

## ***SFI Metal Production***

### ***Newsletter No 1/2018***

This Spring has been a symbol of high scientific activity and conferences. The SFI Metal Production environment was well represented at both INFACON XV in Cape Town and TMS in Phoenix with many first rate presentations. A seminar focusing on all aspects of Dust in industry was held in February. In additions, two successful Workshops on Alumina dissolution with students and Hydro and Alcoa, have been arranged in 2018. A Workshop on Dross formation and utilization was arranged the day before the Spring meeting with delegates from industry and academia.

The SFI Metal Production is the third “generation” center of SFIs funded by the Research Council of Norway. All the SFI centers in this group will be assessed. A Midterm assessment is planned for the SFI(III) in the Autumn of 2018 and the winter of 2019. The annual SFI Forum at the Research Council and part of the Spring meeting had both focus on how to prepare for the Midterm assessment.

The first day of the Spring meeting 2018 in April had a focus on the following topics; Waste from the metallurgical industry, Sustainable metal production, and Refining & Emission. Innovation and Industry were the topic for the last day. I would like to take the opportunity to thank all for their contribution to the Spring meeting; students, industry, research partners, the invited speakers and the Scientific committee.

NTNU is currently appointing 15 innovation managers to help transform more research into practice. The good news is that SFI Metal Production has been awarded one of these full time permanent position Innovation Managers.

*Aud N. Wærnes*



### **SFI Metal Production’s Annual Report 2017**

..... is now available on our web site, <https://www.ntnu.edu/metpro>

If you want a hard copy, please email [marianne.lenes@ntnu.no](mailto:marianne.lenes@ntnu.no)



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### **SPECIAL POINTS OF INTEREST ON PAGE 6:**

SFI Metal Production is looking for a Innovation Manager !!

### Dust seminar

A seminar focusing on all aspects of dust in industry was held in Trondheim 1-2 February.

The seminar was hosted by RD4 together with KPN DeMaskUs.

Presentations at the seminar were held by both Miljø-direktoratet, Industry and the Research organisations.

The seminar was well attended with over 35 participants – predominantly from industry. In particular, it was nice to see plant staff that have not earlier been active in the SFI meetings, joining the seminar!

Hege Rajala Strømnes with her **physics students from metallurgical city of Mo i Rana** visited the **SFI Metal Production** center the 28. February. They heat treated and tested steel samples to demonstrate the effects of cooling rate on the properties. A visit to the electron microscopy lab was also done and we had lunch before visiting other future possible studies at NTNU. It look like the new generation has a cool attitude and hopefully they make right choices ....



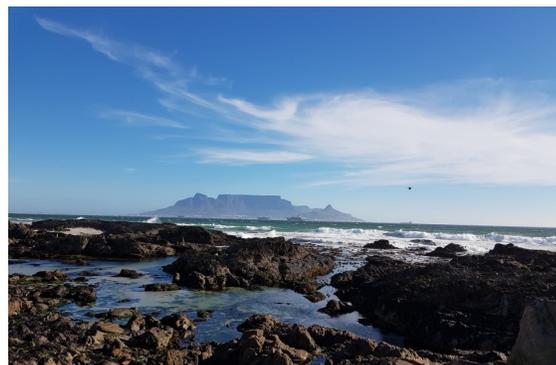
## INFACON XV: International Ferro-Alloys Congress

The 15th International Ferro-Alloys Congress (Infacon XV) was held at the Century City Conference Centre in Cape Town, South Africa from 25-28 February 2018.

INFACON (International Ferro-Alloys Congress) was founded in South Africa in 1974 by the SAIMM (Southern African Institute of Mining and Metallurgy), Mintek (then the National Institute for Metallurgy), and the Ferro Alloys Producers' Association (FAPA) when the first INFACON was held in Johannesburg.

INFACON is controlled by the International Committee on Ferro-Alloys (ICFA) whose objective is to promote the holding of the congress every three years in appropriate locations and to retain the established high technical standard. The intention of INFACON is to stimulate technical interchange on all aspects of ferro-alloy production.

A large delegation of 60 persons from Norway and the SFI partners NTNU, SINTEF, Teknova, Eramet and Elkem were attending the conference. Norway was visible and draw attention to oneself by a lot of delegates, holding several chairs and excellent presentations. From the total of 37 Norwegian presentations, 29 were given by the SFI Metal Production environment.



Oceans view - Table Mountain

### The 16th International Ferro-Alloys Congress (INFACON XVI) will be in Trondheim, 6-9 June 2021

At the 15th International Ferro-Alloys Congress (INFACON XV), in Cape Town (South Africa) on 25-28 February 2018,

Benjamin Ravary (Eramet) Aud N. Wærnes (SINTEF) and Gabriella Tranell (NTNU) convinced the International Committee on Ferro-Alloys (ICFA) that Trondheim and Norway is the perfect place for the next INFACON congress. INFACON is carried out every third year and the next INFACON congress in Trondheim will be in June 2021. Last time INFACON was held in Norway was in 1995.



Tangstad, Wærnes, Ravary, Tranell, Aarhaug, Ostrowski

## The PhD and postdocs from SFI Metal Production and the associated projects.

At this year's INFACON in Cape Town, South Africa, our PhD and postdocs students had the opportunity to attend scientific presentations and discussions, as well as presenting their own work to the audience in an impressive way. We asked some of them about their experiences, both scientific and social, from the conference and the trip to Cape Town.

«All the presentations from my fellow students were very good. Especially Raghed Saadieh and Pyunghwa Peace Kim impressed me with their clear and scientific way of presenting. During conference dinner I am glad that I got the opportunity to see some South African art forms.»

«I enjoyed the presentation on «The use of satellite fire radiative power observations to estimate the availabilities (activity patterns) of pyrometallurgical smelters», by J.P.Beukes. It was an impressive work, as it shows that a massive amount of available data has the potential to be used to increase the transparency of the industry. I also had the chance to meet some new, interesting people, as well as reuniting with scientists met at previous conferences.»

«I was impressed by the presentation about high carbon ferromanganese production titled: «It works in practice, but does it work in theory?», by T. Coetsee. I particularly enjoyed this presentation, because like my work, this work also focused on the MnO reduction process, and has raised questions about her approach to evaluate the reduction temperature of the MnO –C system.»

«During the conference, I got the opportunity to build up my professional network by meeting people from different universities and backgrounds and got the chance to exchange ideas and learn from scientists who had worked many years in the field.»

«I enjoyed the plenary session presentation «European waste to products concepts» by B. Friedrich. It was a good showcase of how various projects in Europe aim to reuse their waste in a more sustainable manner.»

«I was impressed by the plenary session;» Climate changes: threats, realities, and promises” by Bob Scholes. I liked this presentation because it provided an overview of the climate situation, and what we as an industry can do to limit the carbon footprint. Apart from that I very much enjoyed the reception at the beginning of the conference, as I got the chance to talk with a lot of interesting people. All in all, I found the conference very inspiring for my future work. It is also very interesting



# The TMS 2018 Annual Meeting & Exhibition 2018

**TMS2018** (The Minerals, Metals and Materials Society) was year arranged in **Phoenix, Arizona**, from March 11 - 15 with more than 85 symposia in 15 technical tracks and more than 4300 participants from all over the world. Within aluminium, TMS is the globally most attended conference, but it covers many other topics, including rare metal technology, energy technology, high-temperature metallurgical processing and magnesium technology, to mention some. An all-conference plenary session, featuring Charlie Kuehmann of Tesla and SpaceX, was arranged on Monday. Good marketing or pollution of space?



## Visibility and networking

The number of researchers at SINTEF and NTNU contributing to the scientific work presented at TMS was extensive. As usual, SINTEF and NTNU are recognised for giving high quality presentations, which also contribute to the visibility of our research and industrial partners. TMS is also a meeting arena for us to meet industrial representatives and other researchers actively involved in improving the industrial performance of all aspects of aluminium production. SINTEF and NTNU gave together more than 20 presentations, listed below.

- A Study of Anode Baking Gas Composition. Thor A. Aarhaug, Trond Brandvik, Ole S. Kjos, Heiko Gaertner, Arne P. Ratvik.
- Perfluorocarbon Formation During Rare Earth Electrolysis. Karen Sende Osen, Ana Maria Martinez, Henrik Gudbrandsen, Anne Støre, Camilla Sommerseth, Ole Kjos, Thor Anders Aarhaug, Heiko Gaertner, Pierre Chamelot, Mathieu Gibilaro, and Laurent Massot.
- PFC Evolution Characteristics During Aluminium and Rare Earth Electrolysis. Ole S. Kjos, Asbjørn Solheim, Thor Aarhaug, Karen Sende Osen, Ana Maria Martinez, Camilla Sommerseth, Henrik Gudbrandsen, Anne Støre, Heiko Gaertner.
- Evaporation and Diffusion of Mn in Inert Systems. Håkon Aleksander Hartvedt Olsen, Gabriella Tranell
- Validation of Online Monitoring of PFC by QCL with FTIR Spectroscopy. Thor A. Aarhaug, Alain Ferber, Heiko Gaertner, Steinar Kolås, Sven Olof Ryman, Peter Geiser.
- Current Efficiency in Hall-Héroult Cells: The Role of Mass Transfer at the Cathode. Asbjørn Solheim, Henrik Gudbrandsen, Karen Sende Osen, Ole Edvard Kongstein, Egil Skybakmoen.
- Discussion of Bi-Film Index and LiMCA Data in Industrial Aluminum Remelting Trials. Anne Kvithyld, Jan Anders Sæter, Martin Syvertsen, Harry Fossheim, Arne Nordmark, Ronny Sottar, Thorvald Abel Engh
- Experimental Study and Numerical Analysis of Cracking During DC Casting of Large Dimension 7075 Aluminium Billets. K. Ellingsen, Q. Du, M. M'Hamdi, B. E. Gihleengen, R. Ledal, K. O. Tveito, A. Håkonsen.
- XPS Examination of the Oxide-Metal Interface of an Aluminum-Magnesium Alloy Containing Beryllium. Nicholas Smith, Anne Kvithyld, Gabriella Tranell.
- Impact of Inlet Flow on Macrosegregation Formation Accounting for Grain Motion and Morphology Evolution in DC Casting of Aluminium. Akash Pakanati, Knut Omdal Tveito, Mohammed M'Hamdi, Hervé Combeau, Miha Založnik.
- Recycling of Oxide from Dross into Aluminum Electrolysis Cells. Martin Syvertsen, Bjarte Øye.
- Formation of Aluminium Carbide in Hall-Héroult Electrolysis Cell Environments. Bronislav Novak, Arne P. Ratvik, Zhaohui Wang, Tor Grande.
- Understanding the Anode Porosity as a Means for Improved Aluminium Smelting. Epma Putri, Geoffrey Brooks, Graeme A. Snook, Stein Rørvik, Lorentz Petter Lossius, and Ingo Eick.
- Inert Anodes—the Blind Alley to Environmental Friendliness? Asbjørn Solheim.
- Transport of Sodium in TiB<sub>2</sub> Materials Investigated by a Laboratory Test and DFT Calculations. Zhaohui Wang, Jesper Friis, Arne Petter Ratvik.
- Multi-scale Modelling of Titanium Diboride Degradation Using Crystal Elasticity Model and Density Functional Theory. Afaf Saai, Zhaohui Wang, Micol Pezzotta, Jesper Friis, Arne Petter Ratvik, Per Erik Vullum.
- Direct Method for Producing Scandium Metal and Scandium-Aluminium Intermetallic Compounds from the Oxides. Ana Maria Martinez, Karen Sende Osen, Henrik Gudbrandsen, Camilla Sommerseth, Zhaohui Wang, Ove Darell
- CFD Modelling of Alumina Feeding. Kristian Etienne Einarsrud, Sindre Engzelius Gylver, Eirik Manger
- A XANES Study of Sulfur Speciation and Reactivity in Cokes for Anodes Used in Aluminum Production. Gøril Jahrsengene, Hannah C. Wells, Stein Rørvik, Arne Petter Ratvik, Richard G. Haverkamp, Ann Mari Svensson.
- Recovery of REE from the Ferrous Fraction of Processed WEEE (Invited). Mertol Gökөлma, Gabriella Tranell.
- Urban Mining for a Circular Economy: Activities at SINTEF (Invited). Anne Kvithyld, Ana Maria Martinez

# The TMS 2018 Annual Meeting & Exhibition 2018

## Presentations by our industrial partners in Norway:

- Alternative Roof-Vent Emission Monitoring Method. Gunn Iren Müller, Are Dyrøy, Rachel Dosnon, Morten Isaksen, Kristin Sundby, Michel Meyer, Jean-Michel Jolas.
- On-site Benchmarking of LiMCA III Versus LiMCA II for Monitoring of Non-metallic Inclusions in Liquid Aluminium. M. Badowski, T. Dang, N. Towsey, D. Krings, K. Hoffmann.
- Interaction Between Anode Aggregate and Binder in the Sessile Drop Wetting Test. Bruno Rausch, Juraj Chmelar, Hogne Linga, Lorentz Petter Lossius, Rebecca J. Thorne, Viktorija Tomkute
- Productivity and Energy Efficiency Improvements at Two Reverberatory Furnaces at Alcoa, Norway. Henrik Gripenberg, Delwyn Forrest, Per-Bjørnar Bekkevold, Egil Solberg, Johannes Lodin, Fredrik Stark, Fredrik Nyman
- Improved Abart Gas Treatment and Alumina Handling at the Karmøy Technology Pilot. Anders Sørhuus, Sivert Ose, and Eivind Holmefjord

## Other contributions

SINTEF and NTNU are involved in the conference not only with presentations. Besides being the Chair of the Light Metals Aluminum Committee for the last year 2017, Arne Petter Ratvik organised the Light Metals keynote plenary session and panel discussion on Monday morning:

Ana Maria Martinez contributed to the organisation of the symposium "Perfluorocarbon Generation and Emissions from Industrial Processes," besides being a session chair for "FC Measurements, Reduction and Abatement Methods" on Wednesday morning. Egil Skybakmoen chaired the session "Electrode Technology Symposium for Aluminum Production" on Tuesday afternoon. Some action photos are shown below.



*Arne Peter Ratvik , Chair of Light Metal Committee*

Some experiences from our PhD students for the TMS conference and the trip to Phoenix:

«I think the best part of TMS was getting to discuss my work with people in the aluminum industry outside of Norway and getting to see that there is a strong international interest in the work I am doing. It was also good to see what else is happening in the aluminum industry around the world.»

«The location was also very good, as it was centrally located and with more than enough space for it to never feel crowded. The session head seemed very well prepared, leading to a very smooth ride before and after my presentation.»

## Visit to Real Alloy

After the conference, Martin Syvertsen, Anne Kvithyld and Arne Petter Ratvik got to visit the Real Alloy IMSAMET plant in Goodyear, AZ. The plant recycles secondary ingots and dross, among other things, and produces cast ingots and cement additives. The visit gave a good insight in the recycling business as well as challenges related to the operations. It was also interesting to see all the plant processing equipment being placed outdoor with only light roofing for protection.

*Visit to IMSAMET at Goodyear, AZ. From left to right Ray Peterson, Anne Kvithyld, Martin Syvertsen and plant manager Darrin Noe.*



## Innovation Manager— vacancy

### Do you want to work with Innovation at SFI Metal Production?

NTNU has just adopted a new strategy for innovation and is currently appointing 15 innovation managers to help transform more research into practice. The positions form part of the NTNU Strategic Programme for Knowledge-Based Innovation: <https://www.ntnu.edu/innovation-resources/knowledge-based-innovation>

SFI Metal Production will employ one of these fulltime permanent position Innovation managers. Announcement for the Innovation manager at SFI Metal production is found here: Innovation manager – Metal Production and Material Technology

<https://www.jobbnorge.no/ledige-stillinger/stilling/151129/innovasjonsleder-innen-metallproduksjon-og-materialteknologi>

## The SFI Metal Production Spring Meeting

The 2018 Spring meeting was held at the SINTEF administrative building in Trondheim on the 18-19th of April.

The event had a line-up of presenters from NTNU, SINTEF and the industry partners, as well as representatives from Eyde, Enova and the Research Council of Norway (RCN).

The first day started with presentations of scientific results presented by NTNU and SINTEF scientists within the topics; Metal Production, Refining & Emission and Waste & Recycling. In connection with these three scientific topics, time was set aside for discussions regarding the 19 posters presented by our PhD, postdocs and research scientists. The day ended with a nice dinner in SINTEFs canteen, after the 13 associated project were presented.

The second day of the meeting started with the Innovation and Industry session, and Lars Petter Maltby (Eyde Cluster) and Alexandra Bech Gjørsv (CEO at SINTEF) initiated interesting discussions after their presentations. This was followed up by Eramet, Finnjord and Wacker who described how the results from the research produced at the SFI has been of use and/or implemented in their own plants. The final presentation in this innovation session was by Ståle Kvernørud (Enova). He reported of new possibilities for funding for pilot development and experiments from Enova.

The remainder of the meeting was reserved for the Mid-term evaluation, but first Tor Einar Johnsen (RCN) presented the results from the evaluation of the Scheme for Research-based Innovation (SFI's), the DAMVAD report. The last presentations of the 2018 Spring meeting was by centre manager Aud N. Wærnes, first a short presentation of the SFI's status and then facts and time frame for the mid-term evaluation.



## Dross Seminar

Tuesday the 17th of April the SFI Metal Production arranged a seminar on dross.

The background for the seminar was the SFI Report "Overview of solid waste and by-products in the metallurgical industry in Norway" and the following discussion on waste/by-products in the aluminium industry concluded that dross has both the highest value potential and research potential, and will be prioritised by the SFI centre.

The day was organised by into four parts. First looking into the background for the meeting including conclusions from earlier workshops on dross, in addition to rough descriptions of future PhD and postdoc work. Thereafter the background for the formation of dross was presented, both from a theoretical and industrial point of view. Further, today's processes of dross handling were discussed, both for electrolysis and cast house point of view. The last part of the seminar consisted of looking into alternative processes for handling dross, including using plasma rotary furnace and charging the alumina back into the electrolysis cells.

There were 8 industry representatives, 10 from NTNU and 4 from SINTEF present. The discussions were highly opinioned and engaging. Follow-up activities will come.

The students Cathrine and Ingrid are thanked for helping out in the organisation and workshop.

## Upcoming events

### 2018

May 30-31	Nasjonal Konferanse for Materialteknologi (NMS+NMF) Sommermøte, Oslo
June 11-14	Silicon for the Chemical and Solar Industry XIV, Svolvær
August 8-10	Kick-off and Summer School, INTPART- Norwegian-Canadian Partnership in Research and Education on Primary Production of Aluminium (CaNAL), Trondheim.
August 14	PROSIN-konferansen, Arendal
September 17-18	Conference: Mathematical Modelling in Metallurgical Industry, Teknova, Kristiansand
September 26-27	Industri 2018, Bodø
October 14-17	Furnace Tapping 2018 Conference, Kruger National Park, South Africa
November 6-7 A	SFI Metal Production Autumn Meeting, Trondheim General Assembly Meeting



### Center Director

**Aud Nina Wærnes**

*Senior business developer, SINTEF*

Cellphone: +47 93059428  
Aud.N.Warnes@sintef.no

### Executive Committee

Tor Grande, NTNU (Leader)

Nancy Holt, Hydro

Ketil Rye, Alcoa

Leif Hunsbedt, Eramet

Marit Dolmen, Elkem

Eli Aamot, SINTEF

Svenn Anton Halvorsen,  
Teknova

Tor Einar Johnsen, NFR

NTNU Gløshaugen  
Alfred Getz' vei 2  
NO-7491 Trondheim  
Norway

[https://www.ntnu.edu/  
metpro](https://www.ntnu.edu/metpro)

**Twitter**  
@sfimetprod