First European Nanofabrication Research Infrastructure Symposium, ENRIS, 8-10.05.2017

The Nordic Nanolab User Meeting, NNUM17, was held on the 10th of May 2017. The meeting was organized by the Nordic Nanolab Network and hosted by NTNU NanoLab. The aim of the symposium was to feature nanorelated research at the Norwegian University of Science and Technology (NTNU) in the field of nanostructuring and characterization. These meetings address experimental issues through symposia, workshops, and poster sessions, focusing on research, education, and networking.

The objective of the symposium was to feature nanorelated research at the Norwegian University of Science and Technology (NTNU) in the field of nanostructuring and characterization. These meetings address experimental issues through symposia, workshops, and poster sessions, focusing on research, education, and networking. The aim of NNUM is to offer a meeting place for PhD-students, post docs, researchers and engineers working in the field of nanostructures and characterization in Europe. Both students and industry representatives were given the opportunity to present their expertise, and hold discussions on their work at the symposium.

The symposium was organized by NTNU NanoLab and NorTEM. Altogether 263 people attended NNUM2017, which was supported by the Research Council of Norway.

The following day, Thursday 11th of May, the Nordic Centre of Competence in Novel Nanomaterials (Nano@NTNU) held their 3rd Annual Meeting. The Nordic Centre of Competence in Novel Nanomaterials (Nano@NTNU) is a national multidisciplinary research and education network of university and public institutions in Norway, established by the Research Council of Norway and managed by NTNU NanoLab. The network aims to develop and disseminate knowledge about novel nanomaterials and their applications, and to promote collaboration between researchers and industry.

The annual meeting is a platform for networking and knowledge sharing, and serves as a venue for presenting and discussing current research activities within the network. The meeting includes plenary talks, poster sessions, and workshops on various topics related to novel nanomaterials and their applications. Students and professionals from both academic and industrial sectors are invited to participate and present their work.

In 2017, the meeting featured over 100 participants from universities and companies across Norway, representing fields such as physics, chemistry, materials science, and engineering. The meeting also included a poster session, where researchers could showcase their work and engage in discussions with colleagues.

The conference concluded with a dinner at the Toyen Hotel, where attendees had the opportunity to network and socialize with other participants. The event was a success, with positive feedback from all attendees, and plans are already underway for the 2018 meeting. NTNU NanoLab and NorTEM look forward to continuing to support and promote research and education in the field of nanostructures and characterization, and to fostering collaborations between researchers and industry.

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Towards all-domain-wall nanoelectronics

Scale criteria exhibit a broad range of suitable dimensions beyond the bulk regime, resulting in significantly different physical properties, i.e., changes in the critical current. The role of magnetic domain walls in future technologies, in particular, nanoelectronics, has been claimed and proven in great progress as on 1D systems in future nanoelectronics, the international, here, briefly, Prof. D. Meier at the Dept. of Materials Sciences and Engineering, has emulated the behavior of digital switches holding great promise as active 2D systems for future nanoelectronics. An international team, led by Assoc. Prof. A. de Wijn at the Dept. of Mechanical and Industrial Engineering has used atomistic molecular-dynamics simulations to study the effective layer thickness for obtaining N-CNFs with a high active site density and stability. The team used a combined approach that involves accurate ab initio and slab methods to study the interaction of hydrogen with different carbon nanostructures. The results provide insights into the mechanism of hydrogen interaction with carbon nanomaterials, which is crucial for understanding the role of hydrogen in catalytic reactions. The findings also have implications for the design of efficient hydrogen storage materials and catalytic systems for hydrogen fuel cells.
Towards all-domain-wall nanoelectronics

Scale:快樂 mouth below at the bottom of the body. It is surrounded by various teeth, including incisors, canines, premolars, and molars. The structure of the mouth is also influenced by the surrounding muscles and ligaments. The mouth is a part of the digestive system, and is primarily responsible for the intake and processing of food. It is lined with mucous membranes, which secrete saliva to aid in digestion. The oral cavity is the primary site of primary impaction of food and is involved in the secondary impaction of food. The mouth is also responsible for speaking and singing, and is connected to the nasal cavity through the nose. It is a common area for infections and diseases, such as periodontal disease, and can be affected by various conditions, such as cold sores and mouth ulcers.

Nanoscale microbubbles for cancer treatment

Tumor treatment with chemotherapy is hindered by inadequate delivery to the cancer and severe side effects due to the toxic nature of the drugs used. Nanoparticle delivery offers an alternative to overcome these challenges. Nanoparticle delivery systems are nanoscale systems that can target specific sites in the body. They are composed of a drug or drug carrier and a targeting moiety, which is attached to the nanoparticle. Nanoparticle delivery systems are used to deliver drugs to tumors, and are designed to enhance the therapeutic effect of the drug.

How square ice helps lubrication

Graphene growth on PTF

Critical dimensional metrology of a plasmonic photonic crystal based on Mueller Matrix Ellipsometry and the reduced by Rayleigh light

Advanced characterization methods in investigating tribological systems

Nanotribology is an interdisciplinary field that combines the study of nanomechanics, nanoscale friction, and lubrication with the use of advanced characterization techniques. It is used to investigate the mechanical properties of materials at the nanoscale and to develop new lubricants and tribological systems. The field is important for developing new materials and technologies for applications in various fields, such as electronics, energy, and healthcare.

In situ electrochemical microcantilever bending test: A new insight into hydrogen-enhanced cracking

Hydrogen-induced degradation of steels has been a serious problem in different industrial fields, including the petroleum and natural gas industries. Hydrogen-enriched environments can cause cracking, which can lead to the failure of steel components. In this problem, we have investigated the behavior of hydrogen in steel and the mechanisms of hydrogen-induced cracking. This research has been supported by the National Science Foundation (NSF) and the National Institute of Standards and Technology (NIST).

Nitrogen-doped carbon nanofibers for the oxygen reduction reaction: Importance of iron growth catalysis phase

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Nitrogen-doped carbon nanofibers for the oxygen reduction reaction: Importance of iron growth catalyst phase
The image shows SU-8 nano pillars exposed using Elionix EBL system. Photo: Jakob Vinje/NTNU NanoLab.

The Norwegian Micro- and Nanofabrication Network (NorFab) has grown to represent more than a thousand Nordic and European partners, we arranged Europe’s first major international nanofabrication workshop. The workshops had 15-20 participants from 19 countries. Altogether, 263 people attended this meeting organized by the Nordic Nanolab Initiative, NTNU Nano. John will be joining us from Imperial College London. Mello will be joining NTNU as an adjunct position in the Department of Chemistry here.

In 2017, the Network offered six PhD courses on advanced nanofabrication techniques. The focus was on etching, lithography and facility operation issues. The workshops had 15-20 participants from 19 countries. Altogether, 263 people attended this meeting organized by the Nordic Nanolab Initiative, NTNU Nano. John will be joining us from Imperial College London. Mello will be joining NTNU as an adjunct position in the Department of Chemistry here.

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Nanoparticle-microbubbles for cancer treatment

Cancer treatment with ultrasound is limited by inadequate delivery to the tumor and severe side effects, due to restricted acoustic windows and the presence of surrounding critical organs. New strategies for drug delivery are therefore needed to exploit the potential benefit of focused ultrasound.

Towards all-domain-wall nanoelectronics

Scale scalars exhibit a broad range of ideal behavior above the bulk gap, including single-electron transistors, spin Hall effect transistors, and quantum Hall effect transistors. These structures are formed in the nanoscale regime where orbital quantization and zero-dimensional physics are relevant, enabling high performance in low-power devices. The present work is a theoretical study of domain-wall states in ideal nanoelectronics using an algebraic spin-orbit model that incorporates all domain-wall states above the bulk gap. The results reveal a regime of spin Hall conductance for which the spin Hall conductance is protected by topological invariants.

How square ice helps lubrication

Hydrogen-induced degradation of metals has been a severe problem in different industrial fields including the performance and reliability of actuators. Micro and meso-scale 3D printed devices are becoming more and more essential for the design of actuators, sensors, and tribological components which are integrated into functional systems. Therefore, tribological lubrication has become an important research area which is considered in many applications. This work focuses on the importance of iron growth catalyst phase. A team led by Prof. N. Espallargas at the Dept. of Mechanical and Industrial Engineering has used atomistic molecular dynamics and a tribological experiment to investigate wear, surface and friction properties of iron powders.

In situ electrochemical microcantilever bending test: A new insight into hydrogen-enhanced cracking

Carbon and oxygen in the N-CNFs were grown from Hägg carbide, Prateek et al., 2013. What was that particular parameter that...
The Nordic NanoLab User Meeting, NNUM2017, 9-10.05.2017

The Nordic NanoLab User Meeting, NNUM2017, brought together 263 participants from universities, research institutions, and companies from Norway, Sweden, and Finland. The meeting was organized by the Nordic Nanolab Network (NNN) and constituted the third user meeting on a Nordic level.

**Technical Tutorials**

Technical tutorials covering the central disciplines of nanofabrication: etching techniques, thin film technologies, and materials and methods reporting. 15 seminars, with 40 speakers from different organizations, were held.

**Symposium**

Symposium, 07.02.2017.

Nordic NanoLab User Meeting, NNUM2017, 9-10.05.2017

The meeting began with an organ concert in the Nidaros Cathedral, hosted by Trondheim University. The concert was followed by an opening speech from Olav Bolland, dean of the Faculty of Engineering, NTNU, Trondheim. The meeting included a poster session with oral presentations and best poster awards. The best oral presentation was awarded to Dingding Ren (University of Oslo), and the best poster award was given to Yun Deng (University of Oslo) with co-authors Dingding Ren and Svenn Ove Linde.

**Keynote Speakers**

Keynote speakers included Prof. De Chen, director of the Institute of Advanced Materials, Zhejiang University, and Prof. Anne Borg, dean of the Faculty of Natural Sciences, NTNU, Trondheim.

**Nordic NanoLab**

NTNU NanoLab, which is part of the Nordic NanoLab Network, is the largest nanofabrication facility in the Nordic region. The lab is equipped with state-of-the-art nanofabrication equipment, including a plasma cleaner, a lift system, and a sample transfer module.

**User Statistics**

In 2017, there were 336 active users of NTNU NanoLab, with an excess of 25,000 hours booked throughout the year. This represents an increase of 15% from the previous year, with a particular emphasis on the dry etch systems. The lab has also seen an increase in the number of new users, with 156 new users in 2017 compared to 130 in 2016.

**New Equipment**

In 2017, NTNU NanoLab invested in new equipment, including an industrial grade dicing saw, which replaced the old saw and resulted in lower levels of particle contamination. The lab also received a highly requested Kammrath & Weiss sample transfer module for moving samples between the cleanroom and the facilities. The Kammrath & Weiss module is capable of depositing conformal, pinhole-free and uniform films with atomic precision.

**User Hours**

The number of user hours in 2017 was 20,000, with 5,000 hours booked in 2016. The distribution of user hours by category is as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>User Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>30%</td>
</tr>
<tr>
<td>External users</td>
<td>35%</td>
</tr>
<tr>
<td>International users</td>
<td>20%</td>
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<tr>
<td>Research groups</td>
<td>5%</td>
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<tr>
<td>Industry</td>
<td>5%</td>
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</table>

**Next Steps**

In 2018, NTNU NanoLab plans to expand the cleanroom area by 200 m², with the aim of providing more space for users. The lab will also focus on improving the thin-film development and increasing the number of collaborative projects with industry. The lab will continue to invest in new equipment and training programs to meet the needs of users.

**Management**

Dr. Hanna Gautun, Coordinator
Dr. Kay Gastinger, Director

**Board of Nano@NTNU**

- Prof. Dr. Ingrid Hallsteinsen, director of the Faculty of Natural Sciences, NTNU
- Prof. Dr. Håvard Rognmo, head of NorTEM
- Prof. Dr. De Chen, director of the Institute of Advanced Materials, Zhejiang University
- Prof. Dr. Anne Borg, dean of the Faculty of Natural Sciences, NTNU
- Prof. Dr. Olav Indrebø, dean of the Faculty of Engineering, NTNU
- Prof. Dr. Svenn Ove Linde, head of NTNU NanoLab
- Prof. Dr. Thomas Flaten, director of the University of Oslo's Centre for Multidisciplinary Studies in Nanoscience and Nanotechnology

**Disseminations**

The following candidates obtained a PhD degree at NTNU in fields related to nanoscience, nanotechnology and other areas:

1. Jonas Myren Ribe, Biochemistry and Biotechnology, Department of Chemistry, NTNU
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First European Nanofabrication Research Infrastructure Symposium, ENRIS, 8-9.05.2017. The first European community of nanofabrication researchers came together at ENRIS in Trondheim. The event took place at NTNU Campus Kalvskinnet in Trondheim and gathered 123 participants. The symposium was organized by the Nordic Nanolab Network (NNN) and constituted the third user meeting on a Nordic level.

The objective of the symposium was to feature nanorelated research at the crossroads of disciplines, technologies and industries. The scientific program consisted of presentations of nanofabrication and characterization research at NTNU, the University of Oslo and KTH, as well as reports of the work of the Nano3 Partnership and the ENRIS2017. In addition, the symposium featured presentations of interesting work from around the world, poster presentations and three invited speakers.

The annual Grey Goo Symposium is a meeting place for companies and students enrolled in the master program Grey Goo Management. The Grey Goo Management program at NTNU was launched in the fall of 2014 and focuses on the practical and ethical aspects of developing autonomous systems.

The anniversary of the symposium was celebrated with a half-day symposium on nanoscale research at the crossroads of chemicals and electronics. The symposium was organized by the Nordic Nanolab Network (NNN) and constituted the third user meeting on a Nordic level.
The Nordic Nanolab User Meeting, NNUM2017 took place on 9-10 May 2017 in Trondheim. The meeting is organized by the Nordic Nanolab consortium, which includes institutions from six countries: The University of Oslo, NTNU, Chalmers University of Technology, KTH, Linköping University, and Aalto University. The objective of the symposium was to feature nanorelated research at the Nordic Nanolab User Meeting, NNUM2017. The meeting included a poster session, for the first time, a social dinner, and informal discussions during the breaks. Around 100 students from NTNU and six guest students from Denmark gathered to present their own research and to participate in the symposium. The meeting also included a poster session exhibiting 23 posters. The winners of this year's prizes for the best oral presentation and the best poster were Dingding Ren (best oral presentation) and Yun Deng (best poster). The symposium also included a social dinner. The Nordic Nanolab consortium is a network of research infrastructures and 13 companies, from 20 countries, participated at the meeting. ENRIS 2017 was organized by the association of the nanotechnology students, and was sponsored by Nano@NTNU.

Looking forward to 2018, we will hire two additional engineers who will focus on thin film, dry etch and passivation materials for a membrane contactor. An industrial grade dicing saw has been installed to replace our old saw, resulting in lower levels of particle inclusion in the fab. A highly requested Kammrath & Weiss sample transfer module is now available to move samples between the gloveboxes of our nanostructures cleanroom. Our engineers also brought the thin-film and dry-etch instruments back into operation, following a tough period of instrument maintenance due to the chip crisis of late 2016. This means new processes are back and being tested. gloveboxes are open 24/7 and we have added a glovebox to the FIB in an inert atmosphere.

The Nord NanoLab User Meeting, NNUM2017 started after lunch in the same venue as ENRIS. The meeting included a poster session. For the first time, a social dinner was included. The symposium also included a social dinner. Around 100 students from NTNU and six guest students from Denmark gathered to present their own research and to participate in the symposium. The meeting also included a poster session exhibiting 23 posters. The winners of this year's prizes for the best oral presentation and the best poster were Dingding Ren (best oral presentation) and Yun Deng (best poster). The symposium also included a social dinner. The Nordic Nanolab consortium is a network of research infrastructures and 13 companies, from 20 countries, participated at the meeting. ENRIS 2017 was organized by the association of the nanotechnology students, and was sponsored by Nano@NTNU.

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