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SFI METAL PRODUCTION

Newsletter Q3/18

In April 2019, SFI Metal Production has been running for 4 years, i.e. it is time for the Midway evaluation. Therefore, the focus for the Centre this autumn will be the preparation and implementation of the Midway Evaluation. The Midway Evaluation process involves the whole Centre: students, the research partners NTNU, SINTEF and Norce, all the industrial partners, the Executive Committee and the Scientific Committee. The Executive Committee Members have been and will be especially active this autumn with several meetings and workshop on the topic Midway Evaluation. All documents have to be finished before the deadline which is December 14th.

SFI Metal Production would like to thank NORCE and Sverre Anton Halvorsen for arranging the Conference "Mathematical Modelling in Metallurgical Industry" – a big success. More than 50 experts on the metallurgical industry met in Kristiansand to discuss how mathematical models can improve and help process industry. This two-day conference was part of a cooperation between SFI Metal Production and NORCE.

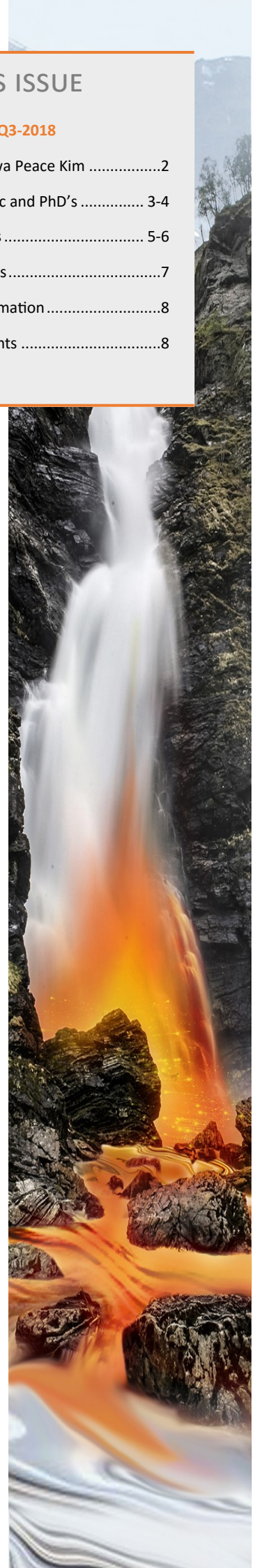
An application to the National Financing Initiative for Research Infrastructure (INFRASTRUKTUR) with the title "National Laboratory for Advanced Metal Production and Recycling for the Future - AMP Lab" was submitted to the Research Council of Norway on the 10th of October. The Infrastructure proposal is anchored in the SFI Metal Production. The AMP-Lab will tailor new experimental techniques for the centre activities. In addition, 3 KPN proposals, 5 IPN proposals and 1 EU project proposal has been submitted this autumn with relevance for the SFI Metal Production.

Our first PhD has been graduated from the Centre. Congratulation to Dr Pyunghwa Peace Kim who successfully defended his thesis medio September! Next in line is Nicholas Smith. He will defend his PhD medio January 2019.

Several new faces are now to be seen in the Centre. In August one postdoc and three PhD's started their work in the Centre. These are presented on page 3 and 4 in this Newsletter.

SFI Metal Production will arrange our annually autumn meeting November 6-7th in Trondheim followed by the General Assembly meeting and a discussion meeting with the Scientific Committee. **See you in November!**

Aud N. Wærnes
Center Director



Congratulation

Dr. Pyunghwa Peace Kim

The first graduated PhD at the Center!

Congratulation to **Dr. Pyunghwa Peace Kim** who successfully defended his thesis September 12th. Peace did an excellent job, first with an impressive presentation of the trial lecture “Slag Foaming” and further with the presentation of his PhD thesis and the defence.

Thesis title: **“The Reduction Rates of SiMn Slags from Various Raw Materials”**.

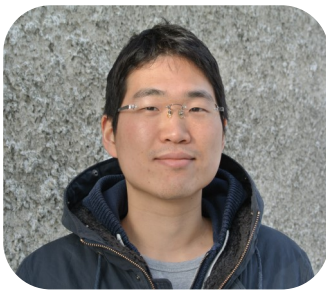
Assessment Committee :

- Professor Emeritus Oleg Ostrovski, University of New South Wales, Australia
- Senior Lecturer, PhD Elias Matinde, University of Witwatersrand, South Africa
- Associate Professor Jafar Safarian, Department of Materials Science and Engineering, NTNU

Supervisors: Professor Merete Tangstad

Co-supervisor Senior Research Scientist Eli Ringdalen.

Photo: Peace together with his parents, the assessment committee and his supervisor.



Shortly about Peaces’s Thesis

What have you been working on the last three years?

I have been working on the kinetic information in the SiMn (Silicomanganese) process from melting of raw materials to production of metal. This is of interest for the SiMn production industries where the effect of raw materials in the furnace is not well known and is assumed to give impact to the metal producing rates.

What is a specific result or conclusion from your research that you would like to highlight?

It was observed that formation of SiMn slag occurs at relatively low temperature below 1400 °C but the main reduction starts to occur at 1500 °C. During the reduction of MnO and SiO₂ at relatively high temperature, the amount of Sulphur clearly influenced the reduction rate where the threshold amount was 0,3 wt%. Sulphur did not behaved as a catalyst for MnO reduction but was assumed to influence the reduction rate between slag and dissolved carbon in the metal phase by increasing the wetting between the two phases.

How have you enjoyed your stay in Norway? You have been here for quite some time now.

I've been here for five years now, and had both my master and PhD here. The academic advisers and professors in this department have been excellent teachers. The working environment is also pretty awesome.

One of the things that surprised me, compared to my culture, is that it is a very parallel working structure, there is less stress between professors, students, and engineers. It was kind of difficult in the beginning, but now I really like the system. I think that kind of thing affects the studying conditions a lot.

My supervisor Merete always pushes you to do better, she's that kind of advisor and teacher. I think that all of Merete's students succeed because we discover that we can do even more, always!

Three new PhD's and one postdoc



PhD Cathrine Kyung Won Solem

Supervisors: Prof. Ragnhild E. Aune and Prof. Gabriella Tranel

Industrial mentor: MSc Egil Solberg, Alcoa Mosjøen

Full title: Parametric Study of Molten Aluminium Oxidation in Relation to Dross Formation.

Aim of project: Predict/model and reduce dross formation in selected aluminium alloy systems.

Thoughts of joining the SFI: I think that being a part of something bigger than just my own project, will be of great value for both me and my colleagues. By creating a network within different topics, have someone to discuss with and always be able to receive and provide help through sharing our experiences, are only some of the advantages with the SFI. I think it is essential to have a group like this to succeed within scientific research, and I am looking forward to be a part of the SFI the next four years.

Postdoc Vincent Canaguier

Supervisor: Prof. Merete Tangstad

Full title of project: SiMn Production

General area: SiMn

Aim of the project: Study the SiMn process, reactions, kinetics and effects of the ore used. The sulfur content of the charge is also considered with additional care.

Thoughts on joining the SFI: I am glad to join an environment offering interactions with the industry, and hope that it will be as fruitful as it can get.





PhD Sindre Engzelius Gylver

Supervisors: Assoc. Prof. Kristian Etienne Einarsrud and Assoc. Prof. Espen Sandnes

Full title of project: Alumina Dissolution in Cryolite

General area :Primary production of aluminium

Aim of the project: Alumina is one of the raw materials used for production of aluminium. During addition of alumina into the melt, floating agglomerates, known as rafts, might form. I will investigate why and how these rafts are formed. More knowledge about this might lead to better feeding techniques, which will lower the energy consumption of the Hall–Héroult process

Thoughts on joining the SFI: I have already had the pleasure of being a part of the SFI as a master student. It is very exciting to have a close collaboration with the industry.

PhD Kamilla Arnesen

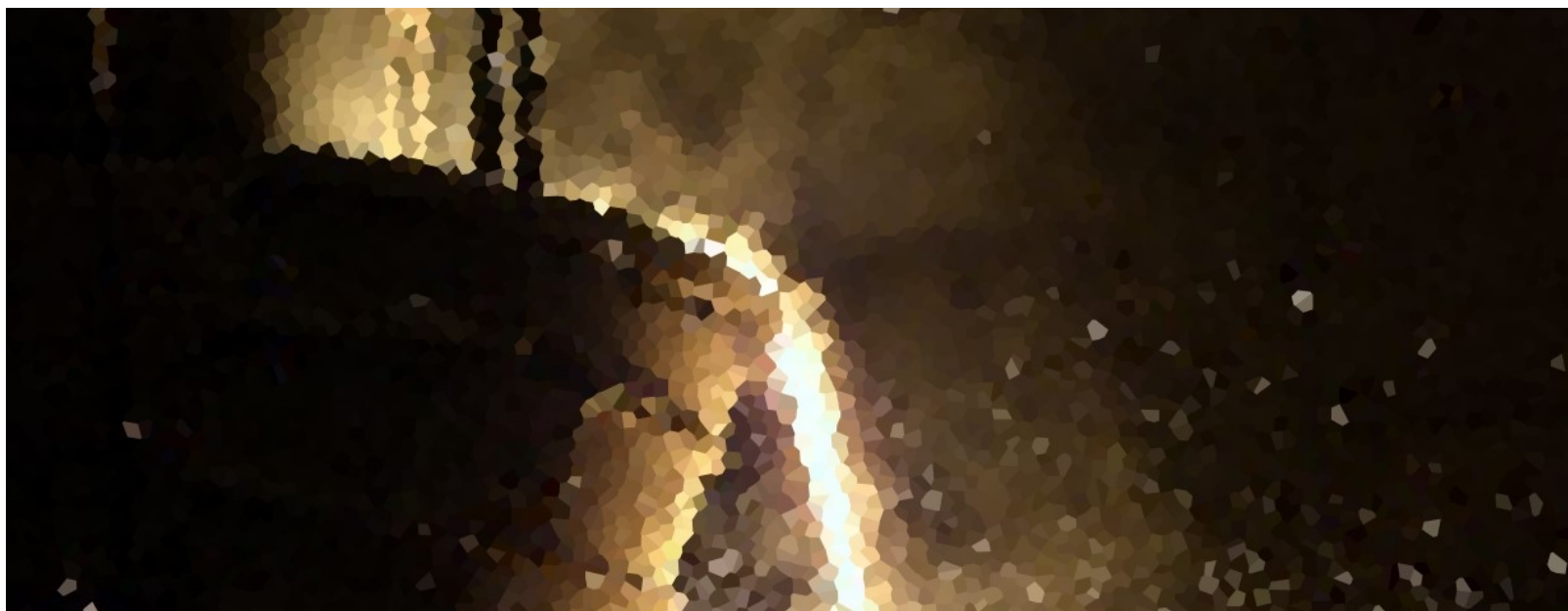
Supervisors: Prof. Gabriella Tranell and Assoc. Prof. Kristian Etienne Einarsrud

Full title of project: Polycyclic aromatic hydrocarbon emission from the metallurgical industry

General area:Emission, Al, Si, Mn

Aim of the project: The project's aim is to investigate the correlation between carbon material properties, process parameters and the formation and decomposition of PAH species in the metallurgical industry.

Thoughts on joining the SFI: I am excited to be joining the SFI group both because of the academic and social environment, as well as the close collaboration with the industry.



CONFERENCES

Extraction 2018, August 26-29

The Extraction2018 conference, August 26–29, 2018, Westin Ottawa, Ottawa, Ontario, Canada was a good event to gather experts and companies in different disciplines of extractive metallurgy. There was a good contribution from partners in SFI Metal Production in the Peter Hayes symposium on pyrometallurgical processing with interesting plenary session speeches about the current and future state of pyrometallurgy in both education, research and industry.



The results of the research work in the areas manganese ferroalloys, silicon, ferrosilicon, alumina, aluminium and waste treatment were presented/published in the conference proceeding from the Centre, summarized to totally 14 presentations from NTNU, SINTEF and ELKEM.

The Nature Conference, September 11-13

The Nature Conference, Minerals and Materials for a Sustainable Future was arranged in Trondheim September 11-13th. Several persons from SFI Metal Production were involved during these three days. Merete Tangstad was chair for the session Sustainability and responsible resourcing of minerals and materials.



Arne Petter Ratvik and Daniel Beat Müller were speakers on the topics Apatite fertilisers production and Monitoring of physical economy, respectively. Norsk Hydro's Hans Erik Vatne talked about the value chain approach to sustainable production of aluminium products.

The three SFI-professors Ragnhild Aune, Gabriella Tranell and Kristian Etienne Einarsrud presented *The future of engineering Stardust*, the conference most challenging title. The presentation started far way back, with the Big Bang and the quotation: "Nature did fabulous job in providing raw materials for us...but almost all present as oxides. That's why we need metallurgists!" Then they gave brief overviews and examples of how to produce metals from oxides. The presentation ended with energy and environmental consideration and the three R's – Reduce, Reuse and Recycle. The SFI Metal Production professors brought their speech to an end with the follow words: "Matter is finite and part of our earths inheritance unlike energy, which is given to us in plentiful every day. In order to optimise these finite material resources for generations ahead, our mission must be to balance and manage our energy system and resource handling portfolio better.

Today, we use our experiences in materials production and technology to improve our every day life with a rather short sighted view. We calculate and simulate to secure the development of intelligent solutions that involves making production processes more energy efficient with a lower environmental impact, as well as safer and smarter but we often forget the bigger picture.

In other words, we dream of solutions that will help us on our way to a sustainable and better future. It's time to make the dream reality – and that is or challenge!"

Mathematical Modelling in Metallurgical Industry

A meeting place for interaction between industry and academia

17-18.9.2018, Kristiansand, Norway



Picture: Dietmar Hömberg, Harald Martens, Kristin M. Flornes, Arne Petter Ratvik, Aud N. Wærnes, Svern Anton Halvorsen.

How math can make for better metals?

More than 50 experts on the metallurgical industry met in Kristiansand to discuss how mathematical models can improve metal production.

Mathematical models are used throughout the metallurgical industry to improve production processes in order to increase quality and reduce cost. A better understanding of reactions and material transport within the hot smelters producing different metals, could provide more consistent quality and less production errors, thus improving competitiveness and profitability.

“This conference is an important meeting place for industry and academia, where the industry makes leading researchers understand industry challenges, and scientific partners present new research and findings. One important issue is how physics-based insight and data-driven analysis may complement each other. The conference aims at improving the communication between industry and academia, which will be of great value for both communities,” says Svern Anton Halvorsen, Chief Scientist, Modelling and Simulation at NORCE.

The two-day conference, Mathematical Modelling in Metallurgical Industry, is part of a cooperation within SFI Metal Production, a Centre for Research-Based Innovation (SFI), hosted NTNU, with SINTEF and NORCE as research partners.

Keynote speakers were Prof. Dr. Dietmar Hömberg from Weierstrass Institute in Berlin, Germany, and Prof. Harald Martens from NTNU. The conference included speakers from South Africa and Iceland, in addition to several presentations from the Norwegian metallurgical industry and research institutions.

Digitalization

At the first similar conference in Kristiansand three years ago, one subject did not make it on to the agenda: Digitalization. This year, presentations also included data driven modelling (statistical models, big data, artificial intelligence, etc.) and how it may help the industry improve work processes. Some speakers stressed the need for models for further automation and improved decision support systems.

“Models should be as simple as possible and help us make the right decisions. We are constantly looking for better mathematical models to support production and development processes,” said Nina Helene Omdahl at Alcoa in Mosjøen.

Due to high temperatures and several complexities, the design and operation of the processes are still to a large degree empirically based, and several process variations are not properly understood.

“Mathematical modelling can effectively be applied to improve today’s knowledge and contribute significantly to solving industrial challenges. Much insight can be established by mathematical analysis. The mathematical descriptions will further supply the basis for computations and simulations, applying modern computers and advanced software. Such simulations constitute valuable tools for enhanced process understanding, process improvements and novel innovations,” says Halvorsen.

The conference in Kristiansand was sponsored by SFI Metal Production, The Research Council of Norway, University of Agder, Eyde Cluster, Vest-Agder County, Aust-Agder County and Kristiansand Municipality.

NEW PROJECTS

Associated Projects

SFI Metal Production constitutes a cornerstone for providing a strong research alignment and a visible European node. The Centre actively seeks for additional financing to ensure self-sustainability beyond the duration of the Centre. We have defined that associated project shall contribute to the generic competence building and/or infrastructure of the SFI Metal Production to realise the vision of the centre.

As up today, the associated projects portfolio with support from the The Research Council of Norway and H2020 is summed up to a total budget of about 280 mill NOK.

PREMA—a new H2020 project

The overall objective of H2020 project PREMA is to demonstrate a technology for pretreatment of Manganese ores that will enable to increase energy flexibility, energy efficiency, enhance raw material use of fines, and reduce CO₂ emissions in production of Mn-alloys.

The logo for the PREMA project, featuring the word "PREMA" in a bold, orange, sans-serif font. The letter "E" has a stylized yellow and orange flame-like shape above it.

Coordinator for this project is SINTEF and the total budget is 11,8 mill €. The other partners are NTNU, Ferro-globe Mangan, MINTEK, Transalloys, Stellenbosch Univ., Deutsches Zentrum für Luft- und Raumfahrt, OFZ, Outotec GmbH, Eramet Research, Helmholtz-Zentrum Dresden-Rossendorf, Inst. for Ecology of Industrial Areas and Outotec Oy.

A new INTPART project CaNAI

INTPART is a network program at RCN working for international Partnerships for Excellent Education, Research and Innovation.

Norwegian-Canadian Partnership in Research and Education on Primary Production of Aluminium (CaNAI) is an INTPART project with Canada and Laval University. The project started in August this year with a Kick-off meeting continued by two days of Summer School. Several Canadians from Laval University were in Trondheim this week and the project leader, Tor Grande (NTNU), and his team carried out an extensive program involving both industry partners and academia.



Coming events

October 11-12, 2018 Silicon Refining short course
Trondheim, Norway

October 14-17, 2018 Furnace Tapping 2018 Conference, *Kruger National Park, South Africa*

November 5, 2018 Executive Committee Meeting
Trondheim, Norway

November 6-7, 2018 SFI Metal Production Autumn Meeting
Trondheim, Norway

November 7, 2018 General Assembly Meeting
Trondheim, Norway

November 8, 2018 Internal Alumina meeting
Trondheim, Norway

Useful Information

Teknova is now an integrated part of **NORCE** Norwegian Research Centre AS. For more information : www.norceresearch.no

Benjamin Ravary (Eramet) is taking over for Leif Hunsbedt (Eramet) as a member of both Executive Committee and General Assembly.

Midway evaluation of SFI Metal Production.

Under the scheme for Centres for Research-based Innovation (SFI), each centre is required to undergo an evaluation under the auspices of the Research Council roughly 3,5 years after start-up. The evaluation forms the basis for determining whether to continue the individual centre for the final three-year period.

Deadline for the Midway-evaluation assesment reports is medio December this year and the evaluation panel will visit the Centre primo March 2019.



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Marit Dolmen, Elkem

Eli Aamot, SINTEF Industri

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