Electrum Laboratory

Complete Solutions in Nano and Microtechnology

Nils Nordell
(Director)
1992: SiC epitaxial development at IMC (now RISE)

Reactor developed and built at IMC
Gas supply and control system by Epigress
- RF-heated, temp up to 1620 °C
- Optimized for uniformity on 50 mm wafer:
  - Thickness within +/- 8%
  - Doping within +/- 35%
- Abrupt doping transients
- Growth on non-planar substrates
1993: SiC at Case Western Reserve Univ., Cleveland, OH

Chemical vapor deposition of SiC thin films on Si

Sublimation of SiC bulk crystals
1997: Multi wafer SiC epitaxial reactor at ABB

Industrial multi-wafer reactor from Emcore
- Capacity: 6 x 35 mm or 50 mm wafers / run
- Stainless steel reactor with loadlock
- Growth temperature: up to 1600 C
- Thickness uniformity: +/- 5%
- Doping uniformity: +/- 20%
1997: ABB Wafer Fab – “Sweden 1”

Cleanroom area: 300 m²
Class: 100 - 1000
Built May - Sept. 1997
In operation until late 2001
We built the fab…

…with a coffee corner
1997: The proud ABB / IMC team

with Christer Ovrén, in charge
Electrum Laboratory

Mission

• To offer a competitive laboratory environment for micro and nano technology:
  – Processes capabilities – including cleanroom – for device fabrication
  – Facilities for characterization of materials and devices.

• To create an open environment for education, research, development and small scale production.

• To assure a cost efficient usage of expensive laboratory resources.
A flexible lab resource

- **Research and development**
  - Inventing, designing, manufacturing of novel devices
  - Establishing novel processes and characterization techniques
  - Synthesis and characterization of new materials and structures
  - Flexibility, allowing different materials and sizes

- **Small scale production**
  - Incubator for start-up and spin-off companies
  - Access to all the lab resources
  - Possibility to rent lab space for proprietary equipment
  - Stability and repeatability maintained

- **Education**
  - Advanced undergraduate and graduate courses.
  - Life-long learning
  - Micro- and nano fabrication technologies and characterization.
Open Access Laboratory Facilities

- Open for academic and commercial users, alike.
- Easy access to processing and characterization tools.
- Education for lab access and tool driving licenses.
- Tool expert assistance or own usage of tools.
- Rent of lab space
- Possibilities for research collaborations.

Simple business model:
- Pay per user and use
- Myfab one-stop shop solution

Common user interface through MyfabLIMS:
- Databases of tools and users
- Booking, Logging, Invoicing
Key Figures

In operation since 1987
1 300 m² clean room lab
Class 100 - 10 000 (particles/ft³)
1 200 m² other labs

Yearly turn around: 55 MSEK
No. users: ca 180
No. dependent of lab: > 600

Total investment value: > 800 MSEK
No. registered tools: 220
Average tool lifetime: 15 years
Re-investment: 15 MSEK/yr
Process Lines
- Tools for industrial production

Silicon Technology
   Silicon – CMOS for circuits
   Silicon – Microsystems technology

Compound Semiconductors
   InP & GaAs – Opto electronics and photonics
   SiC – High temp. and power electronics

Post process: dicing and bonding
Characterization of materials and devices
Design and simulation

ISO 9001 certified management system
• controlled processes and tool uptime
• calibrated characterization tools
The Electrum Innovation System: Fosters Companies:

- Electrum
- RISE
- Myfab
- STING
- KTH
- KISAB
- IRNova
- Silex Microsystems
- Ascilion
- Ascatron
- NanoSce
- Scint-X

In total (2021):
- > 150 M€ turnover
- > 500 employees
Incubator

Access to the whole lab:
• Processes
• Characterization
• Network of researchers and entrepreneurs

Proprietary lab area for rent:
• For own tools

Access to partners: Myfab and ISSP
• Backup processes
• Profile processes

Production incubator: RISE
• Technology transfer
• Technology and product development projects
• Foundry services

Business incubator: STING & KTH innovation
• Startup
• Business lab
• Business accelerator
ISO 9001:2015 certified management system

Defines:
• Overall organization and roles
• Work routines and safety
• Information flow and meetings
• Tool maintenance and uptime
• Process, monitoring and reproducibility
• Characterization tool calibration
• Education of personnel and lab users
• Customer handling
• Yearly user poll
• Yearly audits and continuous follow-up

As part of KTH, also certified according to the environmental management standard ISO14001:2015
From research to company: Silex

Originated as a MEMS PhD project at KTH...

1994
KTH, RISE

Microphone for turbulence research

1996
KTH, RISE, RADI

Miniaturised sensor for blood pressure measurements

1997
RADI, RISE

Clinical blood pressure measurements

2000
RADI, Silex, RISE

2004
Silex

MEMS fab

Production

... Silex has developed to the world's leading "pure-play" MEMS foundry. In 2021:
- turnover 98 MEUR
- 310 employees
From research to company: Ascatron

Silicon Carbide – SiC in early 1990’s immature for electronics...

1992
ABB RISE KTH

A joint research and development program for power devices - SiC epitaxy and processing

1999
RISE

Demonstration of 4.5 kV PiN diode.

Ascatron spin-out. Offers epitaxy and process services to global customers.

2002
Coherent

2020
II-VI Kista

2012
Ascatron

2016
Ascatron

Production of SiC epitaxial material on 150 mm substrates

3DSiC® JBS diode volume fabrication

... has been developed for advanced high power applications. In 2019:
• turnover 1.5 MEUR
• 13 employees
Success stories

Established at own fabs:

**Silex Microsystems**  
World’s leading pure-play MEMS foundry  
988 MSEK turnover and 292 employees (2020)

**II-VI Järfälla (former Syntune)**  
Optoelectronics for telecommunication  
302 MSEK turnover and 167 employees (2020)

Development / Production at Electrum Lab:

**IR-Nova**  
Imaging IR photodetectors and modules  
58 MSEK turnover and 28 employees (2020)

**On Semiconductor (former TranSiC)**  
Silicon Carbide based power devices  
29 MSEK turnover and 13 employees (2019)

**II-VI Kista (former Ascatron)**  
Pure play foundry for silicon carbide epitaxy and processing  
15 MSEK turnover and 13 employees (2019)

**KISAB - Kiselkarbid i Stockholm**  
Defect free silicon carbide substrates  
9 MSEK turnover and 9 employees (2020)

*And several other companies are using the lab services…*

In total (2021):  
> 150 M€ turnover  
> 500 employees
Our start-ups

- **Altitun AB (1997)**
  - Optoelectronics for telecommunication

- **Optillion AB (1999)**
  - Optoelectronics for telecommunication

- **Silex Microsystems AB (2000)**
  - Micromechanic devices for opto and bio applications

- **Comlase NT AB (2001/2003)**
  - Pump lasers and coating technologies

- **Advanced Microwave Device Solutions AB (2001)**
  - High power/high frequency transistors in silicon carbide

- **PhoXtal Communications AB (2002)**
  - Optoelectronics for telecommunication

- **Replisaurus Technologies AB (2002)**
  - Electrochemical Pattern replication

- **IR-Nova (2003)**
  - Imaging IR detectors with high detectivity and resolution

- **TranSiC (2005)**
  - High power transistors in silicon carbide

- **Scint-X AB (2006)**
  - Imaging x-ray detector with high sensitivity and resolution

- **Micro Delta T (2007)**
  - Nanostructured surfaces for enhanced heat transfer

- **NanOsc AB (2007)**
  - Oscillators for telecommunication and other applications

- **Ascatron AB (2011)**
  - Pure play foundry for silicon carbide epitaxy and processing

- **Nocilis Materials AB (2011)**
  - Epitaxy of advanced Si-Ge-Sn-C alloys and energy harvesting

- **Spinn-Y AB (2011)**
  - Spin filter for electron spin polarization detection

- **Epiclarus AB (2012)**
  - Epitaxial growth of III-V material

- **Ascilion AB (2012)**
  - Pain-free glucose measurements

- **Neosense AB (2014)**
  - Sensor for real-time measurement of blood oxygenation

- **Aninkco AB (2015)**
  - Graphene based inks for printed electronics

- **KISAB - Kiselkarbid i Stockholm AB (2017)**
  - Defect free silicon carbide substrates

- **Bright Day Graphene (2017)**
  - Development of sustainable energy solution

- **NanoPro AB (2018)**
  - Consultancy and fabrication of semiconductor devices

- **Gatty Instruments AB (2018)**
  - MEMS based gas sensors

- **Nanosized AB (2018)**
  - Nanoparticle size determination for semiconductor industry

- **TeraSi AB (2020)**
  - MEMS based terahertz devices

- **3Bind Systems AB (2021)**
  - Systems for additive manufacturing
Electrum Laboratory invites you!

KTH and RISE in collaboration offer:

**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 and labs to rent
- Education in process technology, characterization and cleanroom infrastructure.
- Access to the lab resources at our collaboration partners within the Myfab network.
Thanks for your attention!