Our vision:
Regionally based and internationally competitive
University of South-Eastern Norway (USN) is the newest university in Norway, and with 18,000 students, USN becomes the fourth largest university in Norway. USN was established on the 4th of May 2018.

Vestfold Research Park

Department of Microsystems
This group started our research from year 2002
8 Campus in USN.

700 000 inhabitants in the region
18,000 students
1,500 employees
65 bachelor programmes
36 master programmes
9 phd programmes
8 campuses
Bø – Drammen – Kongsberg
Notodden – Porsgrunn
Rauland – Ringerike – Vestfold
MST-Lab at USN Campus Vestfold—
Systems, Packaging and interconnectivity

Main competence:
• Packaging of microelectronics
• Characterization SEM
• Sputter/Electroplating
• Chip/Wafer-bonding
• Flip-Chip interconnect
• BioMEMS
• Environmental testing

More than 30 active industry partners,
• Sensonor
• PoLight
• Projection Design - Barco
• Kongsberg NorSpace
• Kongsberg Maritime
• GE Vingmed Ultrasound
• SINTEF
• Jotun
• SensoCure
• Memscap
• CARDIACCS
• Sensocure
• Medistim
• Lærdal
• ++
USN Laboratory facilities

- 1100 m² MST lab in the Vestfold Research Park

Main facts:
Location: Campus Vestfold
Cleanroom Area: 500 m²
Ultrasound/Charact/Biotech Labs: 600 m²
Start: 2002 - New labs 2013
Type: R&D, Education, Industry projects.
130 high tech tools
Staff: 6 Lab Engineers.
14 professors / 4 asc professors

- Medical devices
- Aerospace/space
- Automotive
- Energy
- Climate/Environment
Microtechnology history in Horten
Department of Microsystems Offers (IMS- MST Lab)

Bachelor Programmes
• Computer Sciences
• Maritime Electro-automation
• Micro and Nano system technology / Electronics
• Product Design

Master Programmes
• Micro- and Nano System Technology
• Industry Master in Micro/ Nano System Technology
• Smart Systems Integration (Joint International Master, Erasmus +)

PhD Programme
• Applied Micro- and Nano Systems
SSI+ Erasmus Mundus Joint Master Degree

1st semester
• Heriot-Watt University
• Edinburgh, Scotland

2nd semester
• University of South-Eastern Norway
• Vestfold, Norway

3rd semester
• Budapest University of Technology and Economics
• Budapest, Hungary

4th semester: Master project
• Any of the partners, or external

~20 students, ~15 nationalities per cohort
First admission 2013, last admission 2020

4th partner from 2019: Aalto University, Helsinki, Finland
SSIs Erasmus Mundus Joint Master Degree
Smart Systems Integrated Solutions

1st semester
• Aalto University
• Helsinki, Finland

2nd semester
• University of South-Eastern Norway
• Vestfold, Norway

3rd semester
• Budapest University of Technology and Economics
• Budapest, Hungary

4th semester: Master project
• Any of the partners, or external

First admission 2021
PhD in Applied Micro and Nano Systems

The PhD-program focus on applied research within:

- Micro optics (MOEMS)
- Sensor technology
- Miniaturized Energy sources
- RF MEMS
- BioMEMS
- Fabrication, Integration and Packaging Technology

Approx 40 students enrolled in the program
MST-Lab is part of NorFab

125 tools in LIMS, booking system

2 new SEM
AFM
XRD
SAM
Sputtering systems
Metal evaporation
Plasma etc and cleaning
Wire bonders
Flip chip equipment
Environmental test
++

www.norfab.no
MST lab at USN
(1) Bosch etching with different mask pattern and parameters

<table>
<thead>
<tr>
<th>Items</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICP power</td>
<td>2500/1250W</td>
</tr>
<tr>
<td>HF power</td>
<td>0 W</td>
</tr>
<tr>
<td>Pressure</td>
<td>80 mT</td>
</tr>
<tr>
<td>C4F8</td>
<td>5 sccm</td>
</tr>
<tr>
<td>SF6</td>
<td>360 sccm</td>
</tr>
<tr>
<td>Table temperature</td>
<td>5 °C</td>
</tr>
<tr>
<td>Total cycle</td>
<td>100-400</td>
</tr>
</tbody>
</table>

**Photoresist**

S 1813 (positive)
Ma-P 1200 (positive)
2. The fabrication result

- **Nanowire forest**

- **Fabrication recipe**

<table>
<thead>
<tr>
<th>Items</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICP power</td>
<td>2500/1250 W</td>
</tr>
<tr>
<td>HF power</td>
<td>100/5/60/0 W</td>
</tr>
<tr>
<td>Pressure</td>
<td>20 mT in strike step</td>
</tr>
<tr>
<td></td>
<td>30 mT in deposition step</td>
</tr>
<tr>
<td></td>
<td>30 mT in breakthrough step</td>
</tr>
<tr>
<td></td>
<td>80 mT in etch step</td>
</tr>
<tr>
<td>Main deposition step</td>
<td>C4F8 – 60 sccm</td>
</tr>
<tr>
<td></td>
<td>SF6 – 5 sccm</td>
</tr>
<tr>
<td>Main breakthrough step</td>
<td>SF6 – 500 sccm</td>
</tr>
<tr>
<td></td>
<td>C4F8 – 5 sccm</td>
</tr>
<tr>
<td>Main etch step</td>
<td>SF6 – 500 sccm</td>
</tr>
<tr>
<td></td>
<td>C4F8 – 5 sccm</td>
</tr>
<tr>
<td>Table temperature</td>
<td>0 °C</td>
</tr>
<tr>
<td>Total cycle</td>
<td>80-160 loops</td>
</tr>
</tbody>
</table>
**USN MST-Lab**

Location: between Tønsberg and Horten, 106 km south of Oslo  
Cleanroom size: 400 m²

The MST-Lab is a flexible cleanroom facility for MEMS processes on silicon wafers and other substrates with emphasize on bonding, packaging and Micro-System-Technology. Therefore the laboratory also contains advanced tools for testing, dicing, pick and place, fine-pitch wire bonding and different flip chip methods. In addition, IMST has laboratories for material preparation and characterization, microsystem measurements (electrically and optically) and BioMEMS research like assembly, packaging and testing of lab-on-chip and microfluidic microsystems.

Website

**Technologies and equipment at USN MST-Lab**

<table>
<thead>
<tr>
<th>Thermal Processes</th>
<th>Thin Film Deposition</th>
<th>Lithography</th>
<th>Dry Etching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Cabinet (Heise)</td>
<td>Au sputter UG Microtech SC500</td>
<td>Furnace Hood 4 for General Solvents</td>
<td>DRIE Deep Etcher Plasma Cleaner PPS</td>
</tr>
<tr>
<td>Climate test chamber</td>
<td>Electroplating Ni</td>
<td>Furnace Hood 6 for corrosive chemicals</td>
<td></td>
</tr>
<tr>
<td>CNT-heater</td>
<td>Electroplating of Cu and Sn</td>
<td>Furnace Hood 7 – Cerostat</td>
<td></td>
</tr>
<tr>
<td>Grease heater</td>
<td>Flame Hood 9 – Au electroplating, Ti etch</td>
<td>Mask Aligner – Koken 65A8 (new)</td>
<td></td>
</tr>
<tr>
<td>High temperature furnace</td>
<td>Laminate film bench 4 Metal finger</td>
<td>Plasma Cleaner Advantech</td>
<td></td>
</tr>
<tr>
<td>oven Binder 850</td>
<td>Plasma Cleaner Advantech</td>
<td>Maskless etch</td>
<td></td>
</tr>
<tr>
<td>Ovation Oven Harmerbridge HTech furnace</td>
<td>Profeosher DENTAK 100</td>
<td>Rinse and dry STI Sputter</td>
<td></td>
</tr>
<tr>
<td>Peltier Chamber</td>
<td>Spitzer ASIA</td>
<td>Spinner 1 Sputter</td>
<td></td>
</tr>
<tr>
<td>Temp chamber Hauken Kened</td>
<td>Thermal Evaporator Mynfield MiniLab T25M</td>
<td>Spinner 2A As Plate Spin 150</td>
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<tr>
<td>Temp chamber Hauken Kened</td>
<td></td>
<td>Wet Etching AS Plate</td>
<td></td>
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<tr>
<td>Characterisation</td>
<td>Bonding and packaging</td>
<td>Chemical and biological methods</td>
<td>Sample preparation</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>----------------------------------------------------</td>
<td>----------------------------------------------------</td>
<td>---------------------------------------------------------</td>
</tr>
<tr>
<td>Acoustic material characterisation</td>
<td>Ball bonder – TPT HB100</td>
<td>Autoclave</td>
<td>Grinding Struers Knuth rotor</td>
</tr>
<tr>
<td>Acoustic Pulse-Echo measurements</td>
<td>Bond pull tester Micropull</td>
<td>Biological Safety Cabinet 2 BIO</td>
<td>ION MILLING IM4000</td>
</tr>
<tr>
<td>AFM XE-200</td>
<td>Critical Point Dryer</td>
<td>Biological Safety Cabinet 3 BIO</td>
<td>MultiPrep system for grinding/polishing Allied</td>
</tr>
<tr>
<td>Ellipsometer</td>
<td>Die Attach Laurier Inc.</td>
<td>Centrifuge Eppendorf 5702R</td>
<td>Polishing Equipment 1 Struers DP10</td>
</tr>
<tr>
<td>Gas chromatograph, Shimadzu</td>
<td>Die Bonder, TPT</td>
<td>Centrifuge Minispin</td>
<td>Polishing Equipment 2 Struers DP20</td>
</tr>
<tr>
<td>He-Leak Detector</td>
<td>Flip-chip bonder FinePlacer Pico (Manual Force 1-40N)</td>
<td>Consort Multi-parameter analyser</td>
<td></td>
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<tr>
<td>Impedance measurement</td>
<td>IR-Camera Pixelink PL-B74EF</td>
<td>Dispenser Chemix Micro Syringe pump 1</td>
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<tr>
<td>Interferometer Wyko NT9100</td>
<td>Optical Microscope, Zeiss V12</td>
<td>Edvocycler</td>
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<tr>
<td>Optical Microscope I Leica DM4000M</td>
<td>Shear tester Delvolce 5600</td>
<td>Electrochemical workstation</td>
<td></td>
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<tr>
<td>Optical Microscope II Neophot 32</td>
<td>Ultrasonic bath FB16051</td>
<td>Electrochemical workstation</td>
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<tr>
<td>Optical microscope Leica DM3 XL</td>
<td>Ultrasonic Cleaning Brandon</td>
<td>Electro Chemical workstation</td>
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<tr>
<td>Optical Microscope Olympus IX51/TH4-200</td>
<td>Vacuum packer</td>
<td>Electro Phoresis</td>
<td></td>
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<tr>
<td>Optical Microscope Olympus MVX10</td>
<td>Vacuum welder, Budafec</td>
<td>Electro Phoresis</td>
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<tr>
<td>Probe Station PWS Probe II</td>
<td>Water Bonding System EVG 501</td>
<td>Fume Hood 1- BIO</td>
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<tr>
<td>Probe station RF</td>
<td>Wire bonder (Ball)</td>
<td>Fume Hood 2- BIO</td>
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<tr>
<td>Probe Station, Pasific Western</td>
<td>Wire Bonder (Ball) Delvolce 5610</td>
<td>Fume Hood 3- BIO</td>
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<tr>
<td>Probestation Cryo, Lakeshore</td>
<td>Wire bonder (wedge), TPT</td>
<td>Incubator Binder CB150</td>
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<tr>
<td>SAM 300, PVA TePLA</td>
<td>Wirebonder (Ball) manual Delvolte 5410</td>
<td>Incubator Labnet</td>
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<tr>
<td>Scanning tank, Onda</td>
<td></td>
<td>Incubator, Orbital shaker</td>
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<tr>
<td>SEM Hitachi SU 3500</td>
<td></td>
<td>Laminar flow bench 1 BIO</td>
<td></td>
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<tr>
<td>SEM Hitachi SU 8230</td>
<td></td>
<td>Reader 1 Tecan Spectra Fluor</td>
<td></td>
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<tr>
<td>Spectrofluorometer, FS5 XRD</td>
<td></td>
<td>Reader 2 Bio Tek Synergy2</td>
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<tr>
<td>Other</td>
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<td>StepOnePlus real-time PCR</td>
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<tr>
<td>Glovebox</td>
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<td>UV Photospectrometer, Shimadzu</td>
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<tr>
<td>Laser Cutting Machine</td>
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<tr>
<td>Optical Lab</td>
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<tr>
<td>Vacuum Chamber</td>
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</tbody>
</table>
Mikrosystem in space

Thinfilms
Miniaturization
Reliability
Pressure sensors
Microsystems in automotive

AIRBAG SYSTEMS

TIREPRESSURE SENSORS
Microsystems in Aerospace

AUTOPILOT SYSTEMS

ALTIMETERS

CABIN PRESSURE SYSTEMS
Miniaturization og packaging/Medical

Piezofilms
Miniaturization
Pressuresensorer
Semiconductors
Three application areas
One common technology

1) Health
2) Maritime
3) Offshore oil & gas

- **World leading industry**
  - Horten cluster: GE Vingmed, Kongsberg Maritime, FFI(NDRE), Medistim

- **World leading research centres**
  - NTNU, UiO, USN Vestfold

- **Ultrasound important for Norwegian economy**
  - Oil, gas, fish, marine resources, health
ULTRASOUND DEVICES

MEDISTIM

Institutt for Mikrosystemer

Universitetet i Sørøst-Norge
Microsystem for Heart Monitoring

- Detect heart infarction
- Surveillance of bypass operated patients
- Early warning if complications occurs
- Faster and more correct treatment than what is possible today

Sensor implanted in the heart muscle

Accelerometer velocity (cm s\(^{-1}\))

Baseline

LAD occlusion

Halvorsen et al, 2009
ISCALERT
Ischemia detection

Early Warning - Early Action

IscAlert™ is a miniaturized disposable biosensor that provides early warning of ischemia.
BIOMEDICAL SEPARATION/CONCENTRATION DEVICES
MICROFLUIDICS
Group for Materials and Micro-integration

- At ESTC 2020:
  Many presentations from our PhD students
  Also many presentations from other USN groups