

Electrum Laboratory

Complete Processes for Nano and Microfabrication

Welcome to the Electrum Laboratory

We offer complete process lines

The Electrum Laboratory constitutes a world-class resource for nano and microfabrication. We offer a fully equipped cleanroom laboratory with complete process lines for device processing, and state-of-the-art laboratories for advanced materials and device characterization. And we offer sophisticated software for device simulation and design.

Our strengths

Research and Development

The laboratory environment is extremely flexible. The activities are centered around our core of research and development groups. These world-leading groups have created major breakthroughs within their fields by inventing, designing, and manufacturing novel devices. Ground-breaking processes are developed and established for both research and small scale production.

Production

Numerous spin-offs are generated from our research and development groups. The start-up companies have further matured in our incubator, where they have ready access to our well established and highly reliable processes as well as to our enabling development facilities for both production and further improvement of their products.

Education

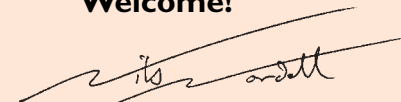
In our laboratory environment we have the unique opportunity to create and present advanced courses in state-of-the-art nano and microfabrication technologies, advanced characterization techniques and modern device design for both undergraduate and graduate students.

Develop with us!

Many people have started as students in the laboratory, continued in research and development projects which have grown into small companies, with the production line already established in the laboratory. At a more mature stage, the companies may move out into new production facilities specially designed for their processes.

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 equipment, our highly skilled staff provide process and development services, and you are invited to rent detached laboratory space where you could place your own specialized equipment, and simultaneously gain access to our full range of highly competitive processes and services.

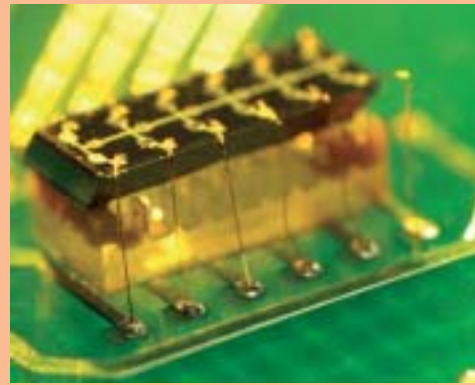
Welcome!



Nils Nordell
Director



Silicon Technology



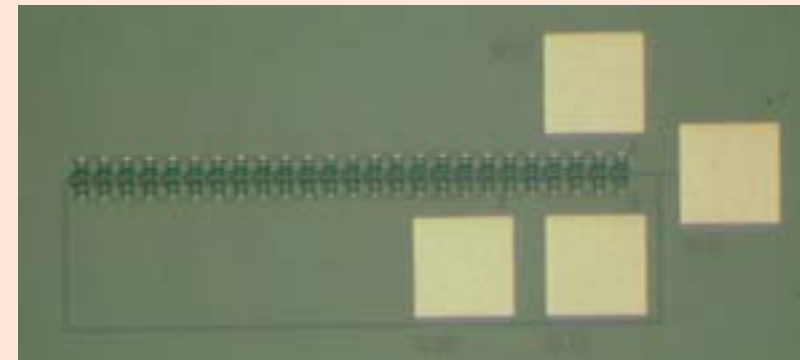
Classic technology renewed

Our expertise to build advanced device structures in silicon – the most widely-used material for electronic devices – is at your disposal. We have refined our process skills to perfection. Furthermore, we can combine silicon with other materials, primarily germanium and carbon, to meet the ever-increasing demands on device performance, e.g. for high frequency applications. We have developed highly specialized processes to allow for the fabrication of novel devices for integrated optoelectronics on silicon substrates.

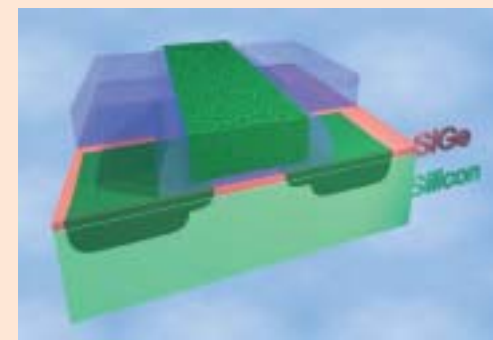


Cross section of a transistor for wireless communication applications in silicon-germanium technology, operating at extremely high frequencies of above 80 GHz. (KTH)

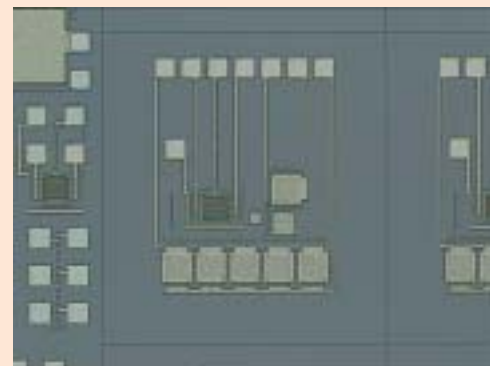
Optical waveguide device with excellent light distribution profile for incorporation in advanced telecommunication systems. (KTH)



A ring oscillator built by ultra high frequency transistors makes the perfect test structure to evaluate the high performance devices. (KTH)



Transistor structure improved by adding a thin silicon-germanium layer in the active region, which enhances the high frequency performance, and reduces the noise level. (KTH)



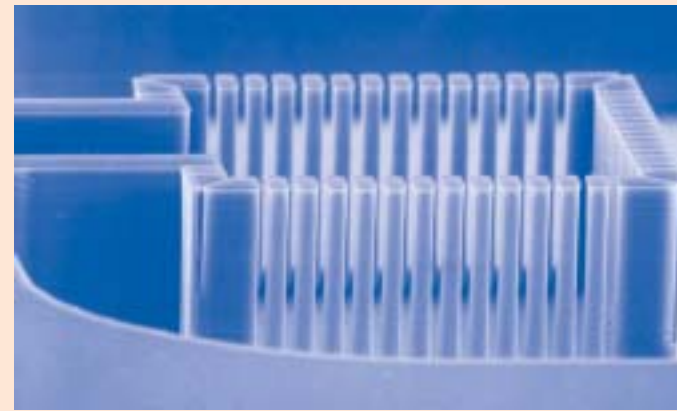
A gas sensor chip fabricated in a specialized process which is compatible with conventional MOS technology. (Produced by Acreo for AppliedSensor, Linköping)

Micro Systems Technology



Mechanics on a very small scale

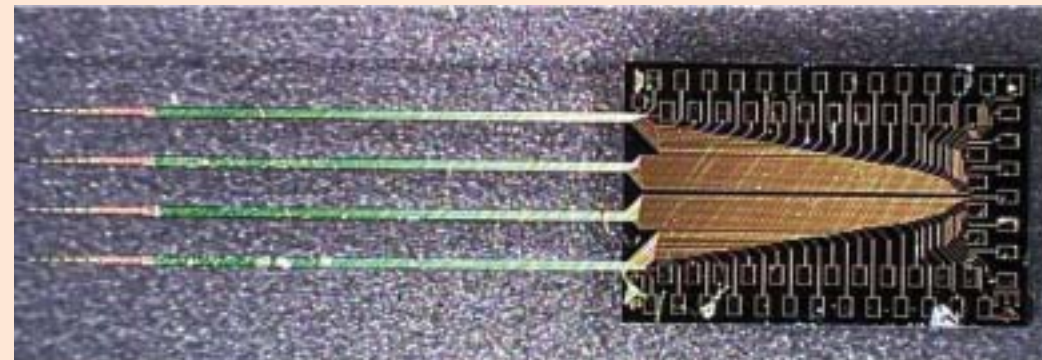
Our resources within micro systems or micro electro mechanical systems are at your disposal. Through innovative design and pioneering process development the groups at Electrum Laboratory master micro systems technology. It represents a link between conventional microelectronics and the fields of medical and biotechnology, providing advanced sensors, analysis solutions and probes. Additional applications are found in the fields of opto technology for data and telecommunications and radio frequency technology used in mobile and wireless systems.



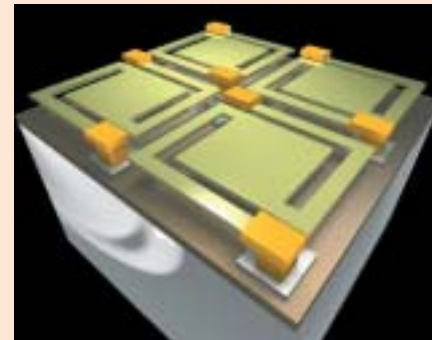
A 0.1 mm long filter-chamber to trap beads with biochemical samples in a fluid for optical analysis of proteins or DNA. (KTH)



Microneedles for painless injection of fluids through the skin. (KTH)



Very sharp measurement probe with multiple recording sites for testing neuron activity in a guinea-pig's brain tissue. (Acreo)



Uncooled infrared bolometer array to be used in a heat detection camera. (KTH)



Microsystems technology is the prime link between conventional microelectronics and biomedical sciences.

Complete processes for silicon technology

Crystal growth
Si/SiGe single wafer reactor

Wet processes
Cleaning
Etching

Lithography
0.5 μm stepper lithography

Dry etch
Oxide etch (RIE)
Poly-Si etch
Metal etch

Deposition
LPCVD furnaces (oxides and nitrides)
Metal sputter
PECVD silicon oxide

Optical waveguides
PECVD doped silicon dioxide
ICP etch of Si and SiO₂

Oxidation and anneal
Furnace stacks
Rapid thermal anneal

Post process
Dicing saw
Wire bonding
Characterization



Complete processes for microsystems

Wet processes
Cleaning
KOH etch

Dry etch
ICP dry etch
Bosch process



Deposition
PECVD nitride
LPCVD nitride/oxide
Spinning of polyimide
Evaporation of metals
Electroplating of metals

Lithography
1:1 mask aligner
Front- and back side alignment

Bonding
Wafer bonder
Furnace anneal
Wire bonding

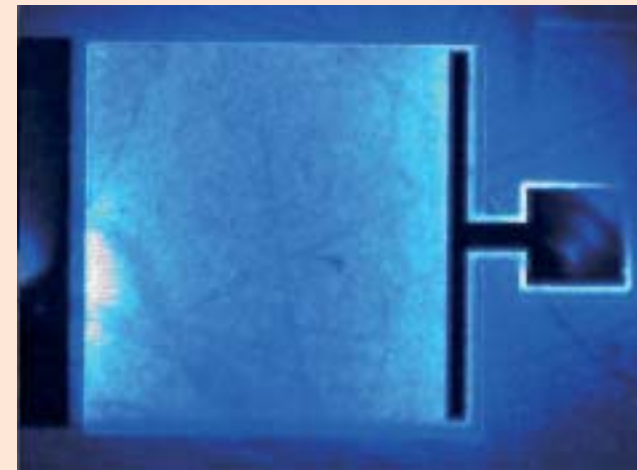
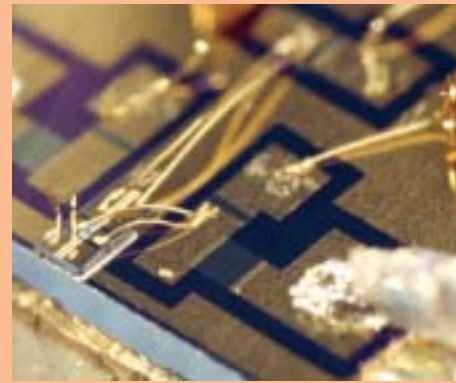
Post process
Dicing saw
Characterization



Compound Semiconductor Technology

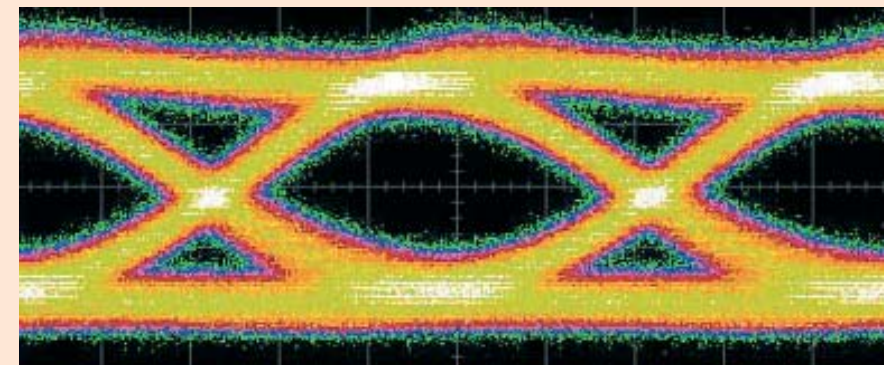
New materials with high potential

We offer our resources within the widely diversified field of compound semiconductors. The art of forming complex device structures using crystal growth techniques has over the years been developed to perfection. We are leaders in this field and offer world-class processes for the conventional optoelectronic materials based on gallium arsenide and indium phosphide, in addition to the wide bandgap materials gallium nitride and silicon carbide. Our applications cover the entire range, from high speed optoelectronics and electronics to high power and high temperature devices.

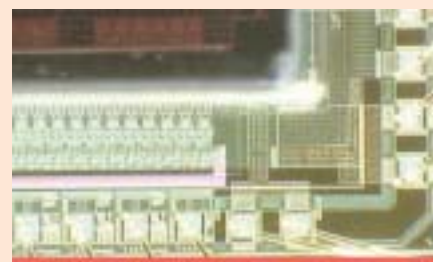


Blue light emitting diode to be used in full color displays, and for general lighting with white light. (KTH)

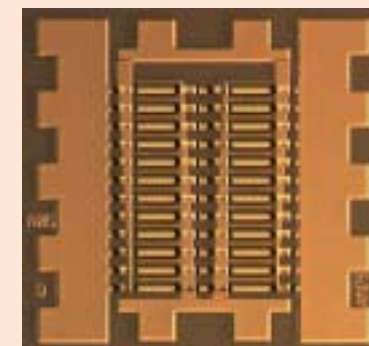
Infrared (IR) detector array used in commercial thermo-vision cameras, with extremely high temperature resolution for surveillance, process control and medical applications. (Acreo)



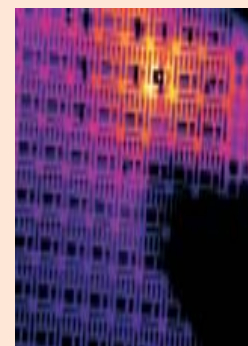
A transmission pattern – “eye-diagram” – generated at 10 Gigabit/second from a vertical cavity laser for low-cost broadband access networks. (KTH)



Spatial light modulator which enables ultra high frequency light modulation for optical communication and signal processing applications. (Acreo)



High power silicon carbide microwave transistor. Several transistors in a parallel design increase the output from one single chip. (AMDSAB)

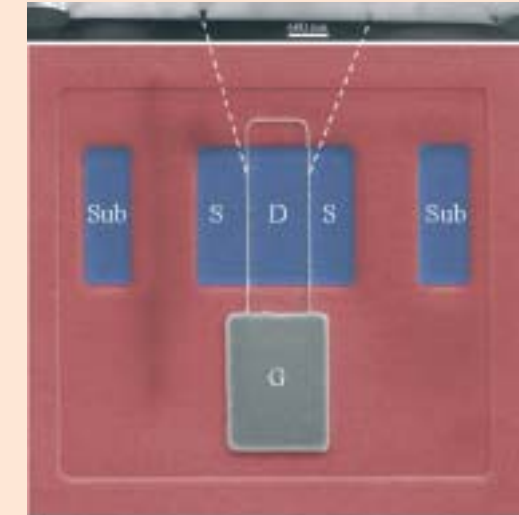
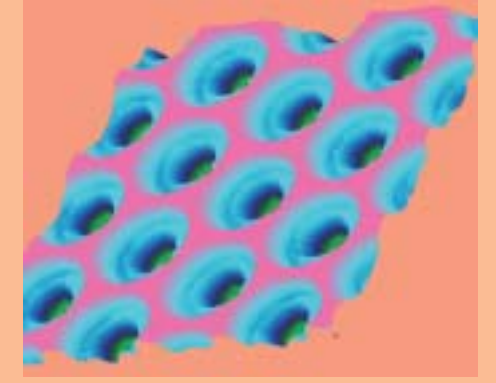


Silicon carbide has a huge potential for power and high temperature electronics. These transistors operate well above 300°C, and are monitored by an IR camera. (KTH)

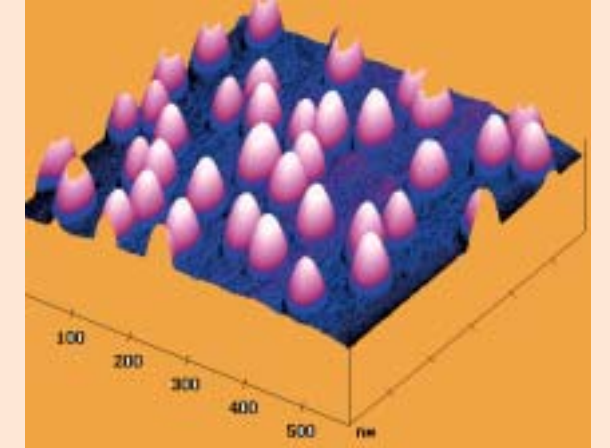
Nano Fabrication Technology

On an atomic scale

Nano fabrication is handicraft on an atomic scale. We offer you expertise that stretches the frontiers and enlarges the potential of micro fabrication technology into the still unexplored fields of nanometer dimensions where entirely new possibilities arise. We develop this new discipline by improving successful device solutions and developing novel inventive device concepts, in which the atomic scale and quantum effects are harnessed.



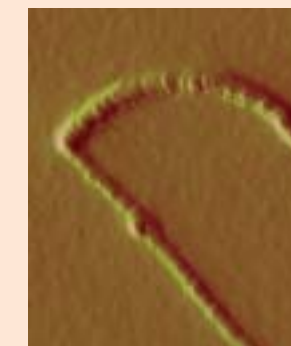
Cross section and top view of a 50 nm gate MOS transistor, operating at extremely high frequencies above 100 GHz, designed for high density integration. (KTH).



Self-assembled quantum dots – 80 nm in diameter – for modulators, detectors, light sources, parallel computing architectures and single electron transistors. (KTH/Acreo)

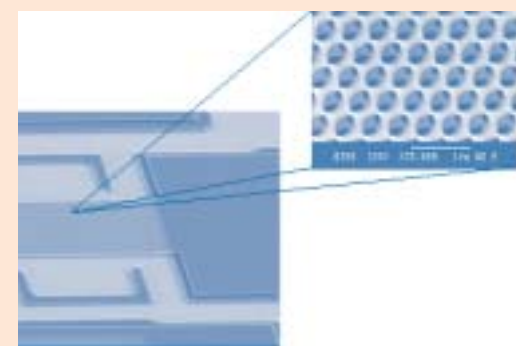


Nano-wire for use in future high density, low power nano-transistors. It could also act as a detector for large molecules in, e.g. biomedical samples. (KTH)



Carbon nano-tubes will become a basic building block in future nano devices – in digital transistors for high density integration, single electron devices and spintronics. (KTH)

Photonic crystals for compact optical components with advanced functions in photonic circuits, e.g. for waveguides, filters and tapers in communication systems. (KTH)



Complete processes for compound semiconductors

Crystal growth
MOVPE of GaAs/GaInNAs/AlGaAs,
MOVPE of GaN/AlInGaN
MOVPE of InP/InGaAsP
HVPE of InP
VPE of SiC

Deposition
PECVD of silicon nitride and silicon oxide
Sputter and evaporator for metal deposition

Lithography
1:1 contact mask aligner
0.5 μm stepper lithography
Direct write laser lithography

Wet processes
Etching
Cleaning

Dry etch
ICP of GaAs
RIE of GaAs and InP
CAIBE of GaN and InP

Anneal
Furnace
Rapid thermal anneal
Post process
Flip-chip bonding
Dicing (saw or cleaving)
Wire bonding
Characterization



Complete processes for nano fabrication

Crystal growth
MOVPE of GaAs/GaInNAs/AlGaAs,
MOVPE of GaN/AlInGaN
MOVPE of InP/InGaAsP

Lithography
e-beam lithography
(with collaboration partners)



Etching
RIE
Electrochemical wet etch
CAIBE of GaN and InP

Characterization
Scanning probe technologies
Scanning electron microscopy



Resources at your disposal

Materials characterization

Our materials characterization laboratories are fully equipped with world-class tools, covering the techniques necessary to characterize the many different materials handled in the process lines.

The laboratory offers conventional optic and electron microscopy. State-of-the-art x-ray characterization gives accurate information about crystal lattices and structures. Atomic composition and chemical properties are determined through highly sensitive analysis of ion masses and electron energies.

We provide a vast range of magnetic, electric and optic characterization of homogeneous materials, thin films and designed structures. Various scanning probe techniques – some of them unique – provide electric, atomic and optic information down to a nanometer scale. Optical measurements are performed over a broad spectral range and ultra fast processes are studied. Some of our measurement techniques may also be applied over a large temperature range.



Process laboratory

The cleanroom laboratory maintains the ultimate infrastructure for nano and microfabrication processes. The process lines combine high reproducibility with extreme flexibility and comprise all the necessary steps for manufacturing a wide range of electronic, optoelectronic and microsystems devices in Si and SiGe, and in compound semiconductor materials, e.g., GaAs, InP, GaN and SiC. We offer a world-class facility for growth of crystal structures in all mentioned materials systems, which together with high resolution steppers and laser beam litho-graphy ensures extremely accurate control of both vertical and lateral dimensions. In addition we provide a wide range of tools for precision etching, together with reliable and flexible processes for the deposition of dielectrics and polymers, metallization, anneal and chip handling.

Device characterization

The laboratories for device characterization provide a versatile facility with advanced tools for electrical testing of electronic devices up to extremely high frequencies and high powers at voltages and current ranges covering orders of magnitude. Even highly accurate capacitance and noise measurements are performed. Optoelectronic devices, including light emitting diodes, lasers and detectors are readily characterized with respect to wavelength, high frequency response, output power and efficiency.

Device simulation tools

Physics based simulations of both devices and manufacturing processes can be carried out using software from leading commercial suppliers. The research and development groups also develop and provide new software for simulations and design of novel devices within their research fields.



www.electrumlab.se

A joint venture between KTH and Acreo

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

The Laboratory is operated by KTH in collaboration with Acreo – the leading Swedish research institute in microelectronics and optics. KTH is represented by IMIT (Department of Microelectronics and Information Technology), and S3 (Department of Signals, Sensors and Systems).

Users

Other users of the Electrum Laboratory are companies active in the field of semiconductor technology, e.g. FLIR Systems AB, Silex Microsystems AB, Advanced Microwave Device Solutions AB (AMDS), Comlase NT AB, PhoXtal Communications AB and Replisaurus Technologies AB, as well as academic groups from KTH departments and other Swedish universities. The Electrum Laboratory also collaborates with the process laboratories at Uppsala University and Chalmers.

Start-ups from the lab

Altitun AB Optoelectronics for telecommunications

Silex Microsystems AB Microelectromechanic devices for opto and bio applications

Advanced Microwave Device Solutions AB High power transistors in silicon carbide

PhoXtal Communications AB Optoelectronics for telecommunication

Optillion AB Optoelectronics for telecommunications

and several more.

Contacts

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KTH in collaboration with Acreo

