Chair: Professor Veena Sahajwalla, Director
Sustainable Materials Research & Technology, (SMaRT Centre)

Symposium aims to bring industries and research institutions together to present scientific and engineering advances in environmentally sustainable materials, processes, associated technologies and economic benefits

**Industries and Research Institutions Participating:**
- Arrium Steel (Australia), Austral (Australia), BlueScope Steel (Australia), Castrip LLC (USA), China Metallurgical Industry Planning & Research Institute, CSIR-IMMT (India), CSIRO (Australia), Environment Protection Authority (NSW), Engineers Australia, Hanyang University (S.Korea), Lend Lease (Australia), Linc Energy Ltd (Australia), Nextek (UK), Nyrstar (Australia), Pottinger (Australia), Swerea MEFOS AB (Sweden), Transpacific Group (Australia), The University of Tokyo (Japan), Xi’an University of Architecture and Technology (China) and UNSW Australia

**Day 2 afternoon session:**
*Presentations by early-career professionals from industries and research institutions*

**Date:** 3 & 4 October 2013

**Time:** 8:30am - 5:30pm

**Venue:** Level 6, Business Lounge, Australian School of Business
Building E12, via west end, UNSW Australia

**Registration:** Free

**Symposium Dinner:** 3rd October, 6pm start (cost: TBC)

For Catering purposes please email your RSVP for both days or day 1/day 2, by 27th September 2013,
Smart.Symposium2013@unsw.edu.au

For any further information, please contact Dr Nayruti Trivedi - T: +61 2 9385 6432

Jointly organised by:

[UNSW Logo]

[SMaRT@UNSW Logo]

[AIST Logo]
Thursday 3rd October 2013

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**Opening Session**

- 9:00 – 9:05 | Welcome: Scientia Professor Veena Sahajwalla, Director, SMaRT @UNSW |
- 9:05 – 9:20 | Opening Address: Professor Fred Hilmer, Vice Chancellor UNSW |
  - Jennie Lang, Vice President, Advancement |

**Plenary Session (Chairs: Professor Veena Sahajwalla and Julie Hare)**

- 9:40 – 10:05 | Innovative Waste Recycling and Energy Efficiency Solutions: A Perspective from one of Australia’s largest integrated manufacturers and distributors of steel |
  - Tony Dixon (Arrium Steel) |
- 10:05 – 10:30 | Catching our Calories: Waste as an Energy Resource |
  - Dr Peter Isdale (Transpacific Industries) |

**Keynote Session (Chairs: Andrew Petersen and Lloyd Green)**

- 11:05 – 11:25 | Sustainable Iron and Steelmaking in a Changing Landscape |
  - Darryle Lathlean (BlueScope Steel) |
- 11:25 – 11:50 | The separation and recycling of complex mixtures of post-consumer polymers into high value products |
  - Edward Kosior (Nextek) |
- 11:50 – 12:15 | Innovative Waste Management in NSW |
  - Stephen Beaman (EPA NSW) |
- 12:15 – 12:30 | Panel Discussion (Chairs: Andrew Petersen and Lloyd Green) |

**Keynote Session (Chairs: Mark Finney and Habib Zughbi)**

- 2:00 – 2:25 | A Swedish initiative on recycling |
  - Johan Eriksson and Jan-Olov Wikström (Swerea MEFOS) |
- 2:25 – 2:50 | The CASTRIP Thin Strip Casting Technology – Environmental and Energy advantages |
  - Dr Rama B Mahapatra (Castrip LLC) |
- 2:50 – 3:15 | If you build it, they will come – the trials and tribulations of using new materials |
  - Matt Williams (Lend Lease) |
- 3:15 – 3:40 | Innovate or Die: Darwin in the Boardroom |
  - Nigel Lake (Pottinger) |

**Session: Iron based Products and Processes (Chairs: Stephen Durkin and Habib Zughbi)**

- 4:10 – 4:25 | Iron recovery from waste copper smelting slag by solid carbon |
  - A/Prof Joo Hyun Park (Hanyang University) |
- 4:25 – 4:40 | Energy and Exergy Analysis of Iron-making Processes |
  - Emeritus Professor Oleg Ostrovski (UNSW) and Dr Guangqing Zhang (UoW) |
- 4:40 – 4:55 | Can ductile cast iron sheets meet the demands from environmental issues to develop sustainable society? |
  - Professor Yasushi Sasaki (UNSW) |
- 4:55 – 5:30 | Panel Discussion (Chairs: Stephen Durkin and Habib Zughbi) |
- 5:30 – 6:00 | Pre-Dinner Drinks |
- 6:00 – late | Symposium Dinner |
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<td>8:45 – 9:00</td>
<td><strong>Morning Coffee</strong></td>
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<td>9:00 – 9:25</td>
<td><strong>Session: Iron and Steel making Processes (Chair: Mark Eaton)</strong>&lt;br&gt;Keynote Presentation: Development of New Application of Iron- and Steelmaking slags in Japan&lt;br&gt;Professor Kazuki Morita (The University of Tokyo)</td>
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<td>9:25 – 9:40</td>
<td>Environmentally sustainable EAF Steelmaking through the introduction of recycled polymers&lt;br&gt;Paul O’Kane (Arrium Steel)</td>
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<td>9:40 – 9:55</td>
<td>The Whyalla Operations, our key business drivers and our current operating approach&lt;br&gt;John Tsalapatis and Mark Eaton (Arrium Steel)</td>
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<td>9:55 – 10:10</td>
<td>Low Cost/No Cost Energy Efficiency Improvement in the Manufacturing Environment&lt;br&gt;Murray Ackers (BlueScope Steel)</td>
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<td>10:10 – 10:25</td>
<td>Development of Environmentally Friendly Fluoride-free Mould Flux for Steel Continuous Casting&lt;br&gt;Yaru Cui, Oleg Ostrovski, Jianqiang Zhang, Yashui Sasaki, Jian Yang (Xi’an University of Architecture and Technology, China and UNSW)</td>
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<td>10:25 – 10:55</td>
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<td>11:20 – 11:45</td>
<td>Keynote Presentation: Trend of Energy Resources and Solid Waste Utilization of China Steel Industry in the New Era&lt;br&gt;Mr Li Xinchuang (China Metallurgical Industry Planning &amp; Research Institute)</td>
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<td>11:45 – 12:00</td>
<td>Alternate materials and fuels in the Brickmaking process&lt;br&gt;Steven Mouzakis (Brickworks Building Products)</td>
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<td>12:00 – 12:15</td>
<td>Industrial Symbiosis &amp; Ecology – remanufacturing waste&lt;br&gt;Rod Clare (Office of Environment and Heritage, NSW)</td>
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<td>12:15 – 12:30</td>
<td>Product Obsolescence: Pathways to e-waste&lt;br&gt;Dr Miles Park (UNSW)</td>
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<td>12:30 – 12:45</td>
<td>Fly Ash – From Coal Power Stations – A Valuable Engineering Material?&lt;br&gt;A/Prof Sri Bandyopadhyay (UNSW)</td>
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<td>12:45 – 1:00</td>
<td>Panel Discussion: (Chairs: Mark Eaton, John Tomac and Ben Waters)</td>
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<td>2:00 – 2:25</td>
<td><strong>Early Career Professionals Session: (Chairs: Yasushi Sasaki and Daniel Miles)</strong>&lt;br&gt;Keynote Presentation: Cleaner energy solutions for the mining, power and petrochemical industries using underground coal gasification&lt;br&gt;Dr Greg Perkins (Linc Energy Ltd)</td>
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<td>2:25 - 2:40</td>
<td>Energy solutions &amp; Waste management at Vizag Steel&lt;br&gt;Ranjan Mohanty and Dipankar Das (Vizag Steel)</td>
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<td>2:40 – 2:55</td>
<td>Overview of the waste recycling process in the Zinc smelter at Nyrstar, Port Pirie&lt;br&gt;Dr Pedro Yunes (Nyrstar)</td>
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<td>2:55 – 3:10</td>
<td>Working with Industry to Achieve Compliance&lt;br&gt;Lisa Green (Department of Environment and Heritage Protection Queensland Government)</td>
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<td>Afternoon Tea</td>
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<td>3:30 – 3:45</td>
<td>Assessment of greenhouse gas footprints of metals with recycling scenarios using life cycle assessment&lt;br&gt;Dr Nawshad Haque, Terry Norgate, Stephen Northey (CSIRO)</td>
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<td>3:45 – 4:00</td>
<td>Structural optimization using bend-twist coupling for wind turbine blades&lt;br&gt;M. Herath, A. Lee, and A/Prof Gangadhar Prusty (UNSW)</td>
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<td>4:00 – 4:15</td>
<td>The influence of CaO-FeO-Al2O3-SiO2 oxide system on the reduction of carbon composite pellet&lt;br&gt;Hewitt Park and Prof Veena Sahajwalla (UNSW)</td>
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<td>4:15 – 4:30</td>
<td>Professional Affiliation&lt;br&gt;Richard Hanna (Engineers Australia)</td>
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<td>4:30 – 4:45</td>
<td>Panel Discussion (Chairs: Yasushi Sasaki and Daniel Miles)</td>
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<td>Closing of the Symposium- Daniel Miles</td>
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Tony Dickson  
General Manager Marketing & Business Development Steel  
Arrium Steel  

“Innovative Waste Recycling and Energy Efficiency Solutions: A Perspective from one of Australia’s largest integrated manufacturers and distributors of steel”

As one of Australia’s largest steel businesses, OneSteel manufactures, processes and distributes steel and metal products to the Australian construction, resources, manufacturing and rural markets. OneSteel, through its core capabilities, is focused on developing and implementing recycling and energy efficiency solutions as part of its broader sustainability strategy.

Dr Peter Isdale AM  
Group Manager - Research and Innovation  
Transpacific Industries Group Ltd

“Counting Calories: Reforming our Waste”

If we throw something away, is it “wasted”? If it, or its physical or chemical architecture finds a reformed expression for re-use, it is not. The recent FAO revelation that we waste (defined as “throwing away”) about a third of produced food has come as a shock to many. But where do the hundreds of millions of tonnes “thrown away” go to?.. In one form or another, every element will reappear in our ecosphere. But while thermodynamics are on our side, commercial time seldom is. We may “throw away” our resources for one use, but retrieving, revising reforming and redeploying them in other formats (configurations, volumes, aggregations, locations) brings them back into play again. The major barrier to this is heavily driven by supply chain logistics and availability of novel technology solutions. While the Waste Hierarchy drives our planning cycle of resource use, we may posit that many “end-of-life” commodities might in fact be waypoints to a re-use that commercial-scale reforming technology and logistics systems have not yet illuminated. In this discussion, we look at ways that some biogenic compounds of commercial importance (such as, hydrocarbons, plastics and food) are defying the final curtain of the Heirarchy.
Keynote Session

Darryle Lathlean
Manager Iron & Steelmaking Technology, Manufacturing
BlueScope Steel

“Sustainable Iron & Steelmaking in a Changing Landscape”

This presentation focuses on the current operating regime of BlueScope Steel at Port Kembla Steelworks and the significant changes undertaken over recent years and the impact of such, both current and forecast in the future, in relation to the steel industry’s sustainability. It briefly highlights the activity to sustain economic viability, by remaining a socially responsible business and making environmental management good business. It also references some of the research & development work undertaken to potentially offset greenhouse gas impacts in the future.

Edward Kosior
Managing Director
Nextek Limited

“The separation and recycling of complex mixtures of post-consumer polymers into high value products”

The recycling of plastics in Europe is being practiced at rates of up 50% in many countries as way of reducing the environmental impact of the large volumes of packaging used in current societies. It is now possible to "close-the-loop" on some plastics packaging products and remanufacture new packaging to the demanding standards required by the European Food Standards Authority. The key challenges involve the sorting of plastics into mono-polymer streams of very high purity as well as multiple steps of physical and chemical decontamination to ensure that all possible contaminants are removed. The technologies of separation and decontamination will be described for PET, HDPE and PP packaging systems as well as the potential opportunities created for recycling businesses that can displace virgin resins with these high performance recycling systems.
Johan Eriksson* and Jan-Olov Wikström
*Research Manager at Process Metallurgy Department
Swerea MEFOS AB

“Swerea Industrial Recycling – A Swedish initiative on recycling”

The Swerea group of institutes was established in 2005, consisting of five institutes with close cooperation with the Swedish manufacturing industry, but also with subsidiaries in other European countries.

The Swerea group consists of Swerea MEFOS (process metallurgy, heat treatment, metalworking et c.), Swerea KIMAB (material use, material and process development, corrosion et c.), Swerea SICOMP (composite materials) and Swerea SWECAST (foundries, cast metals). The group has 550 employees and around 600 member companies.

A project with all Swerea institutes started in 2013 with the aim to jointly develop cross-over solutions for recycling problems.
Rama B Mahapatra
Chief Metallurgist
Castrip LLC [joint venture company- BlueScope Steel (Australia), Nucor Steel (USA) and IHI Co (Japan)]

“The CASTRIP® Thin Strip Casting Technology – Environmental and Energy Advantages”

The CASTRIP® Process utilizes the twin-roll concept to continuously cast thin-strip. Development of this technology began at Port Kembla, Australia in 1989 under the code name Project ‘M’. It was initially a joint project between BlueScope Steel and IHI Japan. Nucor Steel, USA later joined the Project in early 2000 and a joint venture company known as Castrip LLC was formed between BlueScope Steel, Nucor Steel and IHI to market and license the technology. Nucor Steel, USA currently operates two commercial CASTRIP facilities located in Crawfordsville, Indiana and Blytheville, Arkansas for the production of low-carbon steel sheets in the thickness range of 0.8 to 1.5 mm. One of the key features of the CASTRIP process is the ability to produce ultra-thin hot-band gauges that can compete with traditional cold rolled material in many applications.

The CASTRIP process has many inherent advantages over conventional casting and rolling technologies. These include a smaller foot print, lower capital cost, simpler and more flexible operating plants, more tolerance to high residual scrap feed and superior environmental performance as it eliminates a number of intermediate processing steps that exist in conventional strip production routes. Thus the energy consumption and corresponding greenhouse gas emissions associated with the CASTRIP process are about 80 to 90% lower compared to conventional casting/strip production technologies. The metallurgical regime associated with the CASTRIP process is dramatically different from conventional casting as a consequence of extremely high heat flux and rapid solidification rates which enables production of unique microstructures and other product features which cannot be readily obtained with conventional casting/rolling processes.

This presentation will provide an update on the current status of CASTRIP® Technology with an emphasis on environmental and energy advantages both from a process and product application context.
**Matt Williams**  
Sustainability Manager, NSW &nACT- Project Management & Construction  
Lend Lease

"*If you build it, they will come – the trials and tribulations of using new materials*"

Innovative new materials and new ways of using existing materials are constantly being discovered but it isn’t easy to find organisations that are willing to take a chance on an unproven new product. The next generation of construction materials and methods are at serious risk of being overlooked if contractors are unwilling to change practices but for those brave enough to experiment, client attraction and industry leadership are clear benefits. Matt Williams is going to share some examples of the way new materials and methods are being developed at Lend Lease, from alternative concretes and engineered timbers to embodied carbon reduction and sequestration.

**Nigel Lake**  
Joint CEO and Founder  
*Pottinger*

"*Innovate or Die: Darwin in the Boardroom*"

Over the last fifty years, there have been many advances in the techniques used to develop strategy, value projects and identify risk. Companies are now a relentlessly focused on creating value for shareholders, and their progress is measured second by second on world stock markets. Despite this sophistication, the most of the largest creators of value in the last decade have been companies started by recent graduates and drop-outs in garages. The largest destroyers of value have been very well established corporates. My presentation explores the critical importance to companies and societies of embracing invention and innovation, and how the animal preference for the perceived safety of the status quo is one of the biggest risks facing companies today.
It has been estimated that for every tonne of copper produced, about 2 to 3 tonnes of slag are generated and every year, approximately 30 million tonnes of slag are generated by global copper production. Disposal of such large quantities of copper slag often presents waste management problems; copper slag is classified as a hazardous waste because it contains heavy metals. Copper slag is widely used in the sand-blasting industry and it has been used in abrasive blast treatment and in the manufacture of abrasive tools. The potential use of copper slag as a partial substitute in cement and as an aggregate in concrete and asphalt mixtures has also been reported. Recently, some studies have attempted to recover iron from copper slags. Copper slags can be considered a novel ‘mining resource’ because they contain iron of a very high grade, viz. 40 to 50 mass pct total Fe, which means that 14 to 15 million tonnes of Fe could potentially be recovered per year. However, few studies have investigated reduction of FeO in high FeO (> 50 mass pct) slags, such as copper smelting slags. Furthermore, no studies have reported quantitative ‘iron recovery’ during smelting reduction of copper slags. Therefore, in the present study, we investigated the effect of flux (lime) addition on the reduction of iron oxide in copper slag by solid carbon, and quantitatively investigated how slag foaming affected iron recovery using typical kinetic analysis. We found that iron recovery was strongly affected by the thermophysical properties of the copper slag. In the kinetic analysis, we determined mass transfer coefficients with and without considering slag foaming using a gas holdup factor. Iron recovery was maximal (~90%) in the 20%CaO system because no solid compounds such as Mg$_2$SiO$_4$ and Ca$_2$SiO$_4$ formed in this system, resulting in a highly fluid slag. This fluid slag allowed iron droplets to fall rapidly with high terminal velocity to the bottom of the crucible.
Oleg Ostrovski* and Guangqing Zhang#

*Emeritus Professor
UNSW

#Lecturer
University of Wollongong

“Energy and Exergy Analysis of Ironmaking Processes”

Efficient usage of energy resources is among most important tasks of further development of metallurgical industry. Energy management on the basis of the first thermodynamic law (energy conservation or heat balance) allows minimisation of wastes and improvement of energy efficiency. Further, higher level energy savings can be achieved on the basis of the second thermodynamic law, which includes analysis of exergy.

The paper discusses the concept of exergy, the energy and exergy balances of blast furnace ironmaking and direct ironsmelting processes, and exergy losses in these processes.

Exergy consumed in direct ironsmelting is in the range of 5000–9200 MJ/THM depending on the PCR and HTE (4140 MJ/THM in the ‘ideal’ reactor with PCR=1 and HTE=1). Direct ironsmelting processes are generally farther from equilibrium in comparison with blast furnace ironmaking. For HTE=0.75 and PCR=0.4–0.5, energy and exergy of off-gas constitute more than half of energy and exergy supplied to the smelting reduction furnace. Off-gas utilisation is critical to the fuel efficiency.

Further development of BF ironmaking targets decreasing coke consumption and overall CO₂ emission. Energy consumption of blast furnace iron making under various operation conditions are analysed. For a blast furnace operated under optimised conventional operation conditions with 200 kg/THM carbon in the form of PCI, the consumption of coke carbon is 198.3 kg/THM. Under a condition of 100% indirect reduction of iron, pure oxygen blast, total recycling of off gas CO, and complete replacement of tuyere coke by PCI, theoretical coke consumption can be reduced to 53 kg carbon/THM, while the consumption of PCI carbon is 325.5 kg/THM. However, the overall net energy consumption would increase by 4.7%. Even so, the innovated blast furnace operation provides advantages of pure CO₂ for sequestration, environmental benefit from low coke consumption, removal of hot stove for blast heating, and potential increase of productivity out of enhanced reaction kinetics and reduction of bosh gas content. In both cases, the exergy destruction is almost the same.
Yasushi Sasaki
Visiting professor
UNSW

“Can ductile cast iron sheets meet the demands from environmental issues to develop sustainable society?”

Steel industry is now facing unprecedented demands of CO_2, energy and resource issues. The improvement or modification of the conventional technology could not be enough to meet the demands, or disruptive technologies must be developed. As an alternative technology to meet the environmental issues, the feasibility of the ductile cast iron sheet production is discussed. The production energy (per weight) of cast iron is one of the least compared with other metals, ceramics and plastics, and is easily recycled. The usage, however, is restricted due to their brittleness. The ductile cast iron was developed to solve this brittle problem by introducing graphite spheroidization and is now extensively used in many fields such as automobile parts. However, ductile cast iron sheets have not been commercially produced at this moment due to the technological difficulty. Today’s steel commodities are mainly produced from steel sheets. Thus, once ductile iron sheets are possibly produced, most of conventional steel sheets can be replaced by the ductile iron sheets. Then, we can reduce huge amount of energy consumption and CO_2 emission drastically, and consequently the cost.

The ductile cast iron sheets can be produced by using a strip casting process. At first, (1) cast iron sheets are produced by a strip caster. (2) the produced sheet can be annealed to develop spherical graphite precipitation. The obtained ductile cast iron has almost the same mechanical properties with the low carbon steel and can be used in many applications. However, the ductile iron cannot be used under the high strength requirement conditions. The enhancement of steel strength has been mainly established by optimizing the microstructure. It requires a lot of heat treatments and additional alloy elements. Instead of these approaches, we may adapt mechanical engineering approach. Namely, the strength of ductile cast iron can be enhanced by introducing structural shapes such as colgate or shaveron structure sheets. We call these ductile cast iron sheets as architect ductile cast iron sheets. The architect ductile cast iron sheet can be a promising candidate to develop the sustainable society due to its low production energy, and easy to recycle.