials and generator technology

project leader

Professor Shi Xue Dou, Institute for Superconducting & Electronic Materials, University of Wollongong

project BA11011

principal researchers

Professor Shi Xue Dou, Professor Chao Zhang, Dr Sima Aminorroaya, Dr Zhen Li, Dr Germanas Peleckis, Institute for Superconducting & Electronic Materials, UOW; Professor S.S. Li, School of Materials Science and Engineering UNSW

researchers

Dr Zhen Li, Dr Sima Aminorroaya, Dr Germanas Peleckis

postgraduate students

Mr T Katkus, Ms Xinqi Chen, Mr Chao Han

OBJECTIVES AND BENEFITS

This project seeks to use advanced thermo-electrical (TE) technology to develop advanced prototype TE generators. It will investigate, develop and optimise bulk TE modules made from naturally-abundant elements which are stable at high temperatures and have high comparative conversion efficiency. An industrial scale TE device will be designed and manufactured using experimental and theoretical data. This project will enable Baosteel to become an industry leader in energy-efficient steel manufacturing by using TE power modules and generators to harvest waste energy, cutting its carbon footprint and energy costs.

HIGHLIGHTS AND ACHIEVEMENTS

December 2012

- Attended BAJC conference to give update on progress of project.

July 2012 – current

- Designed and synthesised high-performance thermoelectric materials including doped metal oxides and metal chalcogenides.
- Fabricated testing equipment for use in assessing the performance of thermoelectric modules.
- Attracted ARC Linkage grant and Auto CRC grant.

project title

Identifying pathways to step change improvements in energy efficiencies and reduced CO_2 emissions through the use of innovative chemistries for iron-making

project leader

Professor Peter Hayes, PYROSEARCH, University of Queensland

project BA11012

principal researchers

Professor Peter Hayes, Professor Eugene Jak

researchers

Dr Jiang Chen

OBJECTIVES AND BENEFITS

This project aims to enhance the thermal and chemical efficiency of iron-making, by improving the qualities of a key first step, sintering. Critical to sinter quality is the microstructure of the sinter, which is highly sensitive to chemical composition of the matrix material. New experimental techniques have recently been developed that can now provide the key fundamental information on the crystal phases that will form during sintering. This phase equilibrium information can then be applied to predict the crystal phases that will form during sintering process and the proportions of these phases, thus assisting in the optimisation of the sinter plant and blast furnace performance. The research will fill major gaps in the scientific knowledge base that will enable Baosteel to practically apply the research outcomes to a wide range of ore sources, process chemistries and temperatures.

HIGHLIGHTS AND ACHIEVEMENTS

January- December 2012

- Dr Jiang Chen appointed as Research Fellow
- Training on EPMA/research techniques/safety induction completed.
- Research assistance provided by PYROSEARCH group.
- Developed and demonstrated an improved experimental methodology for characterisation of phase equilibria for low-silica oxide systems
- Developed preliminary experiments into appropriate research strategies and methodologies to study remaining chemical systems
- Obtained initial phase equilibrium results for isothermal sections in Fe2O3-SiO2 -CaO-Al2O3 system in air, produced progress report

December 2012

- Attended BAJC conference to give update on progress of project.

January 2013

- PYROSEARCH research team visited Baosteel Ironmaking Institute in Shanghai for project planning discussions, and presented an oral report on the results of initial phase equilibrium research into isothermal sections in Fe2O3-SiO2 -CaO-Al2O3 system in air. Baosteel Ironmaking Institute appointed an engineering liaison representative to facilitate ongoing communication and project planning.

June 2013

- PYROSEARCH research team visited Baosteel Ironmaking Institute in Shanghai to present recent findings. All to-date milestones have been completed, and the project is on schedule. Discussions were held on value of the new results for understanding the sinter formation mechanisms and possible improvements of sinter quality, and an agreed plan for the upcoming period has been produced.
- The PYROSEARCH research team also attended the Baosteel Academic Conference, Shanghai.

project title

Creating a viable titanium business for Baosteel

project leader

Associate Professor Ma Qian, School of Mechanical and Mining Engineering, University of Queensland (UQ)

project BA11014

principal researchers

Dr Min Yang, Professor Graham B Schaffer, Professor Xinhua Wu, Dr Ya Feng Yang, Dr Shudong Luo

OBJECTIVES AND BENEFITS

This project aims to develop low-cost medium to high-strength powder metallurgy titanium alloys and their fabrication processes using inexpensive Ti powders. The research will provide Baosteel with patentable technologies to manufacture low-cost, high performance powder metallurgy titanium products for a wide range of applications in the automotive, aerospace, medical and other industries.

HIGHLIGHTS AND ACHIEVEMENTS

15 January 2013

- Succeeded in a Queensland State Government Research Partnership Program Project application with Baosteel on advanced manufacturing of titanium
- Presented at the annual AJC conference and produced two journal articles

30 June 2013

- Designed a new low-cost powder metallurgy titanium alloy with promising as-sintered tensile mechanical properties.
- Designed a preliminary new low-cost powder metallurgy titanium alloy with promising as-sintered tensile mechanical properties.
- Succeeded in an ARC Linkage Project application with Baosteel on titanium hydride powder metallurgy

17 June 2013

- Submitted original data on the composition and mechanical properties of the new alloy to Baosteel.

project title

Advanced materials for new-generation high energy storage

project leader

Professor Ian R. Gentle, Surface Chemistry Group, School of Chemistry and Molecular Biosciences, University of Queensland

project BA11016

principal researchers

Dr Da-Wei Wang, Mr Qingcong Zeng

OBJECTIVES AND BENEFITS

This project aims to produce carbon-supported (C/S) sulphur cathodes with excellent stability and high specific capacity, and incorporate them into practical high-energy Li-S batteries. Using innovative Li-S technology developed at UQ, a novel class of core-shell structured carbon particles with a mesoporous core and a microporous shell will be created to enhance the energy and stability of the sulphur cathode. It promises breakthroughs in the commercialisation and use of Li-S batteries for clean energy storage and supply, particularly for use in electrical vehicles.

HIGHLIGHTS AND ACHIEVEMENTS

July-Dec 2012

- A major advance in the understanding of O species on hollow carbon matrix has been made. This revealed that oxygen at an optimal level on the carbon surface significantly improved the reversible utilization of sulfur in the cathode.

Jan-May 2013

- A new polymeric form of C-S nanocomposite was discovered with extremely promising performance. With this material, lifetime with no decay of up to 500 cycles and practical capacity of sulfur approaching 80% of its theoretical value was achieved.

Jan-May 2013

- A method of optimizing Li-S performance by the introduction of a family of natural biopolymers has been introduced. Combined with controlled redox chemistry of the biopolymers in organic solvent, the performance of the cathode has been greatly improved.

project title

Control strategies of surface quality of stainless steels

project leader

Professor Zhengyi Jiang, School of Mechanical, Materials and Mechatronic Engineering, University of Wollongong

project BA110017

principal researcher

Dr Dongbin Wei

researcher

Dr Jingwei Zhao

postgraduate students

Ms Xiawei Cheng, Mr Liang Hao

OBJECTIVES AND BENEFITS

This project aims to investigate and solve the problem of common surface defects in stainless steel, such as cracking and deep marks in continuously cast slab, and surface oxidisation, which occur during the production process. The project will conduct fundamental research into these problems, focusing on the rolling processes, and develop effective control strategies to improve the quality of stainless steel. It will improve quality and cut production costs for Baosteel's high-tech, value-added products including stainless steel strips and plates.

HIGHLIGHTS AND ACHIEVEMENTS

July 2012 – June 2013

- Completed literature review.
- Installed newly-designed rig in chamber of Gleeble 3500.
- Conducted primary rolling tests to investigate oxidisation behavior of deformation zone in hot-strip rolling of stainless steels, identified problems and proposed improvements to rig.
- Conducted study of oxidation kinetics of stainless steels.

December 2012

- Attended BAJC conference to give update on progress of project.

March 2013

- Presented new research outcomes to Baosteel Stainless Steel Research Center, Baosteel Research Institute.
- Conducted hot rolling tests on Hille 100 experimental rolling mill, investigated the effects of deep oscillation of continuously cast slabs and grinding on surface morphology.
- Conducted hot-rolling tests of samples with manufactured marks to verify new findings.

project title

Hybrid composite metal laminates with designed cores for high manufacturability

project leader

Professor Mark Hoffman, School of Materials Science and Engineering, University of New South Wales

project BA11018

principal researcher

Dr Tania Vodenitcharova

OBJECTIVES AND BENEFITS

This project aims to develop new, cost-effective light-weight metal laminate materials with high strength and formability. The research will address current formability problems by designing lattice cores which enable the material to be shaped into panels with high strength to weight ratios. Truss core architecture will be topologically designed, and core-sheet bonding investigated using computational simulation techniques to create optimised truss elements, ascertain post-deformation behaviour, and develop bonding techniques. Potential commercial applications of the research include light-weight, high-strength materials which could be used to manufacture flooring and cabin structures for trains and high-speed ferries, aeroplane flooring and internal frames, and motor vehicle chassis.

HIGHLIGHTS AND ACHIEVEMENTS

June 2012

- Submitted Progress Report on Stage A (2012) of the project to Baosteel.

November 2012

- Submitted Progress Report on Stage B (2012) of the project to Baosteel.

December 2012

- Selected laminates with a truss core as the formable structures studied to determine the effect of material choice on the failure modes of the materials, under chosen forming loading conditions (two-dimensional bending with a constant curvature).
- Attended BAJC conference to give update on progress of project.

March 2013

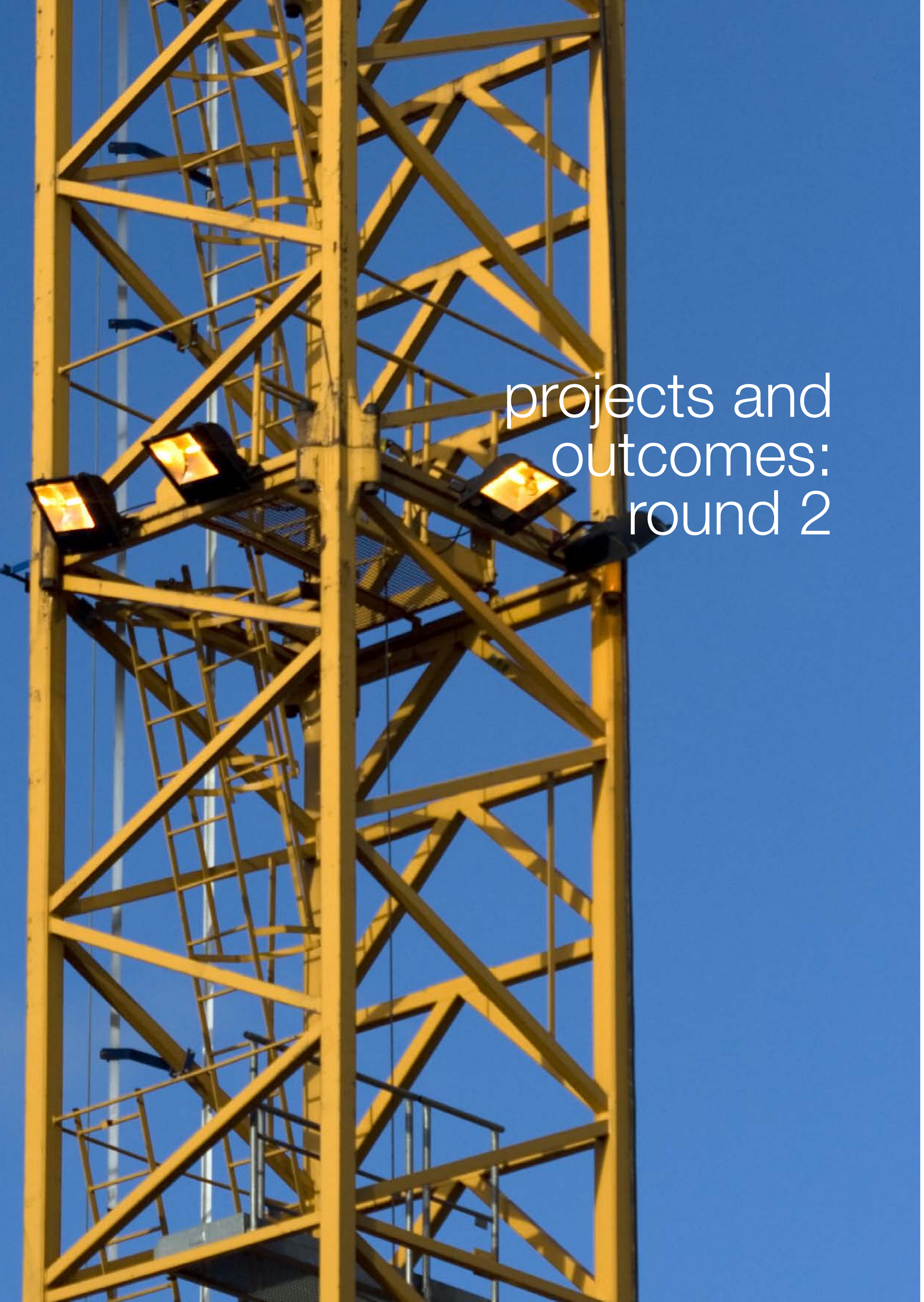
- Investigated two materials with extreme yield strength (high and low), elucidating the effects of increased bending curvature on four different combinations of material strengths and truss and skin architectures.

April 2013

- Submitted Annual Progress Report (June 2012-June 2013) on the project to Baosteel for publication on the company's website.
- Constructed failure maps of the material combinations and truss and skin architectures, identified four modes of failure, and conducted a further study of the second failure mode to discover the safe range of curvatures at which truss beams can be bent without buckling.

May 2013

- Submitted Progress Report on Stage A (2013) of the project to Baosteel.
- Determined the range of curvatures for safe bending, and the residual deformation for efficient bending, under set research parameters.
- Determined the safe bending curvature ranges of the four material combinations to assess the efficiency of manufacturing by bending processes.



projects and outcomes: round 2

project title

Investigation of slag systems for low-cost iron-making in Baosteel

project leader

Dr Baojun Zhao, School of Chemical Engineering, University of Queensland

project BA12002

principal researchers

Associate Professor Geoff Wang, Professor Shengli Wu, Research Institute, Baosteel;
Professor Jinming Zhu, Iron-making Plant, Baosteel

postdoc research fellow

Dr Xiaodong Ma

postgraduate student

Kyoung-Oh Jang

OBJECTIVES AND BENEFITS

This 3-year project aims to optimise iron blast furnace performance through systematic fundamental studies. It will use novel research techniques pioneered by the University of Queensland's School of Chemical Engineering to characterise the physiochemical properties and behaviours of a series of slags within the blast furnace. The project will apply these techniques to provide accurate and reliable fundamental data on the slags' phase equilibria, viscosity and desulphurisation capacity. It will significantly reduce iron-making costs by improving Baosteel's ability to use cheaper low-grade iron ores and poor-quality coals.

HIGHLIGHTS AND ACHIEVEMENTS

January 2013

- Project commenced
- Appointed Postdoctoral Research Fellow Dr Xiaodong Ma
- Conducted FactSage predictions and preliminary experiments in the system CaO-MgO-Al2O3-SiO2 related to the bosh slag of blast furnaces

April 2013

- Appointed Postgraduate Student Kyoung-Oh Jang

June 2013

- Conducted FactSage predictions and preliminary experiments in the system "FeO"-CaO-MgO-Al2O3-SiO2 related to the bosh slag of blast furnaces
- Project meeting at Baosteel

project title

Performance of lubricant and rolling pressure characterisation

project leader

Professor Liangchi Zhang, School of Mechanical and Manufacturing Engineering, University of New South Wales.

project BA12003

principal researchers

Dr Li Shanqing and Dr Qu Peilei, Research Institute, Baosteel;
Dr Jiang Zhenglian, Cold Strip Plant, Baosteel

research fellow

Dr Mei Liu

postgraduate student

Mr Chuhan Wu

OBJECTIVES AND BENEFITS

This project will develop high-performance cold strip metal rolling technology by accurately characterising roll-strip interactions, including the effect of lubricant and lubricant additives on rolling pressure and performance. It aims to open a new pathway for revealing the mechanisms of rolling deformation in mixed lubrication, and find a feasible solution that enables high-performance rolling with superior precision and surface integrity. It will enable Baosteel engineers to develop new, high-performance rolling lubricant and processes that significantly increase the company's competitiveness.

HIGHLIGHTS AND ACHIEVEMENTS

January 2013

- Project commenced.

January 2013 – June 2013

- Analysed loading conditions in cold rolling of metal strip.
- Conducted statistical analysis of contact between two rough surfaces.
- Introduced an innovative concept of equivalent interfacial layer to address complex solid-solid and solid-liquid interactions in the mixed lubrication regime.
- Developed a three-dimensional model of mixed lubrication in rolling.
- Implemented 3D mixed lubrication model on a commercially-available finite element code to predict variations in rolling pressure and friction.

project title

Fluoride-free mould flux for steel continuous casting

project leader

Professor Oleg Ostrovski, School of Materials Science and Engineering, University of New South Wales

project BA12011

principal researchers

Dr Jianqiang Zhang

research fellow

Dr Yaru Cui

postgraduate student

Under recruitment

OBJECTIVES AND BENEFITS

This project aims to establish the scientific grounds for the development of fluorine-free boracic mould flux as an alternative to fluorine, and for use in industrial steel casting. It will study the melting properties, viscosity and crystallisation of fluoride-free mould flux and the extent of boron volatility in different fluxes. The project will research (i) crystal structure development and the precipitation process in boracic mould flux; (ii) the effect of B_2O_3 in the fluorine-free flux on the flux-metal reaction; (iii) the volatility of boron in boracic flux; and (iv) the wetting of non-metallic inclusions by the molten boracic flux. This research will lead to the design of a more environmentally-friendly, cost-effective fluoride-free mould flux which will meet Baosteel's requirements for casting high-quality steel without surface defects.

HIGHLIGHTS AND ACHIEVEMENTS

January 2013

- Project commenced.

January-June 2013

- Visiting Fellow Dr Yaru Cui appointed to research team.
- Started recruitment process for a PhD student researcher.
- Conducted some experiments on the effects of basicity (CaO/SiO_2 ratio) and additions of Na_2O, Li_2O and TiO_2 on boracic flux melting points, crystallisation and heat conductivity.
- Carried out first experiments on melting point measurement using DSC method.

project title

Competitive 6xxx series aluminium automotive body panels with improved formability

project leader

Professor Chris Davies, Head, Department of Mechanical and Aerospace Engineering, Monash University

project BA12014

principal researchers

Professor Jian-Feng Nie, Assoc. Professor Nick Birbilis, and Dr Paul Rometsch, Yongsheng Gao, Kehan Diao, Bing Yang, Weijun Feng, Automobile Steel Research Institute, Baosteel R&D Center

research fellow

Zhou Xu

postgraduate students

Yuan Wang and Shravan Kairy

OBJECTIVES AND BENEFITS

This project will address the current formability shortcomings of 6xxx series aluminium alloys by focussing on alloy and process design, with an emphasis on specialised cold rolling, heat treatment and alloy composition. It will conduct strategic research leading to the next generation of high formability 6xxx series aluminium alloys for use in exterior and interior automotive body panel applications. Modelling and experiments will deliver a thorough understanding of 6xxx alloy sheet formability, and propose novel alloy-process combinations that deliver better formability than existing benchmark alloys with no degradation of bake-hardening properties. It will provide Baosteel with alternative solutions to customer demands for lighter-weight alloys for use in its automotive businesses.

HIGHLIGHTS AND ACHIEVEMENTS

January 2013

- Project commenced

March 2013

- Appointed Monash University research team. Secured BH180 steel and AA6016 aluminium alloy sheet materials for benchmarking work at both Monash and Baosteel
- Identified mechanical and corrosion tests to be performed at Monash
- Held detailed technical discussions with our counterparts at Baosteel and agreed on formability benchmarking tests and procedures
- Conducted preliminary thermodynamic and precipitation modelling
- Commenced testing and analysis of the benchmarking materials

project title

Novel approach to grain refinement for continuous casting and ingot casting of steels

project leader

Dr Mingxing Zhang, School of Mechanical and Mining Engineering, UQ

project BA12029

principal researchers

Professor David St John, Professor Andrej Atrens, Prof Jin Zou, Assoc. Professor Carlos Caceres, Dr Qing Zheng, Steelmaking Division, Baosteel R&D Institute, Baosteel

research fellow

Dr Qiang Wang

postgraduate student

Mr Jianmin Li and Miss Ming Li

OBJECTIVES AND BENEFITS

The project aims to improve the quality of steel products by refining their grain size, decreasing porosity, eliminating macro-segregation, columnar structure and transverse cracks. It will apply well-established crystallographic and independence grain refinement theories used for processing light metals to develop novel and effective grain refiners for the continuous and ingot casting of steels. Its research tasks include: (i) identification of new and effective grain refiners using the E2EM model and its associated database; (ii) validation of the predicted grain refiners in steel casting; (iii) development of grain refining master alloys to be added during continuous and ingot casting; and (iv) verification by industrial-scale trials conducted at Baosteel. It will create new products such as patented master alloys for use in the grain refinement of steels, opening up new business opportunities.

HIGHLIGHTS AND ACHIEVEMENTS

- January 2013 Project commenced
- Appointed two PhD students and one Research Officer
- Extended the edge-to-edge matching database used to identify new grain refiners for continuous and ingot steel casting
- Produced a microstructure characterisation of high manganese steels, and wrote a report for Baosteel
- Developed a novel and effective method to evaluate and predict the possibility of hot cracking of cast steels during curved apron continuous casting

project title

The next generation protective conversion coatings for Mg alloys

project leader

Dr Xiao-Bo Chen, Department of Materials Engineering, Monash University

project BA120031

principal researchers

Associate Professor Nick Birbilis, Dr Mark Easton

research fellows

(Dr Katharina Pohl will commence from August 2013)

Dr Shiwei Xu, Dr Gaofei Liang, Dr Qi Yang and Mr Yongzhu May, Baosteel

postgraduate student

Mr Chong Ke

OBJECTIVES AND BENEFITS

This research project aims to develop a cost-efficient, environment-friendly alternative method of producing practical chromium-free conversion coatings that actively protect Mg alloys from corrosion. It will develop a novel protective surface coating system for Mg alloys by: (i) Developing a series of pre-treatment processes to achieve a favourable intermetallic-free surface of Mg alloys for subsequent conversion film growth; (ii) Building appropriate condition windows using computed forms of equilibrium thermodynamic calculations to produce desirable MG alloy coatings; (iii) Applying a protective metal phosphate conversion coating to provide Mg alloys with the functionality to meet the needs of different end users; and (iv) Testing the corrosion resistance of such coated Mg alloys under service conditions. It promises to significantly transform the Mg alloy market by enabling industry to use these alloys to produce lightweight metal parts for energy-efficient transportation vehicles.

HIGHLIGHTS AND ACHIEVEMENTS

February 2013

- Produced a detailed research plan as a result of discussions with Baosteel on 26th February. The plan includes the following priority objectives:
  I. Develop a conversion/anodising coating with a low corrosion rating for newly-developed Mg-Zn (Al)-Ca-Mn alloys.
  II. Develop surface treatment technology to minimise the galvanic corrosion that occurs when Mg components are connected with other noble parts (Al/Steel).

March 2013

- Project commenced. Studied the corrosion rate of a series of phosphate-based conversion coatings applied to special alloys (Mg-Al-Mn-Ca and Mg-Zn-Mn-Ca), via potentiodynamic polarization curves in 3.5 wt% NaCl and Salt Spray. Coating properties were characterised by SEM, EDX and XRD

June 2013

- Recruited Postdoctoral Researcher Dr Katharina Pohl, who will join the project in August.

project title

Significance, measurement and control of centreline segregation in continuously cast line pipe steels

project leader

Assoc. Professor Huijun Li,
School of Mechanical, Materials and Mechatronic,
University of Wollongong

project BA12035

principal researchers

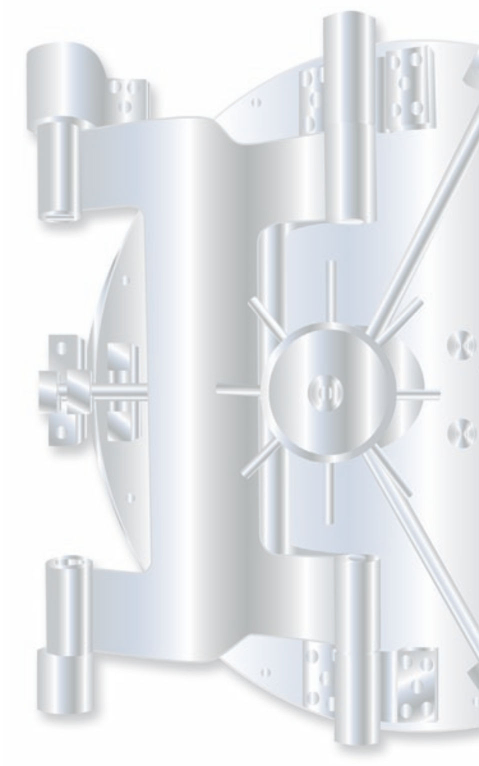
Dr Cheng Lu, Professor Frank Barbaro, Professor John Norrish, Dr Ian Simpson, Australian Pipeline Industry Association; Professor Zheng Lei, Mr Guangzheng Gui, Mr Mingzhou Bai, Ms Jianlan Shen, Mr Liqiang Fan, Mr Guodong Xu and Mr Guangzheng Gui, Baosteel

research fellow

Dr Linhong Su

postgraduate student

Mr Jintao Li



OBJECTIVES AND BENEFITS

This project targets new advanced steel-making technologies to improve the quality of continuously cast steel. By comprehensively evaluating current techniques used to assess and quantify centre line segregation, it aims to establish a simple prototype computer vision-based segregation evaluation method. Acceptance criteria will be based on and validated against the Mannesmann Scale. The project will also produce a draft internal Standard Operating Procedure for Baosteel. This research has great potential to improve Baosteel's market share, product quality and reputation as a supplier of high-strength steel pipe to the international pipeline industry.

HIGHLIGHTS AND ACHIEVEMENTS

1 January 2013

- Project commenced

1 May 2013

- Developed a MATLAB program based on image analysis, and used the program to evaluate the five Mannesmann standard charts for centreline segregation

30 May 2013

- Conducted further analysis using black and white images generated from the Mannesmann charts

20 June 2013

- Conducted literature review of evaluation techniques of centreline segregation in continuously-cast pipe steels

project title

An advanced investigation of oxidation and wear mechanism of high-speed steel hot rolls

project leader

Professor Kiet Tieu, School of Mechanical, Materials & Mechatronic Engineering, University of Wollongong

project BA12045

principal researchers

Professor Dale Sun, Research Division, Baosteel Research Institute; Dr Qun Fan, Baosteel Research Institute,

research fellow

Dr Hongtao Zhu, Dr Qiang Zhu

postgraduate student

Mr Hoang Phan

OBJECTIVES AND BENEFITS

This project aims to achieve a theoretical and technological breakthrough that will enable steel manufacturers to predict abrasive roll wear performance in the production of multi-phase high-speed steels (HSS) at high temperatures. It will systematically investigate the oxidation and mechanism of HSS roll in practical hot rolling conditions, using an integrated approach involving new experimental set-ups, advanced computational modelling, and material characterisation techniques. It will provide practical solutions to: (i) the promotion of the effective oxide scale 3-5 μm in thickness on HSS roll with less warm-up coils; (ii) characterisation of the oxide and wear failure of HSS roll in service; (iii) prediction of transverse HSS roll in terms of thermal expansion and wear; and (iv) guidelines for optimum roll regrinding. The project promises to improve the production quality of HSS steel rolls and reduce the costs of roll wear.

HIGHLIGHTS AND ACHIEVEMENTS

March 2013

- Designed and conducted trial tests of a detailed experimental plan for investigating the initial oxidation behaviour of high-speed steel, using an advanced laser-scanning confocal high temperature microscope.

April 2013

- Developed a numerical model to predict the temperature variation and thermal expansion of work rolls during hot rolling. The proposed model, programmed by the Matlab program, will be used to determine the roll surface temperature and the corresponding build-up of oxide layer.

May 2013

- Conducted trial experiments on Gleeble 3500 thermo-mechanical simulator, for studying the high-frequency thermal cyclic oxidation of high speed steel samples.

June 2013

- Developed and successfully trialed a characterisation of oxide scale after oxidation test, using SEM, FIB, TEM, XRD and AFM methods.

project title

Advanced Nanocrystalline/Amorphous Heterostructural Fe-based Soft Magnetic Materials for High Performance Electric Motors

project leader

Dr Dewei Chu, School of Materials Science and Engineering, University of New South Wales

project BA12053

principal researchers

Dr Shishu Xie, Silicon Steel Department, Baosteel, China; Professor Michael Ferry, Professor Sean Li and Dr Kevin Laws

postgraduate student

Mr Hamid Lashgari, Mr Ze Qian

OBJECTIVES AND BENEFITS

This project aims to develop the experimental and theoretical development of advanced Fe-based nanocrystalline alloys with optimised soft magnetic properties, which can be used to manufacture high-performance, energy-efficient next-generation electrical motors, generators and transformers. It will employ a novel concept of specific element doped nanocrystalline/amorphous heterostructures to produce Fe-based nanocrystalline alloys which have saturation magnetic flux density Bs > 2.0 Tesla, coercive force Hc < 1.0 A/m, to improve the engineering of high-performance Fe-based soft magnetic materials with high control and reliability. Advanced Fe-based nanocrystalline alloys with low energy loss and high permeability have great potential as replacements for the silicon steels now used in electric motors.

HIGHLIGHTS AND ACHIEVEMENTS

4 January 2013

- Project commenced
- Conducted study of first-principle calculations of magnetic properties, investigating and simulating the effect of B and Cu on the structure and magnetic properties of FeSi alloys
- Designed and fabricated Fe-based nanocrystalline alloys (Bs=1.6 T) using melt-spinning and annealing approaches, based on preliminary simulation studies

publications

Round 1

X. Xia, N. Birbilis, C.H.J. Davies, J.F. Nie, *Composition effects on the corrosion of Aluminium-free magnesium alloys*, Proc. Conf. Corrosion And Prevention '12, (ACA), Melbourne, Australia, 2012. (Paper 142).

Xu, W. *Investigation of crack formation processes during strip casting of low carbon steel*, Technical Presentation to Baosteel Strip Casting Team, Baosteel, Shanghai, China, 19 November 2012.

Ferry, M. *Direct strip casting of metals and alloys* and *Production and properties of amorphous metals*, Short Courses to Baosteel Talent Development Institute, Baosteel, Shanghai, China, 20 November 2012.

Jiang, Z.Y., Wei, D.B., Cheng, X.W., Hao, L., Zhao, J.W., 2013, *Control strategies of surface quality of stainless steels*. BAJC Annual Symposium, 13-14 December 2012, Brisbane, Australia.

Hao, L., Cheng, X., Peng, J., Wei, D.B., Jiang, Z.Y., 2012, *Study on deformation behaviors of oscillation marks in hot rolling of stainless steels*. BAJC Annual Symposium, 13-14 December 2012, Brisbane, Australia.

Cheng, X., Jiang, Z.Y., Wei, D.B., Hao, L., Zhao, J.W., Peng, J., Lu, S., Jiang, L.Z., 2012, *Effect of water vapor on oxidation of ferritic stainless steel 445J1M in simulated reheating environment*. BAJC Annual Symposium, 13-14 December 2012, Brisbane, Australia.

Xu, W., Wu, J., Wang, X., Fang, Y., Yu, Y., Quadir, Z., Laws, K., Ferry, M, 2012, *Mechanisms of crack formation in twin roll cast carbon steel sheet*, BAJC Annual Conference, 13-14 December, 2012, Brisbane, Australia.

Yu, A.B., Kuang, S.B. and Hou, Q.F., 2012. *Modeling and analysis of ironmaking processes for improving energy efficiency in Baosteel*. BAJC Annual Conference, Brisbane, 13-14 December

Wu, C.H., Zhang, L.C., Li, S.Q., Jiang, Z.L., Qu, P.L., 2013, *A Novel Multi-scale Statistical Characterisation of Mixed Lubrication in Metal Strip Rolling*. ISIJ International., Review in process

Xu., W. *EBSD and its applications*, Short Course to Baosteel Talent Development Institute, Baosteel, Shanghai, China, 25-27 February 2013.

Jiang, Z.Y., Wei, D.B., Cheng, X.W., Hao, L., Zhao, J.W., 2013, *445J1M sticking mechanism and technical solutions*, seminar presentation on 27 March 2013, Baosteel, Shanghai, China.

Ferry., M. *The application of 3D-EBSD in the study of deformed and annealed metals*, 5th Baosteel Biennial Academic Conference, Shanghai, China, 3-6 June, 2013.

Wu, C.H., Zhang, L.C., Li, S.Q., Jiang, Z.L., Qu, P.L., 2013, *Three-dimensional Simulation of Mixed Lubrication in Metal Strip Rolling*. Baosteel BAC 2013, 4-6 June 2013, Baosteel, Shanghai, China

Hou, Q.F., Dong, K.J., Zhao, X.Y., Li, J. and Yu, A.B., *Study of the solid flow in systems with screw feeder by discrete element method*. The Fifth Baosteel Biannual Academic Conference, Shanghai, China, 4-6 June 2013.

Yu, X.L., Jiang, Z.Y., Wei, D.B., Zhou, C., 2013, *Thickness-dependent phase evolution of oxide scale studied by high temperature x-ray diffraction (HTXRD)* (invited talk). Proceedings of BAC 2013, June 4-7, 2013, Shanghai, China.

Cheng, X., Jiang, Z.Y., Wei, D.B., Hao, L., Zhao, J.W., Peng, J., Lu, S., Jiang, L.Z., 2013, *The effect of water vapour on oxide scale of ferritic stainless steels at high temperature*. Proceedings of BAC 2013, June 4-7, 2013, Shanghai, China.

Xu., W. *Designing a high-strength strip-cast low alloyed low carbon steel*, Technical Presentation to Baosteel Strip Casting Team, Baosteel, Shanghai, China, 6 June 2013.

Wu, C.H., Zhang, L.C., Li, S.Q., Jiang, Z.L., Qu, P.L., 2013, *Three-dimensional Simulation of Mixed Lubrication in Metal Strip Rolling*. Baosteel BAC 2013, 4-6 June 2013, Baosteel, Shanghai, China

Cheng, X., Jiang, Z.Y., Wei, D.B., 2013, *Effects of oxide scale on hot rolling of an austenitic stainless steel*. Int. J. Surface Science and Engineering (in press, accepted on 8 August 2013)

Cheng, X., Jiang, Z.Y., Wei, D.B., Hao, L., Zhao, J.W., Peng, J., Lu, S., Jiang, L.Z., 2013, *Effect of water vapour on oxidation of ferritic stainless steel 21Cr-0.6Mo-Nb-Ti in simulated reheating environment*. Advanced Materials Research, 280, 690-693.

Jood, P., Mehta, R. J., Zhang, Y., Peleckis, G., Wang, X., Siegel, R. W., Borca-Tasciuc, T., Dou, S. X., Ramanath, G., 2011, *Al-Doped zinc oxide nanocomposites with enhanced thermoelectric properties*, Nano Lett., 11, 4337.

Jood, P., Peleckis, G., Wang, X., Dou, S. X., 2012, *Effect of gallium doping and ball milling process on the thermoelectric performance of n-type ZnO*, J. Mater. Res., 27, 2278.

Aminorroaya, S., Ikeda, T., Lalonde, A., Pei, Y. Z., Dou, S. X., Snyder, G. J., 2013, *Rational design of p-type thermoelectric PbTe: The temperature dependant sodium solubility* J. Mater. Chem. A, 1, 8725.

X.B. Chen, M.A. Easton, H.Y. Yang, T.B. Abbott, N. Birbilis, *Corrosion resistant conversion coatings for magnesium alloys*, in: Corrosion Prevention of Magnesium Alloys (Ed. G.L. Song). Woodhead Publishing, 2013, ISBN-13 978 0 85709 437 7.

X.B. Chen, M.A. Easton, H.Y. Yang, T.B. Abbott, N. Birbilis, *Corrosion resistant electrochemical platings on magnesium alloys*, in: Corrosion Prevention of Magnesium Alloys (Ed. G.L. Song). Woodhead Publishing, 2013, ISBN-13 978 0 85709 437 7.

Round 2

Z.R. Zeng, C. Davies, N. Birbilis and J.F. Nie, *Development of highly formable micro-alloyed Mg sheet and alloys,* Presentation at International Workshop on Processing-Microstructure-Mechanical Properties of Magnesium Alloys, Madrid, Spain, 21-24 May 2013.

J.F. Nie, *Precipitation and solute segregation in magnesium alloys*, Presentation at International Workshop on Processing-Microstructure-Mechanical Properties of Magnesium Alloys, Madrid, Spain, 21-24 May 2013.

De Jong, B., 2013, *Gleeble 3500 conducted research projects at the University of Wollongong, Australia*, seminar presentation on 5 June 2013, Baosteel, Shanghai, China.

H. Li, L. Su, C. Lu, F. Barbaro, *Evaluation of centreline segregation in continuously cast line pipe steels,* The fifth Baosteel Biennial Academic Conference, 4-6 June 2013, Shanghai, China.

Tieu Kiet, Zhu Qiang, Zhu Hongtao and Lu Cheng, 2013, *A study of oxidation and wear on high speed steel roll material*, Invited paper BaoSteel Biennial Conference , 5 June 2013, Shanghai.

H.T. Zhu, Q. Zhu, P.B. Kosasih, W.F.H. Zamri and A.K. Tieu, *Mechanical properties of oxide scale on a high speed steel roll material surface*, BaoSteel Biennial Conference, 5 June 2013, Shanghai.

L. Su, H. Li, C. Lu, I. Simpson, F. Barbaro, L. Fletcher, L. Zheng, M. Bai, J. Shen, G. Xu and G. Gui, *Review on the evaluation of centreline segregation in continuously cast line pipe steels*, to be presented at The 6th International Pipeline Technology Conference: 'A better view of pipeline technology', 7-9 October, 2013, Ostend, Belgium.

Tian, R., Donelson, R., Ling C. D., Blanchard, P. E. R., Zhang, T., Chu, D., Tan T. T., Li, S., 2013, *Ga substitution and oxygen diffusion kinetics in $Ca_3Co_4O_{9+\delta}$ based thermoelectric oxides*, J. Phys. Chem. C, 117, 13382.

Zhu, H., Zhu, Q., Tieu, A.K., Kosasih, B., Kong, C., 2013, *A simulation of wear behaviour of high-speed steel hot rolls by means of high temperature pin-on-disc tests*. Wear, 302 (1-2) , pp. 1310-1318

H. Zhu, Q. Zhu, B. Kosasih and K. Tieu, 2013, *Investigation on mechanical properties of high speed steel roll material by nanoindentation*. Materials Research Innovation, (in press)

Zamri, W. F. H., Kosasih, P. B., Tieu, A. K., Zhu, Q., & Zhu, H, 2013, *Finite element modelling of the nanoindentation of layers of porous oxide on high speed steel*. Journal of Steel Research International (in press)

FINANCIAL STATEMENT FOR THE PERIOD 01 JULY 2012 TO 30 JUNE 2013

BAJC Grantors: Baoshan Iron & Steel Co Ltd (Baosteel)
The University of Queensland
The University of New South Wales
Monash University
University of Wollongong
Australian Research Council (ARC)
The Cooperative Research Centre's (CRC)

Cash Balance as at 30-06-2012	**$1,179,047.81**

INCOME (CASH)

Grant and Collaborative Research

Baosteel R & D Fund (Round 2 – Year 1)	$1,640,000.00
Baosteel R & D Fund (Round 1 – Year 2)	$1,940,000.00
Baosteel – BAJC operational funding	$250,000.00
UNSW – BAJC operational funding	$50,000.00
Monash U – BAJC operational funding	$50,000.00
University of Wollongong – BAJC operational funding	$50,000.00
UQ – BAJC operational funding	$100,000.00
Total Cash income	**$4,080,000.00**
ARC-Linkage Grant (total)	$460,000.00
CRC Grant (total)	$500,000.00
TOTAL INCOME (cash)	**$5,040,000.00**

EXPENDITURES

Grant and Collaborative Research

Payment in cash to projects*	$2,324,000.00
Allocated ARC Linkage Grant	$460,000.00
Allocated CRC Grant	$500,000.00

Baosteel Centre – Management

Personnel – Salaries	$276,864.74
Staff Development	$150.00
Consumables (stationery, printing)	$2,240.19
Services (Professional consultancy)	$8,122.81
Marketing & Advertising	$480.51
Equipment for Office	$2,666.31
Telecommunications	$1,157.64
Travel and meetings**	$43,017.56
Financial costs & taxes	$1,197.03

TOTAL EXPENDITURES (INCLUDING GRANT & RESEARCH FUND ALLOCATION)		**$2,659,896.79**
Operating Result*	**Cash Balance as at 30 June 2013**	**$2,599,151.02**

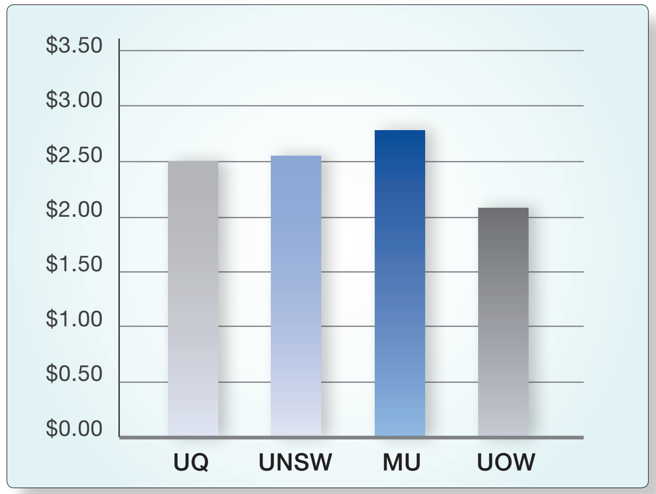
* Cash balance includes funds to be paid to projects later in 2013.
** Travel and meetings includes costs associated with TAC and Board meetings.

IN-KIND FOR PROJECTS

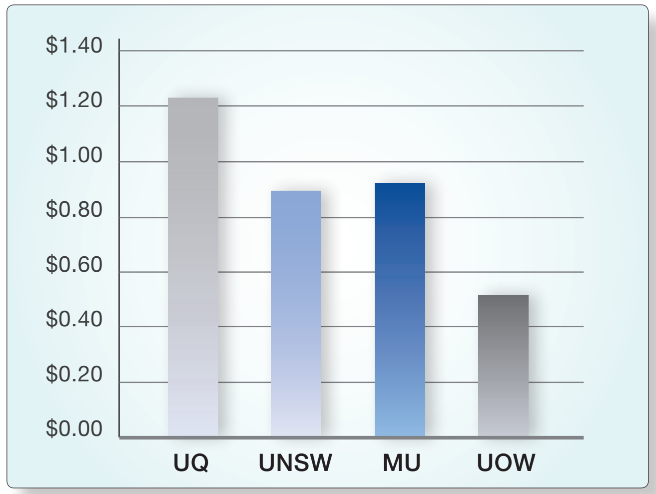
Partnership In-kind for Research Projects 2012-13

Baosteel	$1,020,267
The University of New South Wales	$767,828
Monash University	$972,293
University of Wollongong	$620,592
The University of Queensland	$1,368,430
Total In-kind Contribution	**$4,749,410**

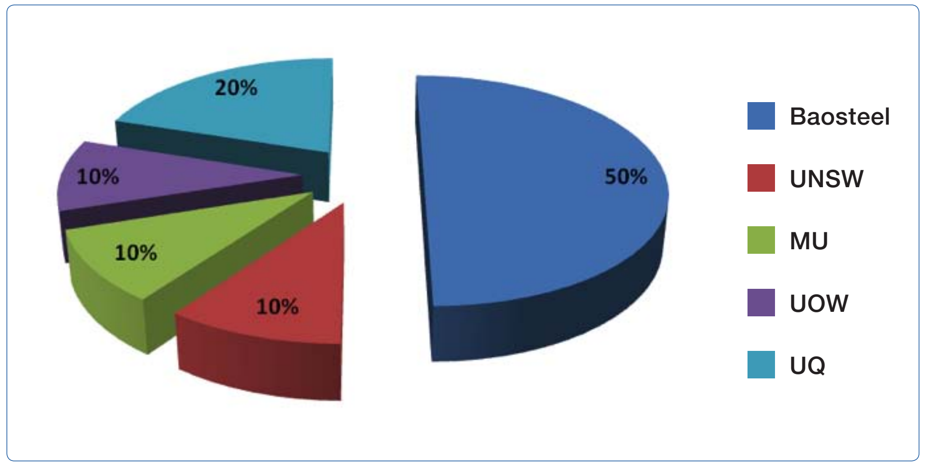
YTD BAOSTEEL PROJECT FUNDS (A$ MILLION)



YTD LEVERAGED FUNDS (A$ MILLION)



BAJC OPERATION FUND 2012–13



Centre Board

The Centre Board is responsible for setting priority and strategic research themes, annual budget, funding rules, approval of project funding. It will provide guidance and oversight to the Centre management team.

The Centre Board consists of 9 representatives, comprising a Board Chair appointed by Baosteel, a Board Co-chair appointed by the University of Queensland, 4 members from Baosteel including the Board Chair, 2 from UQ including the Co-Chair and the Centre Director, and 1 each from other Participating Institutions. The Centre Deputy Director, who serves as the Centre Board Secretary, and Chair of the Technical Advisory Committee (TAC), will have observer status.

Professor Jinghai Li
Board Chair
Vice President of Chinese Academy of Sciences (CAS)
Institute of Process Engineering (IPE), CAS, Beijing, China

Professor G.Q. Max Lu
B.Eng M.Eng PhD FTSE FIChemE
Board Co-Chair
Deputy Vice-Chancellor (Research)
The University of Queensland

Dr Pijun Zhang
President of Baosteel Research Institute (R&D Centre)
Baoshan Iron and Steel Co. Ltd

Professor Judy Raper
PhD GAICD
Deputy Vice-Chancellor (Research), University of Wollongong
Executive Director, Australian Institute of Innovative Materials

Professor Victor Rudolph
Centre Director,
School of Chemical Engineering
The University of Queensland

Professor Freider Seible
Dean,
Faculty of Engineering
Monash University

Dr Warwick Dawson
Director of Research,
University of New South Wales

Dr Laizhu Jiang
Senior Engineer,
Assistant President of Baosteel Research Institute (R&D Center)
Baoshan Iron and Steel Co. Ltd

Dr Jian Yang
Senior Engineer,
Baosteel Research Institute (R&D Center)
Baoshan Iron and Steel Co. Ltd

Professor Aibing Yu
Federation Fellow and Scientia Professor
Board Observer
Chair of the Technical Advisory Committee (TAC)
University of New South Wales

A/Professor Geoff Wang
Board Secretary
Centre Deputy Director,,
School of Chemical Engineering
The University of Queensland

Technical Advisory Committee

The Technical Advisory Committee (TAC) consists of a Chair, 4 internationally recognized Australian based academics and experts recommended by the Participating Institutions and approved by the Centre Board, and 4 technical liaison advisors appointed by Baosteel. The Chair of the TAC was jointly nominated by Baosteel and UQ and approved by the Centre Board. The main role of the TAC is to conduct technical assessments on the research proposals and makes recommendations for funding to be approved by the Centre Board.

Professor Aibing Yu
Federation Fellow and Scientia Professor
TAC Chair
School of Materials Science & Engineering, University of New South Wales

Dr Pijun Zhang
President of Baosteel Research Institute (R&D Centre)
Baoshan Iron and Steel Co. Ltd

Professor Shi Xue Dou
Faculty of Engineering Director, Institute for Superconducting and Electronic Materials
University of Wollongong

Professor Ian Gentle
School of Chemistry and Molecular Biosciences
The University of Queensland

Emeritus Professor David Young
School of Materials Science and Engineering,
University of New South Wales

Professor Yuri Estrin
Department of Materials Engineering
Faculty of Engineering
Monash University

Professor Xinhua Wu
(Baosteel's TAC member)
Department of Materials Engineering
Faculty of Engineering
Monash University

Dr Laizhu Jiang
Senior Engineer,
Assistant President of Baosteel Research Institute (R&D Center)
Baoshan Iron and Steel Co. Ltd

Dr Jian Yang
Senior Engineer,
Baosteel Research Institute (R&D Center)
Baoshan Iron and Steel Co. Ltd

Management Team

The management team, comprising the Director (50% full time equivalent), a Deputy Director and an Administrative Assistant, is responsible for project call-for-proposals, project coordination and facilitation, project meetings, reporting, budgetary management and IP management. It provides reporting and secretariat services to the Centre Board, including organizing Centre Board meetings and documentation. The management team of the Centre is also responsible for organizing the meetings of the Technical Advisory Committee and Centre annual conference, website and hosting visits from Baosteel personnel. A Baosteel coordinator was also appointed to participate in the Centre management.

Professor Victor Rudolph
Centre Director
The University of Queensland

Miss Sarah Flett
Administrative Assistant
The University of Queensland

A/Professor Geoff Wang
Centre Deputy Director
The University of Queensland

Mr Yongzhu Ma
Baosteel Coordinator
Research Engineer,
Baosteel Research Institute
(R&D Center)
Baoshan Iron and Steel Co. Ltd

CONTACT DETAILS

Director: Professor Victor Rudolph

Deputy Director: Associate Professor Geoff Wang

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