

# Newsletter Q2/17

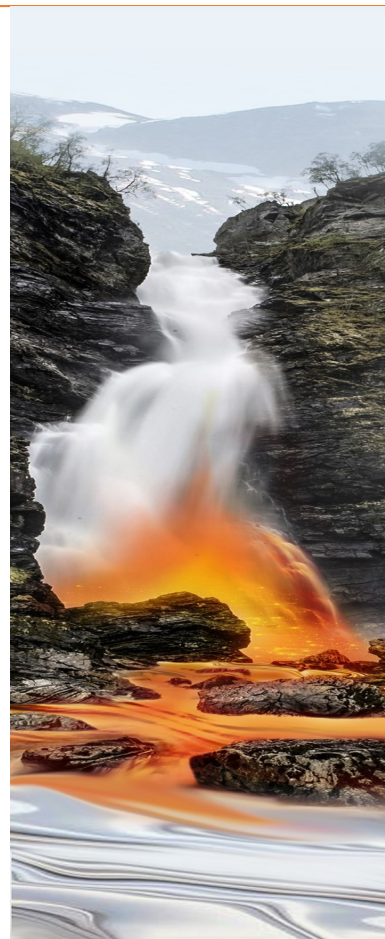
## Activities at the SFI

The first part of 2017 is over, busy months with lot of activities for the members of the SFI Metal Production. Several Workshops, conferences and project meetings with participants from research and industry have been arranged - covering the wide span of the SFI. Some examples are PAH formation and emissions, CFD modelling, Summer school on Silicon at Iceland and the Spring Meeting. The SFI members have also been presenting their work at Conferences like TMS and SINTEFs Circular Economy conference in Mo. Several exchange students have been visiting the SFI premises. A description of the activities are given later in this Newsletter.

Long Term Plans for SFI Metal Production has been made, and was approved by the Executive Committee in June. The Long Term Plan will be presented for approval of the General Assembly in November. The process making the plan started early in 2017, and have been carried out in close cooperation with the industry partners. The Long Term Plan will be a guide for the annual work plans.

The SFI team will like to thank all partners in the SFI for an interesting and productive winter and spring. We are looking forward to meet you all after the summer holiday.

*Have a nice summer holiday!*



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### SPECIAL POINTS OF INTEREST

- Science Facts with the latest research from the SFI.
- Interesting seminar and meetings to place in your schedule this autumn.



Gabriella Tranell, Iceland 2017

## Si Summer school, Iceland 13-15 June

The 4th Si summer school was arranged by Gabriella Tranell and Merete Tangstad at NTNU together with Gudrun Sævarsdottir at Reykjavik University in Reykjavik, Iceland 13-15 June.

The school had a record attendance of 63 people from around Europe, South Africa, USA and South America. The school had lecturers from both NTNU/SINTEF and Iceland, with an invited lecture from Javier Bullon, retired CTO of Ferro Atlantica/Ferro Globe.

The program covered both Si production, raw materials, refining, casting and environmental/OHS issues. We were also fortunate enough to get a guided tour of the new United Silicon plant near Keflavik.

See you all in Norway 2019!

*«If it is not new or disrupting, don't bring it to a SAM conference»*

Visit:

Hydro Al Recycling,  
Dormagen

The annual excursion for the 3rd year material students at NTNU this year went to Germany. As part of the tour, we visited Hydro's Al recycling plant in Dormagen, on the 4th of April.

We were very well received and the students were impressed by the size of operation and the rate of automatic metal sorting. After a nice German style lunch, we travelled on to the wineries in Bad Dürkheim outside Mannheim.

*Thank you Hydro for your hospitality!*

## SAM 11

The 11th meeting of the Society and Materials conference, SAM-11, took place in Norway, at Trondheim's NTNU on 15 and 16 May, 2017. 5 keynote lectures, 25 presentations and 10 posters were presented to an audience of 77 participants from 3 continents and 15 countries. The academia/RTO/industry distribution was 65-17-18 %, while the gender ratio was 43/57%, males/females.

In the introductory, the pioneering and seminal role of NTNU in the fields of metals, society and societal metrics (MFA in particular) was emphasized.

Then the chair of the scientific committee stressed the point that the conference was to bring together material "hard" sciences and social "soft" sciences. Moreover, the conference serves as an experimental laboratory, where new ideas are tested and discussed in terms of methodology but also of implementing them to solve strategic societal challenges: "if it is not new or disrupting, don't bring it to a SAM conference!! If it does not connect both material and social dimensions, do not propose it either!"

SAM-12 is planned May 22nd to 24th 2018 in Metz in France.

Read more about the conference at:  
[www.sovamat.org/](http://www.sovamat.org/)



Host of SAM 11: Leiv Kolbeinsen,  
NTNU/SFI, RD5

Participants at  
SAM11



## Conference on Circular Economy

It was arranged the 10th-11th of May 2017 in Mo i Rana, Norway. The conference gave participants insight in how to succeed in business within the framework of circular economy, and how research and innovation can contribute! The conference provided with background details to understand circular economy, and facilitate learning and experience transfer across sectors through examples of business and research as well as facilitated discussions. Successful leaders within their fields, contributed with experiences and recommendations in how to succeed. In addition, important Norwegian governmental actors describe how they could assist companies in realising their projects.

## 12th International Conference on CFD

SINTEF and NTNU hosted the 12th International Conference on CFD (Computational Fluid Dynamics) in the Oil & Gas, Metallurgical and Process Industries in Trondheim May 30th to June 1st. The conference was sponsored by SFI Metal Production. More than 100 studies were presented and roughly 20 papers on metallurgical applications (tapping, casting, reactors and more). The 80 participants attended the conference showed a high interest of the topics. The conference is organized in cooperation with CSIRO.

## PAH Meeting

RD4 arranged a workshop 21st of April on the status and way forward on research in the area of PAH emissions. The workshop was attended by industry representatives from both Elkem, Wacker, Eramet, GE and Hydro, in addition to NTNU and SINTEF. On-going industrial campaigns in the Si and Al industries will continue in the fall. Industry representatives are interested in strengthening the SFI research through a parallel IPN application to the RCN.

## Industrial Secondary Flows

A specialist meeting was arranged regarding Industrial Secondary Flows. The meeting was held at March 30th 2017 at Hotel Scandic Lerkendal, Trondheim. It was arranged together with the innovation project Waste-2-Value and representatives from the industry, the EYDE-network, Glencore Nikkelverk and ReSiTec, in addition to the representatives from SFI Metal Production.

## The 5 RD Domains

**RD1**  
**Fundamentals and modelling tools**  
Arne Petter Ratvik  
Senior Research Scientist  
SINTEF  
[arne.p.ratvik@sintef.no](mailto:arne.p.ratvik@sintef.no)

**RD2**  
**Primary Metal Production**  
Merete Tangstad  
Professor  
NTNU  
[merete.tangstad@ntnu.no](mailto:merete.tangstad@ntnu.no)

**RD3**  
**Recycling and refining**  
Anne Kvithyld  
Senior Research Scientist,  
SINTEF  
[anne.kvithyld@sintef.no](mailto:anne.kvithyld@sintef.no)

**RD4**  
**Emissions and energy recovery**  
Gabriella Tranell  
Professor  
NTNU  
[gabriella.tranell@ntnu.no](mailto:gabriella.tranell@ntnu.no)

**RD5**  
**Materials and Society**  
Leiv Kolbeinsen  
Professor  
NTNU  
[leiv.kolbeinsen@ntnu.no](mailto:leiv.kolbeinsen@ntnu.no)



## Science FACTS RD2

More than 100 tons of  $\text{SiO}_2$ - $\text{Al}_2\text{O}_3$ -CaO slag has been found in the Si and FeSi furnaces at excavations.

Micahl Ksiazek, Eli Ringdalen,  
Merete Tangstad, MSc-Siri Marie Bø

The size of the quartz particles is not affecting the phase transformation.

Eli Ringdalen  
MSc-Marthe Kjeldstadlie

More than 50% of a transition amorphous phase, between quartz and cristobalite, can be found in some quartz during heating.

Eli Ringdalen  
MSc-Marthe Kjeldstadlie

A new method of investigating the softening and melting of quartz was developed.

Eli Ringdalen  
MSc-Karin Fjeldstad Jusnes

Si is produced in large amounts inside the SiC structure at 1750 °C.

PhD- Sethu Jayakumari

$\beta$ -SiC from charcoal can be transformed more easily to  $\alpha$ -SiC at 2100°C than  $\beta$ -SiC from coal

PhD- Sethu Jayakumari

The raw materials in SiMn production melts and mixes at 1300 °C, but is not reduced until 1500 °C.

PhD-Peace Kim  
MSc-Joakim Holtan

The reduction rate of SiMn slag increases with a factor more than 10 when increasing the S content from 0.3 to 0.5%.

PhD-Peace Kim, MSc-Trine Asklund  
Larsen, Exchange-student Ryosuke Kawamoto

The slag basicity is not affecting the reduction rate for FeMn slags

Xiang Li, MSc-Didier Ngoy

The dissolution rate of C into Mn-Fe alloys is more than 5 times faster than reported values for Fe.

PhD- Hamideh Kaffash

Some Mn-agglomerates will disintegrate over 3 months

Leiv Kolbeinsen, Eli Ringdalen  
MSc Thomas Bye

## Spring Meeting 25<sup>th</sup>-26<sup>th</sup> of April 2017

Climate change and its relation to emissions, including those from the process industry, was the background for the first session. Øyvind Slåke/Norsk Industri presented the ongoing processes based on the Norwegian Industries' Roadmap - Combining Growth and Zero Emissions by 2050, the Report from the Government's expert committee for Green competitiveness and the Report to the Norwegian Parliament, Industry – Greener, smarter and more innovative. Focus on R&D, access to renewable energy on competitive conditions were highlighted, Process21 is an important process for the SFI members. Eli Ringdalen followed up with a presentation of the "Road-map for gas in the Norwegian metallurgical industry: greater value creation and fewer emissions". The vision for the road map is a sustainable metallurgical industry that will attain CO<sub>2</sub>-neutrality by 2050. Expanding the use of gas will contribute to make this vision a reality.

**The first thematic topic – Waste** /Anne Kvithyld. Prof. Markus A. Reuter's presentation "Digitalizing the Circular Economy", focused on Fairphone2 as an example for Design for Recycling. What is the best recycling scenario out of three alternatives? A dismantling process was the best option showing that the choice of process is important. Anne Kvithyld presented the report "Waste and by-product overview of the metallurgical industry in Norway", with a special focus on the SFI partners. It is an important report that will form the basis for the selection process for coming activities on waste. Anders Sørhuus/GE presented the process/equipment developed by GE together with the Al-industry with the title "Alumina as collector of impurities from the Al electrolysis cell". Sean Kelly was the last speaker with recycling of Al with focus on automotive scrap flows.

**The second thematic topic - "Modelling by use of FactSage"**. Post Doc Elmira Moosavi Khonsavi presented "FACTSage thermodynamic modelling; background and selected applications in SFI". Thermodynamic is very important to the work in the SFI. This was well demonstrated by some examples; removal of P from metal, Dusting and fuming from FeMn production, and Al-electrolysis. Kai Tang followed up with examples of modelling of slag properties from thermodynamic data (Slag- Struc), and the last presentation from Asbjørn Solheim on thermodynamics in Al electrolysis.

Sverre Gulbrandsen-Dahl/SINTEF Raufoss, and Centre Manager SFI Manufacturing - "Ups and downs, The nature of Science". The relation between the challenges in the Norwegian productivity that is declining and the results in NCE and SINTEF Raufoss that has shown an increased productivity: 46 per cent vs 18 % in Norwegian Industry in general (excl. oil and gas). The SFI Manufacturing has high ambitions when it comes to Spin-Off projects reflecting the situation at Raufoss.

**The third thematic topic "My projects in 5 minutes"** with the PhDs and Post Doc's in SFI Metal Production. Thank you to all the students, Post Docs and Marianne for excellent presentations – all on time and to the point. A Poster session with the PhD and Post Docs, followed thereafter in the coffee area with time for further discussions.

Prof. Margaret Hyland took the challenge and stepped in for Anne Kjersti Fahlvik with the presentation "Innovations, research and industry – a powerful combination" with examples from New Zealand, combining culture and science projects. Thank you for your contribution!

**The last thematic topic was Particle technology** with Gabriella Tranell. Ida Kero started with results from FUME project on dust formation in the ferroalloys industry. Heiko Gaertner followed with a state of the art on PAH in the metals industry. Both topics are very important for the SFI.

All the presentations are available on the SFI eRoom - My eRooms > SFI Metal Production > Administration > Meetings > 2017 > SFI Spring Meeting April 2017

## Exchange students Summer/Autumn 2017

### Matthew Kovalchuk

PhD student  
University of Pittsburg  
«Phase equilibria in common  
Sulphur-containing atmospheric  
dust compositions »

### Diego Correa Ramos

PhD-student  
The Federal University of Viçosa,  
Brazil  
«Use of charcoal in Si-  
production.»

### Ralph Glastonbury

PhD student  
NorthWest University in S. Africa  
«XRD, SEM and Porosity analysis  
of Soderberg electrodes»

### Alireza Cheraghi

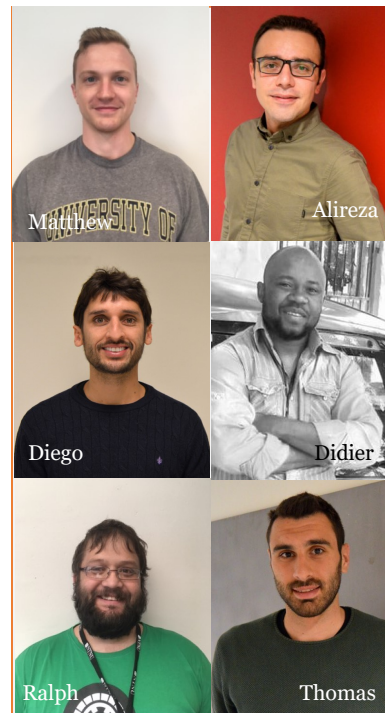
PhD student  
Sharif University of Technology.  
«Pre-Reduction of Manganese Ore  
to Produce Ferromanganese»

### Didier Ngoy

MSc-student  
«Use of South African ores in Fe  
Mn production.»  
From South Africa.

### Thomas Berto

McS student  
University of Padua, Italy.  
«Characterization of the Morpho-  
logy and Permeability of Ceramic  
Foam Filters (CFF)»



«The reduction rate of SiMn slag increases with a factor more than 10,  
when increasing the S content from 0.3 to 0.5%.»

PhD-Peace Kim, MSc-Trine Askund Larsen, Exchange-student Ryosuke Kawamoto

## SCIENCE FACTS

Some of the results for the various the Research Domain in the SFI are presented in the issue of the SFI Newsletter on page 4 and 5. Hope you will enjoy the latest news from the research from the SFI.

### Science Facts RD2

A mineral with the pseudobrookite structure is Armalcolite, named after the crew of the Apollo 11 moon landing (Neil A. Armstrong, Edwin E. Aldrin and Michael Collins) because it is found in appreciable amounts on the moon. Armalcolite has the ideal formula  $\text{Fe}_{0.5}\text{Mg}_{0.5}\text{Ti}_2\text{O}_5$  limited by the following compounds:  $\text{MgTi}_2\text{O}_5$ ,  $\text{FeTi}_2\text{O}_5$ ,  $\text{FeMg}_{0.5}\text{Ti}_{1.5}\text{O}_5$  and  $\text{Mg}_{0.5}\text{Ti}_{2.5}\text{O}_5$ .

PhD-Rune Stana

During excavation of a Silicon furnace it was seen that the 2-3 outer cm's of the electrode was totally transformed to SiC.

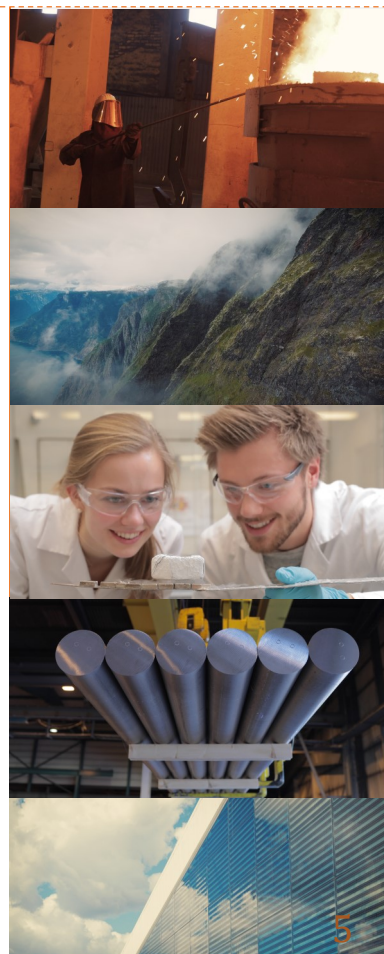
Pre-treatment of bauxite with hydrogen at 350 °C made the bauxite and its leached residue magnetically susceptible.

Methods and procedure for running SiMn pilot experiments have been further developed to allow comparison of results from different experimental series. The experiments are run for 8 hours at around 180 kW and produces around 250 kg metal. Good results with up to 20 % Si requires stricter control of raw material analysis and electrode position than in industrial operation.

### Science Facts RD3

Metals from the incinerator is worse than lacquered material in the respect that it do not coagulate.

The aluminium oxide strength are affected by high levels of Be.



## SFI Metal Production

Metal Production is an interdisciplinary Centre for Research-based Innovation (SFI). During the next decades, the Norwegian metal industry will need to achieve even higher-quality output with more efficient use of resources and energy.

The main goal of the Metal Production is to enable industrial innovation and give the industry long term access to world class fundamental competence and candidates. This will enable the industry to maintain its position at the forefront of sustainable innovation.

## Upcoming Events

### 2017

<b>August 29<sup>th</sup> - 30<sup>th</sup></b>	<b>HSC Chemistry Course</b> Trondheim, Norway
<b>September*</b>	<b>EIT Raw materials—Stakeholders Meeting &amp; National Brokerage Event EU Projects</b> Trondheim, Norway
<b>September 22<sup>nd</sup></b>	<b>Executive Committee Meeting</b> Trondheim, Norway
<b>October 11<sup>th</sup> - 12<sup>th</sup></b>	<b>Tapping Seminar</b> Trondheim, Norway
<b>October*</b>	<b>Industri 4.0/Big Data og IPR</b> Norway
<b>November 7<sup>th</sup> - 9<sup>th</sup></b>	<b>SFI Metal Production Autumn Meeting</b> Trondheim, Norway
<b>November 28<sup>th</sup> - 29<sup>th</sup></b>	<b>Recycling Seminar</b> Trondheim, Norway

*\* Dates to be announced. Follow our webpages for updates.*

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