A Best Practice Report

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Trondheim/ Norway

NANO@NTNU - strategic initiative on nanotechnology, nanoscience and functional materials

- Norway’s largest University (40,000 students)
- About 80 professors with nano-related activities
- Annually about 200 papers within Nanotechnology (2015)
- Study program with 35 MSc students / year in Nanotechnology
- State of the art cleanroom (700m², ISO 7-5) opened in 2009
  - Nanostructuring, -synthesis, and -characterisation
- Strong competence in nanoscience, -technology and functional materials
  - Nanomaterials, Nanophysics and Bionanotechnology/Nanomedicine
European Research infrastructure landscape
The Nordic Nanolab Network Collaboration

- Collaboration on the management level started 2010
- Initiated by the RI’s themselves
- Motivated and driven by synergies
- No separate funding
- Prioritized activity of the national research infrastructures
- Circulating responsibilities – rotating network leadership
Nordic National Research Infrastructures

- Open access for all users at same conditions (almost same prices)
- Providing SOA equipment for internationally top level research
- Constitute a direct link between applied university research and industrial applications
- 2 distributed and 2 centralised infrastructures
- Different funding models
Nordic NanoLab Network (NNN)

Cooperation of the national cleanroom infrastructures in the Nordic countries

- on the management level
- on the expert level
- on the user level

Key numbers (2014):
- Open access to 10 cleanrooms in 4 national infrastructures serve over 2,000 users
- >1500 tools for micro- and nanofabrication in over 10,000m² cleanroom area
- Almost 300,000 user hours
Management Group

• Experience exchange
  – Synergies from similar organisations and missions
  – Funding application strategies
  – Cleanroom administration
  – Pricing and financing policies
  – Common booking system (not at all nodes)

• Political instruments on a Nordic level
• International cooperation (i.e. EU-initiatives)
• Coordination on high-end equipment investments

• Typically two meetings/year, lunch-lunch
Nordic User Meetings

• Two common user meetings Myfab/NorFab in Sweden 2013 and 2015
  – About 250 participants each
  – 20 tutorials on cleanroom-related techniques
  – 4 invited presentations
  – Networking
  – Exhibition

• Towards the first All-Nordic Meeting in Trondheim, Norway in 2017
The Nordic Nanolab Expert Network (NNEN)

- Competence and experience exchange
- 5 topical groups:
  - Dry etch
  - Thin film
  - Lithography
  - Characterisation for cleanroom processing
  - Facility operation

- Open for all cleanroom infrastructures in Nordic countries (about 20 labs)
- 1 – 2 meetings per year and web-discussion forum, typically 20 – 25 participants
- Typically 1 – 3 experts per topical area per lab
- NNEN contributes to the User Meetings by arranging tutorials etc.
What do you need?

• Some open-minded and engaged people
• Information-sharing spirit
• Some funding (no EU-money involved so far)
• Operational national infrastructure system
Challenges

• Competition between labs on the European level (Horizon2020)
• No long-term funding scheme established (but we improve)
• Myfab and NorFab are not a “legal body”
• Equipment coordination is challenging
Why bother?

• Learn from experiences in different countries:
  – Financing models
  – Cleanroom running
  – (Re-) Investment strategies
  – Cleanroom Management software

• Cost- and resource efficient, and quality improved user meetings
• Credit from the national research councils
• Instrument backup in down time
• Access to single process steps at other labs
• Larger “critical mass” both politically and scientifically
What’s next?

• Try to get funding from the Nordic Council of Ministers/ NordForsk for Nordic user meetings
• Web-forum for users?
• Extension/connection towards Europe - EuroNanoLab
• Initiating stronger scientific cooperation between the nodes
• Common process database in the LIMS system
• Exchange of engineers/management staff
The Nordic Nanolab Network
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Brief Presentations of the four Nordic National Research Infrastructures

• NorFab, Norway
• Myfab, Sweden
• DTU Danchip/CeN, Denmark
• Micronova, Finland
NorFab Norway
Norwegian Micro- and Nanofabrication Facility

Mission:

- **Open access** for high-level academic and industrial research (infrastructure and meeting places)
- Coordination of **complementary equipment** investments
- **Project support** for research projects without sufficient funding
- **Transfer of competence** between nodes and the micro/nano community in Norway

Key numbers (2014):

- 22 engineers
- 468 users
- About 250 tools in 2300m² cleanroom area
- 41 local companies
- 46476 user hours

www.norfab.no

Norway

- NTNU NanoLab
  - Nanostructuring and -characterisation
- UiO MiNaLab
  - Thin-film processing
- SINTEF MiNaLab
  - Si-batch processing
- MST-lab
  - Packaging and interconnectivity

[Image of a cleanroom setting with individuals in protective gear]
Norwegian Micro- and Nanofabrication Facility

3 nodes – 4 partners
- Founded 2010
- 2M€ from RCN/year

Key numbers (2014):
- 22 engineers
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- 46476 user hours

www.norfab.no
Norwegian Micro- and Nanofabrication Facility

- **Distributed national infrastructure** - 4 largest research cleanrooms at 3 nodes
- **Open access** for high-level academic and industrial research (infrastructure and meeting places)
- Coordination of **complementary equipment** investments
- **Project support** for research projects without sufficient funding
- **Transfer of competence** between nodes and the micro/nano community in Norway
- Common cost plan, price policy and investment plan
- Yearly match-making seminars with Norwegian industry
- myfab LIMS - booking system
Norwegian Micro- and Nanofabrication Facility

- NTNU NanoLab: Nanomaterials, BioNano/NanoMedicine, NanoPhysics,
- UiO MiNaLab: Semiconductor physics, Ion beam modification and analysis, electronic devices,
- SINTEF MiNaLab: Diffractive gratings, microfluidics, MEMS/MOEMS, Radiation detectors
- MST-lab UC Vestfold and Buskerud: Packaging/Molding Electroplatening, wafer bonding
Myfab Sweden

Realize your nano vision
Myfab – the Swedish Research Infrastructure for micro- and nanotechnology

Mission:
• Distributed infrastructure offering clean-room facilities and expertise support
• Advanced research and education in academia and industries
• Researchers and product developers
• Myfab LIMS common booking system

Key numbers (2014):
• staff 65 (1 in 3 with a PhD)
• about 800 tools in 5400 m² cleanroom area
• 850 users, 175 000 hours
• 100 companies/institutes
• 81% academic 19% comm.

Mission:
• Distributed infrastructure offering clean-room facilities and expertise support
• Advanced research and education in academia and industries
• Researchers and product developers
• Myfab LIMS common booking system
Myfab – The Swedish Research Infrastructure for micro- and nanotechnology

- User-fee based open access to academy and commercial users + access program for new users
- Subsidized academic user fees
- Education, process support and process service
- State-of-the-art tools – total tool investm. about 180 M€
- Myfab LIMS in-house developed for efficient operation – used by several other national RIs = partners
- Typically 50 PhD exams/y,
- About 20 spin-outs per 5y

myfab.se
This is Myfab

Myfab – the Swedish research infrastructure for micro- and nanofabrication

- Distributed infrastructure
- Clean-room facilities and expertise support
- Best equipment in Sweden
- Advanced research and education
- Researchers and product developers
- Universities and high tech industries
- Common booking system

Thomas Swahn
Director Myfab
Chalmers, Gothenburg
MYFAB – SWEDEN’S OPEN-ACCESS NANOTECHNOLOGY RESEARCH INFRASTRUCTURE

800 instruments, 850 active users, 100 companies/institutes.

65 highly trained support personnel, 1/3 with a PhD

5400 m² total cleanroom area

1.7 M€/y from the Swedish Research Council

Research: 81% Commercial: 19%
Myfab’s management

Thomas Swahn
Director Myfab
Chalmers, Gothenburg

Stefan Nygren
Manager MSL
Uppsala University
Uppsala

Ivan Maximov
Manager LNL
Lund University
Lund

Peter Modh
Manager NFL
Chalmers
Gothenburg

Nils Nordell
Manager Electrumlab
KTH Royal Inst. of Tech.
Stockholm
Myfab Laboratories

Nanofabrication Lab
Chalmers MC2
Gothenburg

Electrum Laboratory
KTH Royal Inst. of Tech.
Stockholm

Microstructure Lab
Ångström Laboratory
Uppsala University

Lund Nano Lab
Lund Univ.
Lund University

Outstanding Technologies

Microwave and Photonic process line
Nano and Quantum Technology process line

Si-technologies
Compound semiconductors
Nanomaterial synthesis

Life Science
Materials science and thin film technology
Ion Beam Technology

Nano imprint lithography
Epitaxy/nanowires, ALD and aerotaxy characterization
DTU Danchip/Cen
Overview and services

Jörg Hübner
Director DTU Danchip/Cen
Denmark
DTU Danchip/Cen –
The Danish Cleanroom infrastructure
Merged in 2014 with the Center for Electron Nanoscopy, CEN

Mission:

- To push the boundaries of micro/nanofabrication and electron beam based characterization.

- To provide Denmark with state-of-the-art infrastructure, technology and education within micro- and nanofabrication and electron beam based characterization.

- To enable Danish industry to exploit the existing and future benefits of nanotechnology and electron beam based characterization.

Founded 1992 (MIC) / 2003
• 7 M€/year operational costs

Key numbers (2016):
• staff 70 (incl. 5 PhD stud.)
• 11 state of the art electron microscopes (SEM/TEM)
• about 150 tools in 1350 m² cleanroom area
• >500 users
• 21 companies
• >45000 user hours

http://www.danchip.dtu.dk/english
DTU Danchip/Cen – The Danish Cleanroom infrastructure

Founded 1992 (MIC) / 2003
• 7 M€/year operational cost (full cost)

Key numbers (2016):
• staff 70 (incl. 5 PhD stud.)
• 11 state of the art electron microscopes (SEM/TEM)
• about 150 tools in
  1350 m² cleanroom area
• >500 users
• 21 companies
• >45000 user hours

http://www.danchip.dtu.dk/english
DTU Danchip/Cen – additional facts

Technology and characterization research
- 15 scientific staff, 5 PhD students doing research in processing technology and e-beam based characterization methods.

Danchip ISO 9001 certified

Contribute to university course curriculum
- With own BSc, MSc courses (electron microscopy), course assistance, summer schools, PhD courses etc.

Fully owned and fully financed by the Technical University of Denmark (DTU)

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- 7 M€/year operational costs

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- staff 70 (incl. 5 PhD stud.)
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- about 150 tools in 1350 m² cleanroom area

- >500 users
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http://www.danchip.dtu.dk/english
Micronova, Finland
Micronova – Finnish National Cleanroom Infrastructure

Mission:

- **develop innovative, enabling technologies**, and to apply these in practical micro- and nanosystems.
- **scientific collaboration** (EU-projects, nationally funded projects, academic-industry co-creation)
- offers **pilot and small-scale mass fabrication services** as well as facilities for companies: ISO 9001:2008 certification (fabrication, small-volume production and facility maintenance)
- acts as a **first-rate educational centre** for young researchers
- **MSc and doctoral programmes** with strong international participation

1 Cleanroom - 2 partners: VTT and Aalto University
- Founded 2002

Key numbers (2015):
- 15 engineers
- 300 users
- 350 tools
- 20 companies have own operators in the cleanroom
- 40,000 user hours

Finland

www.micronova.fi
1 Cleanroom - 2 partners: VTT and Aalto University
• Founded 2002

Key numbers (2015):
• 2600 m² cleanroom
• 15 engineers
• 300 users
• 350 tools
• 20 companies have own operators in the cleanroom
• 40000 user hours

www.micronova.fi
Micronova –
The Finnish National Cleanroom Infrastructure

- develop innovative, enabling technologies, and to apply these in practical micro- and nanosystems.
- node for scientific collaboration (EU-projects, Nationally funded projects, academic-industry co-creation)
- offers pilot and small-scale mass fabrication services as well as facilities for companies: ISO 9001:2008 certification for fabrication, small-volume production and facility maintenance
- acts as a first-rate educational centre for young researchers
- MSc and doctoral programmes with strong international participation
Micronova offering

- Contract R&D Process development
- EDUCATION MSc, PhD
- CLEANROOM Space & Tool usage
- IP Licensing and Tech. transfer
- VTT MEMSFAB Manufacturing Services

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