Complete Solutions in Nano- and Microtechnology

ELECTRUM LAB
KTH & ACREO IN COLLABORATION

Welcome to Electrum Laboratory

The Electrum building, with offices and vast laboratories, was inaugurated in 1987. The idea was already at that time to build an environment for innovation, common to education, research, development and small scale production. The world class experimental resources should attract leading research groups, capable of producing ground breaking scientific results, leading to new products and paving the way for new companies.

The original Electrum idea has proven to be an enormous success. Many people have started out as students in the laboratories, then continued in research and development projects, which have presented outstanding scientific results and eventually grown into small companies. At a more mature stage, the companies have moved to their own, new, production facilities – specially designed for their processes – and making room in our laboratories for the next generation of growing research and development activities.

Today the Electrum Laboratory is the thriving base for students, researchers and entrepreneurs from different disciplines. Our world leading research and development groups master a wide range of technologies and application areas.

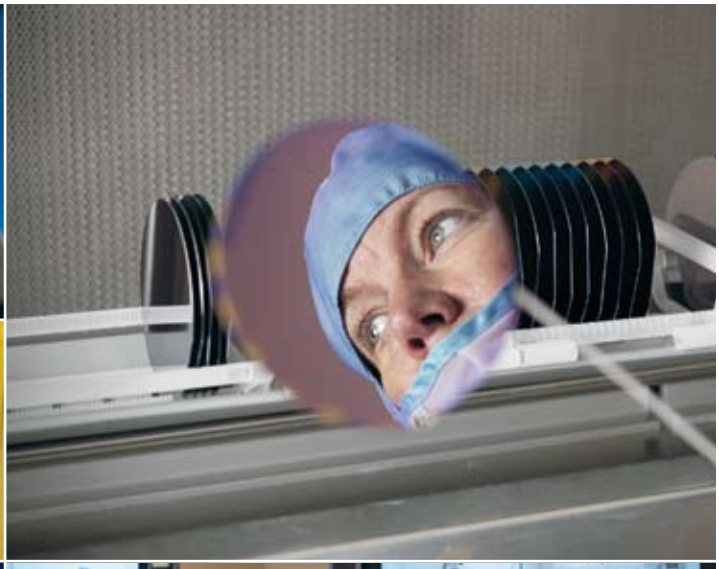
Inventors and entrepreneurs use our production and characterization resources for device prototyping and manufacturing in our ISO 9001 certified laboratories, and we play a strategic role as a production incubator for high tech spin-offs.

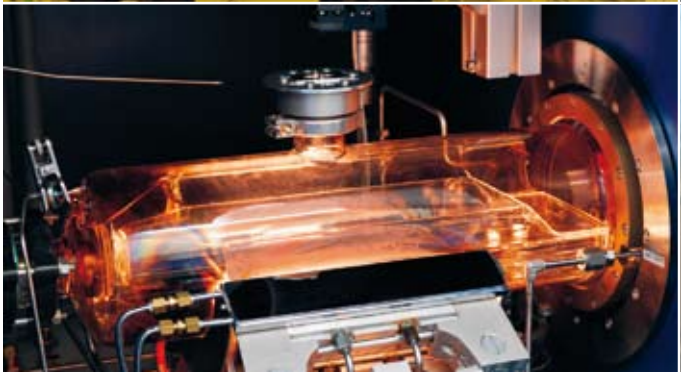
Advanced courses based on our deep knowledge in nano- and microtechnology, processing, and characterization techniques are regularly presented to graduate and undergraduate students.

Now the Electrum Laboratory offers you the chance to realize your unique ideas in our highly flexible and dynamic environment. We offer ready access to processes and characterization techniques. Our highly skilled staff provides processing services and our researchers and development engineers are eager to solve your specific problems in joint projects. You are also invited to rent detached laboratory space for your own specialized tools, and simultaneously gain access to our full range of highly competitive resources and services.

Welcome!

Nils Nordell
Director




Resources at your disposal

The Electrum Laboratory maintains a multitude of laboratories, covering most aspects of nano- and microtechnology. In our flexible facilities both single samples and batches are equally welcome. We handle separate steps to full sequences in fabrication and characterization. We offer access to sophisticated software for calculation and simulation. Our personnel are available to help you to master the wide world of nano- and microtechnology.

PROCESS LABORATORIES

The cleanroom laboratory accommodates the ultimate infrastructure for nano- and microfabrication and comprises the necessary tools to manufacture electronic, photonic, and microelectromechanical devices based on a wide range of semiconducting materials, including, e.g., Si, SiGe, GaAs, InP and SiC etc. The quality assured process lines combine a good throughput capacity with high reproducibility and extreme flexibility, and are partly ISO 9001 certified.

We maintain a world class facility for growth of crystalline semiconductor materials and structures which together with high resolution stepper lithography and precision etching techniques, ensures highly accurate control of both lateral and vertical dimensions. In addition we provide the processes for deposition of metals and metal stacks, dielectrics and polymers, for oxidation and anneal, and for wafer bonding and chip handling.

A well equipped wet chemistry environment is established for synthesis of nanoparticles and formation of nanostructured surfaces.

MATERIALS CHARACTERIZATION

Our materials characterization laboratories feature most relevant tools for measuring physical properties. By combining several techniques from our palette we are able to provide an integrated in-depth understanding of surfaces, materials, and structures, both as part of a process flow and on single samples.

Our state-of-the-art microscopy facility offers high resolution imaging and chemical analysis by scanning and transmission electron microscopes, and in-situ sample manipulation by focused ion beam technology. Liquid samples are also allowed in our environmental microscope.

Atomic composition and chemical properties are determined through highly sensitive analyses of ion masses and electron energies. Crystal structures are analyzed by X-ray diffraction and electron diffraction. Surface properties are analyzed by using various scanning probe techniques – some of them unique – providing electrical, optical and chemical information down to atomic scale. Nanoparticles are characterized according to size, mass, structure and composition, and we also offer access to a wide range of techniques for optic, magnetic and electric characterization.

DEVICE CHARACTERIZATION

Our device characterization laboratories provide access to advanced tools for in-depth testing of the devices manufactured.

Electronic devices are tested up to extremely high frequencies in our probe stations, which handle voltages and currents in ranging orders of magnitude and allow for high power. Failure analyses of single devices and integrated circuits are easily made with our emission microscopes.

Optoelectronic devices are readily characterized with respect to wavelength, high frequency response, output power, and efficiency. Bit error rates are determined for optical communication systems and transmission properties of optical waveguides.

Sensors – spanning a vast diversity of kinds – are characterized according to their functionality and performance.

SIMULATION TOOLS

Physics based simulations of devices are performed using software from leading commercial suppliers. Our research and development groups develop and provide new software for simulation and design of novel devices, structures and phenomena within their research fields.

SKILLED PERSONNEL

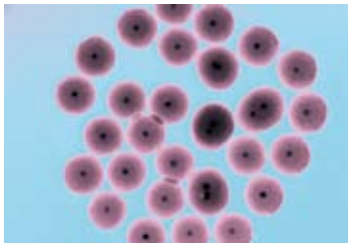
Our processing, characterization and simulation resources are handled by our staff of skilled personnel who are happy to help all users make the very best out of the technologies.

Application fields

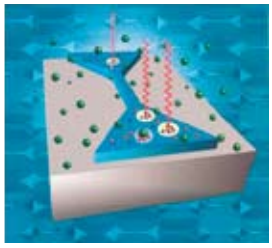
X-ray detector for medical applications (Acreo/Scandidos).

LIFE SCIENCE

With the goal to improve human health and quality of life, our research and development activities support both modern biotechnology and medical technology. We explore, e.g., methods for integration of living cells with electronics, novel methods for drug delivery, sensors for human implants, novel methods and detectors for body imaging, and analysis technologies for proteins and DNA.

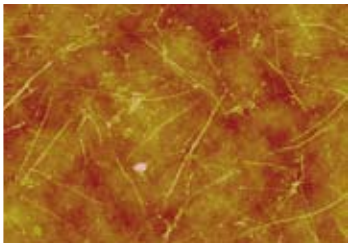


Core shell nanoparticles for intelligent drug delivery (KTH).



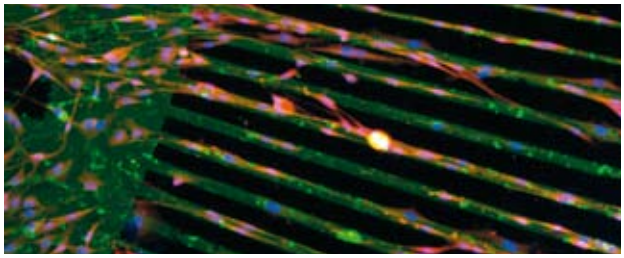
Protein lab-on-a-chip sensor based on silicon nanowires (KTH).

Hollow microneedles for painless drug injection (KTH).



Carbon nanotube network based transistors for biosensing applications (KTH).

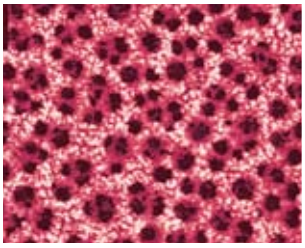
Neurons grown into electronics to enable electric control of nerves (Acreo).



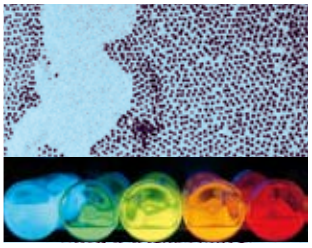
Cascade boiling from a nanostructured surface (KTH/Micro Delta T).

ENERGY AND ENVIRONMENT

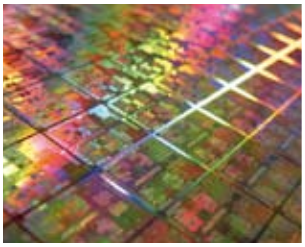
Energy saving and environmental issues are addressed with a sustainable society and a flourishing earth in mind. We develop electronics for efficient power handling in motors, generators and transmission lines, fuel cells and battery technology, as well as surfaces for increased efficiency in heat exchangers, and intelligent mirrors and windows for reducing energy losses.



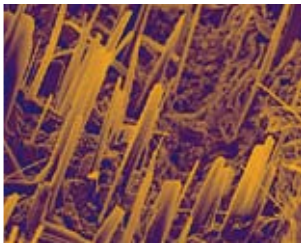
Nanostructured surface for enhanced heat transfer (KTH/Micro Delta T).



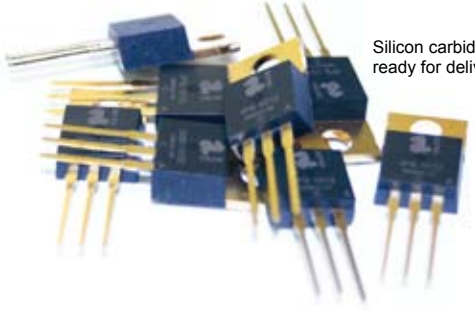
Nanoparticles of various sizes for light absorbtion in solar cells (KTH).



Silicon carbide high power transistor (Acreo).



Structured nanomaterial for high efficiency fuel cells (KTH).

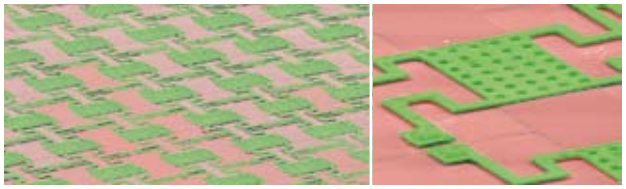


Silicon carbide transistors ready for delivery (Acreo).

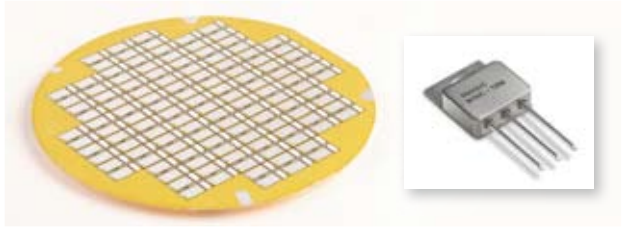
Night vision IR camera for pedestrian recognision (KTH/Acreo/Autoliv, ill. by BMW).

TRANSPORTATION

Transportation of people and goods is an important foundation of our global society. The demands for safety and energy efficiency in transportation are driving forces for our research in the field. We are active in early warning systems for detection of pedestrians and animals on the road, new technology for batteries and fuel cells, and highly efficient electronics for control of electric motors.

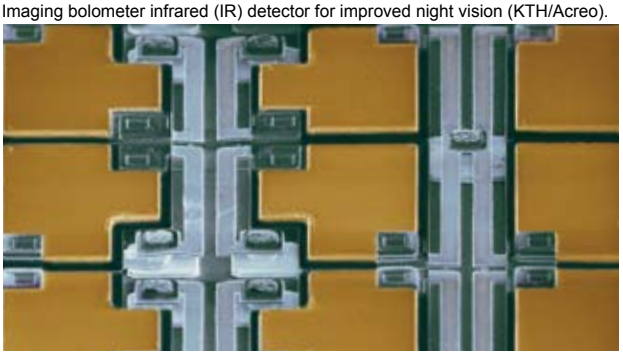


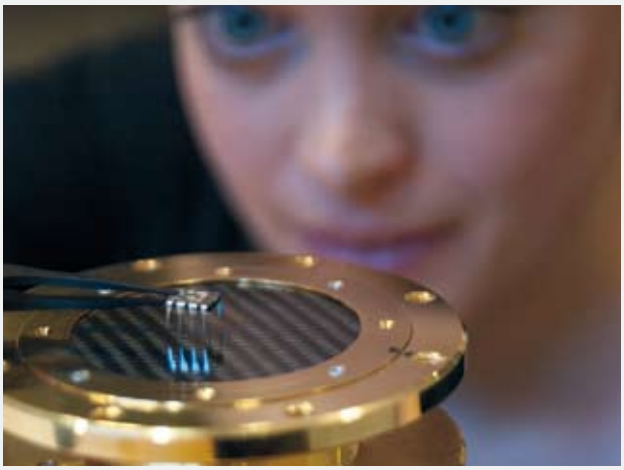
High impedance surface array and a single element for automotive radar to avoid collisions (KTH).



Silicon carbide high power transistors for motor control on wafer and in a high temperature package (TranSiC).

Imaging bolometer infrared (IR) detector for improved night vision (KTH/Acreo).



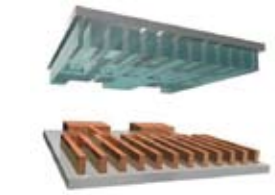


X-ray detector for integration in production lines (Scint-X).

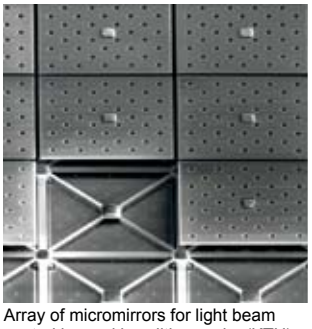
AUTOMATION AND PROCESS

Efficiency in industrial processes and automatic handling of products during assembly and delivery is fundamental in maintaining a competitive industry. We develop sensors and electronics for improved transport control, logistics, sensors and actuators for in-line control of industrial processes, and new methods for the manufacturing of electronic devices.

Array of microlenses for integration with light emitters and detectors (Acreo).



Replication of metal patterns for efficent electronics fabrication (Replisaurus).



Array of micromirrors for light beam control in maskless lithography (KTH).

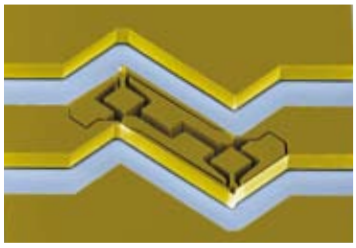
PC board with ultraviolet sensor for system integration (Acreo).

Bolt with an integrated sensor, as part of a machine element (Acreo).

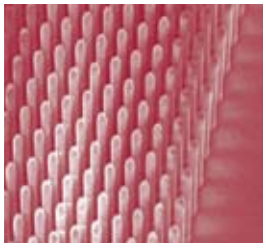
Quantum cryptography for secure telecommunication (KTH).

COMMUNICATION

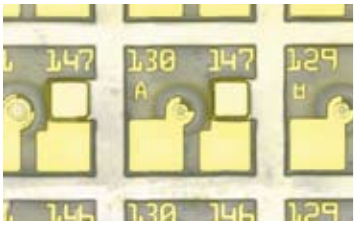
The development of modern communication technologies for mobile phones and information transfer over optical fibers has, for decades, been the focus of research groups at Electrum. This tradition is continued and today we develop devices for next generation communication and information systems. These include high speed electronics, quantum optoelectronics, network devices and memories etc.



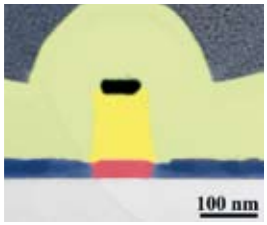
Microelectromechanical switch to handle high frequency signals (KTH).



Photonic crystals for compact photonic circuits (KTH).



Vertical cavity surface emitting lasers for fiber optic communication (KTH).



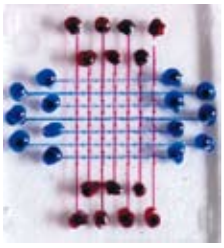
Silicon nanoelectronics for low power and high frequency (KTH).

Photonic integrated circuits enable broadband telecommunication (KTH).

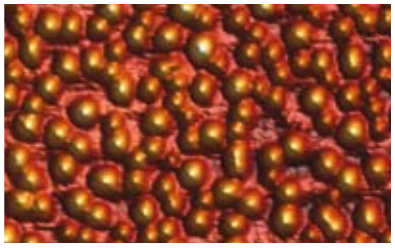
Thermal imaging detectors for night vision and thermal detection (IRnova).

SAFETY AND SECURITY

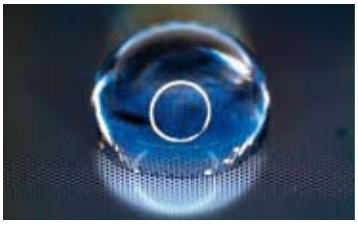
The ever increasing demand for safety and security systems is accompanied by a demand for intelligent sensing solutions and high-integrity information handling. We develop systems for highly secured information transfer and product tagging, imaging sensors over a broad wavelength range, and sensors with high selectivity and sensitivity for chemicals and biomolecules



3-dimensional microfluidics for complex sensors (KTH).



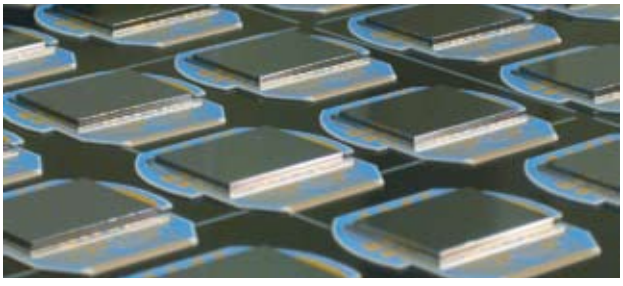
Quantum dots will increase the efficiency for imaging infrared detectors (Acreo/IRnova).



Super hydrophobic porous membrane for antibody based sensors (KTH).

Electrochemical microfluidic sensor for pathogens (Acreo).

Volume production of infrared detector arrays for surveillance cameras (IRnova).



Collaboration

The Electrum Laboratory is an environment for innovation. We invite you from academy, institute or industry to work together with our skilled personnel in a collaboration project designed according to your needs. You always have access to our ISO 9001 certified processes and calibrated characterization tools. Most of our processing tools handle small to medium scale production volumes.

INDIVIDUAL USERS

As an individual user of our laboratories you will receive all necessary training and guidance. We will help you to make the most efficient use of our facilities, and as you participate in our educational program you will qualify to use the tools you need on your own. Our skilled staff is always available for further assistance and training.

FOUNDRY SERVICES

As an alternative, we will perform the processing and characterization for you. Either as a single measurement or process step or in a full processing sequence to manufacture a device as a prototype or in longer series. We work according to your pre-defined scheme or we can define the processes together with you in a process definition project. We may also perform all necessary in-process and post-process characterization, in order to verify the results.

COMMISSIONED RESEARCH

Our research and development groups are willing to share competence and build new knowledge together with you in commissioned research and development projects, where access to laboratory resources may be a part of the project.

EDUCATION PROGRAMS

In our laboratory environment we have unique possibilities to create and perform advanced courses in laboratory and cleanroom infrastructure, nano- and microfabrication, advanced characterization techniques, modern device design etc. at both undergraduate and graduate levels. We also offer professional courses, designed in accordance with your specific needs and strategic goals.

INCUBATOR

In our incubator your manufacturing or device innovation is given the time and opportunity to grow in a controlled manner. You have access to our infrastructure, equipment and personnel resources and you may rent laboratory space to place your own proprietary tools in this environment.

This way you may postpone substantial investments until your business has proven to be sustainable. You get the technical support needed and you work within a fully functional infrastructure – also in the cleanroom with all media, if necessary. You can concentrate on your technical development and we serve you with the necessities.

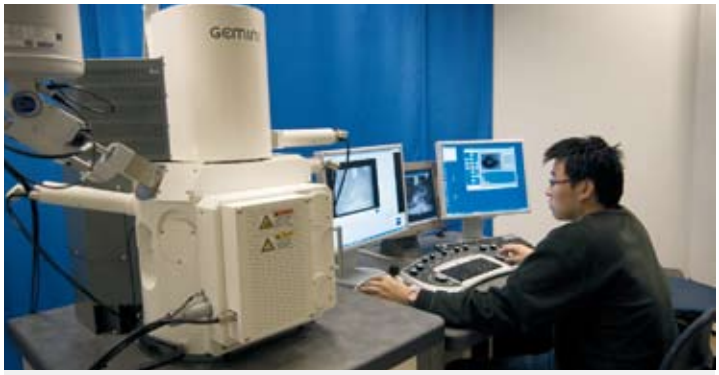
The network of people active in the laboratories is open to you; from skilled technicians, process and development engineers, to researchers and entrepreneurs. This open environment offers a basis on which to start collaborations and eventually find the right competence for your company. Our national and international collaboration partners are also available to you and, in addition we also have some fund-raising experience.

Spinoffs

- **Altitun AB** (1997) Optoelectronics for telecommunication. Established at own fab. Sold to ADC for 872 MUSD in 2000. Knowledge transferred to Syntune AB (2003)
- **Optillion AB** (1999). Optoelectronics for telecommunication. Moved to own fab in 2002.
- **Silex Microsystems AB** (2000) Microelectromechanic devices for opto and bio applications. Moved to own fab in 2004. Today a world leading foundry in microsystem technology.
- **Comlase NT AB** (2001/2003) Pump lasers and coating technologies.
- **Advanced Microwave Device Solutions AB** (2001) High power/high frequency transistors in silicon carbide. Sold to Intrinsic Semiconductor in 2004.
- **PhoXtal Communications AB** (2002) Optoelectronics for telecommunication.
- **Replisaurus Technologies AB** (2002) Electrochemical pattern replication.
- **TranSiC AB** (2005) High power transistors in silicon carbide.
- **Scint-X AB** (2006) Imaging X-ray detector with high sensitivity and resolution
- **IRnova AB** (2007) High performance and high quality imaging infrared detectors
- **NanOsc AB** (2007) Compact oscillators for telecom and other applications
- **Micro Delta T AB** (2007) Nanostructured surfaces for enhanced heat transfer.

...and several more

Facilities



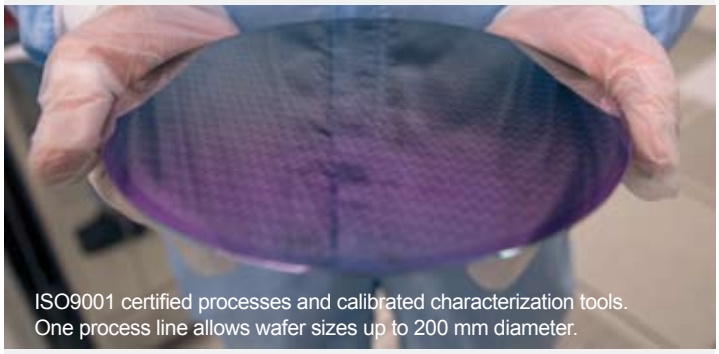
LABORATORIES

1300 m^2 process laboratory in ISO class 5-7 cleanroom (corresponding to 100 - 1000 (0.5 μm) particles /ft^3).

Climate control within 22°C ± 1°C and RH 40 % ± 5 %.

1500 m^2 analysis, characterization and synthesis laboratories.

Specific de-vibrated areas fulfill the VC-C and VC-E criteria.



ISO9001 certified processes and calibrated characterization tools. One process line allows wafer sizes up to 200 mm diameter.

PROFILE COMPETENCES

MATERIALS SYNTHESIS

Extensive resources for crystal growth of advanced materials and quantum structures: vapor phase epitaxy for semiconducting materials, magnetron sputtering for spinntronic materials, and pulsed laser ablation for functional oxides etc.

STEPPER LITHOGRAPHY

i-line and g-line stepper lithography allowing a linewidth of down to 0.5 μm and an alignment accuracy of 90 nm. Sidewall transfer lithography provides linewidths in the 10 - 100 nm range reproducibly.

PRECISION DRY ETCHING

Precision dry etching by state-of-the-art processes with end point detection. Separate etching chambers for conventional Si structures, deep Si structures, other semiconductor materials, metals and dielectrics.

NANOCHARACTERIZATION

A wide range of characterization techniques for materials and devices: high resolution scanning and transmission electron microscopy, nanoparticle characterization, scanning probe techniques and a variety of electric, optic and magnetic characterization.

Process equipment

- Epitaxy:
  - MOVPE for InP/InGaAsP(N) and GaAs/AlGaAs
  - HVPE for InP/InGaAsP
  - VPE for SiC
  - VPE for Si/SiGe
- Steppers and contact lithography
- Automatic and manual photoresist and developer stations
- Metallization
- Precision dry etching
- SiO_x and SiN_x plasma deposition
- Furnace processes
- Rapid thermal anneal
- Lapping and polishing
- A wide variety of wet etching and cleaning processes
- Die mounting and bonding

Materials characterization

- High resolution (field emission) scanning electron microscopy:
  - Allowing liquid samples (environmental microscopy)
  - In-situ focused ion beam sample manipulation
  - Chemical analysis with electron dispersive spectroscopy
- High resolution transmission electron microscopy:
  - Chemical analysis with electron dispersive spectroscopy
  - Electron energy loss spectroscopy
- Surface profilometry
- Secondary ion mass spectrometry
- Scanning probe techniques:
  - Atomic force microscopy
  - Scanning capacitance microscopy
  - Kelvin probe microcopy
  - Scanning tunneling microscopy
  - Scanning optical near field microscopy
- X-ray diffraction
- Photoluminescence
- Optical microscopy
- X-ray photoelectron spectroscopy
- Hall-effect measurements
- Deep-level transient spectroscopy
- Fourier transform infrared spectrometry
- Variety of nanoparticle characterization techniques

Device characterization

Electrical characterization

- High frequency network analyzer
- Current-Voltage
- Capacitance-Voltage
- Electrical spectrum analysis

Optical characterization

- Spectral range measurements
- High frequency network analyzer
- Bit error rates in fiberoptical transmission systems
- High frequency optical sampling oscilloscope
- Current-Optical power
- Current-Voltage
- Sensor detectivity
- Fourier transform infrared spectrometry
- Carrier-lifetime measurements
- Characterization of optical waveguides

Partnership

JOINT VENTURE

The Electrum Laboratory is owned by KTH Royal Institute of Technology – the leading technical university of Sweden.

The facility is operated by KTH in close collaboration with Acreo – the Swedish research institute for microelectronics, optics and communication technology.

PART OF THE MYFAB NETWORK

The Electrum Laboratory is part of the Myfab network of Swedish university laboratories for micro- and nanotechnology, and one of the funding laboratories, together with Ångström Microstructure Laboratory at Uppsala University and the MC2 Nanofabrication Laboratory at Chalmers.

The users at the three laboratories are given access to the processes, characterization techniques and world class research and development competences at major academic institutions and institutes in Sweden.

www.kth.se
www.acreo.se
www.myfab.se

ELECTRUM LAB
KTH & ACREO IN COLLABORATION

www.electrumlab.se

Open for business

Electrum Laboratory is open for research and production, for industry and academic users, for single device handling and for batch processing.

Processes – from separate process steps to full device process sequences.

Characterization – from single measurements to integrated analysis for deep understanding of complex structures.

- **Process and characterization services are provided by our skilled experts.**
- **Commissioned research and development projects.**
- **Prototyping and small scale production.**
- **Access to our tools for your own personnel.**
- **Cleanroom area to rent.**
- **Education in process technology, characterization and cleanroom infrastructure.**
- **Access to the lab resources at our collaboration partners within the Myfab network.**

Contact

info@electrumlab.se
Visting address: Kistagången 16/Isafjordsgatan 22
www.electrumlab.se

ELECTRUM LAB
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