

Annual Report 2009

Department of Materials Science and Engineering

 NTNU

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Picture on front page:

Melting of titania slag in cold crucible, high frequency induction furnace.

Photo: Errol J. E. Halberg.

Annual report for

Department of Materials Science and Engineering

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The editor thanks

- ✓ Brit Wenche Meland, Hilde Martinsen Nordø, Hege Knutsdatter Johnsen and Åse Lill Salomonsen for collecting the administrative data and taking care of the process of printing the report.
- ✓ Skipnes AS for printing.

FROM THE EDITORS

The Department of Materials Science and Engineering in 2009 can be summed-up as having been a productive and busy year, with respect to both education and research. However, the sudden decease of Professor Trygve Foosnæs overshadows the other events of the year. The passing of Trygve, with his dedicated care both for students and colleagues, is a tremendous loss for the Department.

Excellent student recruitment to our programs continued in 2009. The ongoing efforts to improve the quality of our study programs, to include students in our research activities, and the "open door" policy are key focus areas. We see this as an important effort in recruiting graduate master students for the PhD study programs, and consider it key in achieving a good balance between foreign and domestic PhD students at the Department. The PhD students at the Department are truly an international community, with close to 50 % of the candidates coming from abroad. The dedicated research efforts of our PhD candidates and postdocs contributed strongly to the high number of publications in international journals and other dissemination efforts of scientific results from the Department. The many hours they invest in our laboratories are highly appreciated, as are the supervision by our scientific staff and the support offered by our technical staff. A total of 15 candidates were awarded the degree PhD at the Department in 2009.

The Department is strongly involved in study programs and research activities in NTNU's strategic areas: Materials, Nanotechnology and Energy Technology. Several new research projects were granted in 2009, among other several projects founded by the FRINAT and FRITEK programs in The Research Council of Norway.

In spite of the fact that many of our research partners in the industry experienced difficult times as a result of the financial crisis, the Department managed to continue at the same pace as previous years. Much effort has gone into finalizing research contracts and consortium agreements. This is partially caused by the new instructions from the Research

Council of Norway requiring signed consortium contracts before approving projects, but is also related to the increased focus on intellectual proprietary rights and new instructions regarding postponement of publications from university employees.

The cooperation with SINTEF is still strong and we continue to actively develop the unique and successful research cooperation between Industry, SINTEF and NTNU.

The process to establish a new research infrastructure (Solbygg), mainly for the expanding research on solar cells, continued in 2009. Since the financing of a complete "Solbygg" in line with the initial plans seems to be difficult to achieve in the short term, we are now focusing on a plan to build "Solbygg" in two stages.

Three new professors started at the Department in 2009, Ragnhild E. Aune and Gabriella M. Tranell from January 1, both in the field of process metallurgy, and Bjørn Holmedal, who started March 7. The professorship of Bjørn Holmedal within physical metallurgy is sponsored by a gift from Hydro Aluminium. Since we were not able to find a candidate for the professorship awarded by Hydro Aluminium in aluminium electrolysis technology, we agreed on using the financial contribution to hire two adjunct professors. The positions were advertised in 2009 and the process of hiring started. By this we hope to be able to maintain our strong support and research contributions to the primary aluminium industry at the Department.

Several employees at the Department received awards in 2009. Professor Øystein Grong accepted NTNU and SINTEF's Technology Award for the application of advanced technology. He received the award for his achievements in developing a novel technology for joining aluminium plates. The idea is original and unlike other known aluminium joining technologies. Student Knut Erik Steinsberg received the best technology student prize. His supervisor for the master thesis was Professor Knut Marthinsen. Professor Trygve Foosnæs received, post-mortem, a new team effort prize honouring his extraordinarily efforts in creating a good team environment for

students. Professor Tor Grande received the equal opportunities prize as a result of the many women employed in scientific positions during his period as Head of the Department, resulting in a better gender balance in the scientific staff. PhD student Arjan Ciftja received the 2009 TMS Young Leader Professional Development Award. He was selected from one of the five TMS technical divisions to attend TMS conferences, learn more about activities and leadership opportunities within the society, and network with prominent society members and leaders.

The annual report has the same outline as previous years. The first part comprises short reports on some of the current research in the four

research groups at the Department, the annual list of publications and conference proceedings and the laboratory infrastructure. This is intended to give external readers an impression of the research being performed. The second part, which comprises an overview of the staff, current and completed Master- and PhD-students and departmental extracurricular activities, is presenting a comprehensive overview of our annual activity and is more intended for the archives.

Finally we would like to acknowledge the scientific staff for their contribution to this report. In particular we would like to acknowledge Secretary Åse Lill Salomonsen and the other members of the administrative staff for their efforts.

NTNU July 2010
Arne Petter Ratvik

Professor Dr.ing. Trygve Foosnæs in memory

Professor Dr.ing. Trygve Foosnæs died suddenly and unexpectedly April 24, 2009.

Trygve Foosnæs was born January 4, 1951, and was educated as M.Sc.Eng. in 1975 and got the Dr.ing. degree in 1979 with the thesis "Gas Complexations of Neodymium Halides" at the Chemistry Department, the Norwegian Institute of Technology (NTH). He was post doctorate fellow at Argonne National Laboratory, Illinois, USA for 2 years after his doctor thesis. There he worked with matrix isolation spectroscopy.

Trygve came back to Institute of Inorganic Chemistry at the Norwegian Institute of Technology as a lecturer in 1981. He showed early a strong commitment to education and student affairs and served also as the faculty student advisor. He was very interested in industrial research and moved with his family to Hydro Aluminium Technology Centre in Årdal in 1983. His main research direction in Hydro Aluminium was process improvements and specially connected to anodes. He initiated also use of more fundamental methods as laser determination of HF in the potroom and Raman spectroscopy for electrolyte characterization. He was always research oriented and he had 53 publications and patents referred to in Chemical Abstract.

Trygve Foosnæs had several management positions within Hydro Aluminium and had the ability to connect to national and international networks. His administration of the large research projects EXPOMAT and PROSMAT on behalf of the Norwegian Aluminium Industry was specially noteworthy. He established a close scientific contact with the research institutions in Trondheim and the Industry.

Trygve returned to the Norwegian University of Science and Technology as a Professor in Material Science in 2001. He took up research connected to aluminium production and specially carbon technology. He became advisor for several Master and Ph.D students and he was also participating in starting up one of the first international MSc program at NTNU "Light Metals Production". He was in negotiation with the top management of Hydro



Aluminium on a new industrial research program the day before he died.

Trygve had many administrative duties, but students affairs were always very close to his heart. He was a motivated and popular lecturer in General and Inorganic Chemistry. The students loved him and our largest auditorium was packed with students during the arranged memorial ceremony. He was very concerned with the well-being of students and had always time for students with problems. Trygve was also active with recruitment activities and research dissemination. He gave lectures to junior and senior high school students and organized "Researchers Night" which was always fully booked with 1100 high school students. He was also managing the course "Experts in Teamwork". He took the Master students to excursions to demonstrate how industry worked. His efforts will last for a long time.

Trygve had a deep concern for his fellow beings and worked often behind the scenes and let the others to get the honours. He received the newly Faculty established award "Team player" posthumously.

Trygve Foosnæs is strongly missed by colleagues and students at NTNU and earlier colleagues in the aluminium industry. We are grateful for his achievements and his humour and he is helping us to remember to have concern for others.

Professor emeritus, Dr.techn. Jan Lützow Holm in memory

Professor emeritus, Dr.techn. Jan Lützow Holm died suddenly in his home September 3, 2009.



Jan Lützow Holm was born September 16, 1932. He was educated as MSc.Eng. from the Chemistry Department, the Norwegian Institute of Technology (NTH) in 1959, became Dr.ing. in 1963 and was conferred the Dr.techn. in 1978 on the thesis "Thermodynamic Properties of Molten Cryolite and other Fluoride Mixtures".

He worked as scientific assistant and later research fellow in Institute of Inorganic Chemistry, NTH 1960-65. In 1965-1967 he was Research Associate at The James Franck Institute (Institute of Metals), The University of Chicago, Illinois, USA. From 1961 till 1984 Jan Lützow Holm served in different positions at NTH. He was appointed Professor at Institute of High Temperature Chemistry and Silicate Science in 1984 and later by merger Institute of Inorganic Chemistry and Department of Chemistry, NTNU. From 2002 he served as Professor Emeritus.

Lützow Holm has a sizable scientific production with 82 papers referred in Chemical Abstract. Many of these papers deal with molten salts physical chemistry, especially molten fluorides and chlorides of alkali and alkaline earth metals and aluminium. The studies consisted of thermal analysis of phase diagrams, calorimetric and surface tension studies. The studies were an important contribution to the understanding of the production of magnesium and aluminium. Due

to the technical interest it was supported by NTNF and NAVF.

His study of thermochemistry and structure of oxide systems were important in relation to ceramic materials. Jan Lützow Holm was member of The International Committee of Thermal Analysis (ICTA) and participated in most of their conferences and seminars. His scientific studies using thermal analysis made him highly respected in the international thermal analysis community. He did important work on the different modification of silica and gave theoretical interpretation of the mechanism of transformation. The characterization of cristobalite from the micro-silica produced by the silicon producers was of great technical importance as the structure is decisive for its behaviour when it is added to cement in order to obtain increased strength by use in concrete.

Jan Lützow Holm's knowledge and skills in thermodynamics and silicate chemistry became highly appreciated by SINTEF Ceram Group and he was hired as a consultant on a regular basis. Holm was very engaged in the Norwegian ceramic industry and in the Norwegian Ceramic Society and delivered many excellent and engaged talks in the annual "Christmas" meetings. He was often centre in the traditional Christmas party after the formal program in these meetings since he had a good sense of humour and was always in a cheerful mood. Every year he visited some of the Norwegian ceramic factories together with his students.

Jan Lützow Holm taught General Chemistry, Thermal Analysis and Phase Diagrams. He was also very adamant to continue the lectures of our father of High Temperature Chemistry at NTH, Håkon Flood.

Jan was very interested in politics and actual problems and often brought with him newspaper clippings. His remarks were always with a grain of humour. He is missed very much by his colleagues.

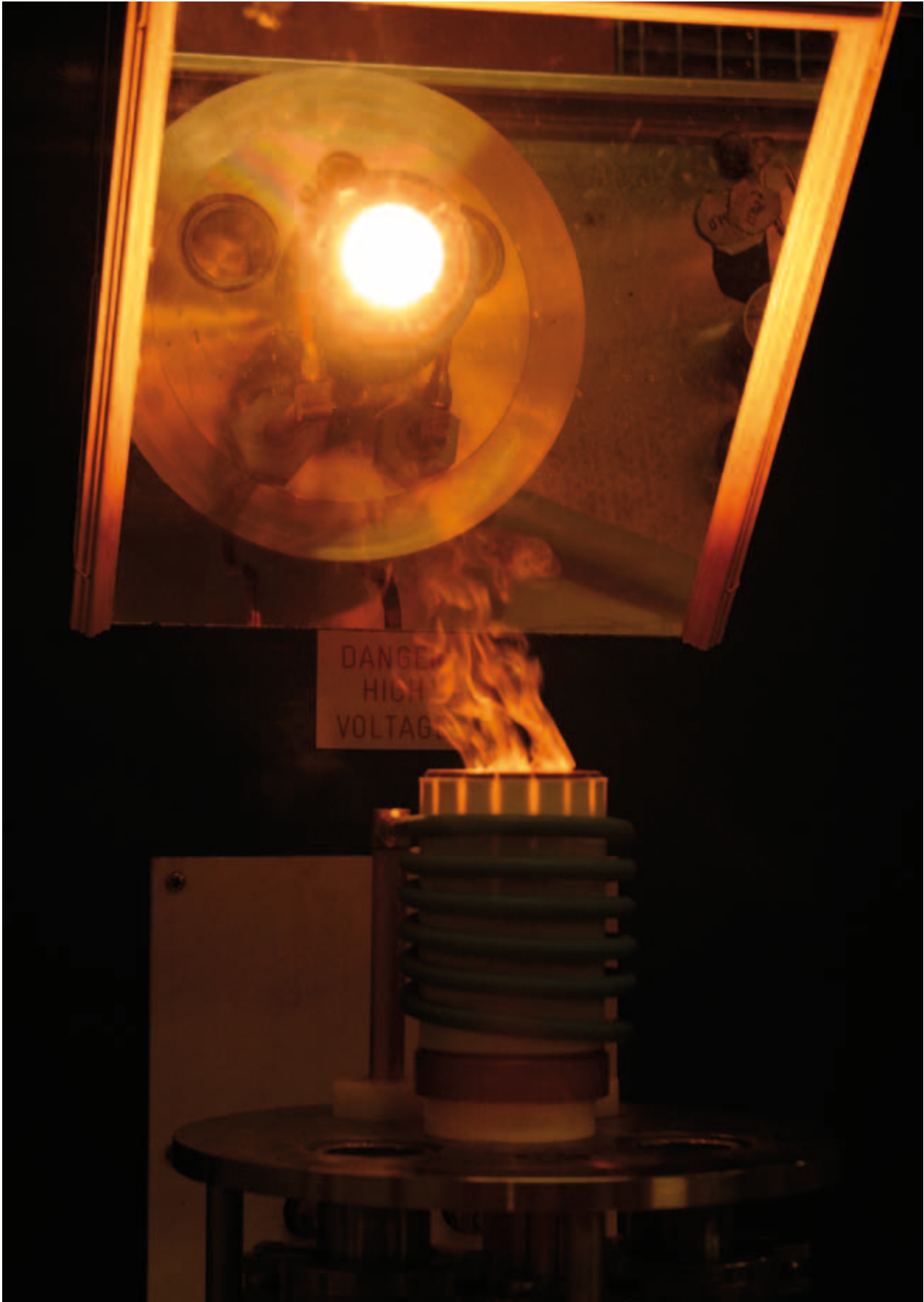


Photo: Sean Gaa/SINTEF

Melting of titania slag in cold crucible, high frequency induction furnace.

Professor Erik Nes – A Nestor in Norwegian and International Light Metals Research has retired

October 24, 2009, Professor emeritus Erik Nes, turned 70. The occasion was duly marked on October 27, 2009, with an honorary international symposium and a subsequent celebration dinner, organised by colleagues at the Department of Materials Science and Engineering.



Erik Nes (born 1939 in Skien), received his MSc in Physics from University of Oslo in 1967 and his PhD degree from University of California (Berkeley) in 1970. He spent 10 years at the Central Institute for Industrial Research (now SINTEF, Oslo), the last 5 years responsible for light metal alloy research. In 1980 Erik Nes was appointed Professor of Physical Metallurgy at the Norwegian University of Science and Technology. His main field of research and teaching was related to the characterization and modelling of the evolution of microstructure and texture and their associated properties during processing of metals in general and aluminium alloys in particular.

During his academic life he made important contributions to the understanding and quantitative description of various softening reactions, like recovery and recrystallization, and more recently also of substructure evolution and work hardening during plastic deformation. Nes has educated 14 PhD students, and several tens of MSc-students in physical metallurgy, mainly of aluminium alloys. He has presented a long series of key-note lectures at international conferences and published more than 200 scientific papers.

For more than 30 years Erik was a profiled researcher in the International and Norwegian light metals community, and he has played a key role in the build up of light metal research in Norway.

During his whole academic career he worked closely with SINTEF and with the Norwegian and international light metals industry, especially Hydro Aluminium. Nes has a wide international network and has participated in, and initiated, several EU-funded frame work programs. He was the chairman of the 3rd International Conference on Aluminium Alloys in Trondheim in 1992. In 1989 Nes took the initiative to the first International Summer School on Aluminium Alloy Technology at NTNU/SINTEF in Trondheim, and event that has been organized 9 times in the period 1989-2007, everytime with Erik Nes as the Chairman of the organization committee.

The international symposium at NTNU October 27, brought together colleagues, friends, former graduate students as well as collaborators from NTNU, SINTEF, Norwegian and international aluminium industry and academic partners in Europe and in the US. This included a number of specially invited lecturers from leading academic institutions and industrial research laboratories within light metals research in Europe and North America, including KTH, Sweden, RWTH Aachen, Germany, Univ. of Manchester, England, Ecole Des Mines St. Etienne, France, Hydro R&D Bonn, Alcan R&D Voreppe and Drexel Univ., PA, USA. All the leading international aluminium companies were represented (Rio Tinto Alcan, Sapa, Novelis, Alcoa).

In addition to a short "review" of Erik's professional the symposium covered a number of interesting topics related to research topics and problems Erik has been working with during his career, including normal and abnormal grain growth, textures, dynamic recrystallization, subgrain growth and solute drag effects. Erik Nes officially retired on October 1, 2008, however, he has kept an office place, and is still active publishing, and he is taking actively part in ongoing research and project activities related to aluminium.

Knut Marthinsen

INTERNATIONAL CONFERENCES AND COURSES

1. The Department arranged, together with SINTEF Materials and Chemistry, the **3rd International Workshop on Crystalline Silicon Solar Cells** in Trondheim June 3-5, 2009. The workshop, which had previously been held in China and Japan, brought together about 160 delegates from 17 countries. About 80 scientific papers were presented in oral- or poster sessions.

2. The Department arranged, together with Padova University a Mini-Master course on **Advanced casting design of automotive components** in Vicenza, Italy, June 22-26, 2009 in Vicenza, Italy. The course, which was arranged within the EU project NADIA, was attended by about 50 students from Europe.

3. The Department arranged, together with TU Bergakademie Freiberg, the **2nd Norwegian – German Group Seminar on Solar Cell Materials** in Freiberg, Germany, September 7-11, 2009. The seminar was attended by about 40 participants from Freiberg and Trondheim and 22 presentations were made.

Lars Arnberg

Mini-Master on Advanced casting design of automotive components in Vicenza, Italy, June 22-26, 2009.



Photo: Shahid Akhtar



Photo: Shahid Akhtar

3rd Chinese – Norwegian Symposium on Light Metals, Shanghai Jiao Tong University, October 19-23, 2009

The NTNU strategic area 'Materials' and the Department of Materials Science and Engineering (DMSE) arranged the symposium in collaboration with Shanghai Jiao Tong University (SJTU) and the National Natural Science Foundation of China (NSFC). The symposium attracted 118 participants; 15 (Norway), 100 (from all over China) and 3 guests (other countries in Europe and Canada).

In total 50 lectures were given including plenary and keynote lectures by Norwegians presenting the Research Council of Norway and the priorities in Sino – Norwegian research cooperation (Thomas Hansteen), Norway and EXPO 2010 (Kristin Welle-Strand), Future Challenges in Aluminium Research (Hans Jørgen Roven) and New Methods for Aluminium Electro-winning (Geir Martin Haarberg). From the Chinese side the director of the Engineering and Materials Division at NSFC (Wangxi Zhu), an academician of the Chinese Academy of Engineering (Baicheng Liu), the dean for College of Materials Science and Engineering at Chongqing University (Qing Liu), the Deputy Head of the Institute of Materials Research, Chinese Academy of Sciences in Shenyang (Rui Yang), the light metals specialist at the Department of Materials Science and Engineering at Tsinghua University (Andrew Godfrey), the Chief Editor of the journal Transaction of

Nonferrous Metals Society of China (Saiqian Yuan), the Dean of School of Materials Science and Engineering at SJTU (Yixiong Wu), Vice-Dean of the School of Materials Science and Engineering at SJTU (Chen Lu), the Head of the State Key Laboratory of Metal Matrix Composites at SJTU (Di Zhang) and the Head of the National Engineering Research Center of Light Alloys Net Forming at SJTU (Wenjiang Ding) were among the prominent speakers.

In addition to the academic participation there were also senior representatives from Chinese industry and trade (Inner Mongolia Baotou Aluminium Ltd., Shandong Innovation Metal Technology Ltd., Shanghai Zhenxing Aluminium Industry Ltd, Shanghai Aluminium Trade Association). There were three parallel sessions, i.e. on aluminium-, magnesium- and titanium alloys.

During the symposium the representatives from the Research Council of Norway and the NSFC had an informal meeting discussing the future opportunities and challenges regarding bilateral research collaboration and funding possibilities.

Generally, one could observe an increasing focus on energy consumption, emission control and recycling issues related to the light metals. New research

Communication Manager, Mrs. Kristin Welle-Strand, Innovation Norway in Shanghai, presenting the Norwegian participation plan for EXPO 2010 during the plenary opening ceremony.



Photo: Xiaoning Zhang/SJTU



Photo: Xiaoning Zhang/SJTU

Group picture of the participants taken at the new SJTU campus at Minhang, Shanghai.

directions indicated that both aluminium and magnesium technologies can contribute significantly to sustainable energy production and consumption and new technologies can have large impacts on the emissions of green-house gasses and pollution levels. Such issues have become very important in China and new solutions might have large global impacts.

The participants also attended several social arrangements including official dinners and a sight-seeing to the famous ancient river city Zhouzhuang. The DMSE attendees were Geir Martin Haarberg, Zhihong Jia, Yongjun Chen, Jirang Cui, Juan Tan and Hans Jørgen Roven (Symposium Chairman).

The symposium series has expanded significantly. This was the third in the row, and the fourth is being planned for 2011 in Norway. In conclusion, the symposium revealed numerous mutual interests and

from the discussions among the respective research council members (4 from the RCN), it is reasonable to believe that new funding opportunities can be established for bilateral projects in the future.

The Norwegian Aluminium Cluster is obviously well recognized in China and there should be many opportunities for expanding joint activities and efforts. With the rising global importance of China, such collaborative efforts are becoming more actualized than ever.

Hans Jørgen Roven

Mass transport effects in the oxidation of small organic molecules

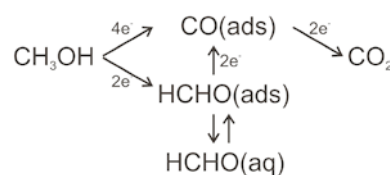
The electrochemical oxidation of small organic molecules like methanol, ethanol and formic acid has been thoroughly studied in the literature. Experimental techniques such as voltammetry, potential steps and rotating disk electrodes have been employed, although very often exclusively in a traditional manner with similar sets of experimental parameters. We show here that by using a rotating disk electrode, transient and steady state response give contradictory behavior in the oxidation of alcohols.

Inspired by the early work by Pletcher and Solis, who investigated the effect of surface pretreatment and employed potential on the rate of methanol oxidation, we wanted to focus on the influence of mass transport with respect to the possible pathways in the oxidation processes.

From basic fluid dynamics it is quite obvious that an increased rotation, hence increased convection, increases the flux of reactants to and products from the electrode surface. Consider a simple one-step reaction with transfer of one electron, which is completely mass transport controlled. The current is then proportional to the flux of reactants to the surface. Evidently, the number of electrons produced (oxidative current) increases with increased rotation rate. In general, most reactions that are mass transport influenced will give an increased current with increased rotation rate. This is the case for formic acid oxidation, which primarily happens through dehydrogenation at free Pt sites in high current potential regions.

The mechanism of electrooxidation of small organic molecules, and in particular methanol oxidation, has been the subject of numerous scientific studies and the general agreement now is that it occurs through a parallel path mechanism. One path is through a strongly adsorbed intermediate known as CO(ads), while the other path is through short lived intermediates to CO₂ or a stable byproduct like formaldehyde. Commonly this parallel path is neglected in systematic studies of methanol catalysts, and the focus has been to improve the CO tolerance of these catalysts rather than preventing its formation.

Although mass transport effects have been questioned for methanol oxidation, very little explanatory effort has been done. Interestingly, a reduced current can be seen for methanol and ethanol oxidation for sustained increased rotation rates (see Figure 1), while an increased current can be observed when the actual change in rotation is performed in potential region of mixed control (Figure 2). The question to consider is why a transient increase in rotation rate increases current, while an identical sustained increase leads to a decrease in current. Literature interpretation of the latter is in terms of increased formation of soluble byproducts preventing complete oxidation. However, reducing the number of electrons produced per methanol at a fixed rate of consumption will indeed lower the current, but this can be offset by an increased rate of reactant consumption. The following mechanism can shed some light on why this can be:



Assume that the transport of HCHO away from the surface increases, but that the path through CO(ads) (serial path) is unaffected, then the rate of HCHO formation will increase thus giving an increased current. Furthermore, a decreased current with enhanced mass transport in the slow scan experiment can be explained by increased amount of CO(ads).

Identification of these two possible mass transport effects in the oxidation of alcohols may have practical importance; if the increased current could be exploited in a direct alcohol fuel cell.

Carl Erik Lie Foss, Frode Seland and Reidar Tunold

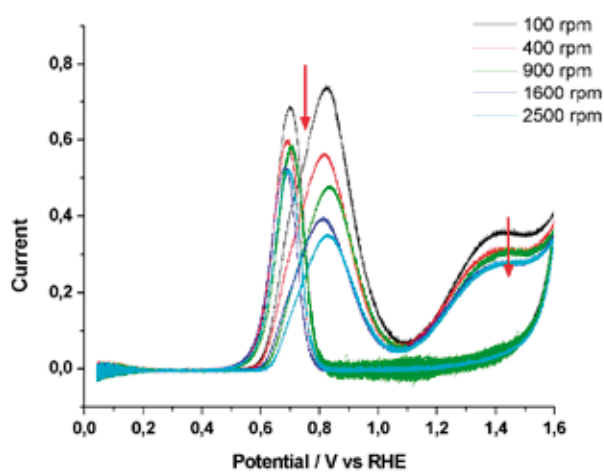


Photo: Frode Seland

Figure 1:

Cyclic voltammograms for methanol oxidation at 2 mV s^{-1} for different stationary rotation rates. Note the significant decreased current with increased rotation rate.

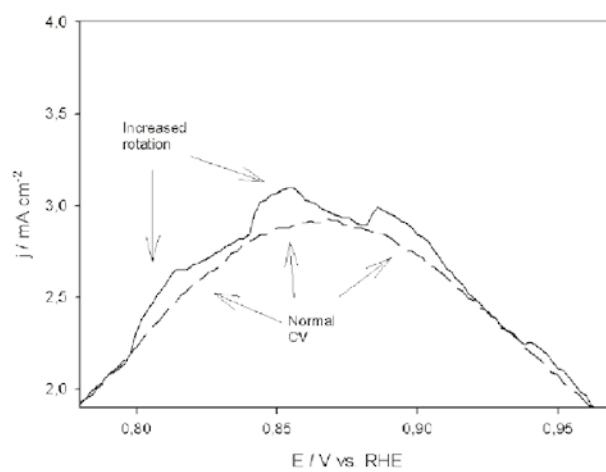


Photo: Carl Erik Lie Foss

Figure 2:

Cyclic voltammograms for ethanol oxidation showing the main oxidation peak in the positive-going scan, at 10 mV s^{-1} and 100 rpm with a transient increase in rotation rate to 2100 rpm .

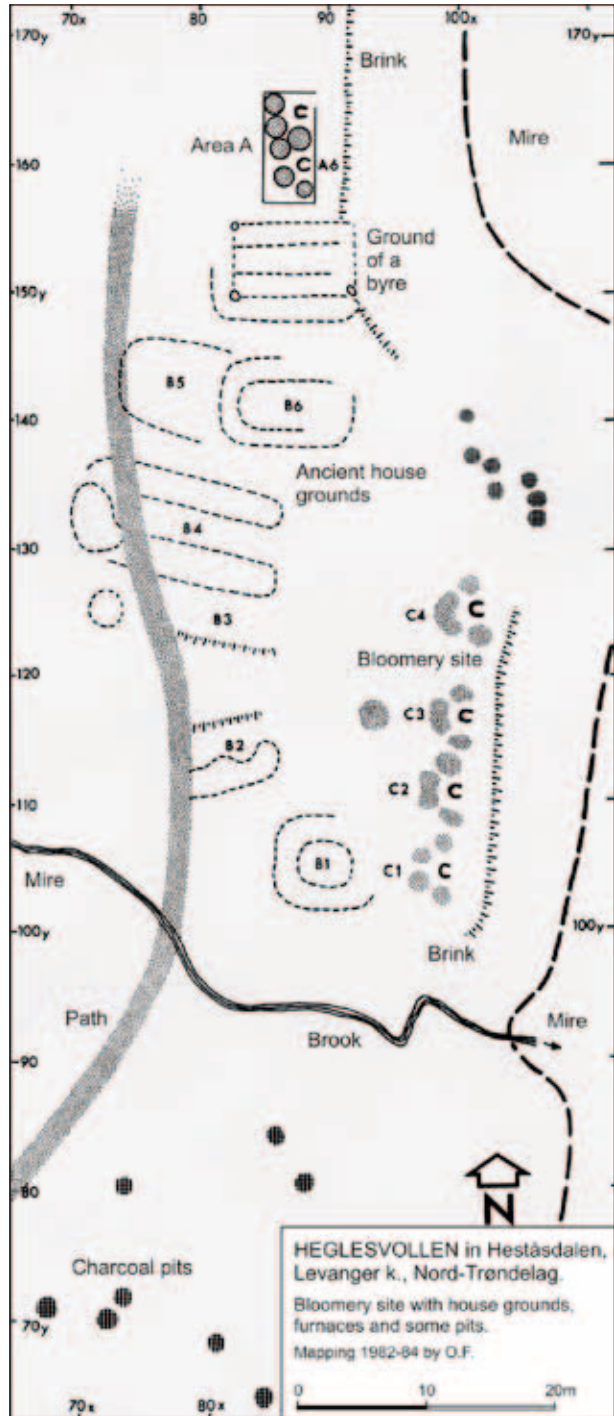
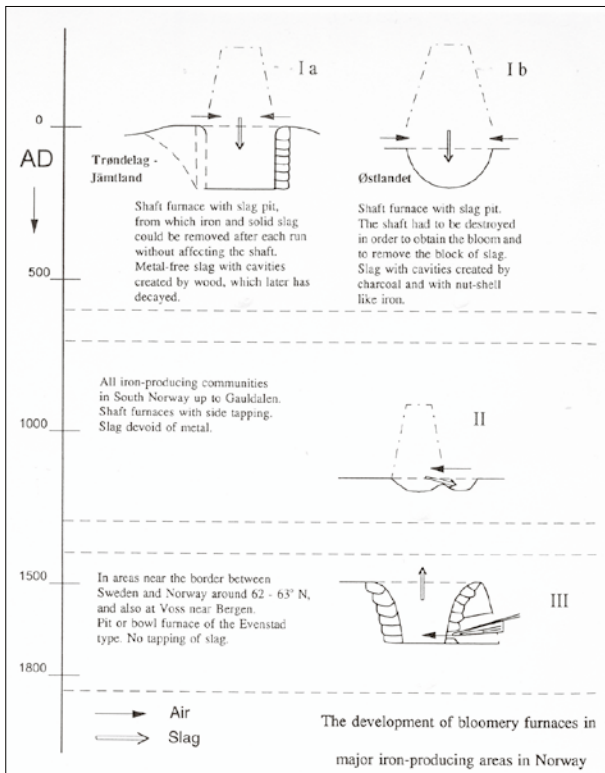
EXTRACTIVE METALLURGY

Direct production of iron

The smelting processes in modern iron- and steelmaking consist of two consecutive steps. Primary smelting takes place as a continuous process in a blast furnace, which is a tall shaft filled with pre-treated ore and coke. Pig iron is tapped around 1300°C together with slag, which is fluxed by addition of lime CaO . The iron is transferred in the liquid state to a converter, which is a vessel lined with an oxide-based ceramic material. The metal is refined in a batch, autogenous process to liquid steel by means of a controlled supply of oxygen through a hollow lance from the top. In this way the carbon content is lowered from about 4 % to 0.2 % or to some intermediate value. These two processes are rugged and lend themselves to very large-scale operation because essential parts are in agreement with the thermodynamics of the systems.

Modern steelmakers would like to make iron and steel in a direct process, but no one has succeeded. The main problem is not reduction, but a control of the carbon content, which tends to be excessive. In principle this can be only achieved with an oxidizing slag.

The great paradox is that direct steelmaking was performed on a small scale with three different methods, documented in Norway from about 300 BC to AD



The "shieling" Heglesvollen, after it was excavated and surveyed in 1982-84. With remains from large-scale ironmaking during the Roman Iron Age.

1800. Only the last has been re-enacted because a full cook-book like description was written in the year 1782. The method was a *step-wise process*, achieved with an extra addition of ore to the primary, carbon-rich iron.

The Roman age process was cyclic: FeO was supplied to the slag bath whenever the temperature was increased. The principle can be named *volume-zone control*.



Photo: Arne Espelund

The slag pit of the bloomery furnace C2a from about year 200 AD, excavated at Heglesvollen in the years 1982-84.

low in carbon would be created in the presence of the important slag-forming constituent Fe_2SiO_4 .

The number of finds from all three periods express that our forefathers developed methods, which were reproduced and resulted in iron of a very high quality. That the processes were developed in societies not relying on script and chemical understanding is remarkable.

Arne Espelund

The Medieval process appears to consist of two steps. The primary step was a prereduction, whereby Fe_2O_3 in the ore was transformed to FeO, which could react with SiO_2 to form fayalite. Upon reduction of this semiproduct, containing FeO and fayalite, pure iron,



Photo: M. Thorleifsen

Medieval bloomery furnace, excavated at Dokfløy.

BASIC project: Boron and phosphorus in solar grade silicon



BASIC is a scientific project regarding the production of high purity silicon for solar cell industry. This four years project (2009-2012) is financed by the Norwegian Research Council. The project is carried out through the collaboration

between NTNU, SINTEF and academic institutions like Xiamen University (China) and MIT (USA). The aim of the project is to provide open, high quality, scientific and technical knowledge about the removal of boron (B) and phosphorus (P) from metallurgical grade (MG) silicon for producing solar grade (SoG) feedstock silicon for PV industry.

It has been postulated that solar-grade feedstock silicon can be developed using either a chemical or a pyro-metallurgical approach. In both cases, the starting point is metallurgical grade silicon and target is to produce a high purity silicon feedstock for production of high performance devices.

In Siemens technology, which is the traditional and dominant process for silicon refining, SiHCl_3 gas is produced by reacting powdered MG silicon with HCl gas. The SiHCl_3 gas is then decomposed on a Si rod at 1100°C by chemical vapour deposition (CVD) technique. In the fluidized bed refining process, which is new, silane (SiH_4) is produced through the hydrogenation of MG silicon in a fluidised bed and pure silicon is deposited from silane.

In the metallurgical refining, which is also new, MG silicon is purified through slag treatment, leaching of solidified silicon particles, and solidification refining. It is worth mentioning that other processes also have been recently suggested for SoG silicon production, but they are mostly under development.

A key process in silicon refining in the metallurgical way is directional solidification of molten silicon, where most of the impurities are removed due to their low segregation coefficients. For example, the segregation coefficient for Ti is 2.1×10^{-8} . However, B and P

are problematic elements and they cannot be effectively removed due to their high segregation coefficient, which are 0.8 and 0.35, respectively. Therefore, it is necessary to do additional refining process focused on removing B and P from MG silicon as much as possible prior the directional solidification.

In the BASIC project the removal of B and P from silicon is studied through various initiatives. With regard to the much higher vapour pressure of P than Si at elevated temperatures, vacuum treatment of silicon can be used for P removal.

Experimental work that is done through this project shows the effect of various parameters on P removal. The figures on the next page show an overview of vacuum refining equipment and samples.

Slag treatment of silicon is also currently applied to remove B from silicon. In this case a silicate slag is in contact with silicon and the dissolved B in silicon is oxidized and removed in the slag phase. An important challenge in the slag treatment is that the components of the slag must not pollute the silicon, if it cannot be removed by the next processes.

Other parameters that affect the slag treatment process such are the thermodynamics of the system, reaction kinetics and the physico-chemical properties of molten silicon and slag. Many of these parameters are still un-known. A very important challenge is also analysing the low level impurities (ppm and sub-ppm level) in silicon and slag and determining the proper techniques for B and P measurement.

The main defined objective of BASIC is Boron and Phosphorus removal from metallurgical grade silicon down to low levels (below 1 ppm) by various techniques. Determining thermodynamic and physiochemical data for solar cell silicon systems, especially within the Si-P system is within this objective. To obtain this, proper characterisation technique for measuring the low levels of impurities is an important issue in the present project.

To keep up the recruitment, an open knowledge

database within these areas is required. In addition four student summer jobs and two master projects per year are funded by the project. The work is mainly done by one PhD student and a PostDoc fellow, in addition to internal and external researchers. Also two PhD students from Massachusetts Institute of Technology (MIT) in USA and Xiamen University in China are supported by BASIC.

Jafar Safarian-Dastjerdi and Merete Tangstad

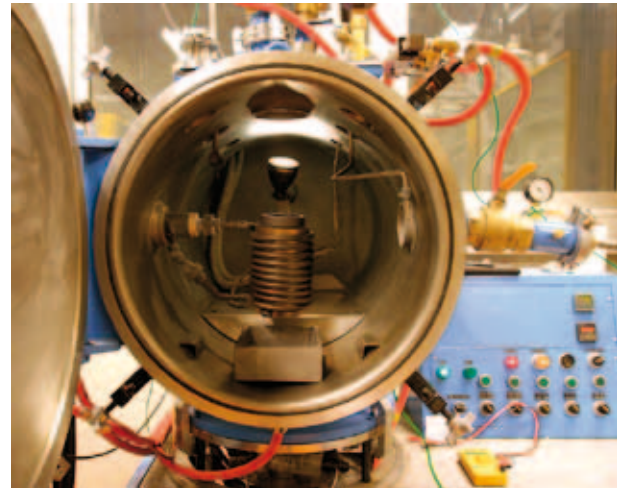


Photo: Melinda Gaal

Figure 1:
The vacuum induction furnace.

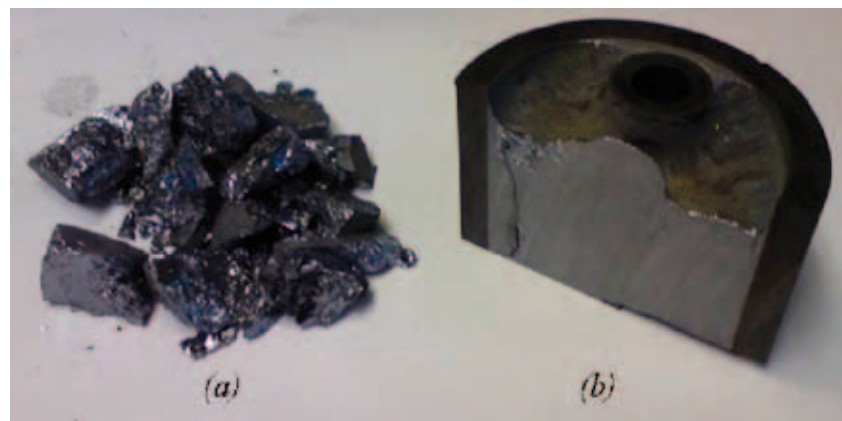


Photo: Jafar Safarian-Dastjerdi

Figure 2:
The cut crucible and refined silicon after vacuum treatment. (a): for ICP-MS analysis, (b): for GDMS analysis.

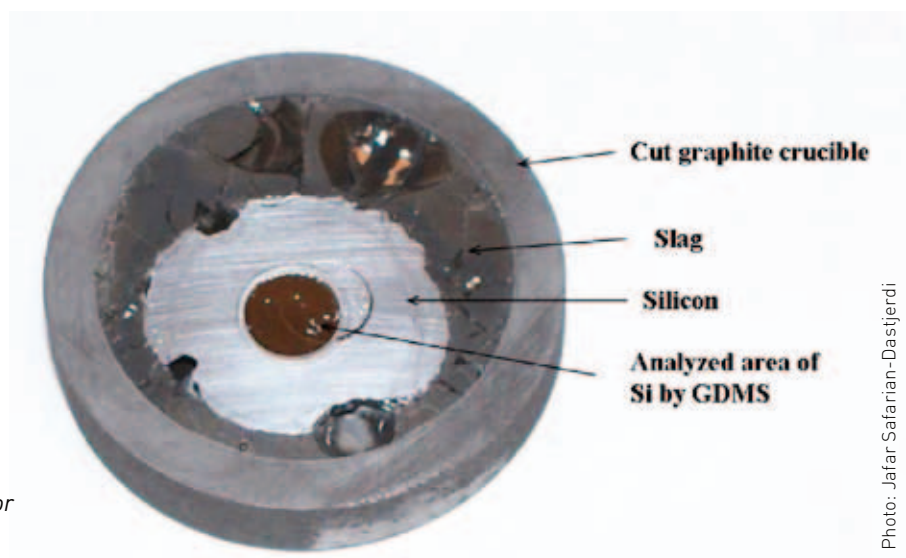


Photo: Jafar Safarian-Dastjerdi

Figure 3:
The sample of refined silicon by slag for GDMS analysis.

Thin film deposition by sol-gel technology

Thin films are frequently deposited onto bulk materials to change the mechanical, chemical, electrical or optical properties of the materials surface. Mechanical properties like wear and scratch resistance are increased by the application of thin films, chemical properties can be altered by designing thin films with hydrophobic (water repellent), anti-fogging or antimicrobial properties while optical properties that can be changed include anti-reflection, opaqueness, fluorescence or light trapping properties. Demanded properties of the film can be obtained by tailoring the composition, structure and morphology of the thin films. In order to achieve this, fundamental understanding of the physics and chemistry taking place during the thin film deposition is essential.

Sol gel method is widely used for preparation of thin films due to compositional homogeneity of the deposited film and the ease of up-scaling. Low cost and minimum environmental hazard make the method even more attractive. However, controlling the structure of the film as it builds up is more challenging. A schematic illustration of the dip-coating process for thin film deposition is shown in Figure 1. A substrate is dipped into a sol composed of nanoparticles dispersed in an aqueous or non-aqueous solvent. The gel structure forms upon withdrawal of the substrate as a result of surface interactions between the nanoparticles when the solvent is evaporated. Interactions between the particles can be repulsive or attractive during deposition either rendering a dense arrangement of the particles or the formation of a network of aggregates. Porous or dense, smooth or rough films can be prepared by changing the chemistry of the sol and thus the surface interactions between the particles. Evaporation of the solvent develops high capillary stresses in the nanosized pores between the nanoparticles. A major challenge using the sol gel method is to deposit thin films without any drying cracks. This can be accomplished by tailoring surface interactions to attain a strong structure that can withstand the drying stresses.

The background for this study lies in the need for a fundamental understanding of the basic processes and forces that determine the success or failure of



Figure 1:
Illustration of thin film formation by dip-coating from a sol of nanoparticles.

the preparation of defect free thin films based on nanosized particles. The project is collaboration between SINTEF Materials and Chemistry, Université de Franche-Comté, France, and our department. The Inorganic Materials and Ceramics Research Group at IMT has for about two decades been using the sol-gel method for various applications. This study targets to support continuing projects by focusing on the fundamentals of the thin film formation. The main objective is to reach a high level of competence in the field of sol gel derived thin films. This will be realized through a fundamental understanding of the thin film formation, i.e. a primary study of the build-up of the first nanoparticle monolayers on a substrate (silicon wafer) and a basic study of the interactions between the sol particles and the first adsorbed layers.

Initial stages of the thin film deposition of silica nanoparticles onto silicon wafers are monitored through *in situ* gravimetric measurements. The deposition behavior of the thin films is dependant on the sol chemistry. The effect of changing the sol pH from 6 to 10 is shown in Figure 2.

The deposition of the films shows that surface interactions are decisive on the transport characteristics

and the deposition behavior of the particles. The conditions that promote aggregation (low pH) in the sol also enhance deposition on the substrate. However, aggregation reduces the mobility of the particles leading to slower deposition rate. Atomic force microscope (AFM) is utilized for characterization of the deposited and dried films. Contact mode scanning carried out in a liquid cell reveals the fragile features dictated by the deposition conditions as shown from the topographic images in Figure 3.

Topography of the films is clearly affected by pH of the sol. The rigid and rough structure formed at pH=10

is strong enough to withstand drying stresses. On the contrary, the soft and compliant structure formed at pH=6 collapses during drying and the film topography becomes smoother. Deposition kinetics is distinct for different deposition conditions imparting information on the film structure. Thus, analysis of deposition kinetics and characterisation of interparticle forces present during the film formation makes it possible to design the structure of the deposited film.

Hasan Güteryüz and Mari-Ann Einarsrud

Figure 2:
Mass change of silicon wafer immersed in silica sol measured as a function of deposition time at pH=6 and pH=10.

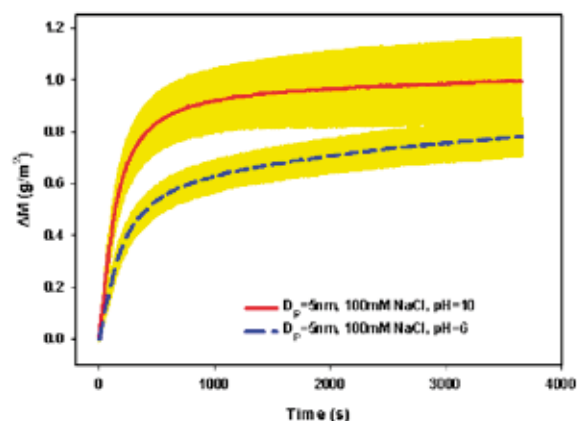


Photo: Hasan Güteryüz

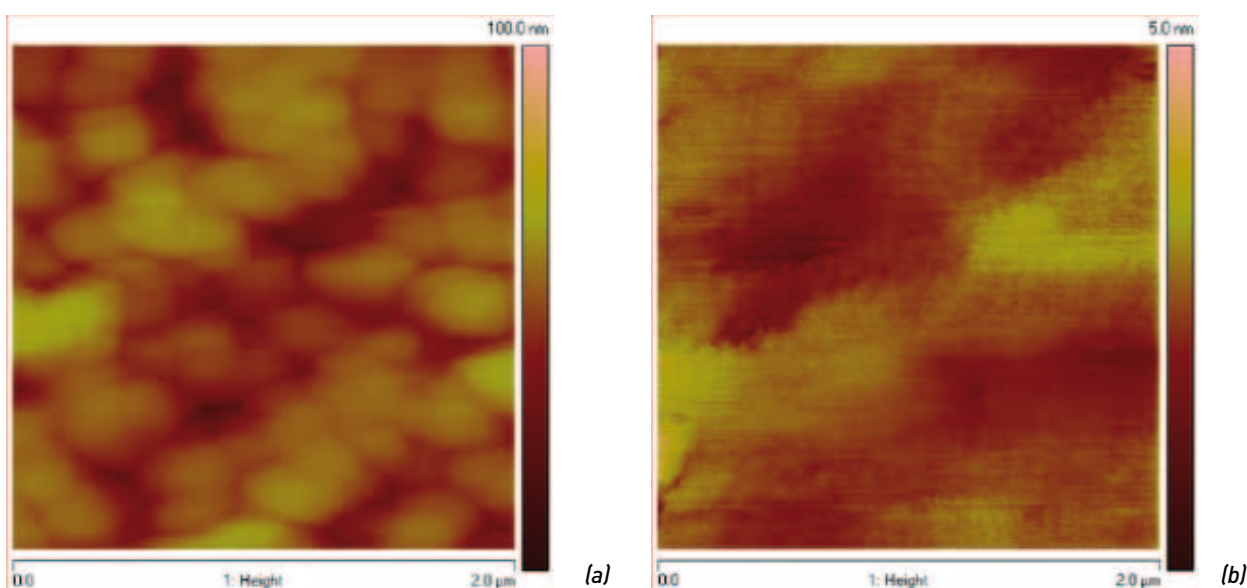


Photo: Hasan Güteryüz

Figure 3:
AFM images of silica thin films deposited from sols at (a) pH = 10 and (b) pH = 6.

The Inorganic Materials and Ceramic Research Group

The Inorganic Materials and Ceramic Research Group celebrated in 2009 the tenth year anniversary for the graduation of their first PhD student.

The Inorganic Materials and Ceramic Research Group was established in the late 1990's by Professor Mari-Ann Einarsrud, Tor Grande and Kjell Wiik. All three were early in their careers involved in high temperature materials chemistry related to metallurgical processes and molten salts. Funding of research in these two areas were at that time not very promising and it was critical to identify new research fields for the Department. The three faculty members decided to strengthen their research activities towards modern ceramic engineering and solid state chemistry. Instead of following the traditional approach, they decided to join forces and to collaborate strongly. Funding for their first common research project and their first common PhD students was established from the Research Council of Norway and from the VISTA program a couple of years later. The first PhD student from one of the common projects graduated in 1999 and in 2009 we can celebrate 10 years anniversary for the first joint PhD student from our group.

At the present time the faculty members of the group have supervised more than 70 master students and 25 PhD students. The group has recently expanded with two new faculty members, Associate Professor

Hilde Lea Lein and Associate Professor Fride Vullum. The research areas for these two new female faculty members are high temperature corrosion/surface science and nanomaterials, and this will also strengthen collaboration with other research groups at NTNU. At present the research group counts about 30 people. The picture shows some of the group members at an internal seminar.

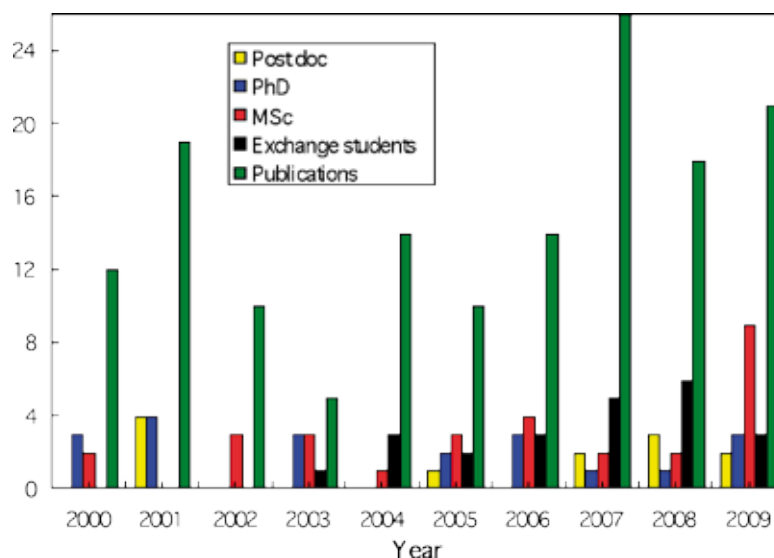
One of the trademarks of the research group has been that the master students and PhD students has one or several co-supervisors in addition to the main supervisor. All the students are followed up by weekly meeting together with other group members. We also have internal seminars twice a semester where both the junior and senior group members are given the opportunity to present their recent results. The group is experimental in nature and PhD students, post docs and the technical staff at the Department are the key personnel in the training of our new students. We have been particularly concerned with increasing the number of post docs in the group. The senior PhD students and post docs are mentors for the junior group members. Looking back the decision to establish a research group of sufficient critical mass have enabled us to be attractive to young talents and to get sufficient research funding for new projects and to develop our experimental facilities. In the future we would also like to strengthen the group by computational materials science.



Photo: Julian Tolchard

A picture of the group members at an internal seminar the spring 2008.

The annual production of post docs, PhD candidates, MSc candidates, international exchange students and publications from the Inorganic Materials and Ceramic Research Group.



What have the research group achieved during the last ten years? First of all we have been able to establish several new research fields at the Department which was the primary goal at the time of establishment. Our research interests span from synthesis of ceramic powders, including 0, 1, and 2 dimensional nanomaterials, oxides for energy technology (fuel cells and membranes), ferroic materials and finally refractory materials and non-oxide ceramics. At present time we have received funding from The Research Council of Norway to develop lead-free piezoelectric and ferroelectric materials, a research area we initiated four years ago. A spin-off company CerPoTech AS was established in 2007. We have also developed

strong collaborative efforts with research group at other departments at NTNU, Department of Chemistry at the University of Oslo and with SINTEF. Strong international collaboration has also been established, and several of the PhD students have spent considerable time at labs in both USA and Japan. Among the publications from the group one can find co-authors from several countries; The Netherlands, France, Sweden, Denmark, the Czech Republic, USA, Canada, Japan and China. Some numbers giving an impression of the activity in the research group is given in the figure below. A more thorough presentation of the research group can be found at the web-site: www.ntnu.no/materialteknologi/english/research/ceramics.

Tor Grande

On an outgrowth concomitant Al-precipitate forming in eutectic silicon particles in Al-Si-Mg alloys

The aim of this project is to develop new aluminium cast alloys for elevated temperature applications, particularly for cylinder heads in modern automobile engines.

Several alloys were designed and investigated systematically with respect to their microstructures and mechanical properties. In Al-Si alloys, nanoscale aluminium precipitates with outgrowths have been observed in eutectic Si particles formed during solidification (Figure 1). The aluminium precipitates appear as spheroids with diameters in the range of 10-20 nm, and are insensitive to heat treatments.

A surprising feature, which is especially clear in the HAADF images, is the much darker, small outgrowth region that is associated with every Al precipitate. This indicates that the outgrowths must have much lower average atomic number than both Si and Al or any combination of Al and Si. No light elements like C, N, or O were detected in the precipitates. Thus, the outgrowths are most likely voids, which were further confirmed by TEM defocus methods (Figure 2). Three orientation relationships between the Al precipitates and the Si matrix were identified from the HRTEM images (Figure

3). The void interface plane in the Al-crystal is {111} and parallel with {001} Si.

Aluminium precipitates in silicon have been observed in materials produced by different processes, such as spray-forming, aluminium implanted silicon and direct chill casting. Two suggestions for the formation mechanism of aluminium precipitates have been given: one is that excess aluminium emerging from Si solid solution melts as liquid droplets by coalescence and subsequently solidifies as spheroidal precipitates; another is that aluminium precipitates act as getters for oxygen impurities, which also stabilizes the precipitates.

The present work, with line-scan and point analyses of a number of precipitates, suggests that the voids form as a direct consequence of precipitation. An aluminium atom in substitutional solid solution in the diamond Si structure occupies the same volume as a Si atom would ($\sim 20.2 \text{ \AA}^3$). When in fcc Al the volume is only $\sim 16.6 \text{ \AA}^3$. In other words, for every 5.6 Al atoms leaving Si solid solution, one empty Si-atom volume is created. It is proposed, based on the present work, that the formation of such precipitate/void complexes is a very likely reason for stabilizing Al precipitates in size and morphology over various heat treatments.

Zhihong Jia and Lars Arnberg

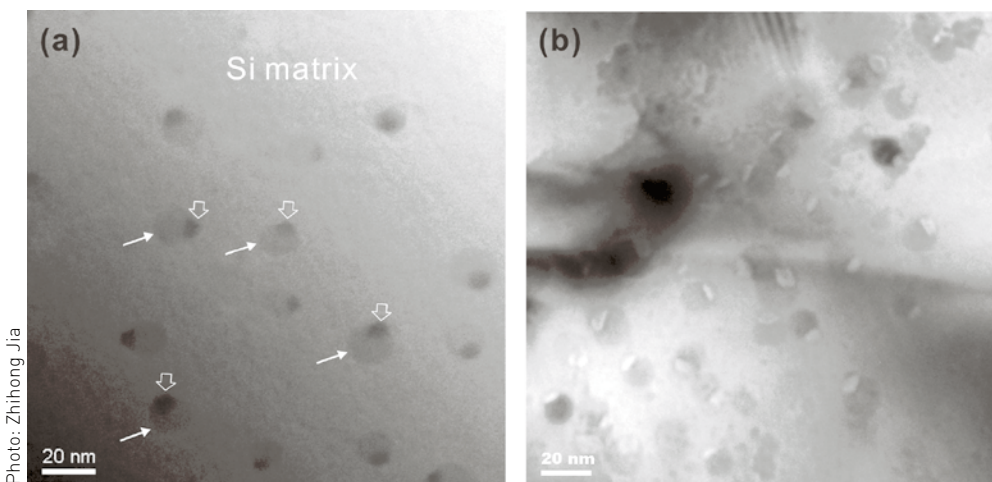


Figure 1: (a) STEM HAADF image taken from a eutectic Si particle, showing Al precipitates (solid arrows) and "dark contrast region" around the precipitates (open arrows). (b) TEM BF images another Si-particle showing Al precipitates and "bright contrast region" around the precipitates.

Photo: Zhihong Jia

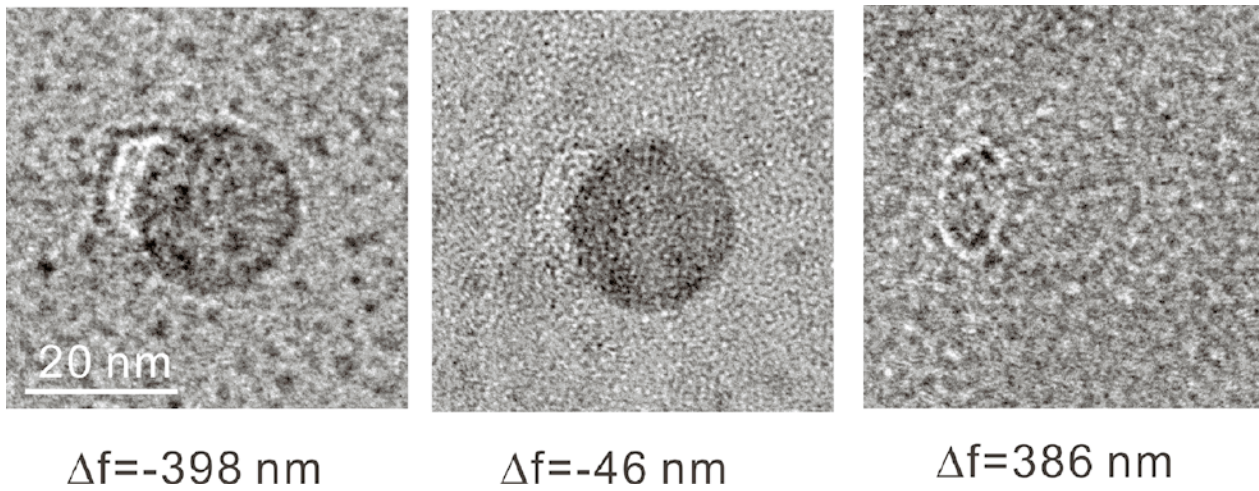


Photo: Zhihong Jia

Figure 2:

Three images of through-focus series, from underfocus (left) to overfocus (right). The Fresnel fringe contrast at the matrix-void interface as a function of objective defocus Df confirms that the void region has a lower projected charge density than Si matrix, indicating the presence of vacancies.

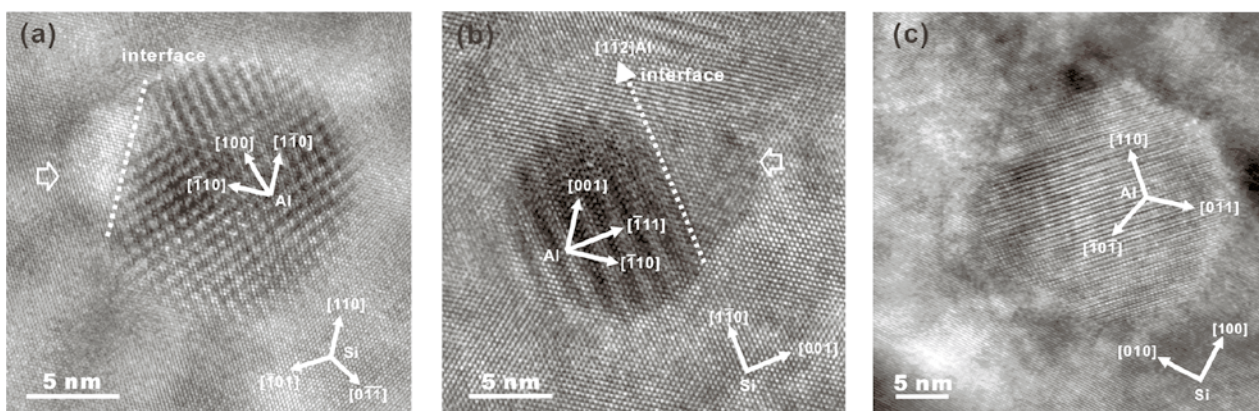


Photo: Zhihong Jia

Figure 3:

HRTEM images of arbitrary Al precipitates in the matrix of Si-particles in three different zone axes:

(a) $[1\bar{1}\bar{1}]_{\text{Si}} \parallel [001]_{\text{Al}}$, (b) $[110]_{\text{Si}} \parallel [110]_{\text{Al}}$ and (c) $[001]_{\text{Si}} \parallel [\bar{1}11]_{\text{Al}}$. Outgrowths are indicated by open arrows in (a) and (b) but it overlaps with precipitate projection in (c). Dashed lines mark traces of the outgrowth / precipitate interface planes which coincide with directions $[110]_{\text{Si}}$ (a) and $[1\bar{1}0]_{\text{Si}}$ (b). Cross-products of such traces yield the real interface plane: $[001]_{\text{Si}} \parallel [\bar{1}11]_{\text{Al}}$, explaining the difference in extension of the outgrowths. Note the missing Moiré contrast in (a), (b) in the outgrowth regions.

Microporosity simulation of aluminium-silicon foundry alloys

Prediction of porosity defects in castings is important to prevent them and, hence, has a great economical benefit. Porosity on a macroscopic scale resulting from shrinkage during solidification can be avoided with the use of well established practical rules. The formation of micro-pores dispersed within the dendritic structure constitutes a complex phenomenon which depends on the liquid metal feeding, shrinkage and gas segregation. The use of modelling tools for microporosity prediction in aluminium alloy system is hampered by the lack of physical data, such as mushy zone permeability, and the lack of careful experimental validation.

The European Project “New Automotive Components Designed for and Manufactured by Intelligent Processing of Light Alloys” (NADIA) started in May 2006 and the Department is one of the 24 partners of this project consortium. In the framework of the NADIA project, porosity data generated from carefully controlled, reproducible casting trials with a step mould die were compared with state-of-the-art modelling tools. The initial series of microporosity simulation results are quite promising and there is good agreement between the measured and simulated microporosity distribution, as shown in Figures 1 and 2.

Shahid Akhtar, Lars Arnberg and Marisa Di Sabatino

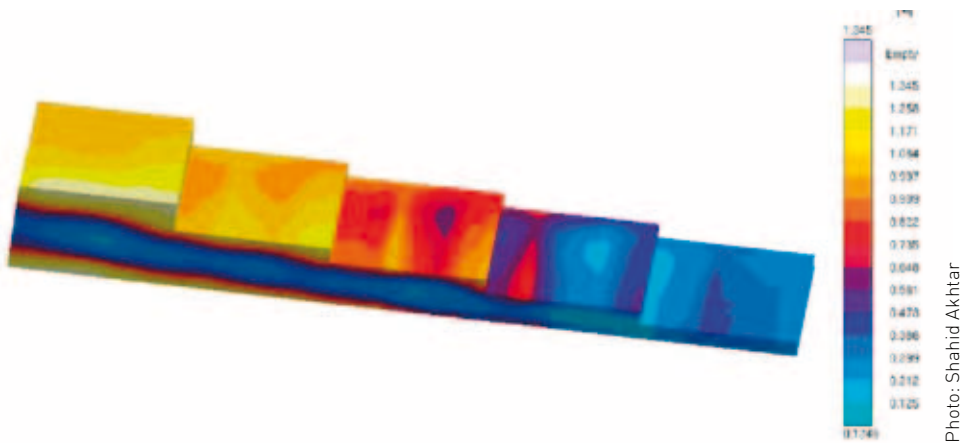


Figure 1:
Predicted pore fraction distribution for the casting with (0.2 mL/100 g melt) hydrogen level.

Photo: Shahid Akhtar

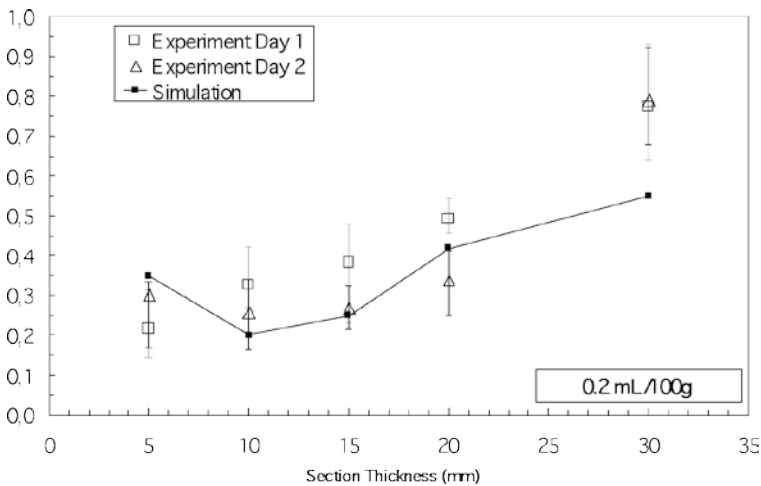


Figure 2:
Porosity (%) vs section thickness (mm) for hydrogen levels 0.2 mL/100 g melt. The porosity measurements carried out on castings made in two different days (Day1 and Day2) as well as the predicted porosity are shown.

Photo: Shahid Akhtar

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Photo: Esma Senel

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LABORATORIES AND EQUIPMENT

METALLOGRAPHY LABORATORY

Responsible scientific employee is Professor Jan Ketil Solberg. Senior Engineer Pål Ulseth and Staff Engineer Torild Krogstad are responsible for the daily management. *Location:* AGV2: E-508, E-514, E-514A and E-520.

Equipments (descriptions and specifications)

The laboratory consists of equipment for sampling, metallographic preparation, documentation and characterization of prepared surfaces in general for light microscopy but also for SEM and TEM. Hardness testing. Classical metallographic preparation equipment: Abrasive cutting, grinding and polishing. Mounting press, grinding and polishing machines, semiautomatic preparation machines. Equipment for marking, precision cutting, ultrasonic cleaning and drying. We do electrolytic polishing of specimens to be examined in SEM / TEM. Several light microscopes with digital cameras with accompanying software for image analysis. Micro and macro hardness testers. Sigmascope for measuring electrical resistance.

HEAT TREATMENT LABORATORY

Responsible scientific employee is Professor Jan Ketil Solberg. Senior Engineer Pål Ulseth is responsible for the daily management. *Location:* AGV2: A-441 and "Smeltehallen".

Equipments (descriptions and specifications)

The laboratory is equipped with furnaces to heat treat materials. 4 muffle furnaces: Naberterm T > 1100°C, Naberterm T > 1280°C, Naberterm T > 1100°C air circulated and Heraus T > 750°C air circulated. Tube furnaces T > 1000 °C. 10 saltbaths for 300-600°C heat treatment and 5 oilbaths for the temperature range RT - 200°C. Abrasive cutting: 3 Discotomes.

ELECTRON MICROSCOPE LABORATORY

Responsible scientific employees are Professor Jarle Hjelen and Professor Jan Ketil Solberg. Close co-operation with the Department of Geology and Mineral Resources Engineering. *Location:* AGV2: F-361, F-362, F-369, F-370 and F-373.

Equipments (descriptions and specifications)

The laboratory is equipped with 3 electron microscopes; SEM, TEM and Microprobe analyzer, as well as equipment for preparing specimens for these microscopes. JEM-2010 TEM: Characterization of crystal structure and micro/nano structures down to atomic level. Determination of local chemical composition. FEI, FIB200: Preparation of specimens for SEM and TEM. JEOL FE-EPMA, microprobe analyzer: Determination of local chemical composition and microstructures down to nano level. Fischione ion etcher: Preparation of TEM and SEM specimens. Fischione plasmacleaner: Cleaning of specimens prior to installation in SEM/TEM/Microprobe analyser. EDS systems on various EMs: JEOL EDS (microprobe analyzer), Edax EDS (ZEISS Ultra), 3 Oxford EDS (TEM, JSM-840, Hitachi) and Bruker EDS (ZEISS Supra): Determine local chemical composition. Gatan GIF200 (TEM): Electron energy loss analysis.

MECHANICAL TESTING/FORMABILITY LABORATORY

Responsible scientific employees are Professor Hans Jørgen Roven and Professor Bjørn Holmedal (rolling and hot torsion). *Location:* AGV2: E-112, E-S004, E-S008 and A-K047.

Equipments (descriptions and specifications)

The laboratory is equipped with modern units for tensile testing, fatigue, fracture toughness, compression, bending, simple shear, accelerated creep, superplastic properties, multi-scale measurements, nanostructuring metals by severe plastic deformation (ECAP), formability tests, extrusion, forging, special pressure tests at high T, mechanical refinement of metals, hydroforming at room temperature and cold rolling and hot torsion testing. For mechanical characterization of metals and materials: Two servohydraulic computerized universal test machines (100 kN in tension/compression): MTS 810 and MTS 880. The forming, formability and nanostructuring units include 1 manual hydraulic press (60 tons) and 1 computerized servohydraulic MTS 1000 kN press with a second biaxial servohydraulic actuator (100 kN). The press units have special tools for nanostructuring of metals such as equal channel angular pressing (ECAP), continuous ECAP, double axis ECAP, high pressure torsion (HPT), but also special dies for hydroforming, formability testing and backward extrusion. Strain analyses and forming limit diagrams (FLDs) can be established based on automatic 3D strain analyses (ASAME) or digital speckle correlation analyses (DSCA). There are also special units for new extrusion technologies. The cold rolling mills are 1 servohydraulic one-stand (maximum 150 mm width) and 1 electricity powered small scale mill. A servohydraulic hot torsion unit is internally constructed and has computerized control and data acquisition.

SOLIDIFICATION/CASTING OF METALS LABORATORY

Responsible scientific employee is Professor Lars Arnberg. *Location:* AGV2: K-007 and "Perleporten": SINTEF Foundry.

Equipments (descriptions and specifications)

The laboratory is equipped with equipment for solidification experiments and aluminium alloy production. 3 resistance furnaces $T < 1000^{\circ}\text{C}$: The furnaces melt 1–5 kg metal at temperature up to 1000°C . Computer equipment: Software for logging of temperature/solidification. Melt viscosimeter: The equipment measures rheological properties of partly solidified metal up to 1000°C .

SOLIDIFICATION/CASTING OF PURE Si LABORATORY

Responsible scientific employee is Professor Lars Arnberg. *Location:* AGV2: GM-103.

Equipments (descriptions and specifications)

Heliosi-laboratory is a clean room class 10 000 (particles/foot³) and equipped for crystallization of high purity Si. There is also equipment for coating and firing of crucibles. Bridgman furnace type Crystalox DS 250: Crystallization of up to 12 kg Si. Typical size: Diameter: 250 mm, height: 100-120 mm. Robotized coating equipment: Coating of crucibles by protective layer. Muffle furnace: Firing of coating.

CHARACTERIZATION OF SILICON – SOLAR CELL MATERIALS LABORATORY

Responsible scientific employees are Professor Lars Arnberg and Dr.ing. Gaute Stokkan. *Location:* AGV2: GM-110, GM-104 and E-418.

Equipments (descriptions and specifications)

The laboratory consists of different activities of material characterization. Wet bench for etching of silicon samples, DI water supply unit and grinding and polishing equipment: Removal of surface oxide, delineate microstructure. Dangerous substances and is run under a special HES agreement. Carrier lifetime measurements, QSSPC and CDI. PVScan 6000: Maps dislocation density on etched surfaces over large areas. Infrared radiography: Shows inclusions and cracks in silicon. LBIC (Light Beam Induced Current): Local short circuit current of solar cells. Furnaces for high temperature annealing in protective atmosphere, $T < 1400^{\circ}\text{C}$: Studies of stability of microstructure during annealing/cooling. GDMS: Trace element analysis in Si and Al Concentrations down to ~ 1 ppb. 4 point probe resistivity measurements: Control of doping level.

PROCESS METALLURGY/METALS PRODUCTION LABORATORY

Responsible scientific employees are Professor Merete Tangstad, Professor Leiv Kolbeinsen, Professor Ragnhild Aune and Associate Professor Gabriella Tranell. *Location:* AGV2: GM-118, E-118, E-204, E-214, "Smeltehallen", K-013, K-020 and K-03x.

Equipments (descriptions and specifications)

The major part of the equipment is high temperature furnaces used for developing and studying industrial high temperature processes, as refining of liquid metal and production of ferroalloys and silicon. In this, also characterization of raw materials to these processes is of importance. One phase furnace: 150 kW, top and bottom electrode. ASEA induction furnace: 50 kg, 2000°C . Baltzer vacuum induction furnace: Low vacuum, 2000°C . "New" vacuum ind. furnace: High vacuum, 2000°C . Elotherm furnace: 500 kg, 2000°C . Crucible (Al) furnace. Electromagnetic furnace. Plasma rotary furnace: 20kg/h, $>2000^{\circ}\text{C}$. PPM reactor. Versatile furnace: g scale, 2400°C . Tubefurnace 1: (red/ox). Graphite tube furnaces 1-3: / g scale. Tubefurnaces 2-3: g scale, 2400°C . DisVaDRI furnace: (red/inert), 500 g, 1200°C . TGA/DTA (lowtemp): 830. TGA/DTA (hightemp): 2400°C , 0,3g. El. res. furnace. Wettability furnaces: mg scale, 1800°C . Cold crucible furnace. Meltspinner. Muffel furnace. Drier. Mill. Crushing equipment. Sieves. Axialpress.

DIFFRACTOMETER LABORATORY

Responsible scientific employee is Professor Bjørn Holmedal. *Location:* AGV2: A-347.

Equipments (descriptions and specifications)

The laboratory is equipped with a diffractometer, an instrument for measuring X-ray diffraction. In addition there is software for analyzing the metal texture, i.e. the statistical distribution of crystal orientations in a metal [pole figures, orientation distribution function (odf)]. X-ray diffractometer: Siemens D5000. Texture software: Bruker.

CHEMISTRY BUILDING II STUDENTLAB

B2-100, B2-114 and B2-169: Associate Professor Hilde Lea Lein has overall scientific responsibility. Engineer Gunn Torill Wikdahl and Senior Engineer Elin Harboe Albertsen are responsible for the daily management. B2-117, B2-123 and B2-129: Associate Professor Hilde Lea Lein has overall scientific responsibility. Senior Engineer Eli Beate Jakobsen is responsible for the daily management. *Location:* B2 in "Realfagbygget": B2-100, B2-114, B2-117, B2-123, B2-129 and B2-169 (student laboratories), B2-109, B2-116 and B2-130 (balance rooms), B2-132 (furnace room), B2-120 and B2-118 (storage rooms), B2-141 (preparation laboratory room), B2-111 and B2-116b (offices).

Equipments (descriptions and specifications)

The laboratories are used for laboratory courses in general chemistry for 1.st grade students, and are equipped with general equipment and instrumentation for this activity. 50 pH- meters. 9 spectrophotometers, 90 volt meters, 12 power regulators, 9 drying cupboards, 12 centrifuges, 12 analytical balances and 6 balances.

LABORATORY FOR CERAMIC SCIENCE AND ENGINEERING

Professor Mari-Ann Einarsrud has overall scientific responsibility for the lab. *Location:* Chemistry building II: 001, 008, 011, 018, 022, 032B, 035, 107, 119 and 125. AGV2: Hot press laboratory.

Equipments (descriptions and specifications)

The laboratory consists of equipment for ceramics processing and engineering: powder synthesis, powder handling, green body formation, firing and machining of ceramics. It is also equipped for the preparation of ceramic thin films and coatings. Spray pyrolyser: Pilot scale equipment for the manufacture of ceramic oxide powders, capacity of 10 kg per day. Wet chemical synthesis of ceramic and inorganic materials: Chemical synthesis equipment, ultrasonic bath, ultrasonic finger, rotavapor, autoclave for hydrothermal synthesis, autoclave for super critical drying, centrifuge, incubator. Handling, dispersion and milling of powder: Viscometer, ball mill, planetary mill, attrition mill, drying cupboard. Manufacturing of films of ceramic and inorganic materials on substrates: Dip coaters, spray coaters, spin coater. Equipment for manufacture of green bodies of ceramic materials: Presses, laminating press, extruder, tapecaster. Drying, calcination and firing of ceramic materials: Chamber furnaces, tube furnaces, high temperature furnaces, hot presses, clean room furnaces. Grinding and polishing: Polishing equipment, grinding equipment, cutting tools.

LABORATORY FOR CERAMIC SCIENCE AND ENGINEERING, CHARACTERIZATION

Professor Kjell Wiik has overall scientific responsibility for the lab. *Location:* Chemistry building II: 014, 018, 032B, 034B, 103 and 107. Perleporten: Lab.

Equipments (descriptions and specifications)

The laboratory is equipped for the characterization of microstructural, thermal, physical, structural and mechanical properties of ceramics. Mechanical testing: Biaxial tester, beam bending of gels to measure mechanical strength and permeability, equipment for 4-points bending test and creep test of ceramic materials at temperatures up to 1100 degrees under controlled atmosphere. Thermal analysis: Thermogravimetric analysis equipment (TGA), thermogravimetric analysis equipment with attached mass spectrometer, differential thermoanalysis equipment (DTA, DSC), and dilatometers. Particle size/surface: Nitrogen adsorption equipment for measuring of surface area and pore size, particle size analyser, and He pycnometer. Transport and dielectric properties: Equipment for measuring electrical conductivity and conductivity relaxation, measuring of gas permeability, characterisation of fuel cells and characterisation of dielectric and piezoelectric properties (Ferrotester). Spectroscopy: FTIR and UV-Vis instruments.

LABORATORY FOR POWDER X-RAY DIFFRACTION

Professor Tor Grande has overall scientific responsibility for the lab. *Location:* Chemistry building II: 113.

Equipments (descriptions and specifications)

The laboratory is equipped with four X-ray diffractometers for quantitative and qualitative X-ray diffraction of powder, films and monoliths at ambient temperature as well as low and high temperature under controlled atmosphere. Siemens D5005, unit A: High resolution diffractometer (θ - 2θ) with primary monochromator for CuK α 1 radiation, scintillator detector. Siemens D5005, unit B: Diffractometer with secondary monochromator, scintillator detector and PSD detector, 40 position sample changer, high temperature camera and sample holder for capillary geometry, Göbel mirror and Soller slits for grazing incidence measurements. Bruker D8 Focus: Diffractometer with PSD detector (LynxEye), 9 position sample changer. Bruker D8 Advance: Diffractometer with PSD detector (Vântec-1), 9 position sample changer, high temperature camera, low temperature camera.

LABORATORY FOR ELECTRON MICROSCOPY IN CHEMISTRY BUILDING II

Professor Mari-Ann Einarsrud has overall scientific responsibility for the lab. *Location:* Chemistry building II: 033.

Equipments (descriptions and specifications)

The laboratory is equipped with one Scanning Electron Microscope with attached Energy Dispersive X-ray Spectroscopy system (EDS) to perform element analysis. Hitachi S-3400 N Electron microscope: Low vacuum electron microscope with SE, BSE detector and Oxford Instruments EDS system. Detector for EBDS analysis. Carbon coater Cressington Carbon Coater: Coating of carbon on samples. Edwards sputter Coater S150B: Sputter station for coating of gold onto samples. Microscope: Leica light microscope.

LABORATORY FOR ELECTROCHEMICAL ENERGY TECHNOLOGY

Professor Svein Sunde and Associate Professor Frode Seland have overall scientific responsibility for the lab. *Location:* Chemistry Building II: 225, 223, 219, 215, 213, 207, 201 and 014.

Equipments (descriptions and specifications)

The laboratory contains equipment for electrochemical measurements, synthesis and applied fuel cell work. UNILab MBraun glove box: Storage of special compounds and chemicals. One electrochemical set-up for experiments in controlled atmosphere (Par 273A with Solartron 1250 frequency analyzer). Cleaning of glass ware and preparation of electrolytes: Dish washer, hydrogen peroxide bath, hot plate, fume hood and MilliQ water installation (deionized water). Synthesis of electrocatalysts: Tubular furnace, ultrasonic bath, heating cabinet, technical scales, centrifuge, Zeta potential measuring equipment, PZC - auto titration equipment, stations for drying electrodes and electrode preparation. Standard Electrochemical measurement set-ups: Potentiostats, arbitrary function generators, computers with special software, water baths. Standard Electrochemical measurement set-ups for elevated temperature: Potentiostats, arbitrary function generators, computers with special software, autoclaves and heating cabinets. Electrochemical measurement set-up for rotating (ring) disk electrode: Potentiostats, RDE motors, shafts and electrodes of various compounds and design (Pine inst. Tacussel/Radiometer). Electrochemical measurement for impedance spectroscopy: Potentiostats, sine-wave generators, frequency response analyzers, computers with specialised software. Electrochemical quartz crystal microbalance: Potentiostats, frequency counter, faraday cage of special design and functionality (including reference quartz crystal), computer with specialised software. Spraying of electrodes and MEA preparation: Manual air brush of various sizes, automatic computer controlled spray stations, screen print, hot press, heating cabinets and analytical scale in an "environmental room". Fuel cell activity: Three individual low temperature PEMFC test stations with load box, data loggers, humidifiers, flow controls, temperature controls, etc. Test station for high temperature PEMFC activity for small organic molecules including evaporator. Stack testing station, Sintalyzer, Ion chromatograph. Photoelectrochemistry: Potentiostats with arbitrary function generator and computer with specialised software. High power Xenon lamp, monochromator, lock-in amplifier, chopper. UV-vis. FTIR.

LABORATORY FOR ELECTROCHEMICAL SCANNING PROBE MICROSCOPY (AFM/STM)

Professor Svein Sunde has overall scientific responsibility for the lab. *Location:* Chemistry building II: 003A.

Equipments (descriptions and specifications)

The laboratory contains two atomic force microscopy / scanning probe microscopy installations (Agilent (2009) and Veeco) with electrochemical cell/environmental chamber, potentiostat and function generator for electrochemical measurements. Agilent SPM: Sample holders, SPM scanners, electrochemical cell and environmental chamber, air floating tables for noise rejections, ancillary hardware for operating the installations. Veeco SPM: Sample holders, SPM scanners, electrochemical cell, air floating tables for noise rejections, ancillary hardware for operating the installations.

LABORATORY FOR CORROSION AND SURFACE TECHNOLOGY

Professor Kemal Nisancioglu and Professor Geir Martin Haarberg have overall scientific responsibility for the laboratory. *Location:* Chemistry building II: 001, 307, 313, 321 and 323.

Equipments (descriptions and specifications)

Laboratories are organised both for teaching and research. Specimen preparation, metallography, optical microscopy, electrochemical testing and characterization, video equipment synchronised with electrochemical polarization equipment. Surface treatment and aqueous electrolysis: Etching, anodizing, metal deposition and winning, electroplating and polishing. Hydrogen penetration and diffusion in metals. Standardised corrosion testing: Autoclave testing, stress corrosion cracking, salt spray testing. Metallographic equipment (grinding/polishing), digital light microscope, various electrochemical testing/characterisation equipment, hydrogen-diffusion cells (Devanathan/Stachurski), autoclaves for corrosion tests at high pressure/temperature, tensioner for tension corrosion tests, salt spray cabinet, furnaces for heat treatment of samples and various workshop tools for cutting, sawing, drilling etc for sample preparation.

ELECTROLYSIS LABORATORY IN CHEMISTRY BUILDING II

Responsible scientific employee is Professor Geir Martin Haarberg. *Location:* Chemistry building II: 413 and 419.

Equipments (descriptions and specifications)

Glove box (Braun): Dry argon atmosphere, and vacuum pump in room 419. Glove box (Vac): High temperature furnace for experiments in salt melts, room 413. Additional furnaces: For experiments in salt melts up to 1000 °C, both traditional tube furnaces with water cooling, and "gold film" furnaces. Oil bath and teflon cell: with rotating electrode for studies of Fe-precipitation from hydroxide electrolytes at temperatures up to 120 °C. Vacuum equipment: With glassware and connections for salt treatment included vacuum pumps and diffusion pump. Electrochemical measuring equipment: Potentiostats with impedance measuring equipment.

LABORATORY FOR ELECTROLYSIS IN PILOTPLANT FACILITY

Professor Geir Martin Haarberg and Head of Department Arne Petter Ratvik have overall scientific responsibility for the lab. *Location:* Chemistry building 5 ground floor.

Equipments (descriptions and specifications)

High temperature furnaces, gas outlets (argon) and watercooling system, a small workshop for sawing and preparation of equipment for high temperature experiments, a storage room for equipment for high temperature experiments and chemicals, apparatus for the manufacture of anodes for aluminium electrolysis, apparatus with vacuum pump for manufacture of waterfree AlF₃, some large furnaces for special experiments are situated in the ground floor, and electrochemical measuring equipment, mainly potentiostats with impedance measuring equipment.

CARBON LABORATORY

Responsible scientific employee is Head of Department Arne Petter Ratvik. *Location:* Chemistry Building II: 303 and Chemistry Hall: 101, 101C, 160, 164 and storage room 054.

Equipments (descriptions and specifications)

Three electrolysis furnaces with temperature controllers: Hewlett-Packard 6269B DC, 6264B DC. Oxide feeding systems and power supplies: Eurotherm 902P, 2408, 2404. Hot air driers: Thermaks Series TS8000. Specific electrical resistivity: RDC-150. Air reactivity: RDC No. 599 - 145. Sodium expansion (Rapoport): RDC No. 497 - 193. Thermal conductivity: RDC No. 178 - 190. Thermal dilatometry. Sodium vapor exposure. CO₂- and air reactivity furnace. Roller mixer. Furnace for carbon sample baking: Nabertherm Mod N 150 H. Four hot air driers: Thermaks Series TS8000. Eirich mixer, 20 liter. Vibrocompactor: S130 Svedala A/S. Ball mill : Herzog - HSM100H. Crusher: Form + Test Profssysteme 506/500/20 D-S. Fischer rammer: RDC No. 604 - 194. Two drilling stations: Strands type S 68. Six diamond saws: Struers labotom, Cuto 20 - Jeanwirtz, Steinadler, Conrad D - 38678, Clipper Majar, Delta - LB300. Jaw crusher: Retsch BB1. Hydraulic press: Lloyd Instruments Ltd, Type LR100K.

CHEMISTRY BUILDING II (KII)–SEMINARS, ENERGY AND MATERIALS

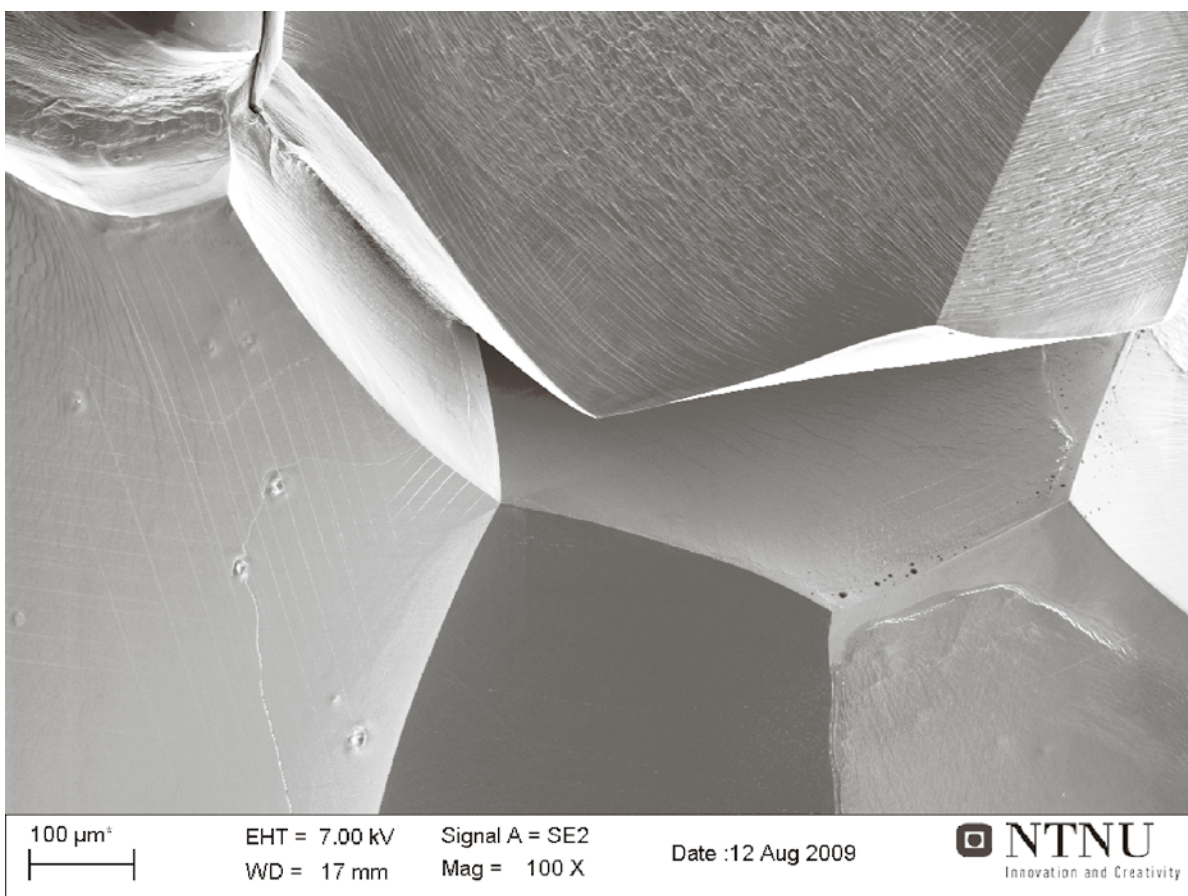
Department of Materials Science and Engineering

Fridays 12.30 in KII (Chemistry building II)

Seminar leader: Reidar Tunold

Speaker	Topic
<i>February 6</i> Professor emeritus Terje Østvold , Department of Materials Science and Engineering, NTNU.	A theoretical study of the scaling risk for wells in a new HPHT field development.
<i>February 13</i> PhD student Kati Tschöpe , Department of Materials Science and Engineering, NTNU.	Autopsies of spent pot linings - a revised view.
<i>February 20</i> PhD student Marte Bjørnsdotter , Department of Materials Science and Engineering, NTNU.	Determination of hydrogen diffusion in stainless steels.
<i>March 6</i> PhD student Kenji Kawaguchi , Department of Materials Science and Engineering, NTNU.	Control of amorphization of IrO ₂ -Ta ₂ O ₅ /Ti electrodes to suppress unwanted side reactions.
<i>March 13</i> PhD student Zhaohui Wang , Department of Materials Science and Engineering, NTNU.	Spent Si ₃ N ₄ bonded SiC sideling materials in aluminium electrolysis cells.
<i>March 20</i> PhD student Stein Rørvik , Department of Materials Science and Engineering, NTNU.	Examination of temperature gradients in resistance heated laboratory scale prebake anodes.
<i>March 27</i> Professor, Dr.ing. Tor Grande , Department of Materials Science and Engineering, NTNU.	Ferroelasticity of LaCoO ₃ -based perovskites - an example of the relevance of solid state chemistry to ceramic science and engineering.
<i>April 17</i> Professor, Dr.techn. Svein Sunde , Department of Materials Science and Engineering, NTNU.	Characterisation of catalysts for the oxygen evolution reaction in PEM water electrolysis.
<i>April 24</i> Associate Professor Pierre Xavier Thivel , University Joseph Fourier, Grenoble, France.	Chemical engineering applied to photocatalysis and fuel cells.
<i>May 8</i> Dr. Torsten Berning , Department of Energy Technology, Aalborg University, Denmark.	A three-dimensional multi-fluid model of a PEM fuel cell cathode.
<i>May 15</i> Professor, PhD Kemal Nisancioglu , Department of Materials Science and Engineering, NTNU.	Separation of double-layer charging and faradaic processes at electrodes.
<i>May 20</i> Dr. Jon G. Pharoah , Fuel Cell Research Centre, Kingston, Ontario, Canada.	Thermal effects in polymer electrolyte membrane fuel cells.
<i>September 11</i> Professor Akimasa Tasaka , Doshisha University, Kyoto, Japan.	Electrical conductivity and viscosity of low temperature molten salts.
<i>September 18</i> PhD student Ole Sigmund Kjos , Department of Materials Science and Engineering, NTNU.	Titanium production from oxycarbide anodes in molten chloride and fluoride mixtures.
<i>September 25</i> PhD Lori Groven , South Dakota School of Mines & Technology, Rapid City, USA.	Solution compustion synthesis as a simple route to carbon nanotube loaded materials.

<p><i>October 2</i> PhD student Eirin Kvalheim, Department of Materials Science and Engineering, NTNU.</p>	<p>Pyroelectrolysis to produce liquid iron at 1550°C.</p>
<p><i>October 16</i> PhD student Mustafa Hasan Balci, Department of Materials Science and Engineering, NTNU.</p>	<p>Photo-chemistry of dye sensitized solar cells.</p>
<p><i>October 23</i> PhD student Esma Senel, Department of Materials Science and Engineering, NTNU.</p>	<p>Effect of anodic segregation of trace element gallium on electrochemical behaviour of aluminium.</p>
<p><i>October 30</i> PhD student Sophie Weber, Department of Materials Science and Engineering, NTNU.</p>	<p>Ceramic thermal barrier coatings prepared by wet chemistry deposition.</p>
<p><i>November 6</i> PhD student Saijun Xiao, Department of Materials Science and Engineering, NTNU.</p>	<p>Depolarised gas anodes in electrowinning of metals in molten salts.</p>
<p><i>November 13</i> PhD student Odne Burheim, Department of Chemistry, NTNU.</p>	<p>The measured heat and work from a PEM fuel cell.</p>
<p><i>November 20</i> PhD student Piotr Ochal, Department of Materials Science and Engineering, NTNU.</p>	<p>CO stripping as an electrochemical tool for core-shell catalyst characterization.</p>
<p><i>November 27</i> PhD Annika Eriksson, Department of Materials Science and Engineering, NTNU.</p>	<p>Interplay between structure and properties in perovskite-related materials.</p>
<p><i>December 11</i> Professor, Dr.ing. Martin Ystenes, Department of Materials Science and Engineering, NTNU.</p>	<p>Beautiful nature and modern technology - photos from Iceland, Norway and elsewhere.</p>



Brittle grain boundaries of pure aluminium.

GUEST LECTURERS

Speaker	Topic
<p><i>March 5</i> Professor Andrew Godfrey, Department of Materials Science and Engineering, Tsinghua University, China.</p>	The use of orientation measurements in investigations of plastic deformation.
<p><i>March 5</i> Dr. Nils Sandberg, Department of Physics, Royal Institute of Technology, AlbaNova University Center, Sweden.</p>	First-principles modeling of diffusion coefficients in Mo.
<p><i>April 24</i> Associate Professor Pierre Xavier Thivel, University Joseph Fourier, Grenoble, France.</p>	Chemical engineering applied to photocatalysis and fuel cells.
<p><i>May 8</i> Dr. Torsten Berning, Department of Energy Technology, Aalborg University, Denmark.</p>	A three-dimensional multi-fluid model of a PEM fuel cell cathode.
<p><i>May 20</i> Dr. Jon G. Pharoah, Fuel Cell Research Centre, Kingston, Ontario, Canada.</p>	Thermal effects in polymer electrolyte membrane fuel cells.
<p><i>June 17</i> Professor Mats Johnson, Department of Inorganic Chemistry, Arrhenius Laboratory, Stockholm University, Sweden.</p>	A synthesis strategy for finding new low-dimensional compounds.
<p><i>March 10</i> Professor Oleg Ostrovski, School of Materials Science and Engineering, University of New South Wales, Australia.</p>	Mn-bearing minerals in Mn ores.
<p><i>September 11</i> Professor X.Q. Zeng, School of Materials Science and Engineering, Shanghai Jiao Tong University, China.</p>	Study on high strength magnesium alloy by RE addition.
<p><i>September 8 and 11</i> Professor Shipu Chen, School of Materials Science and Engineering, Shanghai Jiao Tong University, China.</p>	Long period stacking ordered (LPSO) structures in rare earth – containing magnesium alloys.
<p><i>September 11</i> Professor Akimasa Tasaka, Doshisha University, Kyoto, Japan.</p>	Electrical conductivity and viscosity of low temperature molten salts.
<p><i>September 25</i> PhD Lori Groven, South Dakota School of Mines & Technology, Rapid City, USA.</p>	Solution combustion synthesis as a simple route to carbon nanotube loaded materials.
<p><i>October 27</i> Professor Roger Doherty, Drexel University, Philadelphia, USA.</p>	Abnormal grain coarsening: Role of second phase particles and low angle grain boundaries.
<p><i>October 27</i> Professor Bevis Hutchinsen, KIMAB/KTH Royal Institute of Technology, Sweden.</p>	A mystery story of grain growth and texture.
<p><i>October 27</i> Professor Günter Gottstein, Institute of Physical Metallurgy and Metal Physics, RWTH Aachen, Germany.</p>	A different view on dynamic recrystallization.
<p><i>October 27</i> Dr. Christophe Sigli, Alcan R&D, Voreppe, France.</p>	Recent progress in precipitation modeling.
<p><i>October 27</i> Professor Julian Driver, Ecole Des Mines, St. Etienne, France.</p>	The recovery of cold deformed Al-Mn binary alloys.
<p><i>October 27</i> Professor Jürgen Hirsch, Hydro R&D, Bonn, Germany.</p>	Textures and anisotropy in industrial aluminium alloys.
<p><i>November 13</i> PhD student Odne Burheim, Department of Chemistry, NTNU.</p>	The measured heat and work from a PEM fuel cell.

STAFF

SCIENTIFIC STAFF

Professor, PhD **Lars Arnberg**
Professor, PhD **Ragnhild Elisabeth Aune**,
20 % position from January 1 to March 30, 2009,
80 % position from April 1, 2009
Professor emeritus **Jon Arne Bakken**
Associate Professor emeritus, Dr.ing. **Dagfinn Bratland**
Professor, Dr.ing. **Mari-Ann Einarsrud**,
(80 %) position from January 1 to June 30, 2009
Professor emeritus, Dr.ing. **Thorvald Abel Engh**
Adjunct Professor, PhD **Olaf Engler**
Professor emeritus **Arne Wang Espelund**
Professor, Dr.ing. **Trygve Foosnæs**, to April 24, 2009
Professor, Dr.ing. **Tor Grande**
Professor, Dr.ing. **Øystein Grong**
Professor, Dr.scient. **Jarle Hjelen**
Professor emeritus, Dr.techn. **Jan Lützow Holm**,
to September 3, 2009
Professor, Dr.scient. **Bjørn Holmedal**,
40 % position (Associate Professor) to March 6, 2009,
100 % position from March 7, 2009
Professor, Dr.ing. **Geir Martin Haarberg**
Adjunct Professor, Dr.ing. **Ola Jensrud**
Adjunct Professor, Dr.ing. **Harald Justnes**
Professor, Dr.ing. **Leiv Kolbeinsen**
Associate Professor, Dr.ing. **Hilde Lea Lein**,
maternity leave from October 20, 2009
Professor, Dr.philos. **Otto Lohne**
Professor, Dr.ing. **Knut Marthinsen**
Adjunct Professor, PhD **Mohammed M'Hamdi**
Professor emeritus, M.Sc.Eng. **Ketil Motzfeldt**
Professor emeritus, PhD **Erik Nes**
Professor, PhD **Kemal Nisancioglu**
Professor emeritus **Sverre Olsen**
Adjunct Professor, Dr.ing. **Knut Arne Paulsen**
Adjunct Professor, Dr.techn. **Oddvin Reiso**
Adjunct Professor, Dr.ing. **Christian Rosenkilde**
Professor emeritus, Dr.techn. **Terkel Rosenqvist**
Professor, Dr.techn. **Hans Jørgen Roven**
Professor emeritus, Dr.techn. **Nils Ryum**
Associate Professor, PhD **Per Martin Rørvik**,
from July 1, 2009
Associate Professor, PhD **Frode Seland**
Professor, Dr.philos. **Jan Ketil Solberg**
Professor, Dr.techn. **Svein Sunde**
Adjunct Professor, Dr.ing. **Morten Sørlie**

Professor, Dr.ing. **Merete Tangstad**
Professor emeritus, Dr.techn. **Jomar Thonstad**
Associate Professor, PhD **Gabriella Tranell**
Professor emeritus **Reidar Tunold**
Professor emeritus **Johan Kristian Tuset**
Adjunct Professor, Dr.ing. **Halvard Tveit**
Associate Professor, PhD **Fride Vullum**,
maternity leave from July 4, 2009
Professor, Dr.ing. **Kjell Wiik**
Adjunct Professor, PhD **Volodymyr Yartys**
Professor, Dr.ing. **Martin Ystenes**
Professor emeritus, Dr.techn. **Terje Østvold**
Adjunct Associate Professor, Dr.ing. **Eivind Johannes
Øvrelid**
Professor emeritus, Dr.techn. **Harald Arnljot Øye**

TECHNICAL STAFF

Senior Engineer **Elin Harboe Albertsen**
Senior Engineer **Jan Arve Baatnes**
Engineer **Fritz Helgemo**
Senior Engineer **Harald Holm**
Chief Engineer **Eli Beate Jakobsen**
Engineer **Solveig Louise Sørli Jonassen**, 50 % position
Senior Engineer **Torild Krogstad**
Senior Engineer **Tor Arild Nilsen**, leave of absence
from August 31, 2009
Senior Engineer **Svein Arne Pedersen**, 50 % position
to June 15, 2009
Senior Engineer **Kjell Røkke**
Chief Engineer **Morten Raanes**
Senior Engineer **Pål Skaret**
Senior Engineer **May Grete Sætran**, 50 % position
Chief Engineer **Julian Tolchard**
Chief Engineer **Pål Ulseth**
Engineer **Gunn Torill Wikdahl**
Chief Engineer **Yingda Yu**

ADMINISTRATIVE STAFF

Executive Officer **Martha Bjerknes**
Executive Officer **Elsa Mari Florhaug**, 50 % position
Head of Administration **Trond Einar Hagen**
Office Apprentice **Hege Knutsdatter Johnsen**
Executive Officer **Unni Keiseraas**
Higher Executive Officer **Brit Wenche Meland**
Executive Officer **Hilde Martinsen Nordø**

Head of Department, Dr.ing. **Arne Petter Ratvik**,

50 % position from September 1, 2009,

100 % position from October 1, 2009

Secretary **Åse Lill Salomonsen**

RESEARCH SCIENTISTS

PhD **Julien Degoulange**, from January 22, 2009

M.Sc. **Carl Erik Lie Foss**, from August 17, 2009

PhD **Zhihong Jia**, to August 2, 2009 and from November 11, 2009

PhD **Manping Liu**, to January 31, 2009

PhD **Mohamed Othman Mahmoud**, from January 7 to
October 6, 2009

M.Sc. **Axel Baumann Oftstad**, from June 15 to
December 14, 2009

PhD **Paul Schaffer**, to January 31, 2009 and 20 % position
from February 1 to April 30, 2009

Dr.ing. **Gaute Stokkan**

PhD **Shuihua Tang**

PhD **Mikhail Tsyarkin**

PhD **Harald Vestøl**, 75 % position from March 1, 2009

GUEST PROFESSORS/RESEARCHERS

M.Sc. **Sarah Bernardis**, from April 1 to June 30, 2009

PhD **Pietrzyk Stanislaw**, from August 3 to October 3, 2009

George R. Smith Chair and Professor **Robert H. Wagoner**,
from April 8 to May 7, 2009

Dr. **Mario Williams**, from November 30 to December 10, 2009

M.Sc. **Songsheng Zheng**, from September 10, 2009

Professor **Oleg Ostrovski**, from february to June, 2009

POST DOCTORAL FELLOWS

PhD **Shahid Akhtar**, from October 24, 2009

PhD **Martin Bellmann**

PhD **Dmitry Bokach**

PhD **Yongjun Chen**

PhD **Annika Eriksson**, from March 23, 2009

PhD **Snorre Fjeldbo**

PhD **Edita Garskaite**, to June 3, 2009

PhD **Rajiv Giri**

PhD **José Luis Gómez**

Dr.ing. **Sverre Gulbrandsen-Dahl**, 50 % position

PhD **Manping Liu**, to January 31, 2009

PhD **Stanka Tomovic Petrovic**, 50 % position from
September 1, 2009

PhD **Per Martin Rørvik**, from Januray 18 to June 30, 2009

PhD **Jafar Safarian-Dastjerdi**

PhD **Evanthia Stefanidakis**, to February 28, 2009

PhD **Boyan Yuan**, to June 30, 2009

SCIENTIFIC ASSISTANTS

Leiv Olav Jøsang

Stephen Lobo, to June 30, 2009

Glendon Tan, from May 4 to December 18, 2009

Kira Turkova, 30 % position

DEPARTMENT SCHOLARSHIP HOLDERS

Per Kristian Dahlstrøm

Lars-Erik Owe

Sverre Magnus Selbach, to December 28, 2009

Malin Sletnes, from august 1, 2009

Katharina Teichmann, from June 1, 2009

EXTERNAL SCHOLARSHIP HOLDERS WITH TEACHING DUTIES

Astrid Bakken

Sarina Bao

Stein Trygve Briskeby, to March 1, 2009

Jirang Cui

Halvor Dalaker, to July 31, 2009

Mahdi Darab

Heiko Gaertner, from August 17, 2009

Nils Håvard Giskeødegård, to February 8, 2009

Sidsel Meli Hanetho, maternity leave from August 3, 2009

Astri Bjørnetun Haugen, from August 10, 2009

Fredrik Haakonsen, to January 31, 2009

Liudmila Igorevna Ilyukhina

Kenji Kawaguchi

Eirin Kvalheim

Ørjan Fossmark Lohne, from August 10, 2009

Francesco Madaro, to December 8, 2009

Chiara Modanese

Peyman Mohseni

Erlend Fjøsne Nordstrand, to July 31, 2009

Mari Kirkebøen Næss, from August 1, 2009

Axel Baumann Ofstad, to April 30, 2009

Per Martin Rørvik, to January 17, 2009

Dmitry Slizowski

Sapthagireesh Subbarayan

Tor Olav Løvang Sunde, from August 10, 2009

Guttorm Ernst Syvertsen

Sophie Beatrice Weber

Øyvind Østrem

EXTERNAL SCHOLARSHIP HOLDERS

Shahid Akhtar, to October 23, 2009

Anawati, maternity leave to June 1, 2009

OmidReza Noghabi Asadi, from October 1, 2009
Mustafa Balci, from August 6, 2009
Marte Bjørnsdotter, maternity leave from October 16, 2009
Yacine Boulfrad
Ingvild Margrete Brynjulfsen, from August 24, 2009
Arjan Ciftja, to January 31, 2009
Elena Dal Martello, from March 23, 2009
Pierre Delaleau
Torunn Ervik, from August 24, 2009
Jiregna Hirko Foggi, from January 5, 2009
Jørgen Furu
Hasan Güteryüz
Terje Hals, from September 1, 2009
Lars Klemet Jakobsson, from August 17, 2009
Mehdi Kadkhodabeigi
Nils Eivind Kamfjord, from March 1, 2009
Maulid Kivambe
Ole Sigmund Kjos
Jeffery Kline, from August 20, 2009
Michal Kolar
Michal Ksiazek
Köksal Kurt
Elizaveta Kuznetsova, from October, 2009
Tine Nærland, from June 18, 2009
Piotr Ochal
Stian Seim
Esma Senel
Suwarno Suwarno, from May 13, 2009
Morten Tjelta, from August 17, 2009
Kati Tschöpe
Vinothkumar Palanisamy, from August 12, 2009
G. Nagaraj Vinayagam, from November 2, 2009
Zhaohui Wang
Saijun Xiao
Dongju Zhao, to May 31, 2009
Vegard Øygarden, from August 10, 2009

UNDERGRADUATE ASSISTANTS

Spring semester

Astrid Bakken
 Olav Kigen Bjering
 Ingvild Brynjulfsen
 Erlend Hillestad Bårgard
 Kjersti Meldahl Eide
 Kristian Engen Eide
 Ingelin Clausen Endsjø
 Nina Enaasen
 Espen Austrheim Erdal
 Carl Erik Lie Foss
 Ragnhild Helene Gulbrandsen
 Silje Aamot Haga

Kjell Inge Halten
 Eirik Schrøder Hansen
 Karen Marie Haug
 Astri Bjørnetun Haugen
 Morten Ro Helsem
 Guttorm A. Hoff
 Jens Kristian Holmen
 Hege Holsæter
 Joakim Johnsen
 Steinar Jørstad
 Hans Fredrik Nyvold Kvitvang
 Eva Landsem
 Ørjan Fossmark Lohne
 Erica Huuse Marley
 Thea Ragna Storesund Mohn
 Rolf Heilemann Myhre
 Gerhard Olsen
 Per Fredrik Rosenqvist
 Solveig Rørkjær
 Trine Vibeke Salvesen
 Kjetil Skjeldestad
 Knut Erik Snilsberg
 Jon Strand
 Tor Olav Løveng Sunde
 Cecilie Surdal
 Hanne Sørgård
 Eivind Bruun Thorstensen
 Morten Tjelta
 Espen Tjønneland Wefring
 Vegar Øygarden

Fall semester

Vegar Andersen
 Kai Beckwith
 Olav Kigen Bjering
 Kim Blommedal
 Kristian Karlsen Brende
 Mohsen Dehghan-Niri
 Eirik Djuve
 Kari Forthun
 Mette Grorud
 Halvor Hoen Hersleth
 Guttorm A. Hoff
 Asbjørn Holme
 Jens Kristian Holmen
 Håvard Husby
 Joakim Johnsen
 Steinar Jørstad
 Halvor Kjærås
 Aleksander Kolstad
 Ingrid Kummen
 Hans Fredrik Nyvold Kvitvang

Erica Huuse Marley
 Thea Ragna Storesund Mohn
 Gerhard Olsen
 Håvard Reitan
 Anita Reksten
 Gjert H. Rosenlund
 Ingvild Roti
 Solveig Rørkjær
 Trine Vibeke Salvesen
 Gunstein Skomedal
 Jon Strand
 Johan Kolstø Sønstabø
 Eivind Bruun Thorstensen
 Espen Tjønneland Wefring

SUMMER STUDENTS

Eirik Belland
 Henrik Bostad
 Marthe E. M. Buan
 Sindre Bunkholt
 Thomas Brynjulfsen
 Jens Erik Davidsen
 Solveig Egtvedt
 Ingelin Clausen Endsjø
 Didem Giray
 Susanne Helland
 Lone Sjursen Kleveland
 Robert Kurinec
 Thomas Hartmut Ludwig
 Tomas Manik
 Bronislav Novak
 Bjarte Nygård
 Urd Sæther Olden
 Christoffer Rosario
 Eirik Rotevatn
 Johanna Salomonsson
 Trine Viveke Salvesen
 Linn Sandberg
 Camilla Sommerseth
 Ole Jørgen Østensen
 Henrik Åsheim

APPRENTICE

Jon Michael Love

DEPARTMENT MANAGEMENT (to August, 2009)

Astri Bjørnetun Haugen
 Trygve Foosnæs, to April 24, 2009

Tor Grande (head)
 Øystein Grong
 Trond Einar Hagen
 Lars-Erik Owe
 Geir Martin Haarberg
 Eli Beate Jakobsen
 Leiv Kolbeinsen
 Ørjan Fossmark Lohne
 Knut Marthinsen (deputy head)
 Pål Ulseth

ADVISORY BOARD

Lars Arnberg
 Mari-Ann Einarsrud
 Astri Bjørnetun Haugen
 Trond Einar Hagen (Secretary)
 Odd Sture Hopperstad
 Fredrik Haakonsen/Lars-Erik Owe
 Bjarte Å. Nygård
 Brit Wenche Meland
 Kemal Nisancioglu
 Aud Nina Wærnes (chair)

SUBSTITUTES

Geir Martin Haarberg
 Leiv Kolbeinsen
 Kjell Wiik

DEPARTMENT BOARD (from August, 2009)

Ann Kristin Bjerkelund
 Trond Furu
 Lars-Erik Owe
 Arne Petter Ratvik (head)
 Morten Raanes
 Ragne M. Skarra
 Rudie Spooren
 Svein Sunde

SUBSTITUTES

Jørgen Furu
 Sigrid Lædre
 Brit Wenche Meland
 Merete Tangstad
 Aud Wærnes

GRADUATE STUDIES

PhD Degrees

During 2009, 78 PhD students have worked at Department of Materials Science and Engineering. 15 students have been awarded the degree PhD:

Arjan Ciftja	<i>Solar silicon refining; Inclusions, settling, filtration, wetting.</i> Doctoral thesis 2009:103, IMT-report 2009:113. February 2009.
Major subject:	<i>Extractive metallurgy.</i>
Dr. lecture:	The origin of Fe, Cr and Ni impurities in SoG-Si and their effect on the conversion efficiency of MC Si solar cells.
Thesis advisor:	Professor, Dr.ing. Merete Tangstad.
Co-supervisor:	Professor emeritus Thorvald Abel Engh.
Examination committee:	Professor, Director Roderick I.L.Guthrie, McGill Metals Processing Centre, McGill University, Montreal, Canada. Dr. Kjetil Hildal, Elkem Solar Kristiansand, Norway. Associate Professor Gabriella Tranell (chair).

Halvor Dalaker:	<i>Solubility of carbon and nitrogen in the silicon rich part of the Si-C-N-B-system.</i> Doctoral thesis 2009:215, IMT-report 2009:117. November 2009.
Major subject:	<i>Extractive metallurgy.</i>
Dr. lecture:	Sawing of silicon wafers – Techniques, effects on wafer and sawdust recycling.
Thesis advisor:	Professor, Dr.ing. Merete Tangstad.
Co-supervisor:	Professor, Dr.philos. Otto Lohne.
Examination committee:	Professor Kazuki Morita, Institute of Industrial Science, The University of Tokyo, Japan. Researcher, Dr. Anne Karin Sjøiland, Elkem Solar, Kristiansand, Norway. Professor Ragnhild Aune (chair).

Egil Fjeldberg:	<i>A computational study of recrystallisation and grain growth using a 3D Potts Monte Carlo model.</i> Doctoral thesis 2009:34, IMT-report 2009:107. February 2009.
Major subject:	<i>Physical metallurgy.</i>
Dr. lecture:	The role of atomistic simulations in the modelling of recrystallization and grain growth – status and perspectives.
Thesis advisor:	Professor, Dr.ing. Knut Marthinsen.
Co-supervisor:	Professor emeritus, Erik Aasmund Nes.
Examination committee:	Professor, PhD Andrew Godfrey, Department of Materials Science and Engineering, Tsingua University, China. Dr. Nils Sandberg, Department of Physics, School of Engineering Sciences, Royal Institute of Technology, AlbaNova University Center, Sweden. Professor, Dr.ing. Randi Holmestad, Department of Physics, NTNU (chair).

Brit K. F. Graver:	<i>Effect of trace elements in indium, tin and lead on anodic activation of aluminium.</i> Doctoral thesis 2009:75, IMT-report 2009:109. May 2009.
Major subject:	<i>Electrochemistry.</i>
Dr. lecture:	Nitrogen fixation on aluminium.
Thesis advisor:	Professor, PhD Kemal Nisancioglu.
Examination committee:	Dr. Alison Davenport, University of Birmingham, United Kingdom. Principal engineer Jan Halvor Nordlien, Hydro Aluminium R&D, Norway. Associate Professor, Dr.ing. Hilde Lea Lein (chair).

Harald Görner:	<i>Removal of dissolved elements in aluminium by filtration.</i> Doctoral thesis 2009:225, IMT-report 2009:121. November 2009.
Major subject:	<i>Physical metallurgy.</i>
Dr. lecture:	Influence of oxide inclusions and films on the porosity and properties of aluminium castings.
Thesis advisor:	Professor, PhD Lars Arnberg.
Co-supervisor:	Professor emeritus Thorvald Abel Engh.

Examination committee: Professor Mark E. Schlesinger, Department of Materials Science and Engineering, Missouri University of Science and Technology, Rolla, MO, USA.
Dr. Bjørn Rasch, Hydro Aluminium, Research and Technology Development, Sunndalsøra, Norway.
Professor Ragnhild Aune (chair).

Fredrik Haakonsen: *Optimizing of Strømhard autenitic manganese steel.*
Doctoral thesis 2009:88, IMT-report 2009:112. May 2009.

Major subject: *Physical metallurgy.*
Dr. lecture: The metallurgy of knifemaking - past and present.
Thesis advisor: Professor, Dr.philos Jan Ketil Solberg
Examination committee: Professor Mihai Chimasera, Politechnica University of Bucharest, Romania.
Associate Professor Ragnar Gjengedal, University College of Bergen, Norway.
Professor, Dr.ing. Merete Tangstad (chair).

Morten Sundheim Jensen: *Hot pressing and degradation of TiB₂ inert cathodes.*
Doctoral thesis 2009:127, IMT-report 2009:114. June 2009.

Major subject: *Inorganic chemistry.*
Dr. lecture: Material challenges in future aluminium production.
Thesis advisor: Professor, Dr.ing. Tor Grande.
Co-supervisors: Professor, Dr.ing. Mari-Ann Einarsrud and Professor, Dr.ing. Geir Martin Haarberg.
Examination committee: Professor Mats Johnsson, Division of Inorganic Chemistry, Arrhenius Laboratory, Stockholm University, Sweden.
Principal Engineer, Dr.ing. Eirik Hagen, Primary Metal Technology, Hydro Aluminium, Norway.
Associate Professor, Dr.ing. Hilde Lea Lein (chair).

Morten Karlsen: *EBSD based in-situ observations of polycrystalline materials in the SEM.*
Doctoral thesis 2009:81, IMT-report 2009:111. May 2009.

Major subject: *Physical metallurgy.*
Dr. lecture: Microstructure and properties of arctic steels for offshore applications.
Thesis advisor: Professor, Dr.scient. Jarle Hjelen.
Co-supervisors: Professor, Dr.ing. Øystein Grong, Professor, Dr.ing. Mari-Ann Einarsrud and Professor, Dr.techn. Hans Jørgen Roven.
Examination committee: Professor Sten Johansson, Linköping University, Sweden.
Dr. Gustav Heiberg, DNV (Det Norske Veritas), Høvik, Norway.
Professor, Dr.ing. Knut Marthinsen (chair).

Anders Lilleby: *Experimental and finite element studies of cold pressure welding of commercial purity aluminium by divergent extrusion.*

Doctoral thesis 2009:253, IMT-report 2009:116. December 2009.
Major subject: *Physical metallurgy.*
Dr. lecture: Mechanical properties of ultra-fine grained materials produced by accumulated roll bonding.
Thesis advisor: Professor, Dr.ing. Øystein Grong.
Co-supervisor: Associate Professor, Dr.ing. Hallstein Hemmer.
Examination committee: Professor Carl E. Cross, BAM-Federal Institute for Materials Research and Testing Joining Technology V.5, Berlin, Germany.
Dr.ing. Øyvind Frigaard, Norwegian Defence Laboratory, Kjeller, Norway.
Professor, Dr.scient. Bjørn Holmedal (chair).

Erlend Fjøsne Nordstrand: *The metallurgical foundation of manufacturing of CeS-based grain refiners for steels.*
Doctoral thesis 2009:227, IMT-report 2009:119. November 2009.

Major subject: *Physical metallurgy.*
Dr. lecture: Refining of silicon by the Chokralsky process – limitations and possibilities.
Thesis advisor: Professor, Dr.ing. Øystein Grong.
Co-supervisor: Casper van der Eijk, SINTEF Materials and Chemistry.
Examination committee: Professor Voicu Brabie, Material Science, Högskolan Dalarna, Sweden.
Dr.ing. Ole Svein Klevan, Director Technical Marketing-Ferroalloys to Steel Elkem AS, Elkem Foundary Products, Trondheim, Norway.
Professor, Dr.ing. Merete Tangstad (chair).

Ove Bjørn Paulsen:	<i>Rigid bonded glass ceramic seals for high temperature membrane reactors and solid oxide fuel cells.</i> Doctoral thesis 2009:85, IMT-report 2009:110. May 2009.
Major subject:	<i>Inorganic chemistry.</i>
Dr. lecture:	Dense ceramic membranes in power generation with CO ₂ capture - possibilities and challenges.
Thesis advisor:	Professor, Dr.ing. Tor Grande.
Co-supervisors:	Professor, Dr.ing. Mari-Ann Einarsrud. Research Director Rune Bredesen, SINTEF Materials and Chemistry.
Examination committee:	Senior Scientist Dr. Mohan Menon, Risø DTU, Denmark. Senior Consultant Jan M. Lindemann, Materials Consultants AS, Kristiansand, Norway. Professor, Dr.ing. Kjell Wiik (chair).
Silje Rodahl:	<i>Adhesion of organic coatings on aluminium.</i> Doctoral thesis 2009:55, IMT-report 2009:108. April 2009.
Major subject:	<i>Electrochemistry.</i>
Dr. lecture:	Functional coatings.
Thesis advisor:	Professor, PhD Kemal Nisancioglu.
Examination committee:	Professor, PhD David Scantlebury, University of Manchester, United Kingdom. Senior Engineer, Dr. ing. Sarbjyot Haarberg, MainTech AS, Trondheim, Norway. Associate Professor, PhD Frode Seland (chair).
Sverre Magnus Selbach:	<i>Structure, stability and phase transitions of multiferroic BiFeO₃.</i> Doctoral thesis 2009:219, IMT-report 2009:118. November 2009.
Major subject:	<i>Inorganic chemistry.</i>
Dr. lecture:	Lead-free ferroelectrics and piezoelectrics – materials and challenges.
Thesis advisor:	Professor, Dr.ing. Tor Grande.
Co-supervisors:	Professor, Dr.ing. Mari-Ann Einarsrud. Professor Thomas Tybell, Department of Electronics and Telecommunications, NTNU.
Examination committee:	Professor Maarit Karppinen, Department of Chemistry, Helsinki University of Technology, Finland. Professor Helmer Fjellvåg, Department of Chemistry, University of Oslo, Norway. Professor Jostein Grepstad, Department of Electronics and Telecommunications, NTNU (chair).
Maneesh C. Srivastava:	<i>High pressure die casting of aluminium and magnesium alloys.</i> Doctoral thesis 2009:207, IMT-report 2009:120. October 2009.
Major subject:	<i>Physical metallurgy.</i>
Dr. lecture:	Impurities in commercial aluminium – their origin, distribution and effect on properties.
Thesis advisor:	Professor, Dr.philos. Otto Lohne.
Co-supervisor:	Professor, PhD Lars Arnberg.
Examination committee:	Associate Professor Franco Bonollo, Department of Management and Engineering, Faculty of Engineering, University of Padova, Italy. Senior scientific adviser, Dr.ing. Trond Furu, R & D Materials Technology, Sunndalsøra, Norway. Professor, Dr.ing. Øystein Grong (chair).
Cecilie Ødegård:	<i>The effect of Fe, Al, Ca and Ti in silicon on the conversion of silicon tetrachloride to trichlorosilane.</i> Doctoral thesis 2009:150, IMT-report 2009:115. August 2009.
Major subject:	<i>Inorganic chemistry.</i>
Dr. lecture:	Superpure aluminium: Production, properties and use.
Thesis advisor:	Professor, Dr.ing. Trygve Foosnæs.
Co-supervisor:	Professor emeritus, Dr.techn. Harald Arnljot Øye.
Examination committee:	Professor Edwin Kroke, TU Bergakademi Freiberg, Department of Inorganic Chemistry, Freiberg, Germany. Technology Manager Anja Olufsen Sjaastad, REC ASA, Sandvika, Norway. Professor, Dr.ing. Martin Ystenes (chair).

PhD projects in progress

<i>Name and Title</i>	<i>Thesis advisor</i>
Madhubabu Abburi Electrochemical texturing of Si-wafers in alkaline solutions.	Kemal Nisancioglu
Shahid Akhtar Hydrogen porosity in aluminum castings.	Lars Arnberg
Anawati Effect of trace elements on the electrochemistry and corrosion of aluminium alloys.	Kemal Nisancioglu
Astrid Bakken New alumina based membrane materials for batteries and fuel cells.	Tor Grande
Mustafa Hasan Balci Formation of silicon quantum dots via wet chemical and plasma enhanced chemical vapour deposition methods for solar cell applications.	Mari-Ann Einarsrud
Sarina Bao Purification of aluminum through filtration.	Merete Tangstad
Marte Bjørnsdotter Effect of surface conditions on hydrogen uptake during cathodic protection of steel in seawater.	Kemal Nisancioglu
Yacine Boulfrad Investigation of the edge zone of multicrystalline silicon ingots for solar cells.	Eivind J. Øvrelid
Stein Trygve Briskeby Electrocatalysts of noble metals supported on carbon nanofibres.	Svein Sunde
Ingvild Margrete Brynjulfsen Nucleation and growth of PV silicon during crystallization.	Lars Arnberg
Jirang Cui Recycling of automotive aluminium and process dross.	Hans Jørgen Roven
Per Kristian Dahlstrøm Electrooxidation of small organic molecules.	Frode Seland
Elena Dal Martello The influence of quartz impurities on the properties of silicon solar cells.	Merete Tangstad
Mahdi Darab Synthesis and durability enhancement of CNT based MEAs for PEMFC.	Svein Sunde
Pierre Delaleau Equiaxed dendrite growth in aluminium alloys.	Lars Arnberg
Ole-Kristian Eide IR and NMR spectroscopy of catalyst for olefin polymerization.	Martin Ystenes
Jiregna Foggi Lifetime modelling of overhead powerlines exposed to marine environments.	Kemal Nisancioglu
Odd Einar Frosta Modeling of baked anodes.	Trygve Foosnæs
Jørgen Furu Remelting and recycling of aluminum scraps.	Knut Marthinsen
Heiko Gaertner Flue gas characteristics in aluminium reduction cells under various operational conditions.	Arne Petter Ratvik
Nils Håvard Giskeødegård Adhesion of organic functional groups on aluminium.	Kemal Nisancioglu
Hasan Güteryüz Investigation of the mechanisms governing the deposition of sol particles on a substrate.	Mari-Ann Einarsrud
Terje Hals Novel extrusion processing of aluminium materials.	Hans Jørgen Roven
Sidsel Meli Hanetho Coating and surface modification of multiphase pipelines.	Mari-Ann Einarsrud

Astri Bjørnetun Hauge Lead-free ferro- and piezoelectric (K,Na)NbO ₃ -based materials.	Mari-Ann Einarsrud
Raimo Helenius High pressure die casting of light metals.	Otto Lohne
Yu Hu Defects in monocrystalline silicon for solar cells.	Lars Arnberg
Liudmila Ilyukhina Rational design of mixed oxide catalysts for PEM water electrolysis.	Svein Sunde
Lars Klemet Jakbosson Removal of boron from metallurgical silicon through slag refining as a feedstock for the production of solar grade silicon.	Merete Tangstad
Mehdi Kadkhodabeigi Modeling of tap hole phenomenon in ferroalloys production furnaces.	Halvard Tveit
Nils Eivind Kamfjord Mass and energy balances of the silicon process in order to improve environmental standard and diffusive emission.	Halvard Tveit
Kenji Kawaguchi Electrocatalysis and novel functions of IrO ₂ -based electrodes.	Geir Martin Haarberg
Maulid Kivambe Formation and multiplication of dislocations in silicon for solar cells.	Otto Lohne
Ole Sigmund Kjos Electrochemical production of titanium from molten salts.	Geir Martin Haarberg
Jeffery Kline Silicate slag structure and the analytical techniques utilized in the determination of slag structure.	Merete Tangstad
Michal Kolar Deformation and precipitation in Al-Mg-Si-(Cu) alloys.	Knut Marthinsen
Michal Ksiazek Thermal conductivity in ores.	Merete Tangstad
Köksal Kurt Effect of thermomechanical treatment on trace element segregation and electrochemical activation of commercial and model aluminium alloys.	Kemal Nisancioglu
Eirin Kvalheim Electrode kinetics of anode processes on candidate inert anode materials for oxygen evolution during electrowinning in molten salts.	Geir Martin Haarberg
Magnus Hurlen Larsen Effect of composition and thermomechanical processing on the intergranular corrosion of AA6000 aluminium alloys.	Kemal Nisancioglu
Sten Yngve Larsen Novel carbon materials in electrometallurgical applications.	Trygve Foosnæs/ Morten Sørli
Ingrid Anne Lervik Electrocatalyst for PEM water electrolysis.	Svein Sunde
Jan Lindgård Alkali Silica Reactions (ASR) - performance based testing concept.	Harald Justnes
Ørjan Fossmark Lohne The kinetics of surface exchange reactions in oxide based mixed conductors at reducing conditions and high temperatures.	Kjell Wiik
Francesco Madaro Synthesis of textured piezo- and ferroelectric materials by chemical and ceramic techniques.	Tor Grande
Chiara Modanese Investigation of new Si solar cells feedstock.	Lars Arnberg
Peyman Mohseni Brittle and ductile fracture of arctic steels.	Jan Ketil Solberg
Tine Uberg Nærland Defect complexes in solar grade silicon.	Lars Arnberg

Mari Kirkebøen Næss Liquid Si- and Mn oxidation mechanisms and control.	Gabriella Tranell
Piotr Ochal Carbon-supported core-shell electrocatalysts for oxidation of small organic molecules.	Svein Sunde
Axel Baumann Ofstad Increasing the lifetime of PEM fuel cells - a fundamental study of degradation mechanisms.	Svein Sunde
Morten Andreas Onsrud Characterization of carbon cones and their application as electrode material in lithium ion batteries.	Trygve Foosnæs/ Fride Vullum
Lars-Erik Owe Oxide electrocatalysts for the oxygen evolution reaction during water electrolysis.	Svein Sunde
Vinothkumar Palanisamy Microstructural characterization on shielded active gas forge weld steels.	Jan Ketil Solberg
Andrey Poletaev Nanostructured hydrides of aluminium and magnesium for hydrogen storage.	Jan Ketil Solberg
Magnus Rotan Phase composition, microstructure and resistance to attrition of alumina-based supports for Fischer-Tropsch catalysts.	Tor Grande
Espen Andre Rudberg Oxygen exchange on functional oxide membranes.	Kemal Nisancioglu
Stein Rørvik Migration effects in prebaked anodes.	Trygve Foosnæs
Stian Seim Slag properties and phase relations in the Ti-industry.	Leiv Kolbeinsen
Esma Senel Effect of trace elements on surface properties of aluminium alloys.	Kemal Nisancioglu
Malin Sletnes Wet chemical based methods for deposition of quantum dot structures and production of hybrid materials for enhanced solar cell efficiency.	Mari-Ann Einarsrud
Dmitry Slizowskiy Use of waste materials for ferromanganese production.	Merete Tangstad
Karl Gunnar Solheim The effect of microstructure on the properties of 13%Cr flowlines in operation.	Jan Ketil Solberg
Isac Sorin Metal powder project - "metal printing process".	Lars Arnberg
Sapthagireesh Subbarayan Nanostructuring of light metals; aluminium-magnesium bi-materials.	Hans Jørgen Roven
Tor Olav Løvang Sunde Thin films of transparent conducting oxides by wet chemical methods.	Tor Grande
Suwarno Suwarno Metal hydrides for hydrogen sorption enhanced reactor.	Jan Ketil Solberg
Guttorm Ernst Syvertsen Synthesis and characterisation of nanostructured fuel cells based on proton conductors.	Tor Grande
Juan Tan Segregation of surface activating trace elements indium and tin by heat treatment of model aluminium alloys.	Kemal Nisancioglu
Katharina Teichmann The effect of deformation on the precipitation behaviour of Al-Mg-Si-alloys.	Knut Marthinsen
Morten Tjelta Photoelectrochemical characterization of semiconductor electrodes.	Svein Sunde
Kati Tschöpe FEM modelling of degradation of cathode lining in Hall-Heroult cells.	Tor Grande
Zhaohui Wang Mathematical models for degradation of cathode lining in Hall-Heroult cells.	Tor Grande
Sophie Beatrice Weber Ceramic thermal barrier coatings.	Mari-Ann Einarsrud

Saijun Xiao Gas anode for metal electrowinning.	Geir Martin Haarberg
Dongju Zhao Processing, properties and performance in use of direct reduced iron pellets containing added material to control steel structure.	Leiv Kolbeinsen
Øyvind Østrem Cathode wear in industrial aluminium electrolysis cells.	Christian Rosenkilde
Vegar Øygarden Chemical compatibility, degradation and performance of cathode material in proton conducting fuel cells.	Hilde Lea Lein

PhD projects co-supervised in other departments

<i>Name and Title</i>	<i>Thesis advisor</i>
Dag Herman Andersen Thermo-electrical-mechanical models for anode carbon cracking.	Zhiliang Zhang (Department of Structural Engineering, NTNU) and Trygve Foosnæs.
Tina Kristiansen Aerogels; a new class of materials for catalytic applications.	David Graham Nicholson (Department of Chemistry, NTNU) and Mari-Ann Einarsrud.
Jinbao Lin SPD by CEC of magnesium alloys.	Qudong Wang (Shanghai Jiao Tong University, China) and Hans Jørgen Roven.
Efstathios Ntalias Investigation on the possibility to control water permeability of concrete.	Petros G. Koutsoukos (Department of Chemical Engineering, University of Patras, Patras, Greece) and Terje Østvold.
Maria Psarrou Protecting soil from water erosion through precipitation of calcium phosphate.	Petros G. Koutsoukos (Department of Chemical Engineering, University of Patras, Patras, Greece) and Terje Østvold.
Peter Schmidt Hollow castings produced by LPDC.	Jürgen Bast (T. U. Bergakademie, Freiberg, Germany) and Lars Arnberg.
Anna Smirnova Hydrogen diffusion in super martensitic 13% Cr and X70 pipeline steels.	Roy Johnsen (Department of Engineering Design and Materials) and Kemal Nisancioglu.
Ragnhild Kjæstad Sæterli Electronic structure of thermoelectric materials - TEM studies at the nanoscale.	Randi Holmestad (Department of Physics, NTNU) and Knut Marthinsen.
Zhipeng Zeng Study on the ECAP process for commercially pure titanium.	Stefan Jonsson (Department of Materials Science and Engineering, KTH, Stockholm, Sweden) and Hans Jørgen Roven.
Ida Westermann Mechanical properties of 7xxx alloys - effect of precipitates and elements in solid solution, strain, strain path and strain rate.	Odd Sture Hopperstad (Department of Structural Engineering, NTNU), Bjørn Holmedal and Knut Marthinsen.
Fredrik Widerøe Novel extrusion technology and simulations.	Torgeir Welø (Department of engineering Design and Materials, NTNU) and Hans Jørgen Roven.

COURSE PROGRAM

Descriptions of the courses offered at the Department of Materials Science and Engineering are included in the University Course Catalogue that can be obtained from Student and Academic Section, NTNU. The present survey lists the courses given by our scientific staff.

Course no.	Semester:		Title Credits in parenthesis	Lectures and exercise coordinators	Passed/ Started
	S=Spring	A=Autumn			
TMT4106	S		General Chemistry (7.5)	M. Ystenes	343/395
TMT4110	S		General Chemistry (7.5)	T. Grande	156/165
TMT4120	S		General Chemistry 2 (7.5)	T. Foosnæs, T. Grande	87/88
TMT4130	S		Inorganic Chemistry (7.5)	M.-A. Einarsrud	88/90
TMT4150	S		Refractories (7.5)	K. Wiik, S. Seim	6/8
TMT4165	S		Materials- and Electro Chemistry, proj. (7.5)	G.M. Haarberg	22/22
TMT4175	S		Materials Technology 2 (7.5)	Ø. Grong, K. Marthinsen, O. Lohne	27/27
TMT4206	S		Fluid and Heat Transfer, Intr. Course (7.5)	M. Tangstad, R. Kristoffersen, H.F. Svendsen	22/24
TMT4208	S		Fluid and Heat Transfer, Adv. Course (7.5)	L. Kolbeinsen	1/1
TMT4210	S		Material and Process Modelling (7.5)	K. Marthinsen	36/36
TMT4215	S		Casting (7.5)	L. Arnberg	25/26
TMT4245	S		Functional Materials (7.5)	F. Vullum	19/20
TMT4250	S		Electrochemistry, basic course (7.5)	G.M. Haarberg	37/43
TMT4260	S		Phase Transformations in Metals (7.5)	K. Marthinsen, Ø. Grong	8/9
TMT4265	S		Materials Techn.-Forming Light Metals (7.5)	H. J. Roven, O. Jensrud, O. Reiso	11/13
TMT4275	S		Thermodynamics and Phasediagrams (7.5)	L. Kolbeinsen	21/22
TMT4285	S		Hydrogen Techn., Fuel/Solar Cells (7.5)	S. Sunde	44/54
TMT4300	S		Light and Electron Microscopy (7.5)	J.K. Solberg	44/46
TMT4500	S		Materials Technology, special project (15.0)	Several teachers at the department	4/4
TMT4851	S		Experts in Team (7.5)	T. Foosnæs, F. Steineke	26/26
TMT4900	S		Master thesis, Spec. in Materials Chemistry and Energy Techn. (30.0)	Several teachers at the department	16/16
TMT4905	S		Master thesis, Materials Techn. (30.0)	Several teachers at the department	20/20
TMT5100	S		Electrolysis of Light Metals 2 (7.5)	K. A. Paulsen	3/3
TMT4100	A		General Chemistry (7.5)	M. Ystenes	159/187
TMT4112	A		General Chemistry (7.5)	K. Wiik	189/236
TMT4115	A		General Chemistry 1 (7.5)	T. Grande	90/95
TMT4145	A		Ceramic Engineering (7.5)	M-A. Einarsrud	37/39
TMT4155	A		Heterogen Equilibria/Phase Diagrams (7.5)	T. Grande	54/62
TMT4170	A		Materials Technology 1 (7.5)	G. Tranell, M. Tangstad	30/31
TMT4185	A		Materials Technology (7.5)	L. Arnberg, Ø. Grong, K. Marthinsen, B. Holmedal	95/110
TMT4190	A		Applied Materials Technology (7.5)	O. Lohne, K.H. Holthe	25/26
TMT4222	A		Mechanical Properties of Metals 1 (7.5)	B. Holmedal	22/24
TMT4240	A		Microstructure and Properties of Metals (7.5)	J.K. Solberg	28/29
TMT4253	A		Electrochemical Process- and Energy Technology (7.5)	F. Seland	16/17

TMT4255	A	Corrosion and Corrosion Protection (7.5)	K. Nisancioglu, R. Johnsen	30/32
TMT4280	A	Extractive Metallurgy (7.5)	L. Kolbeinsen	9/9
TMT4292	A	Materials- and Surface Chemistry (7.5)	S. Sunde, K. Wiik	19/23
TMT4305	A	Electrometallurgy (7.5)	G. Tranell, M. Tangstad, H. Tveit	8/8
TMT4320	A	Nanomaterials (7.5)	P.M. Rørvik	50/52
TMT4325	A	Refining and Recycling of Metals (7.5)	R. Aune	
TMT4500	A	Materials Technology, special project (15.0)	Several teachers at the department	39/39
TMT4505	A	Materials Technology, special course (7.5)	Several teachers at the department	34/36
TMT5500	A	Process Metallurgy and Electrolysis, special project (15.0)	G.M. Haarberg	4/4
TMT5505	A	Process Metallurgy and Electrolysis, special course (7.5)	Several teachers at the department	4/4
MT8101	S	Electrochemical Kinetics (12.0)	G.M. Haarberg, C. Rosenkilde	9/9
MT8102	S	Corrosion and Surface Technology (7.5)	K. Nisancioglu	7/7
MT8104	S	Electrolysis of Light Metals 1 (7.5)	K.A. Paulsen, G.M. Haarberg	1/1
MT8200	S	Advanced Chemical Metallurgy (7.5)	L. Kolbeinsen	3/3
MT8206	S	Iron and Steel Metallurgy (7.5)	Ø. Grong	3/3
MT8209	S	Failure Analysis of Metals (7.5)	J. K. Solberg	10/10
MT8214	S	Advanced Silicon – Solar Cells (7.5)	O. Lohne, T.W. Renaas	8/8
MT8218	S	Advanced Materials Science (7.5)	Several teachers at the department	1/1
MT8300	S	Electrolysis of Light Metals 2 (7.5)	K. A. Paulsen	1/1
MT8301	S	Carbon Materials Technology (7.5)	M. Sørli	8/8
MT8305	S	Cement Chemistry (7.5)	H. Justnes	1/1
MT8101	A	Electrochemical Kinetics (12.0)	G.M Haarberg, C. Rosenkilde	1/2
MT8201	A	Advanced Electrometallurgy (7.5)	G. Tranell, M. Tangstad	3/3
MT8210	A	Advanced Solidification Metallurgy (7.5)	L. Arnberg	2/2
MT8213	A	Modelling and Simulation of Materials and Properties (7.5)	K. Marthinsen	1/1
MT8216	A	Recrystallization and Texture (7.5)	K. Marthinsen	3/3
MT8218	A	Advanced Materials Science (7.5)	Several teachers at the department	1/1
MT8308	A	Advanced Solid State Chemistry (7.5)	T. Grande	3/3

M.Sc. STUDENTS

Master of Science in Materials Technology (5 years)

Autumn semester

3rd year

Arya Bastiko
Audun Bilsbak
Erik Bjartnes
Ann Kristin Bjerkelund
Stian Gurrik
Kristoffer Werner Hansen
Thomas Holm
Hans Husby
Torunn Hjulstad Iversen
Hedda Nordby Krogstad
Kristian Larsen
Thomas Larsen
Martin Borlaug Mathisen
Gunnar Sande
Aleksander Rudolf Stoss
Espen Oldeide Strandheim
Erlend Sølvberg
Astri Sømme
Andreas Torstensen
Jørund Vangskåsen
Tobias André Eidsør Viken

4th year

Eirik Belland
Tor Arne Buberg
Jens Erik Davidsen
Sofie Drågen
Solveig Egtvedt
Jan Gaute Frydendahl
Preben Kjos Gabrielsen
Anne-Jorunn Hausken
Ruth Oftedal Herikstad
Håkon Trygve Strøm Jørgensen
Steinar Jørstad
Steinar Lauvdal
Bjarte Åstveit Nygård
Petter Ottesen
Jonas Hovde Pedersen
Mads Reiten
Trine Viveke Salvesen

5th year

Patrick Alknes
Vegard Andersen
Svein Prestrud Astad
Olav Kigen Bjerjeng
Lars-Petter Bjørkeng
Tor Henning Bjørnå
Kristian Karlsen Brende
Thomas Brynjulfsen
Sindre Bunkholt
Kristian Nyborg Dahl
Ørjan Aronsen Ellingsen
Alexander Rise Gallala
Ann Leni Haugstad
Kristoffer Kløgetvedt
Amund Nordli Løvik
Ingeborg Johannesen Odland
Richard Hagvåg Ringstad
Boots Christoffer Demez Rosario
Eirik Andersen Rotevatn
Erling Gjestvang Schrøder
Magnus Skjellerudsveen
Gunstein Skomedal
Hans Magne Torseth
Knut Omdal Tveito

Graduated Master of Technology students

Spring semester

Elena Bai (Italy)
Ingvild Brynjulfsen
Andreas Egholm
Terje Hals
Morten Ro Helsem
Katja Ekroll Jahren
Fenar Kamlow
Ørjan Fossmark Lohne
Christoffer Vikne Moen
Rune Nilsen
Yngve Rønning
Vaseeharan Sivaneesan
Knut Erik Snilsberg
Marte Aadland Sørensen

Master of Science in Chemistry and Biotechnology, Specialization in Materials Chemistry and Energy Technology

Autumn semester

3rd year

Helene Bjerke
Kristin Roberta Brandt
Lene Marie Lysgaard Bristøl
Line Teigen Døssland
Øystein Grøtting
Øystein Gullbrekken
Cathrine Selina Holager
Axel Lødemel Holene
Sigrid Sognli Høyem
Ingrid Kummen
Dan Sætre Lagergren
Roald Bræck Leer
Ingrid Mattson
Christine Møinichen
Anne Marthe Nymark
Gerhard Henning Olsen
Marius Sunde
Arne Hetland Tvedt
Stine Lund Walø
Sandra Wika
Tormod Østmoe

4th year

Inga Askestad
Inger Marie Bjørnevik
Marthe Emilie Melandsø Buan
Kai Erik Ekstrøm
Jarl Erik Morsund Flatøy
Ragnhild Helene Gulbrandsen
Håkon A. Holm Gundersen
Lise Jemblie
Sigrid Lædre
Håvard Mølnås
Anita Reksten
Kristian Grøtta Skorpen
Halfdan Kristoffer Småbråten
Camilla Sommerseth
Øyvind Sunde Sortland
Jørgen Svendby
Mari Lovise Torp

Magnus Weberg
Espen Tjønneland Wefring
Ole Jørgen Østensen
Åsne Århus

5th year

Henrik Klitgaard Bostad
Tone Beate Heiaas Bukholm
Torbjørn Cederløv
Ingelin Clausen Endsjø
Helle Ervik Fossheim
Mette Grorud
Victoria Leivestad
Knut Åge Meland
Urd Sæther Olden
Solveig Rørkjær
Marianne Charlotte Simonsen
Ragne Marie Skarra
Ingrid Stamnes
Henrik Åsheim

Graduated Master of Technology students

Spring semester

Hanne Flåten Andersen
Astrid Bakken
Marianne Elisabeth Berg
Kristin Bergum
Torunn Kringlen Ervik
Carl Eik Lie Foss
Silje Aamot Haga
Astri Bjørnetun Haugen
Caroline Ramstad
Malin Sletnes
Tor Olav Løvang Sunde
Paul Bragelien Tandberg
Morten Tjelta
Vegar Øygarden

Master of Technology in Materials Technology (2 years)

(Master Programme in Materials Technology for Engineers)

Autumn semester

1st year

Eivind Strand Dahle
Knut Ove Dahle
Petter Gire Døhlle (part time)
Atle Korsnes Lian
Marius Slagsvold

2nd year

Anders Welde Gjennes (part time)
Line Sunde Lilleby
Svein Arne Pedersen (part time)
Zeinab Sharifi

Graduated Master of Technology students

Spring semester

Aws Yonis Faisal
Anita Hansen
Per Fredrik Rosenqvist

Master of Science Program in Light Metals Production

Autumn semester

1st year

Lord Famiyeh (Ghana)
Behzad Mirzaei (Iran)
Ali Tabeshian (Iran)
Chen Wu (China)
Amin Hossein Zavieh (Iran)
Mojtaba Tagadosi (Iran)

2nd year

Joseph Prince Armoo (Ghana)
Thomas Hartmut Ludwig (Germany)

Graduated Master of Technology students

Spring semester

Mohsen Dehghan-Niri (Iran)
Yohannes Addis Desta (Ethiopia)
Tone Eilertsen (Norway)
Finnur Flosason (Iceland)
Alex Luyima (Uganda)
Emmanuel Nyankson (Ghana)

Master of Science Program in Silicon and Ferroalloy Production

Autumn semester

1st year

Rajat Sharma (India)
Shawn Wilson (Canada)
Buhle Xakaleshe (South Africa)
Shuang Zhang (China)

2nd year

Stephen Caesar Lobo (Canada)

Foreign guest students at Department of Material Science and Engineering

Spring and autumn semester

Lorenzo Amadio (Italy)
Oliver Baptiste Gabriel Astruz (France)
Elena Bai (Italy)
Hannes Buchholz (France)
Kazim Caliskan (Austria)
Luca Castronuovo (Italy)
Wu Chen (China)
Jose Carlos Casado Coca (Spain)
Lucie Dagbert (France)
Nicolas Dollat (France)
Joseph Dominguez (Australia)
Sebastian Eller (Germany)
Johannes Fischer (Germany)
Pavla Fukatkova (Czech Republic)
Jesùs Estèbanez Garcia (Spain)
Fabio Gatti (Italy)
Julio Dominguez González (Spain)
Germain Gueneau (France)
Emeline Hantute (France)
Martin Hertel (Germany)
Erwan Jagueneau (France)
Björn Kiebaug (Germany)
Seongjun Kim (South Korea)
Petra Koci (South Korea)
Joon Kwon (South Korea)
Julien Laurent (France)
Maria Lohse (Germany)
Guillaume Majeau-Bettez (Canada)
Tomàs Mànik (Czech Republic)
Nicola Marchesi (Italy)
Raphael Marguet (France)
Susana Colomer Moreno (Spain)
Matteo Muratori (Italy)
Alberto Garcia Perez (Spain)
Jiri Petru (Czech Republic)
Marion Picard (France)
Lucia Bricio Platas (Spain)
Alexandre Stricker (France)
Adeline Vincent (France)
Miguel Àngel Jimènez Zamora (Spain)
Alessandro Zana (Italy)
Haitao Zhou (China)

GRADUATED M.SC. STUDENTS WITH TITLES OF THEIR DIPLOMA WORKS

ELECTROCHEMISTRY

<i>Name and title</i>	<i>Supervisor and examiner</i>
Hanne Flåten Andersen Optimizing fuel cell stack Shell Eco-marathon 2009.	<i>Supervisor:</i> Professor Svein Sunde. <i>Examiner:</i> Dr.ing. Asbjørn Solheim, SINTEF, Trondheim.
Marianne Elisabeth Berg Evaluation of the degradation mechanisms of biodegradable magnesium alloys.	<i>Supervisor:</i> Professor Geir Martin Haarberg, Professor Trygve Foosnæs. <i>Examiner:</i> Dr.ing. Astrid Bjørgum, SINTEF, Trondheim.
Aws Yonis Faisal Corrosion protection by coating in multiphase pipelines.	<i>Supervisor:</i> Professor Kemal Nisancioglu. <i>Examiner:</i> Associate Professor Håvard Karoliussen, Sør-Trøndelag University College.
Carl Erik Lie Foss Catalyst for high temperature water electrolysis.	<i>Supervisor:</i> Professor Svein Sunde. <i>Examiner:</i> Dr.ing Egil Rasten, INEOS Norge AS, Porsgrunn.
Asle Fredriksen Titanium production by electrolysis with liquid Zn-electrode.	<i>Supervisor:</i> Professor Geir Martin Haarberg. <i>Examiner:</i> Dr.ing. Arne Petter Ratvik, SINTEF, Trondheim.
Silje Aamot Haga Aging assessment of pressurized equipment at Kårstø - Method development and implementation of selected equipment.	<i>Supervisor:</i> Professor Roy Johnsen, Department of Engineering Design and Materials. Examined at the Department of Engineering Design and Materials.
Caroline Holme Diffusion barrier for high strength steel.	<i>Supervisor:</i> Professor Kemal Nisancioglu. <i>Examiner:</i> Dr.ing. Hjalmar Sigurdsson, The Research Council of Norway.
Caroline Ramstad Characterization of electrocatalysts for use in fuel cells using electrochemical quartz crystal microbalance (EQCM).	<i>Supervisor:</i> Associate Professor Frode Seland. <i>Examiner:</i> Dr.ing. Rune Halseid, Statoil, Oslo.
Vaseeharan Sivanesan The effect of ethylene glycol on the growth rate of different calcium carbonate polymorphs at conditions of hydrate inhibition in natural gas production.	<i>Supervisor:</i> Associate Professor Jens-Petter Andreassen, Department of Chemical Engineering. Examined at the Department of Chemical Engineering.
Morten Tjelta Catalyst for water electrolysis.	<i>Supervisor:</i> Professor Svein Sunde. <i>Examiner:</i> Dr.ing Egil Rasten, INEOS Norge AS, Porsgrunn.

EXTRACTIVE METALLURGY

<i>Name and title</i>	<i>Supervisor and examiner</i>
Astrid Bakken Coating properties of Si_3N_4 used on quartz crucibles for directional solidification of solar grade silicon.	<i>Supervisor:</i> Professor Merete Tangstad. <i>Examiner:</i> Adjunct Associate Professor Eivind J. Øvrelid.
Ingvild Margrete Brynjulfsen Wettability of solar grade silicon on silicon nitride coated silica.	<i>Supervisor:</i> Professor Merete Tangstad. <i>Examiner:</i> Adjunct Associate Professor Eivind J. Øvrelid.
Paul Bragelien Tandberg Production of solar grade Si - new feedstock processes.	<i>Supervisor:</i> Professor Merete Tangstad. <i>Examiner:</i> Associate Professor Gabriella Tranell.

INORGANIC CHEMISTRY

<i>Name and title</i>	<i>Supervisor and examiner</i>
Kristin Bergum Wet chemical preparation and characterisation of nanocrystalline bulk yttrium manganite.	<i>Supervisor:</i> Professor Mari-Ann Einarsrud. <i>Examiner:</i> Dr.ing. Helmer Fjellvåg, Department of Chemistry, University of Oslo.

Astri Bjørnetun Haugen Photocatalytic activity of TiO ₂ -based nanoparticles produced by spray pyrolysis.	<i>Supervisor:</i> Professor Mari-Ann Einarsrud. <i>Examiner:</i> Dr.ing. Helmer Fjellvåg, Department of Chemistry, University of Oslo.
Katja Ekroll Jahren Solid oxide fuel cells with proton conducting La(Sr)NbO ₄ and La _{0.8} Sr _{0.2} MnO ₃ -La(Sr)NbO ₄ composite cathode.	<i>Supervisor:</i> Associate Professor Hilde Lea Lein. <i>Examiner:</i> Dr.ing. Ingeborg Kaus, SINTEF, Trondheim.
Fenar Kamlow TiB ₂ -C composite material during aluminium electrolysis.	<i>Supervisor:</i> Professor Trygve Foosnæs, Adjunct Professor Morten Sørli. <i>Examiner:</i> Dr.ing. Ola Wærnes, SINTEF, Trondheim.
Ørjan Fossmark Lohne Light harvesting by upconversion - yttrium oxide doped with rare earths.	<i>Supervisor:</i> Professor Tor Grande. <i>Examiner:</i> Dr.ing. Tommy Møkkelbost, SINTEF, Trondheim.
Christoffer Vikne Moen BN and Si ₃ N ₄ coating on SiO ₂ crucibles for casting of multicrystalline silicon ingots for solar cells.	<i>Supervisor:</i> Associate Professor Hilde Lea Lein. <i>Examiner:</i> Dr.ing. Tommy Møkkelbost, SINTEF, Trondheim.
Rune Nilsen Silicon for Si ₃ N ₄ bonded SiC-material.	<i>Supervisor:</i> Professor Mari-Ann Einarsrud. <i>Examiner:</i> Dr.ing. Tommy Møkkelbost, SINTEF, Trondheim.
Malin Sletnes Wet chemical based methods for deposition of quantum dot structures for enhanced solar cell efficiency.	<i>Supervisor:</i> Associate Professor Fride Vullum. <i>Examiner:</i> Dr.ing. Tommy Møkkelbost, SINTEF, Trondheim.
Tor Olav Løvang Sunde Transparent conducting oxides in solar cells.	<i>Supervisor:</i> Professor Tor Grande. <i>Examiner:</i> Dr.ing. Tommy Møkkelbost, SINTEF, Trondheim.
Vegar Øygarden Investigation of La[M _(2/3-x) Nb _(1/3-x)]O ₃ (M= Ni, Co) as potential cathode materials in SOFCs based on proton conduction LaNbO ₄ .	<i>Supervisor:</i> Professor Tor Grande. <i>Examiner:</i> Dr.ing. Ingeborg Kaus, SINTEF, Trondheim.
PHYSICAL METALLURGY	
Name and title	Supervisor and examiner
Elin Christine Andersen Development of a corrosion management system for top-side process and utility system for Sevan Marine.	<i>Supervisor:</i> Professor Roy Johnsen, Department of Engineering Design and Materials. Examined at the Department of Engineering Design and Materials.
Elena Bai New design of tidal turbine blades.	<i>Supervisor:</i> Professor Andreas Echtermeyer, Department of Engineering Design and Materials. Examined at the Department of Engineering Design and Materials.
Andreas Egholm A study of recrystallization in ECAP commercial pure titanium.	<i>Supervisor:</i> Professor Jarle Hjelen. <i>Examiner:</i> Dr.ing. Tor Oskar Sætre, University of Agder, Grimstad.
Torunn Kringlen Ervik Growth mechanisms for crystal defects in silicon solar cells.	<i>Supervisor:</i> Professor Otto Lohne. <i>Examiner:</i> Dr.ing. Tanja Pettersen, SINTEF, Trondheim.
Terje Hals Grain refinement in Ti6Al4V by means of boron additions.	<i>Supervisor:</i> Professor Hans Jørgen Roven. <i>Examiner:</i> M.Sc. Haavard Gjestland, Hydro, Porsgrunn.
Anita Hansen Investigation of the energy dependence of breakdown properties with a DC spark setup.	<i>Supervisor:</i> Professor Morten Kildemo, Department of Physics. Examined at the Department of Physics.
Morten Ro Helsem Thermal cycles applied on the medium carbon steel J55.	<i>Supervisor:</i> Professor Jan Ketil Solberg. <i>Examiner:</i> Dr.ing. Ragnar Gjengedal, Corus Packaging, Bergen.
Madelein Hystad The distribution and impact of chromium impurities in compensated SOG-silicon.	<i>Supervisor:</i> Professor Lars Arnberg. <i>Examiner:</i> Dr.ing. Tanja Pettersen, SINTEF, Trondheim.

Siv Malm Nordtømme Characterization of microstructures in HAZ of 13 % Cr weldments.	<i>Supervisor:</i> Professor Jan Ketil Solberg. <i>Examiner:</i> Dr.ing. Morten Karlsen, Statoil, Trondheim.
Per Fredrik Rosenqvist Retained austenite formation and hydrogen traps in martensitic stainless steels.	<i>Supervisor:</i> Professor Jan Ketil Solberg. <i>Examiner:</i> Siv.ing. Bjørn Borchgrevink, Oslo.
Yngve Rønning Silica coating for silicon nitride crucibles for the growth of single crystal silicon by the Czochralski process.	<i>Supervisor:</i> Professor Lars Arnberg. <i>Examiner:</i> Dr.ing. Martin Syvertsen, SINTEF, Trondheim.
Knut Erik Snilsberg Microstructure and mechanical properties of 7xxx-alloys.	<i>Supervisor:</i> Professor Knut Marthinsen. <i>Examiner:</i> Dr.ing. Trond Furu, Hydro, Sunndalsøra.
Marte Aadland Sørensen Heat treatment of Ti-6Al-4V. Microstructure and mechanical properties.	<i>Supervisor:</i> Professor Hans Jørgen Roven. <i>Examiner:</i> M.Sc. Haavard Gjestland, Hydro, Porsgrunn.
Heidi Therese Østby The effect of minority carrier lifetime in monocrystalline silicon after solar cell processing.	<i>Supervisor:</i> Professor Otto Lohne. <i>Examiner:</i> Professor Espen Olsen, Norwegian University of Life Sciences, Ås.

MASTER OF SCIENCE PROGRAMME IN LIGHT METALS PRODUCTION

Name and title	Supervisor and examiner
Mohsen Dehghan-Niri Production of light metals and light metals alloys by electro-deoxidation of mixed metal oxides.	<i>Supervisor:</i> Professor Geir Martin Haarberg. <i>Examiner:</i> Dr.ing. Sverre Rølseth, SINTEF, Trondheim.
Yohannes Addis Destas Titanium electrolysis from molten salts containing titanium chloride.	<i>Supervisor:</i> Professor Geir Martin Haarberg. <i>Examiner:</i> Professor Douglas Inman, Imperial College London, United Kingdom.
Tone Eilertsen Anode effect free starting procedure for aluminium electrolysis cells.	<i>Supervisor:</i> Professor Trygve Foosnæs, Adjunct Professor Knut Arne Paulsen. <i>Examiner:</i> Professor emeritus Jomar Thonstad.
Finnur Flosason Implementation of automatic anode effect quenching into SU3 potline at Hydro Sunndal aluminium plant.	<i>Supervisor:</i> Professor Trygve Foosnæs, Adjunct Professor Knut Arne Paulsen. <i>Examiner:</i> Professor emeritus Jomar Thonstad.
Emmanuel Nyankson Investigating the effect of the water gas shift reaction and other parameters on the reduction degree of iron ore pellets reduced in CO and H ₂ gas mixture.	<i>Supervisor:</i> Professor Leiv Kolbeinsen. <i>Examiner:</i> Associate Professor Gabriella Tranell.

The 3 winners of the competition "Best knife" among students taking the course TMT4190 Applied Materials Technology (fall 2009): Bodil Drange Pedersen, Trond Arne Hassel and Asbjørn Ulvestad.



Photo: John Michael Love

EXTRACURRICULAR ACTIVITIES,

Honours, Participation in Courses, Conferences, Lectures and Study Visits

Shahid Akhtar

Technical University Freiberg, Freiberg, Germany, December 19-23, 2009. Study visit.

Elin Harboe Albertsen

"Risikovurdering" (exposure), Trondheim, Norway, March 12, 2009. Course.

"HMS i laboratorier og verksted" (HSE), Trondheim, Norway, March 2 and 16, 2009. Course.

"Varsling" (duty to warn), Trondheim, Norway, May 4, 2009. Course.

"HSE-Film premiere", project owner and roll-out the film which is based on information in the HSE handbook, Trondheim, Norway, August 31, 2009.

Lars Arnberg

Lars Arnberg is an Affiliate Professor at the Department of Mechanical Engineering, Worcester Polytechnic Institute, Worcester, USA.

European Synchrotron Radiation Facility (ESRF), Grenoble, France, January 19-21, 2009.

Solidification and Casting Group Seminar, Edsåsdalen, Sweden, March 12-13, 2009.

Norwegian Embassy, Tokyo, Toyota, Nagoia, Nippon Steel, Chiba, AIST, Tsukuba, Tohoku University, Sendai, Japan, March 30 - April 3, 2009. Student excursion.

Energy research Centre of the Netherlands (ECN), Petten, The Netherlands, April 20-21, 2009. Project discussions.

Hydro Aluminium, Sunndalsøra, Norway, April 22, 2009.

NADIA, Padova, Italy, May 20-21, 2009. Project discussions.

3rd International Workshop on Science and Technology of Crystalline Silicon Solar Cells (C3SSC), Trondheim, Norway, June 3-5, 2009.

NADIA Mini Master, Vicenza, Italy, June 22-26, 2009.

Institute for Energy Research, Kjeller, Norway, August 27, 2009. Project discussions.

2nd Norwegian-German Group Seminar on Solar Cell Materials, Freiberg, Germany, September 7-11, 2009.

Hydro Aluminium, Sunndalsøra, Norway, September 25, 2009. Project discussions.

International Conference on Modern Problems of Physical Metallurgy of Non-Ferrous Alloys, National University of Science and Technology, Moscow, Russia, October 1-2, 2009. Invited lecture on: "High resolution X-ray videomicroscopy of alloy solidification".

NorSun, Oslo, Norway, October 13, 2009. Project discussions.

Institute for Energy Research, Kjeller, Norway, October 22, 2009. Project meeting.

M. C. Flemings Honorary Symposium, Pittsburgh, USA, October 26-28, 2009. Invited lecture on: "Solidification advances".

4th International Conference on Solidification Science and Processing, Chennai, India, November 20-23, 2009. Invited lecture on: "Liquid decomposition, droplet coagulation and droplet-interface interactions in hypermonotectic Al-Bi alloys".

Martin Bellmann

Solidification and Casting Group Seminar, Edsåsdalen, Sweden, March 12-13, 2009. Presentation on: "Numerical and experimental analysis of the fluid flow in accelerated and decelerated crucibles".

2nd Norwegian-German Group Seminar on Solar Cell Materials, Freiberg, Germany, September 7-11, 2009. Presentation on: "Effect of accelerated crucible rotation on the segregation of impurities in vertical Bridgman growth of mc-silicon".

Dmitry Bokach

LabView basics I and II, National Instruments Norway, Asker, Norway, June 8-12, 2009. Course.

Mari-Ann Einarsrud

Oppdal Workshop on PV Materials, Oppdal, Norway, March 19-21, 2009.

NTNU NanoLab User Meeting, Trondheim, Norway, May 14, 2009.

NANOMAT Conference 2009, Lillehammer, Norway, June 16-17, 2009.

Evaluation of Chemistry in Norway, meeting in committee appointed by the Research Council of Norway, Oslo, Norway, August 13, September 15, October 28, November 20 and December 13, 2009.

4th KIFEE Symposium on Environment, Energy, Materials and Education, Trondheim, Norway, September 6-9, 2009. Lecture on: "Functional films and coatings by sol-gel technology".

Committee to evaluate applications for Swedish Research Council, Stockholm, Sweden, September 14-15, 2009.

Arne Espelund

Tolga, Norway, March 5, 2009. Presentation on: "The history of bloomery ironmaking in Tolga and Os".

U. Follador, Àgordo, Italy, May 15, 2009. Presentation on: "Røros and Àgordo".

Opplandjern Symposium, Kittilsbu, Norway, June 16-18, 2009. Presentation on: "The Evenstad process in time and space".

Meieridag, Norwegian Agricultural Museum, Ås, Norway, September 19, 2009. Presentation on: "The history of the brown cheese".

Kulturvern ved bergverk, Norsk bergverksmuseum, Røros, Norway, September 23, 2009. Presentation on: "Røros and Àgordo - twin cities".

Conference in Bradford, United Kingdom, November 10-12, 2009. Presentations on: "Bloomery ironmaking during the Roman iron age in Mid-Norway" and "Carbon control prior to Bessemer".

Rajiv Giri

Euromat 2009 European Congress and Exhibition on Advanced Materials and Processes, Glasgow, United Kingdom, September 10, 2009. Presentation on: "Pulse plasma surface treatments (PPST) of steels, inconels and titanium alloys for marine and offshore applications".

TEM Gemini Centre Workshop, Kvilhaugen Gård, Trondheim, Norway, November 19-20, 2009. Presentation on: "Application of focussed ion beam (FIB) for TEM sample preparation".

Hasan Gülerüç

EKA Chemicals AB, Gothenburg, Sweden, March 31, 2009. Visit.

NANOMAT Conference 2009, Lillehammer, Norway, June 15-19, 2009. Poster on: "Fundamental studies of thin film preparation by sol gel method".

4th KIFEE Symposium on Environment, Energy, Materials and Education, Trondheim, Norway, September 6-9, 2009. Poster on: "Fundamental studies of thin film preparation by sol gel method".

Université de Franche-Comté, Besançon, France, November 16 - December 12, 2009. Study visit for experimental work.

Astri Bjørnetun Haugen

4th KIFEE Symposium on Environment, Energy, Materials and Education, Trondheim, Norway, September 6-9, 2009. Poster and short lecture on: "Photocatalytically active TiO₂-based nanoparticles produced by spray pyrolysis".

SHAPING4, Madrid, Spain, November 15-18, 2009. Poster and short lecture in Student Contest on: "Hollow spherical TiO₂-based photocatalyst prepared by spray pyrolysis".

Geir Martin Haarberg

MOLTEN 2009, VIII International Conference on Molten Slags, Fluxes and Salts, Santiago, Chile, January 18-21, 2009. Presentation on: "Electrodeoxidation of solid Fe₂O₃ in molten CaCl₂ to produce iron".

Bo Håkansson Symposium, Stockholm, Sweden, January 29, 2009. Participant.

TMS Annual Meeting, San Francisco, USA, February 15-19, 2009. Presentation on: "Electrorefining of silicon in molten chloride electrolytes".

Workshop on Materials Process Engineering, San Francisco, USA, February 19, 2009. Presentation on: "Electrowinning of iron".

Equation Chapter 1 Section 17th Spring Meeting of the International Society of Electrochemistry, Szczyrk, Poland, March 22-25, 2009. Presentation on: "Anodic behaviour of iridium and tantalum oxides coated titanium electrodes in sulphate electrolytes".

University of Tokyo, Tokyo, Japan, May 7-8, 2009. Visit.

Doshisha University, Kyoto, Japan, May 11-15, 2009. Visit.

5th Kurt Schwabe Symposium, Erlangen, Germany, May 24-28, 2009. Presentation on: "Electrochemical deposition of silicon for solar cells".

3rd International Workshop on Science and Technology of Crystalline Silicon Solar Cells (CSSC3), Trondheim, Norway, June 3-5, 2009. Presentation on: "Electrorefining of metallurgical silicon in molten chloride and fluoride electrolytes".

Hydro Aluminium, Reykjavik, Iceland, June 10-12, 2009. Primary production network meeting.

KTH Royal Institute of Technology, Stockholm, Sweden, June 29, 2009. Visit.

42nd IUPAC World Chemistry Congress, Glasgow, United Kingdom, August 2-7, 2009. Participant.

60th Annual Meeting of the International Society of Electrochemistry (ISE 60th), Beijing, China, August 16-21, 2009. Presentation on: "Electrodeposition of lead from chloride melts".

4th KIFEE Symposium on Environment, Energy, Materials and Education, Trondheim, Norway, September 6-9, 2009. Member of the organizing committee.

216th Electrochemical Society Conference (ECS 216), Vienna, Austria, October 4-9, 2009. Participant and co-author.

Kunming University of Science and Technology, Kunming, China, October 16, 2009. Visit and presentation.

East China University of Science and Technology, Shanghai, China, October 19, 2009. Visit and presentation.

3rd Chinese-Norwegian Symposium on Light Metals (CNS2009), Shanghai Jiao Tong University, Shanghai, China, October 19-23, 2009. Presentation on: "Depolarised gas anodes for aluminium electrowinning".

3rd International Workshop of Energy Conversion, Doshisha University, Kyoto, Japan, November 25-27, 2009. Presentation on: "Sustainable electrolysis for energy efficient production of metals and alloys".

Paris, France, December 4, 2009. Member of PhD defence committee for Anne Huguet.

Metalysis, Rotherham, United Kingdom, December 11, 2009. Visit and presentation.

Molten Salt Discussion Group Christmas Meeting, London, United Kingdom, December 14, 2009. Visit and presentation on: "Depolarised gas anodes for aluminium electrowinning".

Zhihong Jia

FONDAL project meeting, Laigneville, France, January 26-27, 2009. Presentation on: "Heat treatment, characterization and mechanical test of family III alloys for elevated temperature applications".

FONDAL project meeting, Oslo, Norway, June 29-30, 2009. Presentation on: "Further investigations on family III alloys for elevated temperature applications".

Elkem Solar, Kristiansand, Norway, September 10, 2009. Presentation on: "Electron microscopy studies on various materials and FIB technique for TEM sample preparation".

3rd Chinese-Norwegian Symposium on Light Metals (CNS2009), Shanghai Jiao Tong University, Shanghai, China, October 19-23, 2009. Presentation on: "TEM studies of precipitates in aluminium cast alloys for elevated temperature applications".

TEM Gemini Centre Workshop, Kvilhaugen Gård, Trondheim, Norway, November 19-20, 2009.

Otto Lohne

ISFIT, Trondheim, Norway, February 25, 2009. Presentation on: "Solar cell activities at DMSE".

NTNU, Trondheim, Norway, March 24, 2009. Presentation on: "Solar cell activities at DMSE". Visit from KD.

NTNU, Trondheim, Norway, May 6, 2009. Presentation on: "Solar cell activities at DMSE". Visit from University of Bergen, Norway.

NTNU, Trondheim, Norway, June 10, 2009. Presentation on: "Solar cell activities at DMSE". Visit from China Council, China and Cicero, Norway.

NTNU, Trondheim, Norway, June 11, 2009. Presentation on: "Solar cell activities at DMSE". Visit from Asian Institute of Technology, Thailand.

NTNU, Trondheim, Norway, June 25, 2009. Presentation on: "Solar cell activities at DMSE".

NTNU, Trondheim, Norway, August 17, 2009. Presentation on: "Solar cell activities at DMSE". Visit from Minister of Environment Erik Solheim.

G-dag, NTNU, Trondheim, Norway, October 10, 2009.
Presentation on: "Solar cell activities at DMSE".

TSO Materials, NTNU, Trondheim, Norway, October 27, 2009. Honorary seminar for Professor Erik Nes on the occasion of his 70th anniversary. Presentation on: "My life with the Frank-Read mechanism".

Knut Marthinsen

Knut Marthinsen was deputy head at the Department of Materials Science and Engineering, and a member of the Board of Research and PhD education at the Faculty of Natural Sciences and Technology, NTNU, until October 1, 2009.

Knut Marthinsen is member of the International Committee for the Joint International Conferences on Recrystallization and Grain Growth (ReX&GG), the International Committee for the International Conferences of Aluminium Alloys (ICAA) and he was also Topics coordinator for the Aluminium Alloys session and a member of the Executive Committee for Thermec'2009, Berlin, Germany, August 25-29, 2009.

Knut Marthinsen is member (NTNUs representative) in the Steering Committee for the BIP NFR projects: "Nucleation control for optimized properties" and "RIRA (Remelting and inclusion refining of aluminium)" and the NFR KMB project: "Defect engineering for crystalline silicon solar cells".

Active participant and NTNU responsible for the area "Alloy development and trace elements" in the NTNU-SINTEF-Hydro Aluminium revised ROADMAP process.

Referee for several renowned international journals with a peer review system.

Administrator and member of the evaluation committee for the PhD thesis and defence of Morten Karlsen, NTNU, Trondheim, Norway, May 15, 2009. Thesis title: "EBSD based in-situ observations of polycrystalline materials in the SEM".

Thermec'2009, International Conference on Manufacturing of Advanced Materials, Berlin, Germany, August 25-29, 2009. Topics coordinator and session chairman for the Aluminium Alloys session. Invited lecture on: "Modelling the work hardening behaviour of AlMgMn alloys". Oral presentation on: "Anisotropy of bending properties in industrial heat-treatable extruded aluminium alloys".

Member of a NTNU committee appointed by the central study administration to review the use of ICT in the MSc

education and to suggest actions to strengthen the integration and technical use of ICT in the MSc studies at NTNU. Report delivered September 1, 2009.

Administrator and member of the Expert Committee to evaluate the applicants for the associate/full professorship in solar cell materials available at the Department of Materials Science and Engineering, Faculty of Natural Sciences and Technology. Report delivered September 11, 2009.

BIP RIRA - Remelting and Inclusion Refining of Aluminium Seminar, NTNU/SINTEF, Trondheim, Norway, October 6-7, 2009. Participation.

TSO Materials, NTNU, Trondheim, Norway, October 27, 2009. Honorary seminar for Professor Erik Nes on the occasion of his 70th anniversary, co-organized together with Ingrid Page. Lecture on: "A review of Erik Nes' professional life - some highlights".

Hosted the EAA-EATP WG5 (European Aluminium Association - European Technology Platform), follow-up meeting at NTNU, Trondheim, Norway, October 28, 2009. Participants from relevant European academic partners and the European Aluminium Industry.

External examiner for doctoral dissertation of Reza Roumina, Department of Materials Engineering, University of British Columbia, Vancouver, Canada, November, 2009. Thesis title: "Mechanical properties of recovered Al-Mg-Sc alloys".

TEM Gemini Centre Workshop, Kvilhaugen Gård, Trondheim, Norway, November 19-20, 2009. Participation.

Kemal Nisancioglu

Vth Aluminium Surface Science & Technology (ASST2009), Leiden, The Netherlands, May 10-14, 2009. International Scientific Committee member. Co-author of presentations on: "Preferential grain etching of aluminium products", "Characterization of surface activation of aluminium by trace element bismuth", "Effect of tin surface segregation on tribological behaviour of pure aluminium", "Effect of tin on anodic activation of aluminium" and "Anodic activation of aluminium alloy AA8006 by group IIIA - VA trace elements".

215th Meeting of the Electrochemical Society, San Francisco, USA, May 24-29, 2009. Co-author of presentations on: "Separation of double-layer charging and faradaic processes at electrodes" (invited) and "Anodic

polarization of silicon wafers in alkaline solutions”.

“Condition control of power lines”, Salten Kraftsamband Nett AS, Fauske, Norway, June 17, 2009. Project meeting.

2nd Workshop on Corrosion Chemistry in Pits, Crevices and Cracks, Mansfield College, Oxford, United Kingdom, July 20-22, 2009. Invited presentations on: “Theoretical challenges in modelling and measurement of reaction kinetics, transport phenomena and solution chemistry in localized corrosion” and “Anomalous behavior of copper as a cathode in intergranular corrosion”. Visit to Diamond Light Source.

Norut Teknologi, Narvik University College, Norway, August 31, 2009. Visit and project meeting: “Electrolytic etching of solar grade silicon wafers”.

216th Electrochemical Society Conference (ECS 216), Vienna, Austria, October 4-9, 2009. Co-author of presentations on: “Characterisation of effect of Cu on anodic activity of AlPb model alloy”, “Nitride formation on aluminium-tin alloy by heat treatment in air” and “Preferential grain etching of AlMgSi(Zn) model alloys”.

4th Aluminium Symposium, Istanbul, Turkey, October 15-16, 2009. Co-author of presentations on: “Effect of surface microstructure on corrosion of aluminium alloys” (invited), “Effect of trace element gallium on corrosion properties of aluminium” and “Anodic activation of commercial aluminium alloys”.

13th European Conference on Applications of Surface and Interface Analysis (ECASIA'09), Antalya, Turkey, October 18-23, 2009. Presentation on: “Surface science of aluminum alloys”.

Laboratoire Interfaces et Systemes Electrochimiques (LISE - UPR15 du CNRS), Université Pierre et Marie Curie, Paris, France, November 5, 2009. Presentation on: “Nanofilm copper segregation as a result of intercrystalline corrosion of AlMgSi alloys”. Invited visit.

Joint meeting, Trondheim, Norway, November 22, 2009. NTNU, SINTEF and Hydro to discuss surface science problems related to: “Utilization of aluminium in solar collectors and solar energy systems”.

Lars-Erik Owe

Røros seminar, NTNU board, Røros, Norway, January 25-27, 2009.

Pisa, Italy, January 28-30, 2009. WELTEM project meeting.

215th Meeting of the Electrochemical Society, San Francisco, USA, May 24-29, 2009. Lecture on: “The effect of anion adsorption on the oxygen evolution reaction on anodically formed iridium oxide”.

SNBL, European Synchrotron Radiation Facility (ESRF), Grenoble, France, June 8-14, 2009. Experiment 01-01-796.

Monteux, Switzerland, September 2-4, 2009. WELTEM project meeting.

4th Kyoto International Forum for Energy and 4th KIFEE Symposium on Environment, Energy, Materials and Education, Trondheim, Norway, September 6-9, 2009. Poster on: “The effect of the electrolyte on the oxygen evolution reaction on iridium oxide”.

Hydrogen and Fuel Cells in the Nordic Countries, Oslo, Norway, November 24-26, 2009. Poster on: “The effect of the electrolyte on the oxygen evolution reaction on iridium oxide”.

Hans Jørgen Roven

Hans Jørgen Roven acted as Head of the Strategic Area Materials at NTNU and vice-dean at the Faculty of Natural Science and Technology up to August 1st, 2009. He is professor in physical metallurgy and responsible for the severe plastic deformation (SPD) nanostructuring group at the DMSE.

Member of the www.nanospd.org promoting international research collaboration on bulk nanostructured materials and Head of FORMLAB, the forming, new forming technology and mechanical testing laboratories at the DMSE.

Member of the Norwegian Academy of Technological Sciences (NTVA) and Member of the Royal Norwegian Society of Sciences and Letters (DKNVS).

Officially appointed Guest professor to the Shanghai Jiao Tong University, China, May, 2007 - May, 2010.

Peer-reviewer to the Engineering and Physical Sciences Research Council (EPSRC), United Kingdom, Natural Sciences and Engineering Research Council (NSERC), Canada and Italian Research Council (CIVR/CINECA), Italy.

Referee for the journals: Materials Science and Engineering A, Metallurgical Transactions A, International Journal of Materials Research, Fatigue and Fracture of Engineering Materials and Structures, Acta Materialia,

Scripta Materialia, Journal of Chemical Compounds, Materials Forum and Computational Materials Science.

Scientific Committee member of La Metallurgica Italiana, the official journal of the Italian Metallurgical Association.

DnV annual meeting, Faculty of Natural Science and Technology, Trondheim, Norway, February 6, 2009. Talk: "Status and challenges materials".

Norwegian Research Council, Oslo, Norway, February 12, 2009. Dialog seminar talk: "Status and challenges".

TMS 2009 annual meeting, San Francisco, California, USA, February 16, 2009. Session chair for mechanical behavior of nanostructured materials (PM session): "Nanostructures by severe plastic deformation". Invited talk on: "Grain refinement and mechanical properties in nanostructured Al and Al-Mg alloys subjected to severe plastic deformation".

Department of Metallurgy and Materials, Colorado School of Mines, Golden, Colorado, USA, March 26, 2009. Invited guest lecture on: "Severe plastic deformation processing applied to light metals".

Organizing Internal Hydro-NTNU-SINTEF Strategy seminar on Aluminium Recycling, Kvilhaugen Gård, Trondheim, Norway, April 15-16, 2009.

PhD committee Linda Bäcke, KTH Royal Institute of Technology, Materials Science and Engineering, Stockholm, Sweden, April 20, 2009. Thesis title: "Modeling the microstructure evolution during hot deformation of microalloyed steels".

Hydro Day 2009, Lerchendam Gaard, Trondheim, Norway, April 24, 2009. Joint plenary presentation on: "Roadmap for future collaboration between NTNU-HYDRO-SINTEF".

EU FP7 project: "Observatory NANO", WP2 - Science and Technology Assessment Automotive and Aeronautics, Nanostructured Metals etc. (www.observatorynano.eu), May, 2009. Evaluation expert regarding the consultancy report.

PhD defence of Morten Karlsen (co-supervisor), NTNU, Trondheim, Norway, May 14, 2009. Thesis title: "EBSD based in-situ observations of polycrystalline materials in the SEM".

Co-supervisor and member of the evaluation committee for the PhD thesis and defence of Zhipeng Zeng, KTH Royal

Institute of Technology, Stockholm, Sweden, June 4, 2009. Thesis title: "Deformation behaviour, microstructure and texture evolution of CP Ti deformed at elevated temperatures".

The new Aalto University in Helsinki, previously Helsinki University of Technology, University of Art and Design Helsinki and Helsinki School of Economics, Helsinki, Finland, June 7-12, 2009. Member official review panel 1.

International Workshop on Aluminium and Steel in a Changing Environment, Brekstad, Norway, June 17-19, 2009. Co-authored presentation on: "Characterization and treatment of aluminium dross".

Fudan University, The Nordic Center in Shanghai, Shanghai Jiao Tong University and Chongqing University, China, June 22-26, 2009. Visit. Part of official NTNU delegation to China.

Indian Institute of Science, Division of Mechanical Sciences, Bangalore, India, July - August, 2009. Professor position review committee.

School of Materials Science and Engineering, Shanghai Jiao Tong University, Shanghai, China, fall 2009. Member scientific evaluation panel.

International Symposium on Liquid Metal Processing and Casting, Santa Fe, New Mexico, USA, September 20-23, 2009. Co-authored poster presentation on: "New approaches for recycling of aluminum scraps".

2nd International Symposium on Bulk Nanostructured Materials - from Fundamentals to Innovations, Ufa, Russia, September 22-26, 2009. Co-authored presentation on: "Microstructural evolution of commercial pure Ti fabricated by equal channel angular pressing (ECAP)".

Shanghai Jiao Tong University, Shanghai, China, September 24 - November 1, 2009. Visiting professor.

Materials Forum (talk # 2009-25), Shanghai Jiao Tong University, Shanghai Jiao Tong University, Shanghai, China, October 9, 2009. Invited guest lecture on: "Rapid solidification of light alloys - some insights, challenges and opportunities".

3rd Chinese-Norwegian Symposium on Light Metals (CNS2009), Shanghai Jiao Tong University, Shanghai, China, 19-23 October, 2009. Symposium chair and organizer. Plenum lecture on: "Future directions in

aluminium alloy research and technological development”, co-authored presentations on: “Microstructural development during severe plastic deformation of commercially pure titanium” and “Recycling of aluminium scraps”.

Shanghai Jiao Tong University, Shanghai, China, October 27, 2009. Invited guest lecture to SJTU graduate students on: “In-situ EBSD, dynamic strain aging and multi-scale strain measurements applied to aluminium alloys”.

Fudan University and Shanghai Jiao Tong University, Shanghai, China, October 29-30, 2009. NTNU delegation.

Marche Polytechnic University, Department of Mechanics, Ancona, Italy, November 8-27, 2009. Visiting professor.

University of Bologna, Bologna, Italy, November 26, 2009. Invited guest lecture on: “Plastic deformation of aluminium alloys - and some related aspects”.

Constitution seminar: Forum for Nuclear Research in Norway, University of Oslo, Oslo, Norway, December 15, 2009. Joint presentation on: “NTNU Materials versus NukEF”.

Per Martin Rørvik

Oppdal Workshop on PV Materials, Oppdal, Norway, March 19-21, 2009.

4th NTNU NanoLab User Meeting, Trondheim, Norway, May 13, 2009. Lecture on: “Hierarchical growth of ferroelectric PbTiO₃ nanorods”.

NANOMAT Conference 2009, Lillehammer, Norway, June 16-17, 2009. Lecture on: “Hierarchical growth of ferroelectric PbTiO₃ nanorods”.

FME Kick off seminar, The Norwegian Research Centre for Solar Cell Technology, Trondheim, Norway, August 10-11, 2009.

4th KIFEE Symposium on Environment, Energy, Materials and Education, Trondheim, Norway, September 6-9, 2009.

24th European Photovoltaic Solar Energy Conference and Exhibition, Hamburg, Germany, September 21-25, 2009.

Researchers' Night 2009, NTNU, Trondheim, Norway, September 25, 2009. Demonstration of: “Svevetog basert på superledende keramer”.

Jafar Safarian-Dastjerdi

Oppdal Workshop on PV Materials, Oppdal, Norway, March 19-21, 2009.

3rd International Workshop on Science and Technology of Crystalline Silicon Solar Cells (CSSC3), Trondheim, Norway, June 3-5, 2009.

24th European Photovoltaic Solar Energy Conference and Exhibition, Hamburg, Germany, September 21-25, 2009.

Frode Seland

4th KIFEE Symposium on Environment, Energy, Materials and Education, Trondheim, Norway, September 6-9, 2009. Presentation on: “Dynamic electrochemical impedance measurements (dEIS) - Oxidation of small organic molecules”.

University of Victoria, Victoria, Canada, June 12 - July 3 and October 14-16, 2009. Study visits (mobility fellowship by NTNU).

ELCAT training course: Advanced instrumental and spectroscopic techniques applied to electrocatalysis, Bangor University, Bangor, United Kingdom, September 13-16, 2009. Participation.

Administrator of committee for PhD defence, Silje Rodahl, NTNU, Trondheim, Norway, April 21, 2009. Thesis title: “Adhesion of organic coatings on aluminium”.

Administrator of committee and deputy 2nd examiner for PhD defence, Odne Stokke Burheim, NTNU, Trondheim, Norway, October 26, 2009. Thesis title: “Thermal signature and thermal conductivities of PEM fuel cells”.

Esma Senel

Vth Aluminium Surface Science & Technology (ASST2009), Leiden, The Netherlands, May 10-14, 2009. Presentation on: “Effect of trace element surface segregation on tribological behaviour of pure aluminium”.

60th Annual Meeting of the International Society of Electrochemistry (ISE 60th), Beijing, China, August 16-21, 2009. Presentation on: “Segregation of trace element gallium in aluminium alloys”.

Electrochem09, Manchester, United Kingdom, September 16-17, 2009. Presentation on: “Effect of trace element gallium on electrochemical behaviour of aluminium”.

4th Aluminium Symposium, Istanbul, Turkey, October 15-16, 2009. Presentation on: "Effect of trace element gallium on corrosion properties of aluminium".

Jan Ketil Solberg

"Nanostructured hydrides of aluminium and magnesium for hydrogen storage" (IFE, NTNU), IFE, Kjeller, Norway, January 20, 2009. Project meeting.

PETROMAKS BIP project: "Pulsed plasma surface treatment for wear and corrosion protection of superalloys and stainless steel valves, pumps and pipes" (MOTech Plasma, NTNU), NTNU, Trondheim, Norway, March 3, April 28, July 9, August 26 and December 8, 2009. Project meetings.

RENERGI BIP project: "An integrated process for hydrogen production and separation" (Statoil, IFE, SINTEF, NTNU), Statoil, Trondheim, Norway, April 24, June 23 and October 20, 2009, and at IFE, Kjeller, Norway, July 6, 2009. Project meetings.

SUP project: "Materials and structural integrity" (Statoil, NTNU), NTNU, Trondheim, Norway, December 4, 2009. Project meeting.

European Synchrotron Radiation Facility (ESRF), Grenoble, France, December 9-12, 2009. Experiments at the Swiss-Norwegian beamline for the BIP project: "An integrated process for hydrogen production and separation" (Statoil, IFE, SINTEF, NTNU).

Juan Tan

SALSA Group Meeting, Trondheim, Norway, April 1, 2009. Lecture on: "Effect of tin on anodic activation of binary model AlSn1000 alloy".

Vth Aluminium Surface Science & Technology (ASST2009), Leiden, The Netherlands, May 10-14, 2009. Poster on: "Effect of trace element tin on anodic activation of aluminium".

SALSA Group Meeting, Trondheim, Norway, June 3, 2009. Lecture on: "Effect of tin on anodic activation of binary model AlSn20 alloy".

The 60th Annual Meeting of the International Society of Electrochemistry (ISE 60th), Beijing, China, August 16-21, 2009. Lecture on: "Passivity breakdown of aluminium alloys by trace element tin".

SALSA Group Meeting, Trondheim, Norway, August 25, 2009. Lecture on: "XPS results of AlSn1000 alloy".

Electrochem09, Manchester, United Kingdom, September 16-17, 2009. Lecture on: "Role of trace element tin on the activation of aluminium".

216th Electrochemical Society Conference (ECS 216), Vienna, Austria, October 4-9, 2009. Lecture on: "Nitride formation on aluminium-tin alloy by heat treatment in air".

3rd Chinese-Norwegian Symposium on Light Metals (CNS2009), Shanghai Jiao Tong University, Shanghai, China, October 19-22, 2009. Lecture on: "Effect of trace element tin on anodic activation of aluminium".

SALSA Group Meeting, Trondheim, Norway, November 26, 2009. Lecture on: "Electrochemical behaviors of AlSn1000 alloy under different treatment conditions".

Shuihua Tang

3rd International Workshop on Science and Technology of Crystalline Silicon Solar Cells (CSSC3), Trondheim, Norway, June 3-5, 2009. Presentation on: "Electrorefining of metallurgical silicon in molten chloride and fluoride electrolytes".

60th Annual Meeting of the International Society of Electrochemistry (ISE 60th), Beijing, China, August 16-21, 2009. Presentation on: "Electrodeposition of solar grade silicon in molten salts".

2009 MSDG Meeting, London, United Kingdom, December 14, 2009. Poster on: "Electrorefining of silicon in molten salts".

Jomar Thonstad

Slovak Technical University, Bratislava, Slovakia, March 19-20 and September 24-25, 2009. Project meetings.

Technical University, Berlin, Germany, June 8-9, 2009. Publication meeting.

AGH-University of Science and Technology, Krakow, Poland, December 8-9, 2009. Project meeting.

Reidar Tunold

60th Annual Meeting of the International Society of Electrochemistry (ISE 60th), Beijing, China, August 16-21, 2009. Presentation on: "The anode process on carbon in chloride - oxide melts".

4th KIFEE Symposium on Environment, Energy, Materials and Education, Trondheim, Norway, September 6-9, 2009. Presentation on: "The anode process in chloride - oxide melts".

216th Electrochemical Society Conference (ECS 216), Vienna, Austria, October 4-9, 2009. Presentation on: "Materials for electrocatalysis of oxygen evolution in PEM water electrolysis".

Kjell Wiik

Sabbatical, August 1, 2008-July 31, 2009: Fuel Cells and Solid State Chemistry Division (ABF), Risø National Laboratory for Sustainable Energy, Risø DTU, Denmark, October 15, 2008 - January 31, 2009 and Membrane Technology Group, Inorganic Membranes, University of Twente, Science and Technology, Enschede, The Netherlands, March 1 - May 31, 2009.

Department of Materials Science and Engineering, NTNU, Trondheim, Norway, May 15, 2009. PhD defence Ove Bjørn Paulsen, committee administrator. Thesis title: "Rigid bonded glass ceramic seals for high temperature membrane reactors and solid oxide fuel cells".

Membrane Technology Group, University of Twente, Science and Technology, Enschede, The Netherlands, May 29, 2009. Lecture on: "Production and characterisation of conducting oxides".

The European Ceramic Society Council Meeting, Conference Center, Auditorium Maximum, Krakow, Poland, June 21, 2009.

COST-539, Electroceramics from Nanopowders Produced by Innovative Methods, (ELENA), management committee meeting, UGH University of Science and Technology, Krakow, Poland, June 22, 2009.

4th KIFEE Symposium on Environment, Energy, Materials and Education, Trondheim, Norway, September 6-9, 2009. Participant.

Researchers' Night 2009, NTNU, Trondheim, Norway, September 25, 2009. Poster/stand on: "Svevetog basert på superledende keramer".

COST-539, Electroceramics from Nanopowders Produced by Innovative Methods, (ELENA), Final workshop, Department of Mechanical Engineering, University of Aveiro, Aveiro, Portugal, October 28-30, 2009. Lecture on: "Processing of La₂NiO₄-powder produced by spray pyrolysis".

Gunn Torill Wikdahl

BRUKER, Topas Course, Trondheim, Norway, April 14-17, 2009.

Researchers' Night 2009, NTNU, Trondheim, Norway, September 25, 2009.

Konstruktiv konflikthåndtering, NTNU, Trondheim, Norway, November 17-18, 2009.

Terje Østvold

Project and board meetings related to "Sand Stabilisation and Water Proofing of Tunnels". This project is operated by the spin-off company Impermeable AS where Terje Østvold is the manager. Radcon Scandinavia, Oslo, Norway, January 23, March 27, April 25, October 23 and December 28, 2009. Project meetings.

Project meeting with Det Norske Oljeselskap on scale prediction for the Frøy field, Trondheim, Norway, February 5, 2009, and for Draupne, Frøy and the Hanz fields, December 10, 2009.

Statoil Rotvoll, Trondheim, Norway, February 18, 2009. Presentation on: "Scale under turbulent flow".

University of Bergen, Bergen, Norway, March 10-13, 2009. PhD defence, opponent.

20th International Oil Field Chemistry Symposium, Geilo, Norway, March 22-25, 2009. Member of committee and session chairman. Presentation on: "Kinetics of CaCO₃ scale formation during core flooding".

International MultiScale courses: RWE Dea AG, GeoSupportCenter, Labor Wietze/Wietze E&P Laboratory, Wietze, Germany, April 29, 2009 and Clariant Scandinavia, Bergen, Norway, August 31 - September 1, 2009.

Project meetings with Det Norske Oljeselskap, WeST group and DuPont on steel surfacetreatment to avoid scale formation, Trondheim, Norway, April 30, May 20 and November 11, 2009.

Statoil Rotvoll, Trondheim, Norway, May 4, 2009. Presentation on: "Sand stabilization".

Project meetings with Statoil on sand stabilization, Stjørdal, Norway, May 4, August 17 and September 14, 2009.

International School of Crystallization, Granada, Spain, May 25-29, 2009. Presentation on: "CaCO₃ scale formation: Visual observations in 2D model pore networks and precipitation kinetics during core flooding". Award for the

best poster presentation from "Laboratorio de Estudios Cristalograficos".

Project meetings with Statoil and SINTEF Petroleum Research, on the understanding of scale formation under turbulent flow conditions, Stjørdal, Norway, May 4 and Bergen, Norway, October 6, 2009.

ICE-HT, FORTH Patras, Greece, May 23 - June 21, 2009. Study visit.

Scale Applied Technology Workshop, Barcelona, Spain, June 22-26, 2009. Presentations on: "How to use MultiScale in prediction of mineral precipitation during oil and gas recovery. What is the main importance of a scale study?" and "Prediction of productivity loss in near well bore area due to CaCO₃ formation".

Cooperation with SINTEF Petroleum Research, project meetings and reporting on running projects, a series of meetings during the year at Statoil, Rotvoll and Stjørdal, Norway.

Statoil, Bergen, Norway, August 17, 2009. Presentation on: "Sand stabilization".

Project meeting with M-I SWACO on sand stabilization, Dynea, Lillestrøm, Norway, August 28, 2009.

BP/University of Leeds/Exprogroup, London, United Kingdom, October 14-15, 2009. Study visit and consulting. Presentation on: "Kinetics of CaCO₃ precipitation".

Terje Østvold is a member of the TEKNA Oil field chemistry symposium board. Meetings in Oslo, Norway, October 28, 2009.

Project meetings with Statoil on CO₂ capture. Several meetings at NTNU and the Statoil Research Centre at Rotvoll, Trondheim, Norway.

Project meeting with PTT Research and Technology Institute, PTT Public Company Limited, Thailand and SINTEF Materials and Chemistry, November 30, 2009.

Annual Report 2009



NTNU – Innovation and Creativity

The Norwegian University of Science and Technology (NTNU) in Trondheim represents academic eminence in technology and the natural sciences as well as in other academic disciplines ranging from the social sciences, the arts, medicine, architecture to fine arts. Cross-disciplinary cooperation results in ideas no one else has thought of, and creative solutions that change our daily lives.

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