iemn

Institute of Electronics, Microelectronics and Nanotechnology

UMR CNRS 8520

Institute of Electronics, Microelectronics and Nanotechnology

MAy 2024 edition

EDITO

IEMN stands for Institute of Electronics, Microelectronics and Nanotechnology. The laboratory, located in the Hauts-de-France region, was created in 1992 to gather, in a unique research structure, disciplines contributing to the progress of electronics, physics, acoustics and their applications. Hence, such an organization was likely to facilitate interdisciplinary research on a wide spectrum of activities ranging from theoretical physics to telecommunication.

Thirty years later after its creation, with the institutional and financial support of five institutions (Lille University, CNRS, JUNIA/ISEN, Centrale Lille Institute and Polytechnic University Hauts-de-France), IEMN has become a major research centre in Micro and Nanotechnology in France, gathering 450 people, including 170 permanent (teacher)-researchers, 90 engineers and technicians, and 140 PhD students.

Today, the core of the institute's activities is centered on micro and nanotechnologies and their applications in the fields of ultra-high data rate communications, technologies for health, energy, transport, internet of things (IoT) and neuromorphic hardware technologies. In order to work on these topics, IEMN researchers have at their disposal exceptional experimental and technical facilities. A large part of the IEMN's research activities are carried out on two platforms, first, the Micro Nanofabrication platform (CMNF) dedicated to the technological fabrication of the next generation of micro-nano-electronic devices and, second, the Multiphysics Characterization platform (PCMP) dedicated to the characterization of materials, devices and systems. As a member of the RENATECH+ network, IEMN has cutting-edge equipment at the highest European level operated by a highly qualified technical staff within the CMNF and PCMP platforms. This facility has been recently supported by the NANOFUTUR Equipex+ program. IEMN is also a member of the GANEXT and STOREX Labex programs, and is a partner of the RS2E network and Graphene European flagships.

IEMN is organized into five scientific departments gathering the 22 research groups of the lab. Since 2020, the governance of the laboratory is assured by a director (Thierry Mélin, CNRS) and two deputy directors (Christophe Delerue, CNRS and Jean-François Robillard, CNRS) assisted by the administration and three councils (namely the Laboratory Council, the Scientific Council and the Technology Council.)

IEMN has numerous national and international collaborations with academic and industrial partners. Middle term joint programs have been established with industrial partners (common laboratories with STMicroelectronics, HCS Pharma and Horiba, Industrial Chair with MC2 Technologies, common IEMN/LEOST cluster). Since 2015, seven start-ups have been created with the support of IEMN by researchers who aim at transferring technological skills capitalized in the framework of research projects to the society in order to improve the daily life by addressing societal challenges.

IEMN is located in several places in Villeneuve d'Ascq, Lille and Valenciennes. The so-called central laboratory in Villeneuve d'Ascq is the largest building gathering the main technological facilities and the institute administration. The other units located on campuses in Lille and Valenciennes are also devoted to research and host numerous equipments allowing a link between the education and research.

Thierry MÉLIN
Director

Christophe DELERUE
Scientific Director

Jean-François ROBILLARD
Director of Technology

The laboratory

The Institute for Electronics, Microelectronics and Nanotechnology has been created in 1992 with the support of three regional partners: The University of Lille (ULille); the University of Valenciennes and Hainaut Cambrésis (UVHC); YNCRÉA ISEN and CNRS (National Center for Scientific Research), a government-funded research organization, under the administrative authority of France's Ministry of Research and Higher Education. The main objective was to gather, in a unique research structure, disciplines contributing to the progress of electronics, acoustics and their applications. Hence, such an organization was likely to facilitate interdisciplinary research on a wide spectrum of activities ranging from theoretical physics to telecommunication. Twenty-five years later, IEMN has increased in scope, doubled its staff, its budget is four times higher than at the beginning and we can claim that original objectives are fulfilled.

Today, nearly 450 people work together in a scientific field ranging from information and communication technologies to micro and nano technologies. The scientific policy of the laboratory is determined within research groups and five research departments promote emerging activities. Middle term joint programs with industrial partners or other national institutions and long-term research initiatives stimulate the resourcing of our research projects. Thanks to the constant financial support of the Hauts de France Regional Council combined with those of our trustees, IEMN features exceptional technical facilities. As a member of the Basic Technological Research Network (BTR RENATECH) with four other CNRS laboratories involved in micro and nano fabrication, IEMN offers to the scientific community a technical platform ranking among the best in Europe. IEMN is strongly involved in IRCICA, the Institute for Advanced Communication, where IEMN research groups work together with researchers from software and physics background.

In 2015, IEMN has been asked to work with the Laboratoire d'Electrotechnique et d'Electronique de Puissance (L2EP) on a project of integration. After a few meetings at the board of direction scale and an introduction made by L2EP to IEMN, a task force has been settled in order to identify existing common studies. Scientific committees of both laboratories have been committed to establish a joint scientific project. The outcome was presented and it has been decided to pursue the process during the next period. A joint text has been written and it presented in the project section of this report.

IEMN is located in several buildings in Villeneuve d'Ascq, Lille and Valenciennes. The so-called central laboratory is the largest building and it regroups all the main technological facilities and the institute administration. The other units located on the ULille, UVHC campus and in Lille YNCRÉA ISEN building are also devoted to research and host various equipments allowing us to make a link between the education at master and engineer levels and research.

In a few figures...

6 research internal flagships:
- Neuromorphic Technologies
- Technologies for Health
- Transportation
- Telecom UHD
- IoT Make Sense
- Smart Energy

3 transverse projects:
- Materials
- Micro & Nano Devices
- Nano Characterization

1600 m² of clean rooms

79 engineers and technicians

154 PhD students, Post-doct

2 platforms:
- Micro and Nano Fabrication Center
- Multi-Physics Characterization Platform

1400 m² of laboratories

175 researchers and research teachers

30 different nationalities

5 research departments:
- Materials, Nanostructures and Devices
- Micro/Nano/Bio Systems, Waves and Microfluidics
- Micro Nano Optoelectronics
- Telecommunications Technologies and Smart Systems
- Acoustics and Integrated Systems

22 research groups:
- EPIPHY: EPItaxy and PHYsics of heterostructures
- NCM: Nanostructures, nanoComponents & Molecules
- PHYSICS: Nano materials physical properties
- SUBLAMBDA: Opto and Micro Electronic Devices
- THZ PHOTONICS
- PUISSANCE: Microwave Power Devices
- ANODE: Advanced NanOmeter Devices
- CARBON: Graphene based devices
- OPTO: Optoelectronics
- MITEC: Microtechnology and Instrumentation for Thermal and Electromagnetic Characterization
- ACOUSTICS
- TPIA: Transduction, Propagation and Acoustic Imaging
- MAMINA: Materials and Acoustics for MIcro and NAno integrated systems
- NANSEE
- BIOMEMS
- AIMAN-FILMS: Magneto-Nano-Electronics - Active structures, MEMS and flexible structures Ultrasonic thermography - Micro-Fluidics
- NAM6: The Micro and Nano Systems
- COMNUM: Digital Communications
- CSAM: Circuits systems and Application of Microwaves
- TELICE: Telecommunication, Interference and Electromagnetic Compatibility
- MICROELEC SI
- WIND: Wide Bandgap Semiconductor devices

IEMN

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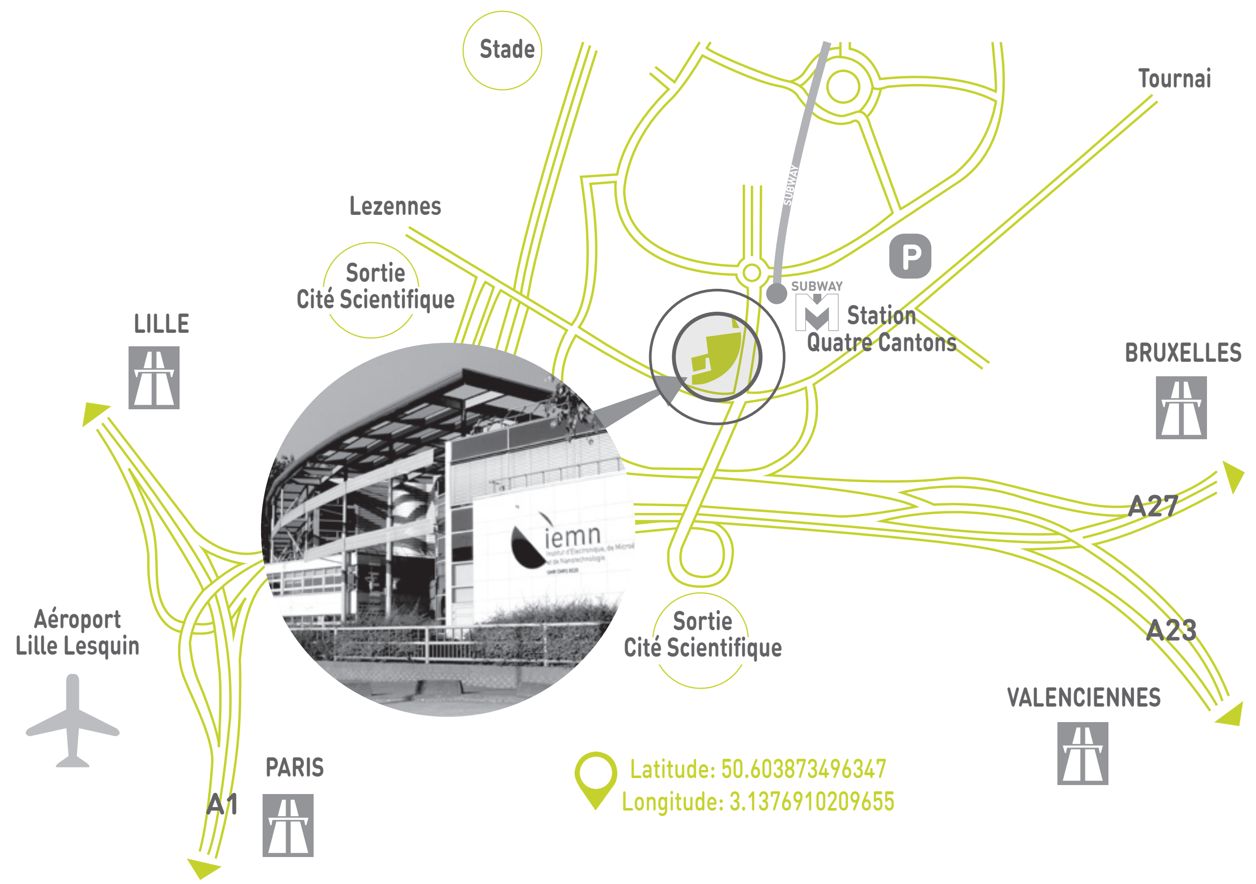


By train

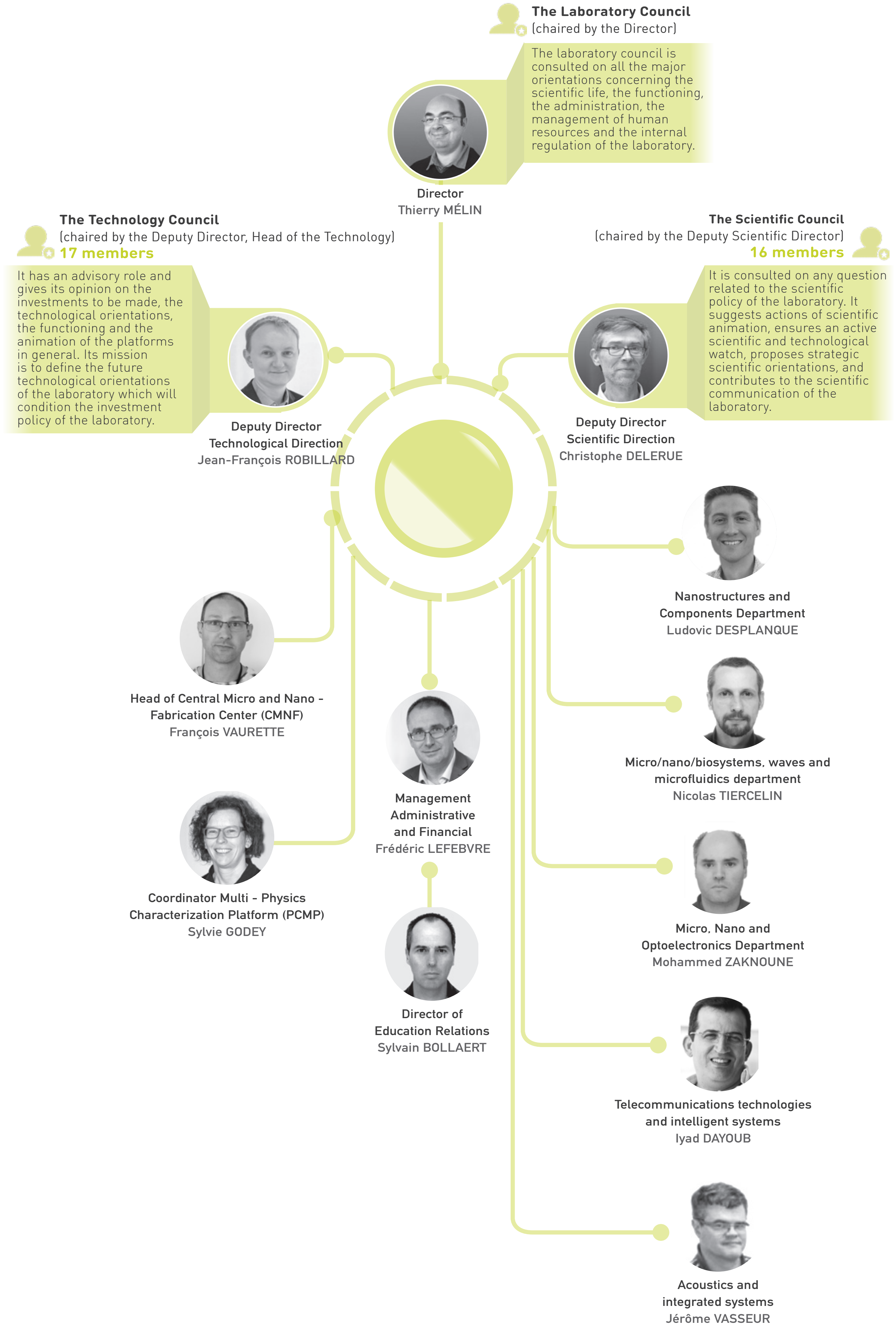
• From the "Lille Flandres" SNCF station
Take the metro line 1 → direction 4 Cantons and get off at the station " 4 Cantons ".
• From the "Lille Europe" SNCF station
Take the metro line 2 → direction St Philibert, change at Lille Flandres station.
Then take line 1 → direction 4 Cantons and get off at "4 Cantons" station.
• At the exit of the "4 Cantons" metro station → turn left and walk up Avenue Poincaré for about 150m. You are now at the IEMN.

By plane

Lille-Lesquin airport is linked to the centre of Lille by shuttle bus (indicative journey time: 20 minutes).
• The shuttle bus stop in the airport is located in front of the arrivals hall.
• In Lille, it is located in rue Corbusier, Centre Eurallile.

By car

• Coming from Lille, Paris, Valenciennes or Brussels → take the direction Gent and exit at Cité Scientifique. You are on the Lille1 campus.
• Coming from Gand → take the direction of Paris and exit at Cité Scientifique.



Central platform of MICRO-NANO-FABRICATION

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IEMN stands for Institute of Electronics, Microelectronics and Nanotechnology, a laboratory created in 1992 by five institutions: Lille University, Polytechnic University hauts-de-france, JUNIA/ISEN, Ecole Centrale Lille and CNRS. IEMN's research is performed based on a strong connection between its technical (Micro Nanofabrication and Multi Physics PlatForm PCMP) where cutting-edge equipments are operated by a highly qualified technical staff.

The scientific policy of the Institute is declined in five research Departments:

- Materials, Nanostructures and Devices
- Micro/Nano/Biosystems, Waves and Microfluidics
- Micro, Nano and Optoelectronics
- telecommunications Technologies and Smart Systems
- Acoustics and Integrated Systems

At the forefront of education and technological research, and owing to numerous dynamic international collaborations, IEMN hosts PhD and graduate students coming from 30 different countries. Nearly 500 people work in IEMN fields of research, mainly Information Communication Technology and Nanotechnology. IEMN's devices can be found in Electronics, Energy, Biotechnologies, Sensors and Instrumentation applications. Moreover, as evidenced by numerous patents plus spin-off's creations, IEMN demonstrates its efficiency in promoting and facilitating technology transfer of innovations emanating from its research groups.

5 RESEARCH DEPARTMENTS AND 22 RESEARCH GROUPS

Materials, Nanostructures and Devices

- EPIPHY: EPItaxy and PHYsics of heterostructures
- NCM: Nanostructures, nanoComponents & Molecules
- PHYSICS: Nano materials physical properties
- SUBLAMBDA: Metamaterials and metasurfaces for wave control

Micro, Nano and Optoelectronics

- THZ Photonics
- PUISSANCE: Microwave Power Devices
- ANODE: Advanced NanOmeter DEvices
- CARBON: Graphene based devices
- OPTOelectronics
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- WIND: Wide Bandgap Semiconductor devices

Micro / Nano / Biosystems, Waves and Microfluidics

- BioMEMS
- AIMAN-FILMS: Magneto-Nano-Electronics - Active structures, MEMS and flexible structures Ultrasonic thermography - Micro-Fluidics
- NANSEE
- NAM6: The Micro and Nano Systems

Acoustics and Integrated Systems

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Telecommunications Technologies and Smart Systems

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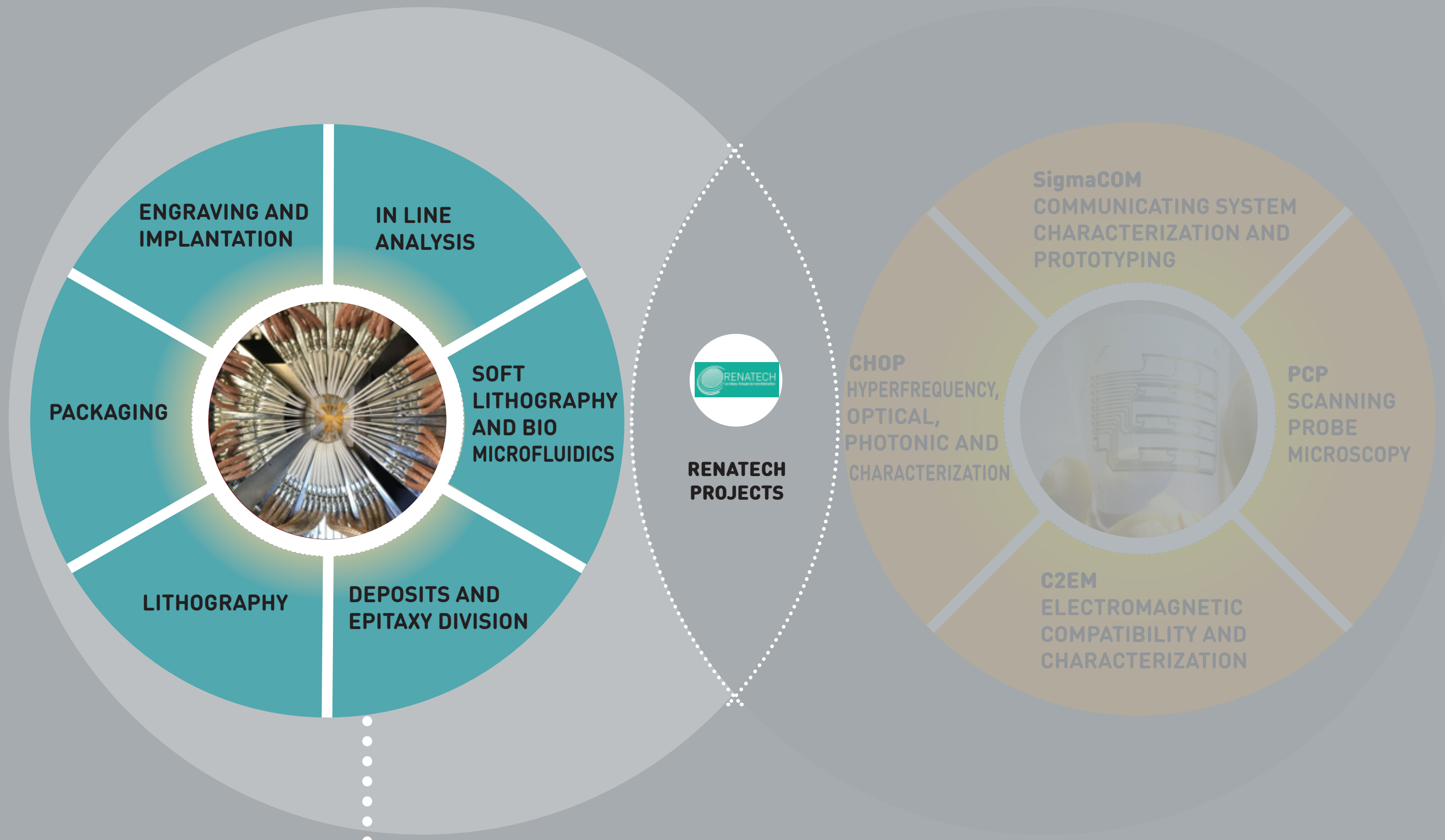

Central platform of MICRO-NANO-FABRICATION

IEMN's micro and nanofabrication facility is a 1600 square meter ISO6 certified cleanroom. Organised into six technological units: deposition and epitaxy, lithography, etching, integration, bio-microfluidics, characterisation and one unit of maintenance, the facility is equipped with a full line of cutting edge technological tools supporting device fabrication.

Primarily conceived as an electronics-based research facility, IEMN's clean room is now renowned as a multidisciplinary facility allowing state of the art device and advanced system fabrication in many research fields ranging from photonics to bioMEMS or acoustics. 20 high skilled engineers and technicians work full time to support the research activities and collaborative projects aiming at exploring uses of micro and nanofabrication. The IEMN micro and nanofabrication facility steadily aims to be at the best international research level in micro and nanotechnology to efficiently support academic institutions and companies that require the use of its large clean-room infrastructures. Thus, IEMN is part of RENATECH, the french national network of large technological facilities, that is an integrated partnership of 5 CNRS laboratories in the field of micro nanotechnologies. RENATECH facilities are opened to both academic and industrial partnerships. In this context, IEMN hosts innovative projects in the best possible conditions by sharing and providing the most advanced know-how in the micro and nanotechnology fields through an access to high technology equipment, staff expertise as well as required training support.

François Vaurette

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DEPOSITION & EPITAXY

Unit MOLECULAR BEAM EPITAXY

Deposition Manager : Isabelle Roch-Jeune
Epitaxy Manager : Christophe Coinon

**Materials engineering process refers to fabrication or modification of materials.
The aim is to obtain materials with specific structure, properties and performances depending on the application.
1 Full Time Employee**

MOLECULAR BEAM EPITAXY

Christophe Coinon

Molecular beam epitaxy (MBE) is a technique to growth crystalline over-layers and heterostructures on a crystalline substrate using atomic or molecular beams. These beams are produced by heating high purity solid source materials or by cracking very pure gases under ultra high vacuum, that then condensate on the substrate.

- Up to 3 inch wafer
- Around 200 epitaxial growths per year

• Epitaxial growth of III-V semiconductors

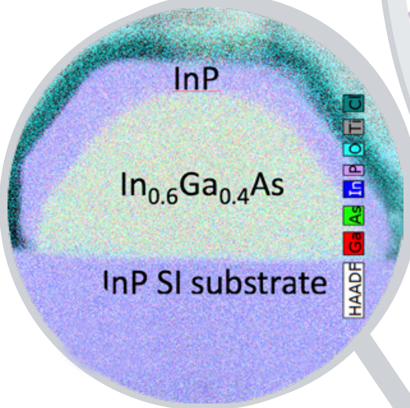
- RIBER COMPACT 21TM
- Effusion cells : Ga, Al, In, Si, GaTe, Be
- Gas injectors : AsH_3, PH_3, CBr_4
- Valved crackers : As, Sb
- Growth on 2 and 3 inch substrates
- RHEED up to 35 KV
- Temperature measurement by band edge thermometry

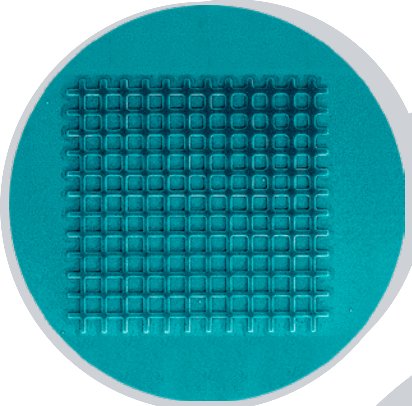
Epitaxial growth of TMDC

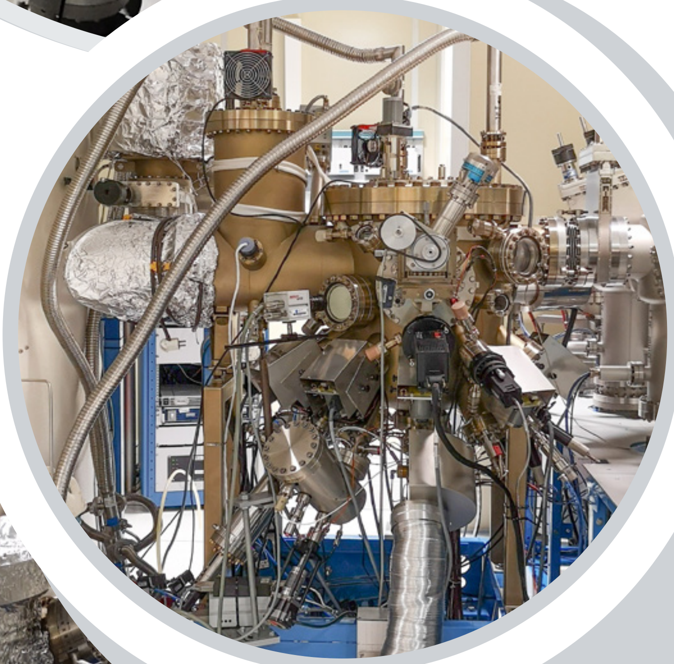
- MBE VINCI Technolgies reactor
- Effusion cells : Ga, In, Se
- Valved cracker : Se
- Linear UHV E-Beam source : Ta, W, Mo, Hf, Nb, Zr
- Up to 3 inch substrates
- RHEED up to 15 KV

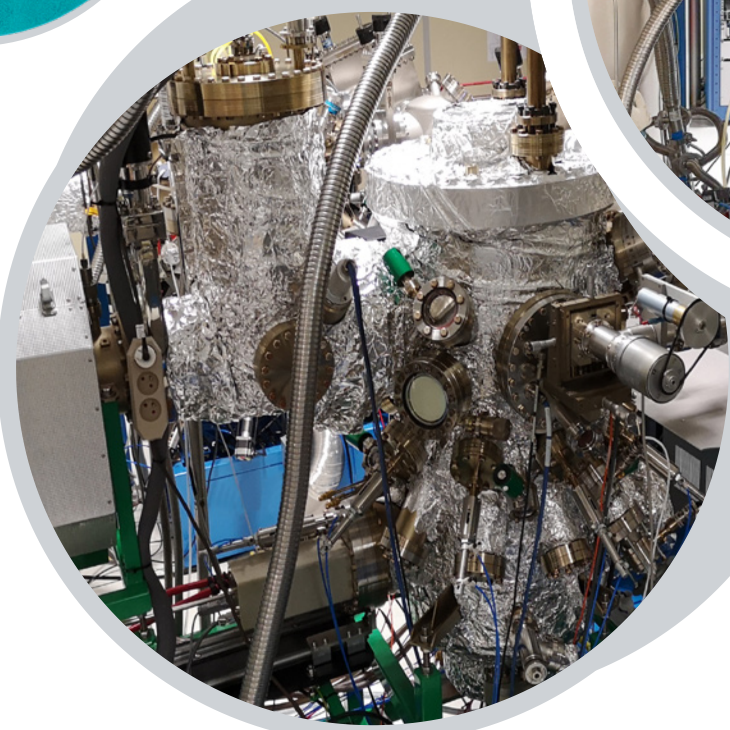
Epitaxial growth of Graphene and BN

- MBE RIBER Compact 21
- Carbon, boron & silicon solid sources
- Borazine B3N3H6 gas source
- N2 valved RF plasma source
- Sample holder heating T ≤ 1500°C
- In-situ characterisation by RHEED
- Coupled under UHV with a surface analysis chamber fitted with LEED and Auger spectroscopy









DEPOSITION & EPITAXY

Unit ORGANIC CHEMISTRY

Deposition Manager : Isabelle Roch-Jeune
Epitaxy Manager : Christophe Coinon

LABORATORY OF ORGANIC SYNTHESIS AND SURFACE FUNCTIONALIZATION

David Guerin

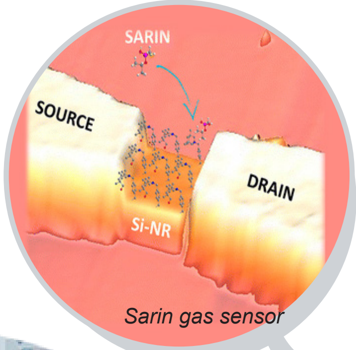
This laboratory is dedicated to chemical synthesis of molecules or materials designed for electronics or nanobiotechnologies. The main activity of the lab concerns the surface functionalization by molecules or by organic thin films. Self Assembled Monolayer technique (SAM) is used to provide specific physico-chemical properties to various surfaces, such as optical or electronical properties, wettability, encapsulation or specific chemical reactivity. Synthesis and grafting of nanomaterials on different substrates are also performed.

Synthesis under inert atmosphere

- Nitrogen glove box
- Schlenkware
- Vacuum / nitrogen manifold

Purification of solvents and organics

- Kugelrohr ovens
- Flash Chromatography
- Distillation
- Rotavapor
- Centrifuge



Sarin gas sensor

ORGANIC PLATFORM

David Guerin

Associated with the laboratory of organic chemistry, the organic platform is dedicated to the preparation of molecular and organic devices. Two connected glove-boxes (M-Braun model, O_2 and H_2O level < 1 ppm) permit to deposit on a substrate various organic materials (self assembled monolayers by surface chemistry or polymers by spin coating) then other organics or metals can be evaporated on-line (by joule effect at 10^{-7} mbar) without any contact with atmosphere.

Vacuum / nitrogen manifold

In addition of usual organic chemistry glassware, the lab is equipped with specific apparatuses for manipulation under inert atmosphere (schlenkware, vacuum/N_2 manifolds, glove box). Solvents, chemicals or nanoparticles can be purified by various equipments (distillation apparatus, Kugelrohr oven, rotavapor, flash chromatography, centrifuge).

Rotavapor

Kugelrohr oven

Flash chromatography

DEPOSITION & EPITAXY

Unit CHEMICAL VAPOR DEPOSITION

Deposition Manager : Isabelle Roch-Jeune
Epitaxy Manager : Christophe Coinon

Chemical vapor deposition process refers to chemical and thermal processes used to deposit or grow high purity conformal thin layers with a good uniformity.
1,85 Full Time Employees

AP-CVD and LP-CVD

Guillaume Cochez

APCVD (Atmospheric Pressure Chemical Vapor Deposition) and LPCVD (Low Pressure Chemical Vapor Deposition) refer to chemical and thermal processes used to deposit high purity thin layers with a good uniformity.

- Up to 4 inch wafer
- 5 process tubes

2 APCVD Tempress Furnaces

- 2 APCVD tubes for thermal oxidations of silicon wafers up to 1100°C with O_2 gas (dry oxidation) or H_2O vapor (wet oxidation) at atmospheric pressure.
- Thickness: from 2 nm up to 2 µm
- Applications: insulation, passivation, smoothing of side effects after plasma etching

3 dedicated LPCVD tubes (dry pumps)

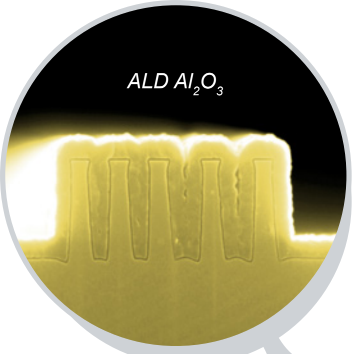
- Polycristalline silicon (≤ 600°C) and in-situ phosphorus doped polysilicon (650 to 750°C)
  - thickness up to 2 µm
- Low Temperature Oxide (SiO_2 deposition at 420°C), boro- (BSGLTO), phospho- (PSGLTO) or BoroPhosphoSilicate Glass (BPSGLTO)
  - thickness up to 5 µm
- Low stress (Si_xN_y) or stoichiometric (Si_3N_4) silicon nitride , 800°C
  - thickness up to 1 µm
- **Applications** → insulation, passivation, p-n junction
- Gas: O_2, H_2, SiH_4, PH_3, BCl_3, SiH_2Cl_2, NH_3, N_2, Ar

ATOMIC LAYER DEPOSITION

Atomic Layer Deposition (ALD) is an advanced thin film coating method which is used to fabricate ultrathin, highly uniform and conformal material layers.

- 2 process chambers
- 1 mono layer growth control
- 1 glove boxe (N, Ar)
- Up to 8 inch wafer

Al_2O_3, NiO, TiO_2, Ta_2O_5, TiN, TaN, ZrN, HfN, Pt...



Isabelle Roch-Jeune

→ TFS200 Beneq

- Flow through chamber
- Thermal enhanced reaction
- Pulsed or continuous.
- Chamber can be heated up to 500°C

9 precursors available

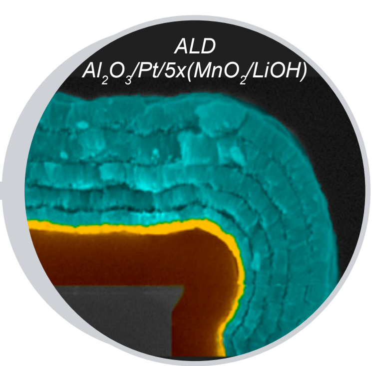
- 3 non-heated canisters : H_2O, TMA, $TiCl_4$
- 4 heated canisters up to 300°C : $MeCpPtMe_3$
- 4 gas lines: O_2, NH_3, H_2, Ar or N_2

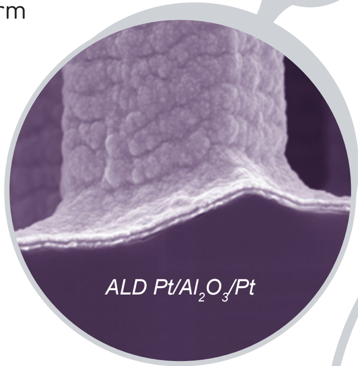
Maxime Hallot

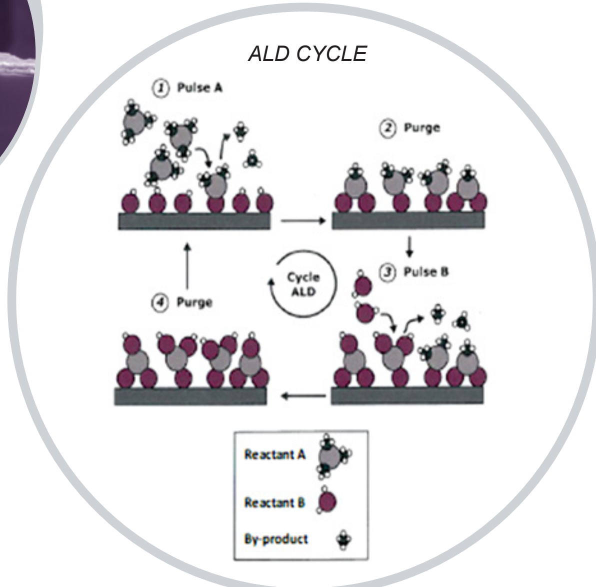
→ ALD PICOSUN - R200 advanced

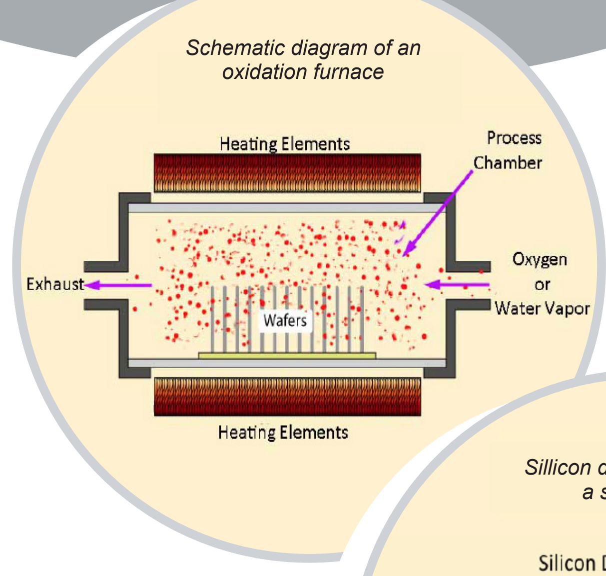
Through-porous and HAR samples

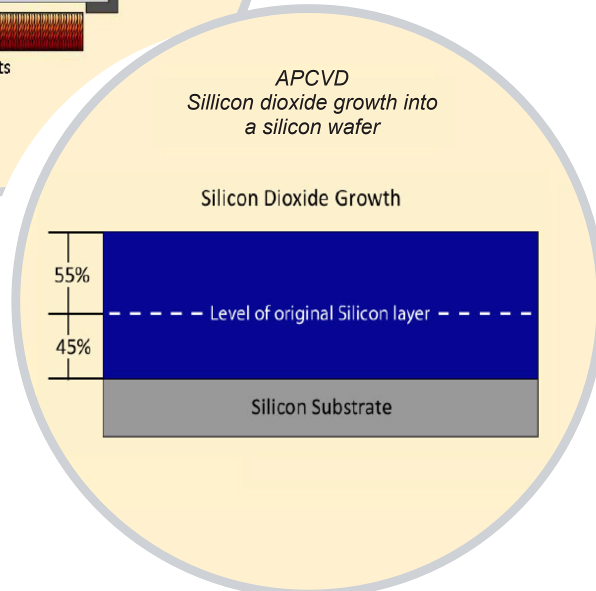
- Process temperature 50-500°C
- Substrate loading options
  Pneumatic lift
  Load lock with magnetic manipulator arm
- Precursors
  2 Liquid sources, 3 sources for solid,
  5 gases, Ozone

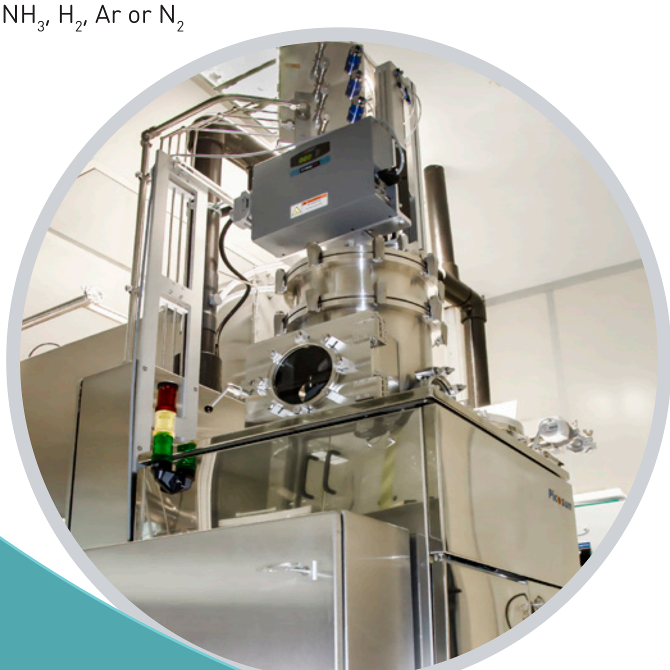












DEPOSITION & EPITAXY

Unit CHEMICAL VAPOR DEPOSITION

Deposition Manager : Isabelle Roch-Jeune
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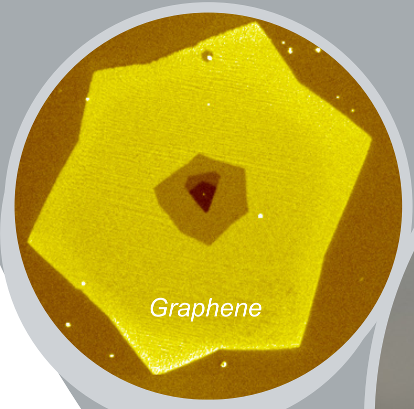
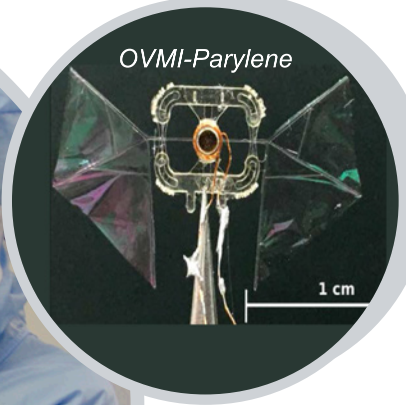
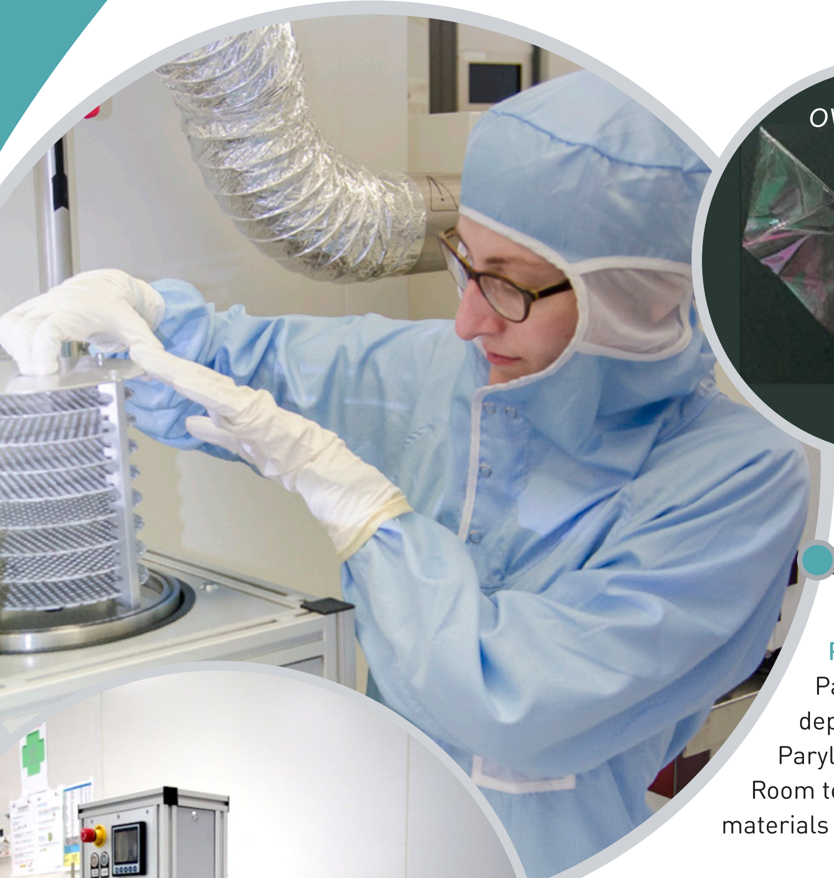
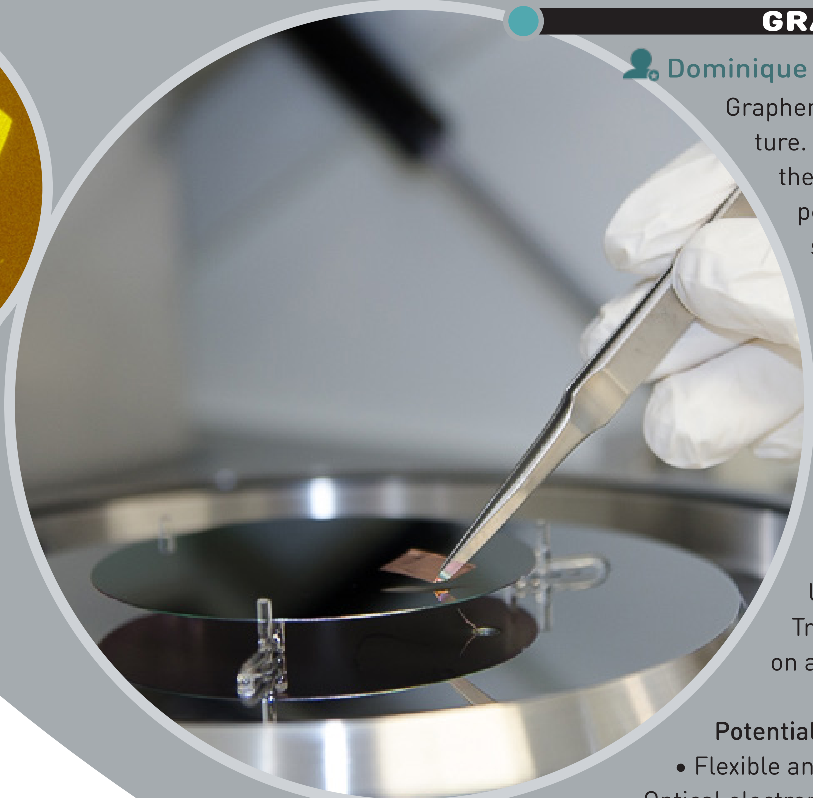








GRAPHENE

Dominique Vignaud

Graphene is a two dimensional carbon allotrope with a honeycomb structure. It is known to be a very light and strong material. It has excellent thermal, mechanical, optical and electrical properties. CVD is an inexpensive technique to produce large area graphene. It is done on metal substrates/layers where hydrocarbon precursors decompose and form graphene.

JETFIRST 100F Rapid Thermal Processor

- Materials: Cu, Ni foils or / and thin films
- Graphene growth in Ar / H_2 / CH_4, rapid heating and cooling ramps.
- Typical conditions on Cu : 980°C - 1050°C (10-100 sccm Ar, 1-200 sccm H2, 1-20 sccm CH_4, 10-20 Torr)

Growth of monolayers, multilayers, hexagonal domains
Up to 4cm² homogeneous graphene sheets optimized growth
Transfer technique by removal of the catalytic substrate and sticking on a large set of substrates (components, flexible).

Potential applications and fields of interests :

- Flexible and transparent conductors
- Optical electronics
- Bioengineering
- Energy technology and storage
- Components
- Sensors
- Composite materials

PARYLENE COMELEC C20S

David Guerin

Parylene thin film : COMELEC C20S

Parylene is the trade name for chemical vapor deposited poly(p-xylylene) polymer series.
Parylene C, D, N available.
Room temperature conformal depositions on a wide range of materials and shapes.

Room temperature deposition (3 steps):

- Vaporisation of the solid dimer
- Pyrolysis of the dimer to yield the monomeric diradical
- Simultaneous adsorption and polymerisation of the monomer on the substrate (at room temperature)

Thickness ranging from 30 nm to 50 µm

Characteristics of Parylene / fields of interests:

- Excellent electrical insulator / dielectric layer
- Biostable/biocompatible
- Highly conformal coating, homogeneous surface
- Very low permeability to gases
- Highly resistant to chemicals
- Device encapsulation/ Surface passivation or functionalization
- Shadow masks/ flexible substrates
- Bonding layers

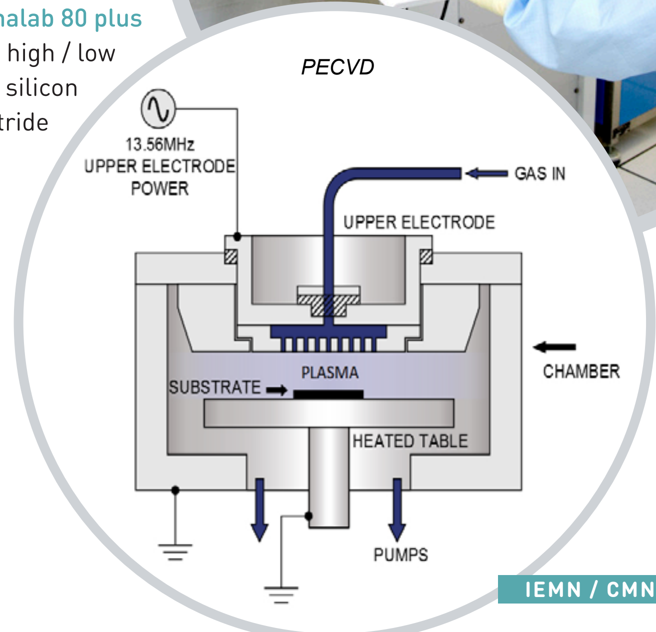
PLASMA-ENHANCED CVD

Plasma-Enhanced Chemical Vapor Deposition is a process used to deposit thin films from a gas state to a solid state on a substrate.

Oxford Plasmalab 80 plus

Film stress can be controlled by high / low frequency mixing techniques to deposit silicon nitride, silicon dioxide and silicon oxinitride

- HF 13.56MHz and BF 50 to 400KHz
- Gas: SiH_4 5% in N_2 - NH_3 - N_2O - N_2 - He and CF_4 / 20% O_2 - O_2
- Deposition temperature: between 100 to 340°C
- Deposition rate: between 100 to 700 Å/mn



DEPOSITION & EPITAXY

Unit PHYSICAL VAPOR DEPOSITION

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Physical vapor deposition is a vaporisation or condensation coating technique, involving transfer of solid materials onto a substrate.
2,2 Full Time Employees

The heat is provided either by joule heeting via a refractory metal element (resistive evaporation) or directly from a focused beam of high energy electrons (electron beam evaporation). More than 3000 depositions per year (Metal, Dielectric material, Magnetic layer)

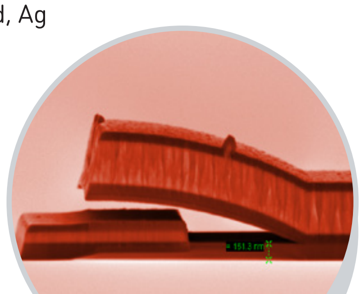
ELECTRON BEAM

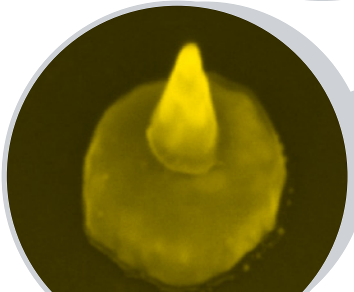
Marc Dewitte & Annie Fattorini

- 2 PLASSYS MEB 550S
- Load lock with substrate treatment (ion beam source 3cm)
- Capacity : 4 substrate holders 4 ''
- Materials: Au, Ti, Ge, Al, Pt, Ni, Mo, Cr, Pd, Ag

Marc Dewitte & Isabelle Roch-Jeune

- 1 PLASSYS MEB 550SL
- Load lock with O2 treatment
- Ion beam in chamber
- Capacity : holder 6''
- Materials : Ti, Ni, Cr, Al, Au, Pt, Pd, Ge


Ti/Au/Ti Cantilever


Cr/Au Nanoprobe

RESISTIVE (JOULE)

Marc Dewitte

- 1PLASSYS MEB 450S
- Load lock with substrate treatment (ion beam source 3cm)
- Capacity : 1 substrate holder 4''
- 3 sources: In, Cr, Au
- Substrate holder with planetary rotation

SPUTTERING SYSTEMS

The sputtering method involves ejecting material from a "target" onto a substrate by sending ions to the target.

- Up to 4" wafer
- 6 deposition process chambers

Marc Dewitte

- 2 ALLIANCE CONCEPT DP650

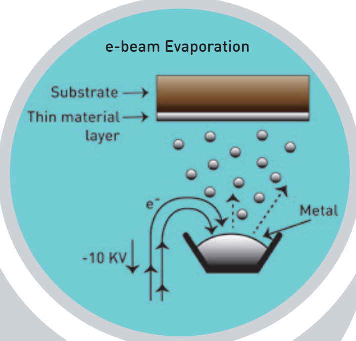
Cold or heated (750°c) substrate holder

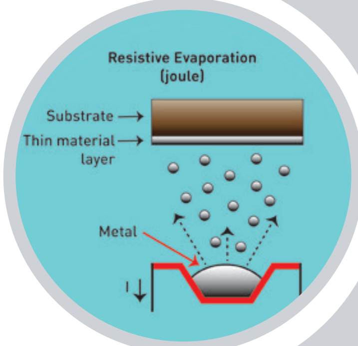
- DP 650n°24
- 4 cathodes 6''
- Powered with 1DC and 1RF source
- Deposited materials : Au, Al, Ti, Cr, Cu

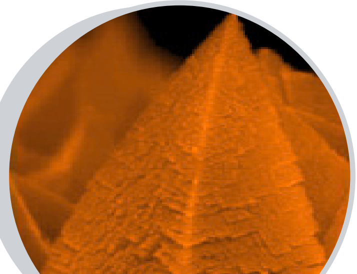
- DP 650n°34
- 6 DC and RF cathodes 4''
- Powered with 1 DC pulse, 1DC and 1RF source
- Deposited materials : Au, Ni, Pt, WTi, TiNi, W, Ta, NiCr, NiCu, TiN, TiC, Fe, Al, Mo, Cu, TaN, Ti, Si, SiO2, ZnO

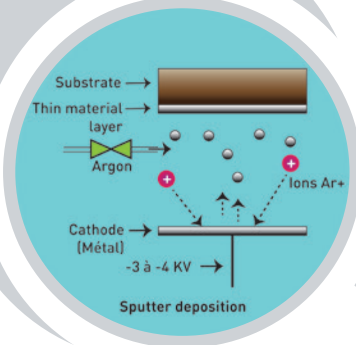
Nicolas Tiercelin

- 1 LEYBOLD Z550
- 1 cathode 6 " and 4 cathodes 4" RF and DC
- Magnetic layer deposition
- TbFe2, TbCo2, TbFeCo, FeCo, Fe, Co, CoPt, FePt, Ta, Cr






VN Sputtering - 550°C



Isabelle Roch-Jeune & Guillaume Cochez

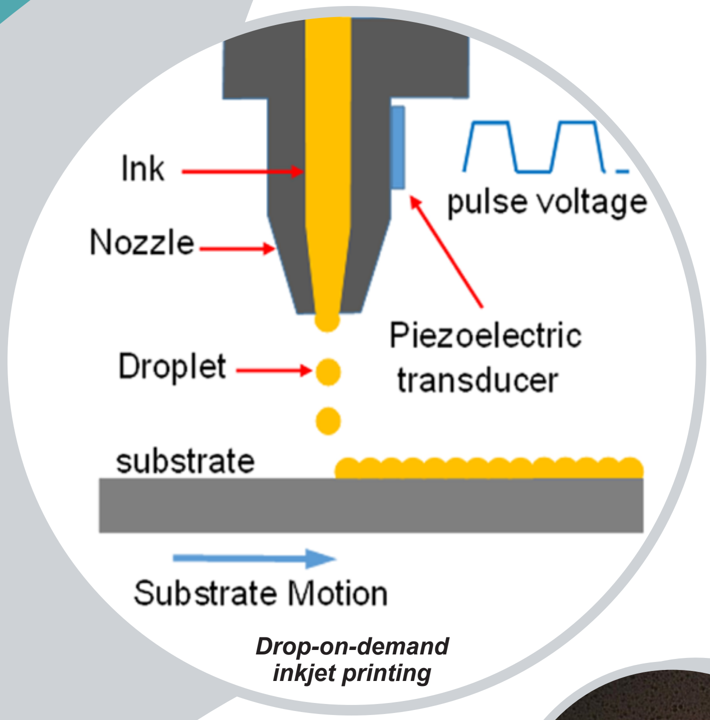
- 1 ALLIANCE CONCEPT CT 200 CLUSTER
- 14 targets, 3 chambers, fully automated sputtering cluster
- **Applications** → single or multi-layers processes, reactive sputtering , co-sputtering
- Realisation of complex structures without vaccum break and cross-contamination of chambers

	Chamber 1 Magnetic Multilayers/Metals (Fe, Co, Pt...)	Chamber 2 - Materials for storage energy (LMNO, WN, VN, LiPON...)	Chamber 3 - Photovoltaic materials AZO, Zn(Sn, Ge, Si)N_2
CHARACTERISTICS	• 6 x 2'' magnetron targets • Confocal sputtering • 2 DC-pulse source and 2-RF sources • Cold or heated (400°C) substrate with rotation for uniformity over 4" • Reactive sputtering of nitrides also allowed • Gas: Ar, N_2	• 4x 4'' (3'' also available) targets in planar mode • 1 DC and 1 RF power source. • Cold or Heated (800°C) substrate holder • Gas: Ar, N_2, O_2	• 3x 2'' magnetron targets in confocal mode + 1x 4'' magnetron target in planar mode. • 1 DC pulse, 1 DC and 1 RF source • Heated (400°C) substrate holder • Rotation for uniformity over 4" • Gas: Ar, N_2, N_2/5%H_2

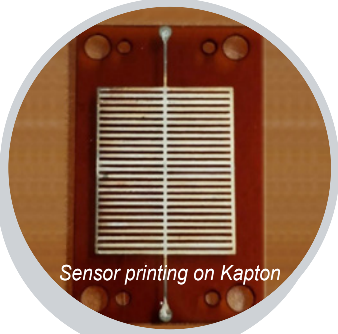
DEPOSITION & EPITAXY

Unit ALTERNATIVE DEPOSITION & HEAT TREATMENT

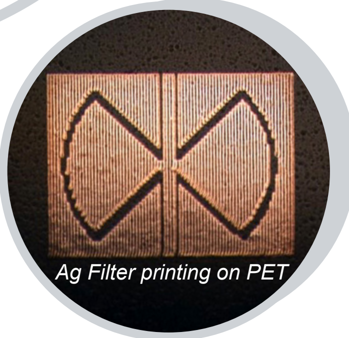
Deposition Manager : Isabelle Roch-Jeune
Epitaxy Manager : Christophe Coinon



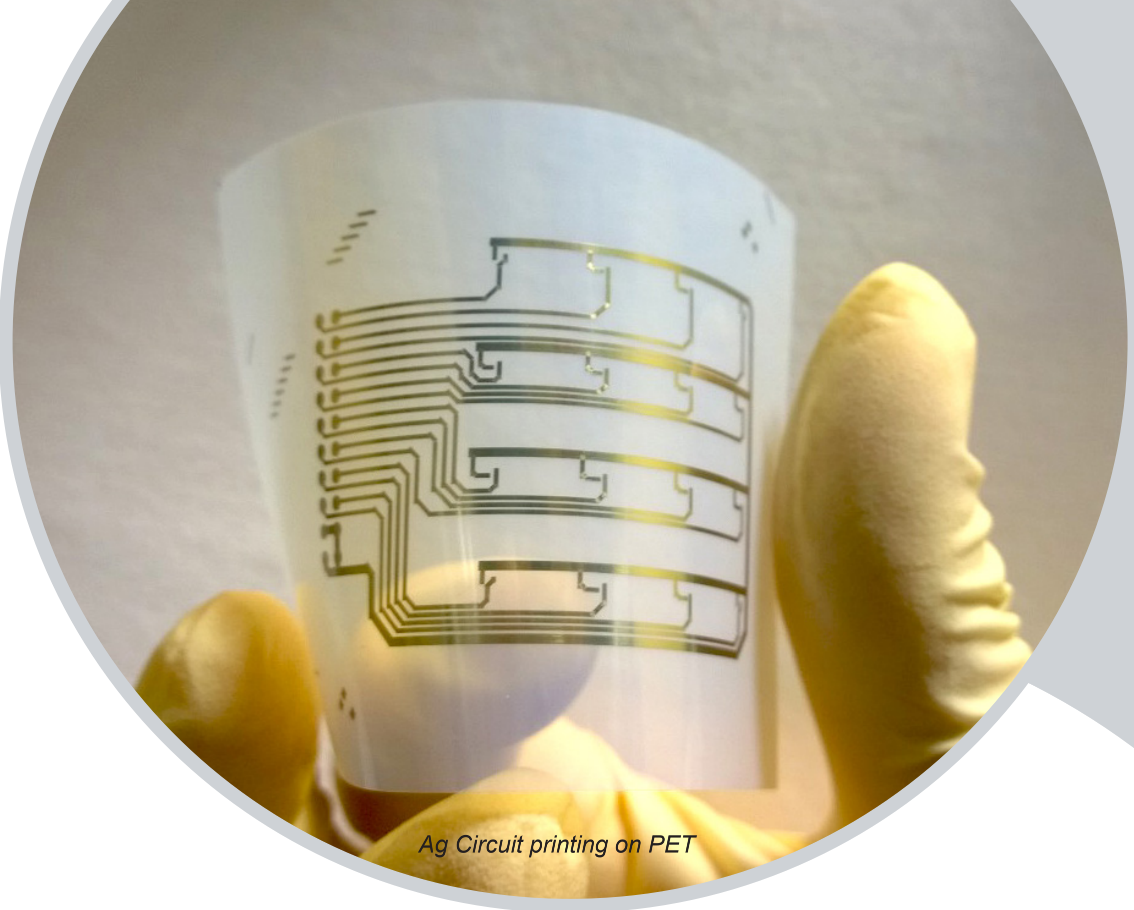
Drop-on-demand inkjet printing



Sensor printing on Kapton



Ag Filter printing on PET



Ag Circuit printing on PET

INKJET PRINTING

Isabelle Roch-Jeune

Powerfull digital materials deposition systems for printing of functional materials: printing onto rigid and flexible substrates

Ceradrop X-Series Inkjet printer

- 2 Dimatix Printhead (128 Nozzles each) Diameter of nozzles 35 µm
- 1 Mono nozzle printhead Diameter of Nozzle 20 µm, 30 µm or 35 µm
- 1 IR Dryer
- Printing with silver nanoparticles ink, biopolymer solutions and carbon ink

FURNACES

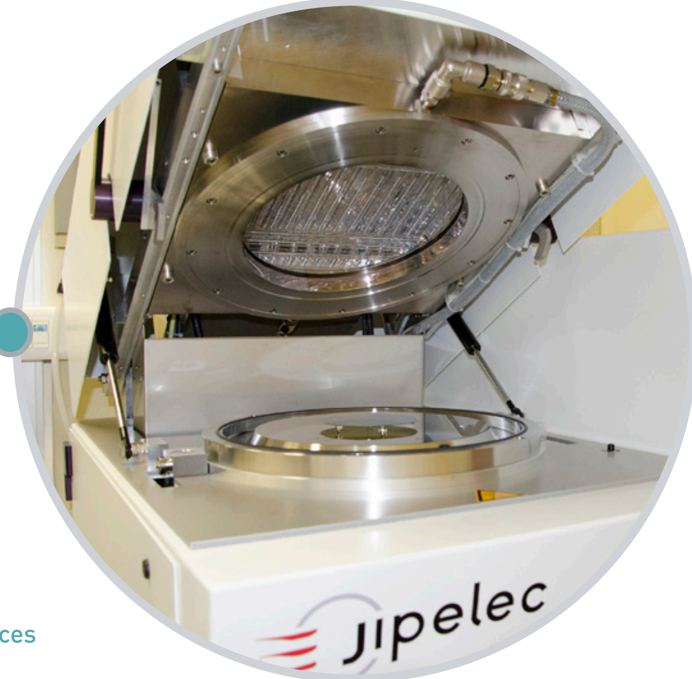
Marc Dewitte

Rapid Wafer Heating System
JIPELEC JETFIRST 200

- Range of temperatures : 100°C - up to 1100°C
- Samples to 8''
- Gas process : N_2 - N_2/5%H_2 - O_2 - Ar

2 Atmospheric Pressure Tubular Annealing Furnaces
CARBOLITE and VASSE

- Range of temperatures : from 100°C to 1000°C
- Samples to 3''
- Gas process : N_2- N_2/5%H_2- Ar



LITHOGRAPHY

Unit

Lithography Manager : Yves Deblock

- Pascal Tilmant
- Saliha Ouendi
- Christophe Boyaval

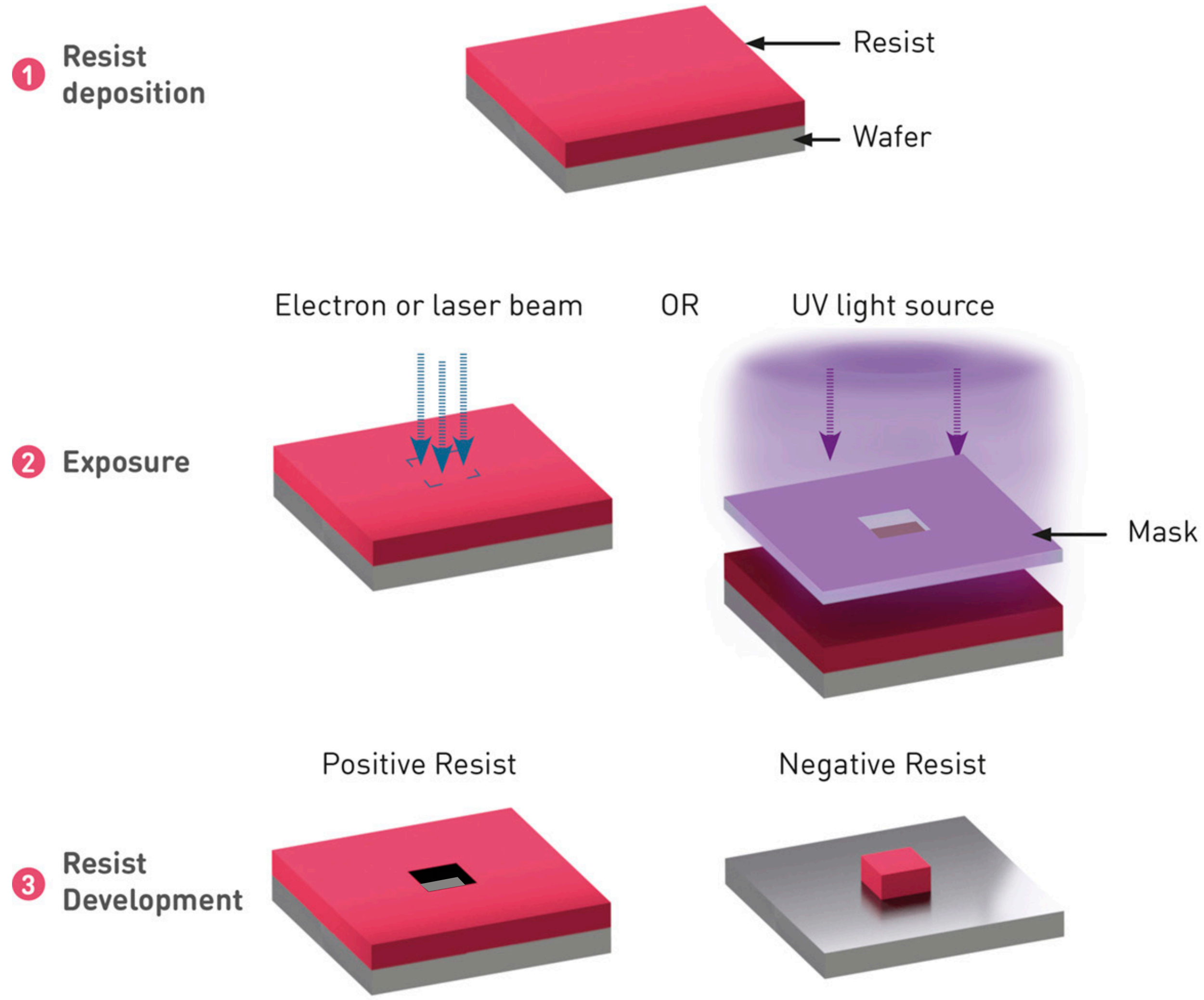
Lithography process gives the capability of patterning materials at micro and nanometer dimensions. It uses radiation (UV light or electrons) to pattern sensitive optical and ebeam resists.
4 Full Time Employees

SPIN-COATING

Pascal Tilmant, Saliha Ouendi, Francois Vaurette

The lithography process uses electron or laser beam to expose in an electron or light-sensitive resist or it uses light to transfer a pattern from a photomask to a light-sensitive chemical photoresist on the substrate.

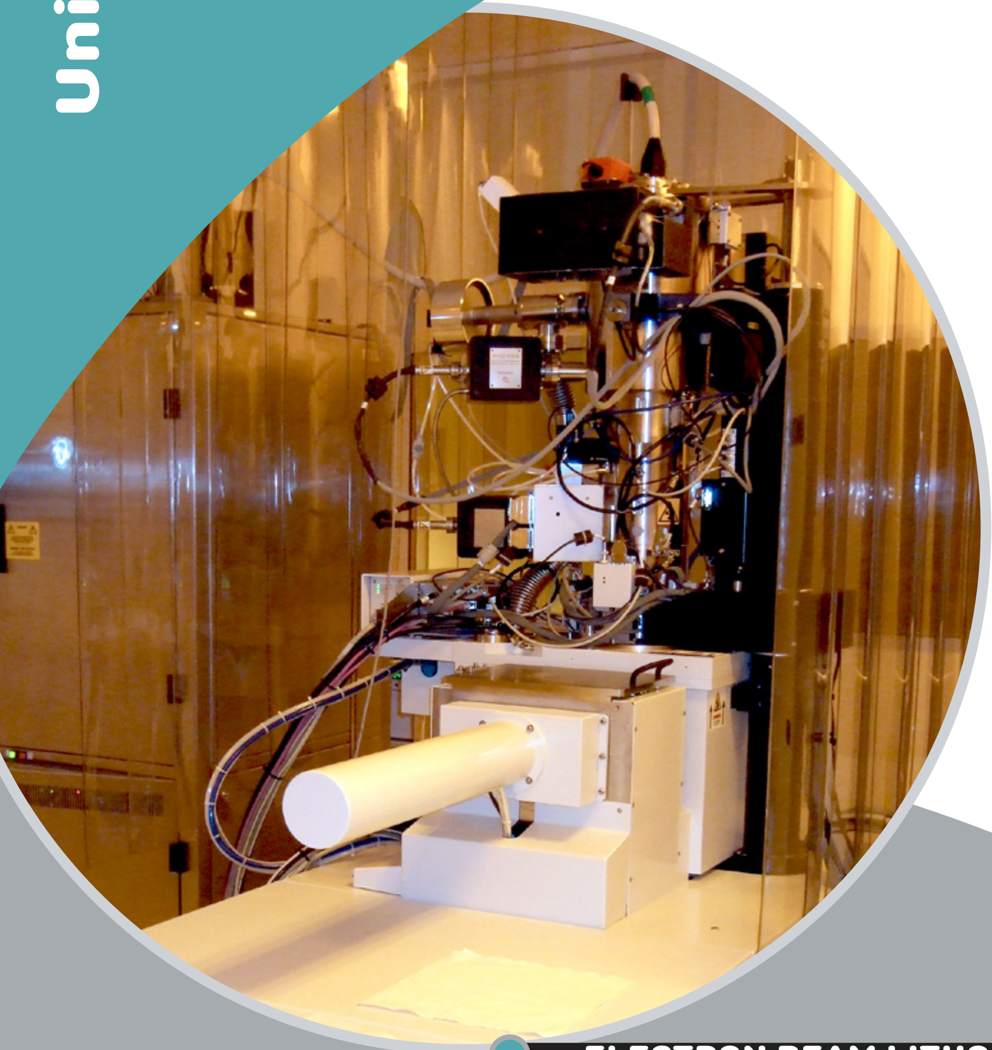
- From 1/4" to 4 inch wafer
- More than 30 resists available
- Optical resists: SU8 - 2000, AZ series, S1800 series, SPR series, PMGI, LOR, UV210, ARP5320, PDMS, BCB dry etch, BCB photosensible
- E-beam resists: - PMMA, COPO, CSAR62, MaN, UV210, HSQ



EQUIPMENTS	CHARACTERISTICS
NanoCalc Thin Film Reflectometry System	• NanoCalc UV2000 / UV / NIR • The NanoCalc-2000 can be used to measure the film thickness from 10 nm up to 250 µm
6 Gyrset RC8 and RCD8 spin coaters	• Wafer size from 3x3 mm to 4 inch and optical mask 4*4, 5*5 inch • System (EBR) edge bead remover for wafers and system auto cleaning with specific solvent
5 SSE Hotplates	• Controlled process with nitrogen until 300°C : uniformity 0.1°C • Programmable with lift pins
2 Sawatec Hotplates	• Controlled process with nitrogen and vaccum until 300°C : uniformity 0.1°C • Programmable with lift pins • Controlled ramp up, steps, dwell, and ramp down

Unit LITHOGRAPHY

Lithography Manager : Yves Deblock



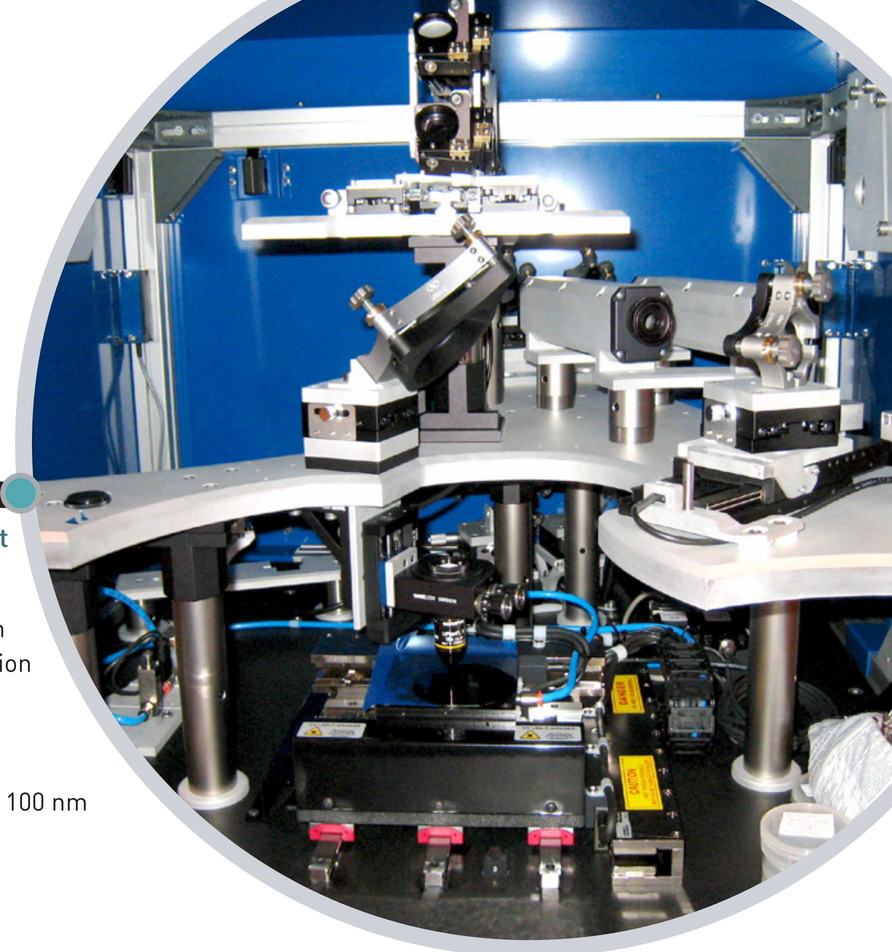
LASER LITHO 2D

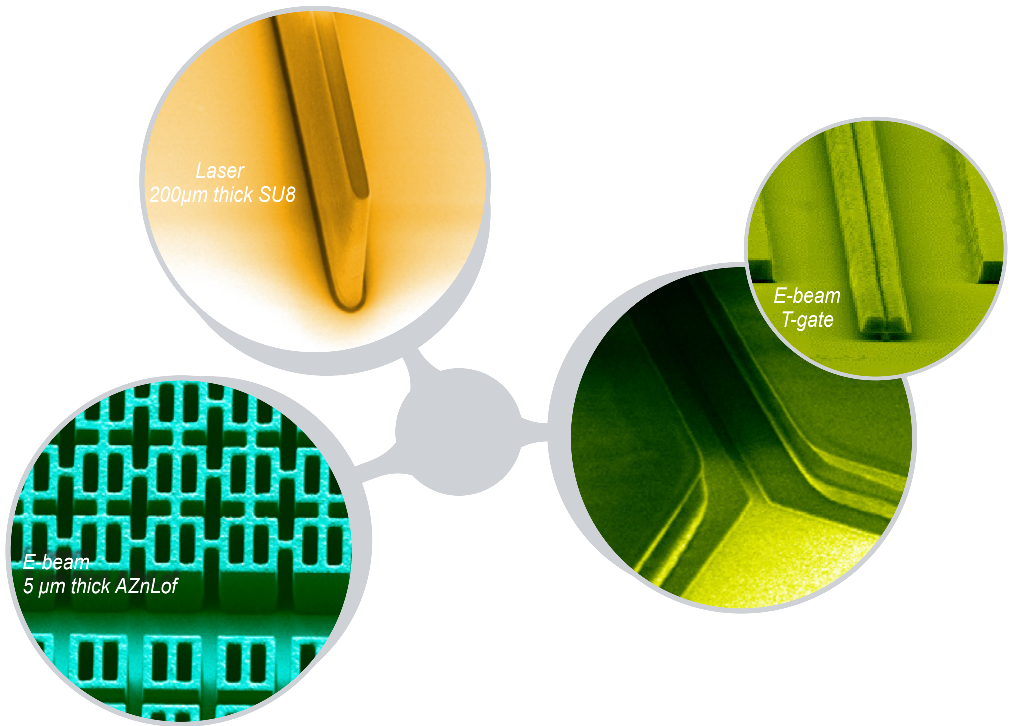
Francois Vaurette, Pascal Tilmant

Dilase 650 Kloé

High Resolution Direct Lithography System
for fast Prototyping and Maskless Fabrication

- Laser source 375 nm, 73 mW
- Wafer writing area 100 x 100 mm
- Laser spot size: 1μm and 10 μm
- Stage travel resolution and repeatability: 100 nm





ELECTRON BEAM LITHOGRAPHY

Yves Deblock, Saliha Ouendi, Francois Vaurette

E-beam lithography is a lithographic process that uses a focus beam of electrons to define in an electron-sensitive resist custom patterns. The solubility of this resist is changed by the electron beam. Therefore, there is a selective removal of the resist by immersing it in a solvent (development).

Two beam writers EBPG 5000 plus

- More than 2000 writings per year
- From small sample (4mm x 4mm) up to 4 inch wafer
- E-beam resists: - PMMA,COPO,CSAR62,MaN,UV210,HSQ,...
  - Optical resists used in e-beam: AznLof, AZ15nXT, AZ40XT,...

EBPG 5000 Plus

- High Resolution Gaussian Beam System
- Thermal Field Emission Gun
- 50MHz Pattern Generator
- Minimum address grid 0.08 nm
- Maximum field size : 524 μm (DAC 20 bits)
- Interferometer stage, 0.6 nm positioning accuracy
- Acceleration voltage: 20kV, 50kV or 100kV
- Automatic 10 positions airlock
- Holders for 2" to 4" wafers , 3" to 5"masks and smaller piece parts
- Overlay and stitching better than 30 nm

Lithography Manager : Yves Deblock

MASK ALIGNERS

Pascal Tilmant, Saliha Ouendi, Francois Vaurette

2 Suss MicroTec MA6/BA6 Mask Aligner and Bond Aligner UV 240-365 nm

- Wafer size from ¼ to 4 inch and mask size: quartz 4*4 and 5*5
- Exposure mode: Proximity, soft, hard and vacuum contact
- Top side alignment (TSA) down to 0.5 µm, bottom side alignment (BSA) down to 1 µm
- Resolution with vacuum contact down to 800 nm with resist Aznlof 2020

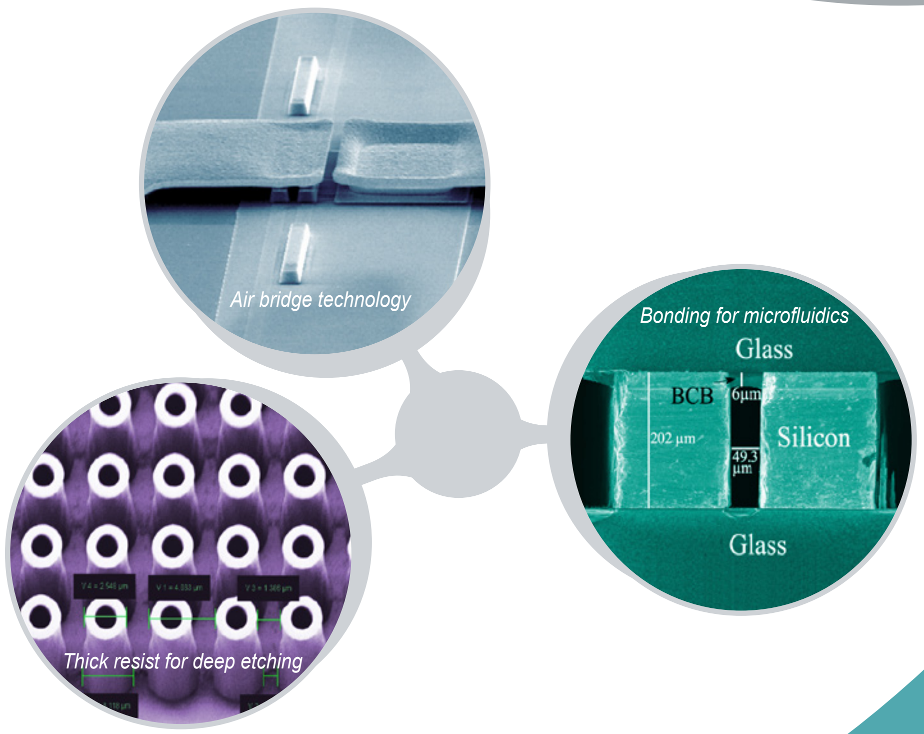
WAFER BONDING

Pascal Tilmant

1 Suss MicroTec SB6e Wafer Bonder in combination with MA/BA6 Mask Aligner

- For aligned and unaligned wafers using thermo-compression, anodic, fusion, adhesive, etc
- Wafer size: pieces smaller than 2 inch, up to 4 inch
- Aligned bonding: down to 3 µm depending on process conditions

	E-beam	Laser	Optical
ADVANTAGES	• High resolution (below 10nm) • No physical mask (computer file only) • High precision for overlay and stitching between 2 layers (better than 30nm) • Possibility to expose very small samples (4mm x 4mm)	• No physical mask (computer file only) • High focus depth (possibility to expose very thick resist)	• Exposure time (a few seconds) • Easy to use
DISADVANTAGES	• Proximity effect • Charging effect • Height measurement • Exposure time (50min for exposing 1mm2 - PMMA on GaAs, 1nA, 100kV)	• Alignment between levels (0,5-1µm) • Exposure time can be long depending on design	• Need a physical mask • Alignment between levels (0,5-1µm)
WHEN USE IT ?	• Design below 1µm • Alignment below 1µm	• Design above 1µm • Prototyping with no physical mask • Very thick resist	• Design above 1µm • Multiple wafers with same design



ETCHING & ION IMPLANTATION

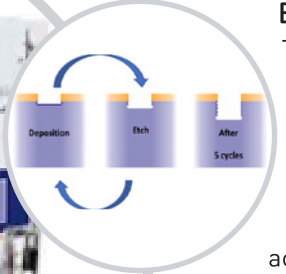
Unit

PLASMA ETCHING

Etching & Ion Implantation Manager: Dmitri Yarekha
• Timothey Bertrand • Laurent Fugère
• Jean Houpin • David Troadec

Etching is used in microelectronics to chemically or/and physically remove layers from the surface of a wafer during process. For many etching steps, part of the wafer is protected from the etchant by a «masking» material which resists etching.
4,5 Full Time Employees

DEEP SILICON ETCHING



Bosch process

The Bosch process is two steps process. It enables highly anisotropic deep silicon etching. It uses fluorine based plasma chemistry (SF_6), to etch the silicon combined with a fluorocarbon (C_4F_8) plasma process to provide sidewall passivation and improved selectivity to masking materials. A complete etch process cycles between etch and deposition steps many times to achieve deep, vertical etch profiles.

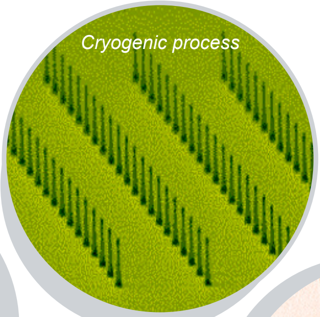
2 Bosch process based reactors:

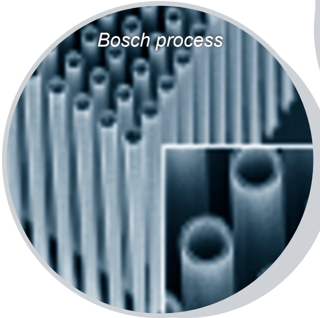
• **Oxford estrelas plasmapro100 with cryogenic capabilities:**
Dmitri Yarekha

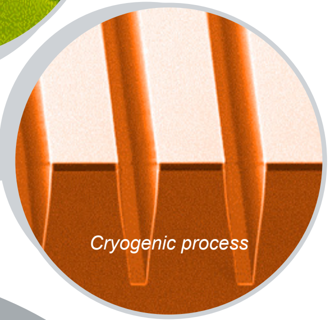
Estrelas is equiped with a **Cryogenic** electrode, that allows to do Si etching at very low temperature (-150°C min. Typically at -120°C / -90°C). No passivation steps or needed at low temperature to obtain anisotropic etching and at the same time it allows to obtain very smooth walls, which is very interesting for optoelectronics applications.

- Etch depth: wafer through
- Selectivity to PR > 250:1
- Selectivity to SiO_2 > 500:1
- Uniformity <± 3%

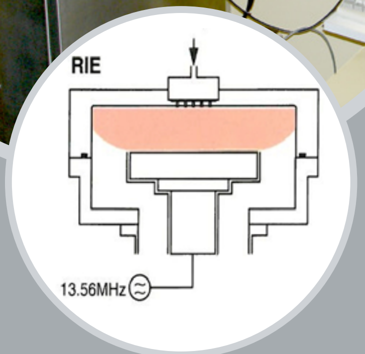
• **SPTS Rapier**
Marc Faucher


Cryogenic process


Bosch process


Cryogenic process

REACTIVE ION ETCHING (RIE)



Reactive Ion Etching (RIE) uses chemically reactive plasma and physical sputtering to remove material deposited on wafers.

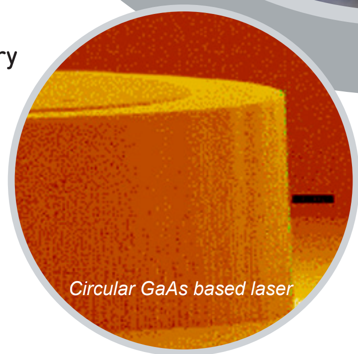
• **2 systems OXFORD Plasmalab 80plus**
- Single 600W RF plasma source determines both ion density and ion energy
- Ion energy dependent on the RF power and process pressure
- Negative self-bias forms at the substrate electrode
- Gas : O_2, CF_4, CHF_3, SF_6, He, Ar, H_2, O_2, N_2
- Laser interferometry endpoint detection systems

INDUCTIVELY COUPLED PLASMA (ICP - RIE)

Timothey Bertrand Dmitri Yarekha

ICP source produces a high density of reactive species. Separate RF generators for ICP and electrode provide separate control over ion energy and ion density often achieving higher etch rate and lower damage. High process flexibility, can also be run in RIE mode for certain low etch rate applications. Materials etched are III-Vs, silicon, silicon oxides, several metals, glass,...
All of our etching chambers are equipped with laser interferometry endpoint detection systems.

• **OXFORD Plasmalab System 100 dual chamber cluster ICP 180**
Two process chambers
- Gas chamber 1 : CH_4, H_2, Cl_2, O_2, SF_6, Ar
- Gas chamber 2 : Cl_2, BCl_3, O_2, SF_6, Ar
- The system includes wafer clamping and helium cooling, providing temperature control (range 5°C to 60°C)


Circular GaAs based laser

• **SENTECH SI 500:**
- Gas: CH_4, H_2, Cl_2, O_2, SF_6, Ar, Cl_2, BCl_3, HBr
- Providing temperature control (range -20°C to 250°C)
- For up to 200 mm wafers

SURFACE CLEANING AND TREATMENT

Dmitri Yarekha

• **Plasma system PVA Tepla 300 semi-auto**
Microwave plasma stripper
Dry process for photoresist stripping and substrate cleaning
Microwave plasma produces a very high concentration of chemically active species with low ion bombardment energy guaranteeing fast ash rate and a damage-free plasma
Tubular quartz chamber with 1000W microwave generator
Option : Faraday cage to reduce electro static discharge (ESD)
Gas : O2, Ar, CF4

• **NAVIGATOR 8**
Photo-resist stripping
Residues cleaning &
descum Surface activation
High plasma density ICP source
Gases: O2, CF4, N2
Power: 13.56 MHz, 1000 W
Pressure: 50 - 1000 mTorr
Chamber heating: 20 - 250 °C
Chuck heating: 20 - 250 °C

• **UV-ozone Cleaner :** Surface oxidation and cleaning by ozone combined with UV(254 nm and 185 nm)

ETCHING & ION IMPLANTATION

Etching & Ion Implantation
Manager: Dmitri Yarekha

Unit

CHEMICAL ETCHING

WET ETCHING

Wet etching is an etching process that uses liquid chemicals to remove materials from a wafer. Chemistry stations:

- Organic, halogeneous, inorganic acids
- Inorganic bases
- Halogeneous and non halogeneous solvents

TREATMENT AFTER WET ETCHING

Jean Houpin

Critical Point Dryer SCFluids (CPD1100)

The Supercritical CO_2 Dryer uses liquid and supercritical carbon dioxide to dry MEMS wafers efficiently and with high yield. Due to zero surface tension in the supercritical state of the CO_2, stiction, a most critical negative yield factor is avoided completely.

The standard used conditions are 76 bar and 40°C

Basic Characteristics:

Wafer max size : 6 inches
Wafer max thickness : 5 mm
Max pressure : 110 bar
Max temperature : 65 °C

WET ETCHING COMPARED TO DRY ETCHING

DRY ETCHING:

- Good Anisotropy
- To achieve small features
- High cost

WET ETCHING:

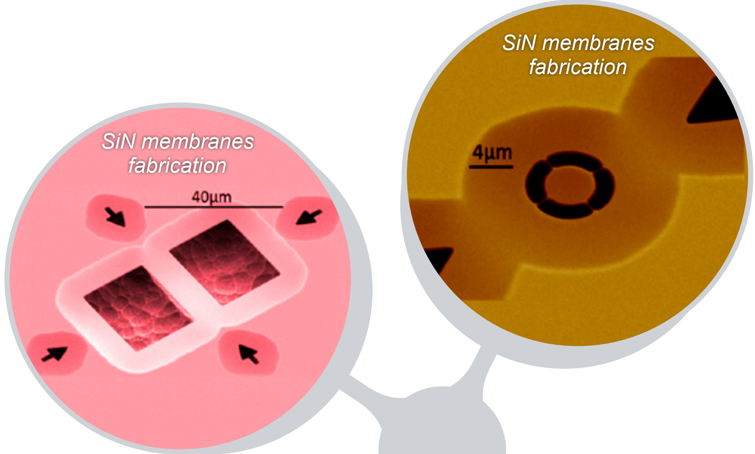
- Low cost, easy to operate
- Good selectivity for most materials
- Isotropic
- sensitive to changes in temperature

XeF2 ETCHING SYSTEM

Jean Houpin   Dmitri Yarekha

The Xactix® X4 SeriesTM is the XeF_2 etch system for releasing Silicon based MEMS devices.
It uses cyclic vapor exposition to isotropically dry etch sacrificial silicon:

- high rate silicon etching system with
- high silicon /silicon oxide selectivity



VAPOUR HF ETCHING SYSTEM

Jean Houpin

The fabrication process of MEMS devices in silicon microtechnologies involves as final step the releasing of the microstructures by an etching of a silicon dioxide sacrificial layer. The "vapour HF" technique gives access to a releasing process which is an alternative to the one including wet HF etching + CO_2 supercritical drying. Advantages of the "Vapour HF" technique are manifold, and come from the dry and anhydrous conditions the "Vapour HF" machine brings: stiction free releasing, carbon free surfaces, selectivity versus metals and silicon nitride.

The SPTS "uEtch" is a single-wafer system. Wafers from pieces to 8 inch can be loaded in the chamber. Using 5 different recipes calibrated on the machine, we are able to etch TOX with an etch rate of 100 Å/min to 1650 Å/min and a uniformity around 2% on 3 inch.

ETCHING & ION IMPLANTATION

Unit **ION BEAM**

Characterisation process refers to in-line inspection for process control and materials study. A wide range of techniques are available from optical, electrical, physical or mechanical.
3,5 Full Time Employees

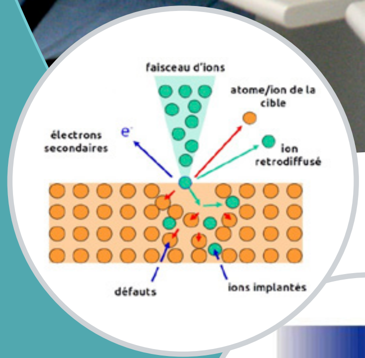
FOCUSED ION BEAM

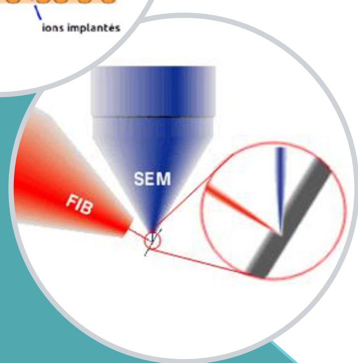
David Troadec

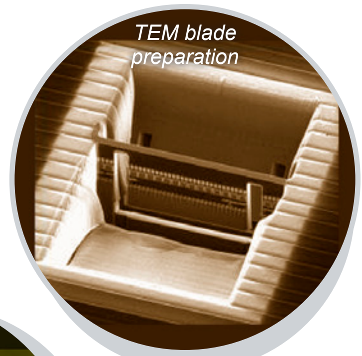
Dual beam system combines a high resolution secondary electron microscope (SEM) and a focus ion beam with gallium metal ion beam source (FIB) for nanoscale machining, patterning, and nanomaterials characterization.
Materials can be milled or deposited while observing the evolution of the surface topography with secondary electrons (SEM or FIB).

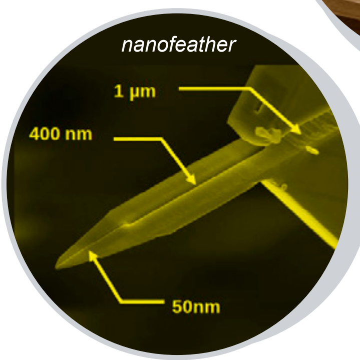
FEI Strata DB235
Stage: 5-axis eucentric, all motorized stage

- Ionic column
  - -Emitter (Gallium LMIS)
  - - Acceleration Voltage (5kV - 30kV)
  - - Probe Current (1pA - 20nA)
  - - Image Resolution (7nm)
- Electronic column
  - - Emitter (Field effect gun (Schottky))
  - - Acceleration Voltage (200V - 30kV)
  - - Resolutions (SEM: 3nm and STEM: 2nm)
- Detectors :
  CDEM, SED, in-lens, STEM
- Gas Injection System :
  Platinum, Tungsten and Carbon









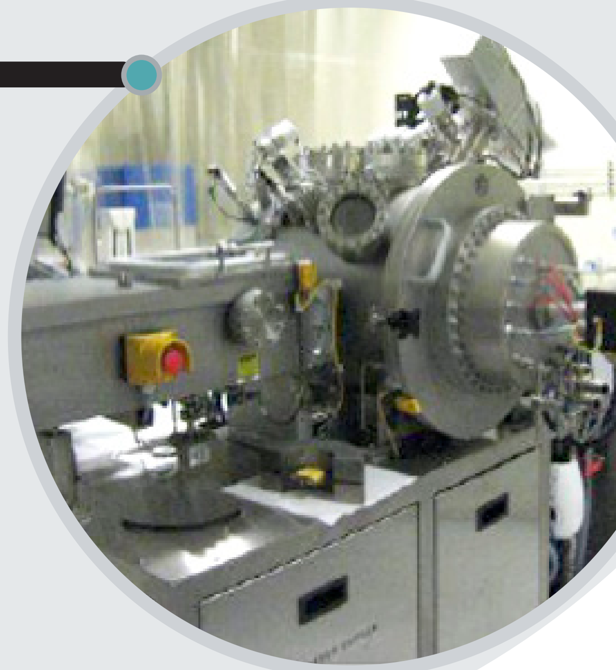
ION BEAM ETCHING (IBE)

Dmitri Yarekha

- High resolution (below 10 nm)
- Universal etchant
- No undercut
- monoenergetic beam - varied to suit experiments
- Field and plasma free - relaxes restrictions

IBE - Beam of neutral ions (Ar+)
RIBE - Beam of neutral and reactive ions (Ar+, O+ et O2+)

IonSys 500
Microwave ECR ion beam220 mm source
- ion energies from 100 – 1000 V
- ion current densities up to 1 mA/cm²
Tilting from 0° to 90°, ± 0.1°
Rotation from 2 to 20 rpm
Cooled substrate holder (-20°C to +50°C), helium backside
Six process gas lines: Ar, N2, O2, CH4, SF6, H2
Endpoint detection - SIMS



ION IMPLANTATION

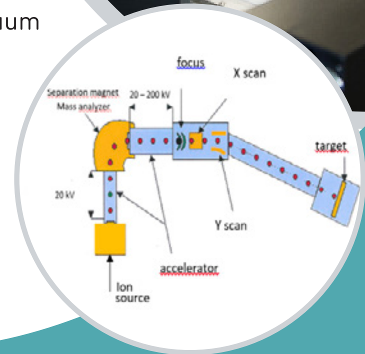
Laurent Fugere Dmitri Yarekha

Ion implantation is a materials engineering process by which ions of a material are accelerated in an electrical field and impacted into a solid. This process is used to change the physical, chemical, or electrical properties of the solid.

- Production and R&D chambers
- More than 250 implantations per year
- Up to 4 inch wafer
- Principal implanted species: As, P, Si, He, Ar, N, C, B, F

Implanter EATON-AXCELIS GA 3204
- Energy : from 5 keV to 200 keV
- Doze : from 1E11 at./cm²
- Sources: Gases, solid
- Tilt : 0° to 45°
- Twist : 0° to 360°
- Target carrier temperature: -10°C to +300°C

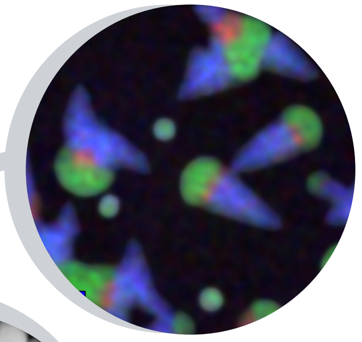
ANNEALSYS Rapid Thermal Annealing
- Temperature range: 100° to 1200°C
- Susceptors : Silicon or Graphite coated with SiC
- Operation : N_2, N_2H_2, High vacuum
- Up to 6 inches



CHARACTERISATION

Unit BEAM

Characterisation process refers to in-line inspection for process control and materials study. A wide range of techniques are available from optical, electrical, physical or mechanical.
3,5 Full Time Employees

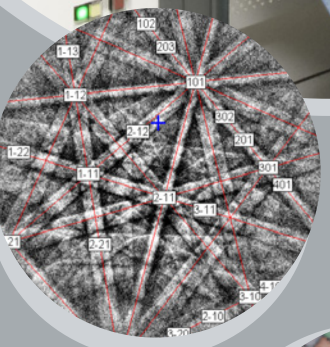


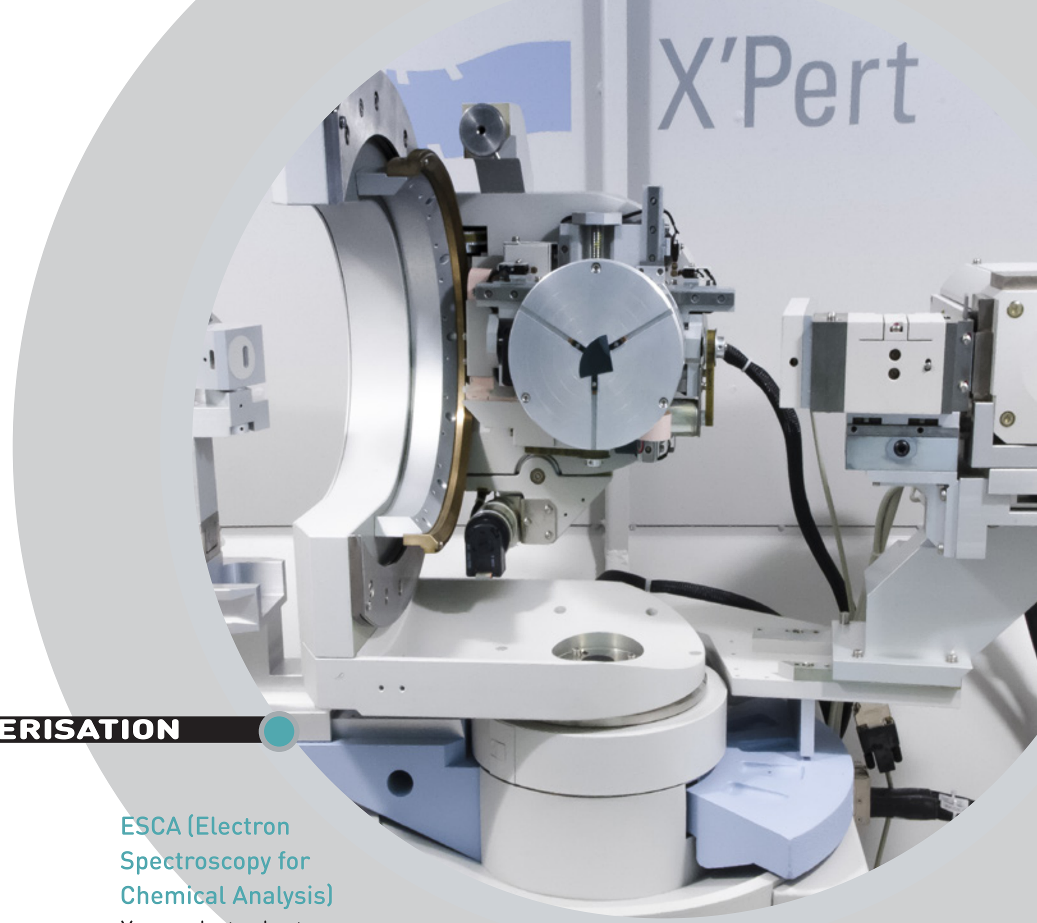
SEM

Christophe Boyaval

SEM (Scanning Electron Microscope) is a microscope that uses an electron beam to illuminate a specimen and produce a magnified image with a 1000 times higher resolution than optical light microscope.

Equipments
- ZEISS ULTRA 55 / EDS Bruker
- ZEISS SUPRA 55 VP / EBSD Oxford
- Maximum resolution : Close to 1nm @ 15kv
  Close to 3 nm @ 1kv
- Source type: Field effect gun
- Detector type: Inlens, Secondary and backscattered electrons
- Analysis: Chemical by EDS and Crystallographic by EBSD
- Wafer size: up to 6 inch
- Low Pressure: 1 to 133 mPa





PHYSICAL CHARACTERISATION

Christophe Coinon

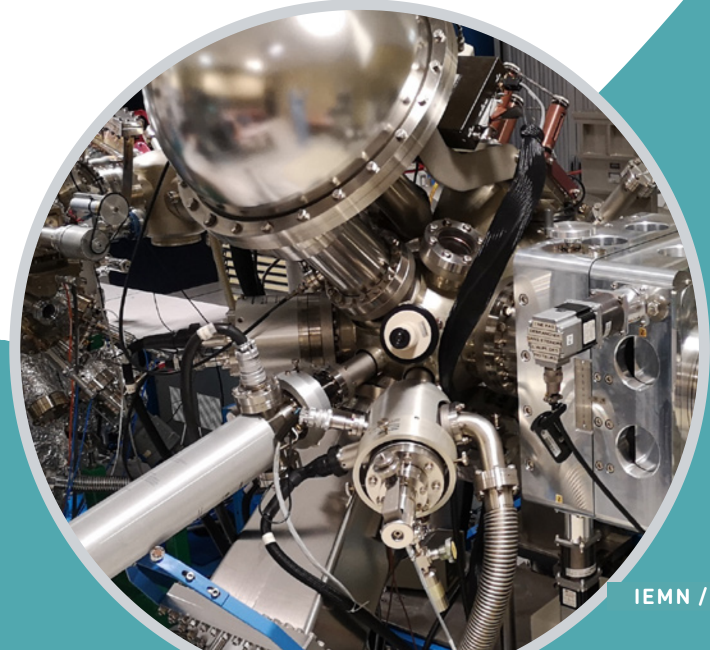
PANalytical X'Pert Pro MRD
TA-DA XRD (Triple and Double-Axis X-Ray Diffraction)
X-ray Diffraction is a tool used for determining the crystalline structure of solids, in which the periodic atomic arrangement causes a beam of X-rays to diffract into many specific directions. The structure is determined by measuring the angle and intensities of these diffraction peaks.

Applications →
- Alloy composition and thickness
- Control of lattice matching of epitaxial layers layers with the substrate
- Interface quality of superlattices
- Thin strained layers
- Relaxation rate, composition and tilt of mismatched layers

ESCA (Electron Spectroscopy for Chemical Analysis)
X-ray photoelectron spectroscopy (XPS) is a surface-sensitive quantitative spectroscopic technique. Based on the photoelectric effect, it allows determining the elemental composition at the parts per thousand range and the chemical state of the elements present within a material.

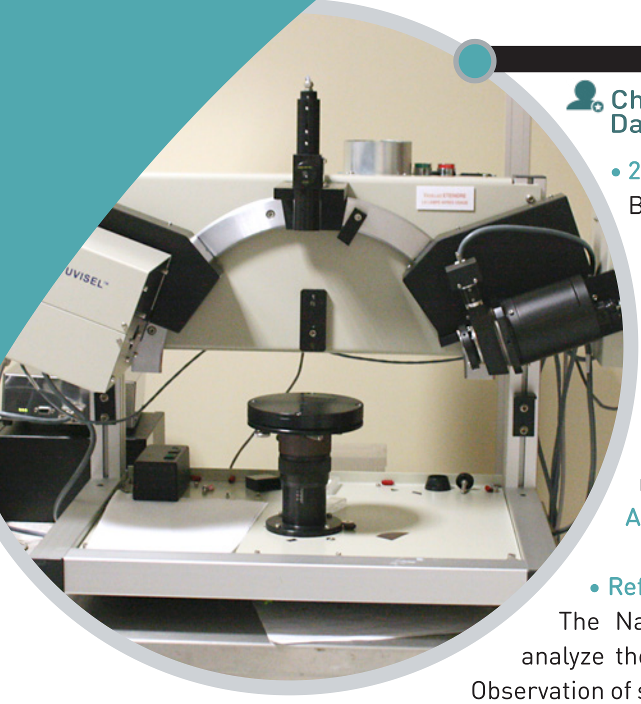
- Monochromatized XPS with ultimate resolution: 0.45eV
- UPS: HeI and He II excitations
- Low Energy Electron Diffractometer (LEED)

Applications →
- III-V MBE grown surfaces and interfaces
- Graphene
- Organic layers
- Characterization of process steps



CHARACTERISATION

Unit



OPTICAL

Christophe Coinon, Yves Deblock, David Guérin

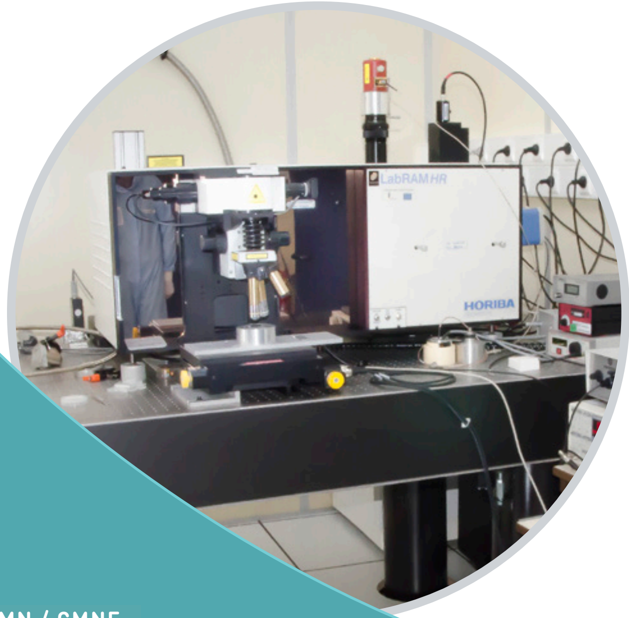
• 2 Horiba Jobin Yvon Spectroscopic Ellipsometers:
Based on optical polarisation for investigating the dielectric properties of thin films (complex refractive index, dielectric function). It can be used to characterise thickness, composition, roughness, crystalline nature, layer inhomogeneity (gradient, anisotropy). Single layers or complex multilayers from a few Å to several µm.
Uvisel: 200 nm - 2000 nm, variable angle, monochromator.
AutoSE: 440 nm - 1000 nm, mapping, spot views.

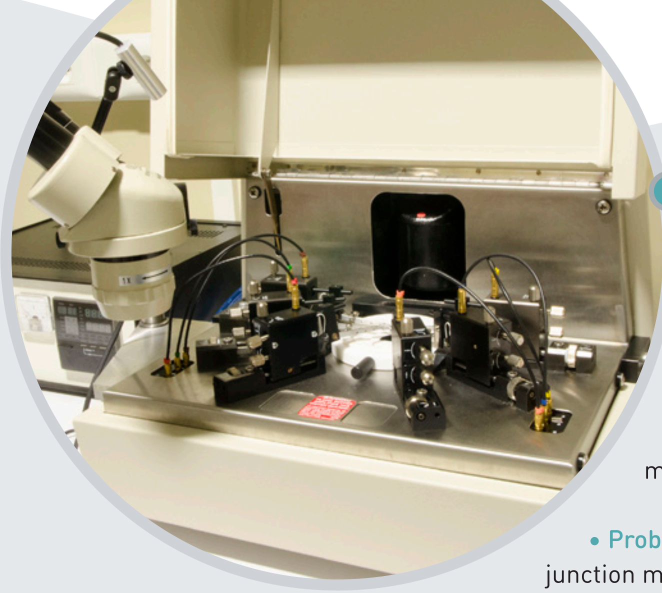
• Reflectometer
The NanoCalc Thin Film Reflectometry System allows to analyze the thickness of optical layers from 1 nm to 250 µm . Observation of single thickness with a resolution of 0.1 nm and single-layer or multilayer films in less than one second.

• µ-Photoluminescence & Raman Lab RAM HR
PL can be used for band gap measurement, alloys composition and thickness,
Interface studies of heterostrucutres.
Raman can be used for graphene (strain, doping, thickness)

• UV/vis Spectrometer (Perkin Elmer)
Absorption spectrum of liquids or thin films from 200 nm to 900 nm

• Mid/Near Infrared Spectrometer FTIR (Perkin Elmer)
Absorption spectrum by ATR, by specular reflectance or by transmission from 550 to 10000 cm-1 (1-20 µm)





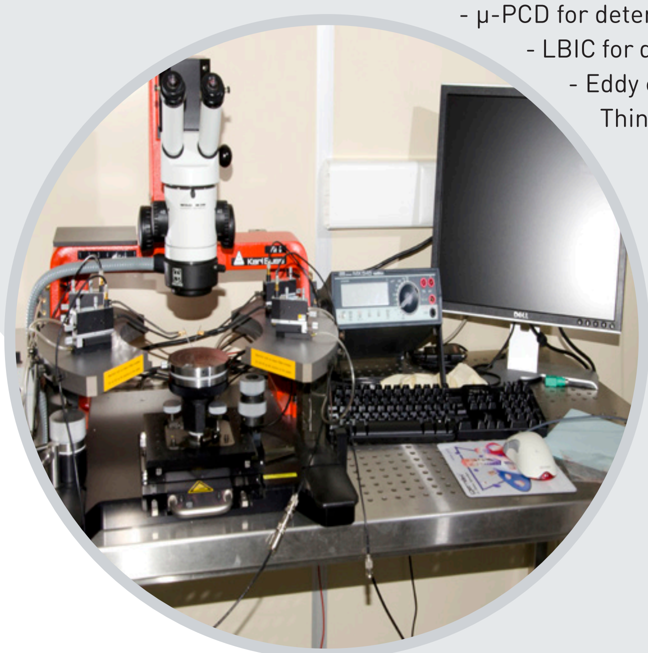
ELECTRICAL

Christophe Coinon, Christophe Boyaval, David Guérin

• Hall Effect: The Accent HL5500PC is a turn-key, high performance Hall System for the measurement of resistivity, carrier concentration and mobility in semiconductors. Modular in concept, allowing easy upgrade paths, the system is suitable for a wide variety of materials, including silicon and compound semiconductors. It has both low and high resistivity measurement capabilities to 300K or 77K.

• Probe station: Two microwave probe stations are available in the IEMN for idv and junction measurement.

• The semilab WT-2000PVN system is a non contact platform for samples inspection (silicon, ...) quality control and process monitoring.
It is equipped with a variety of measuring options, including solar cell characterisations. It enables automatic mappings in the following modes:
- µ-PCD for determination of minority carrier lifetime
- LBIC for diffusion length and internal quantum efficiency evaluation on solar cells
- Eddy current for non-contact resistivity measurement
Thin film's Stress measurements



SURFACE TOPOGRAPHY

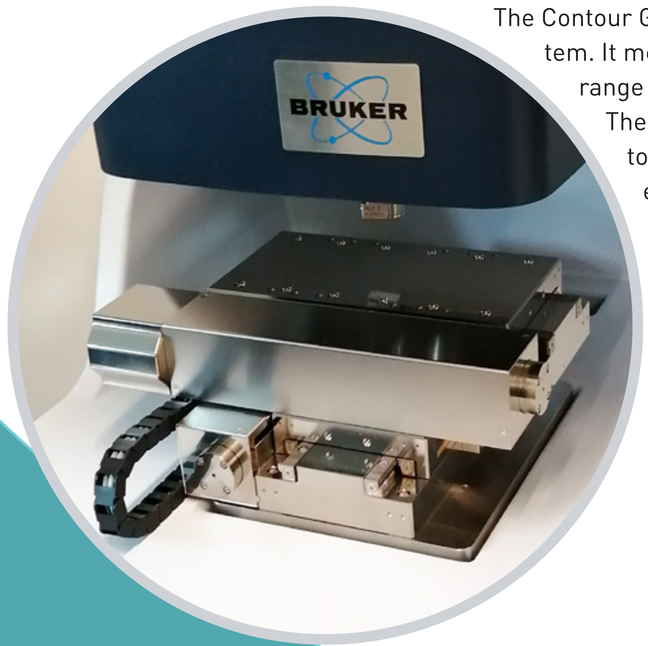
Christophe Boyaval, Flavie Braud

AFM Edge (Bruker).

The AFM Edge is used for measuring very small dimensions such as step heights and roughness on different materials. Roughness around 0.1nm and step heights below 1nm can be measured. Peak Force Tapping™ allows making measurements without damaging surfaces and tips. The motorized table authorizes the positioning of large substrates with a scanning range of 100µm.

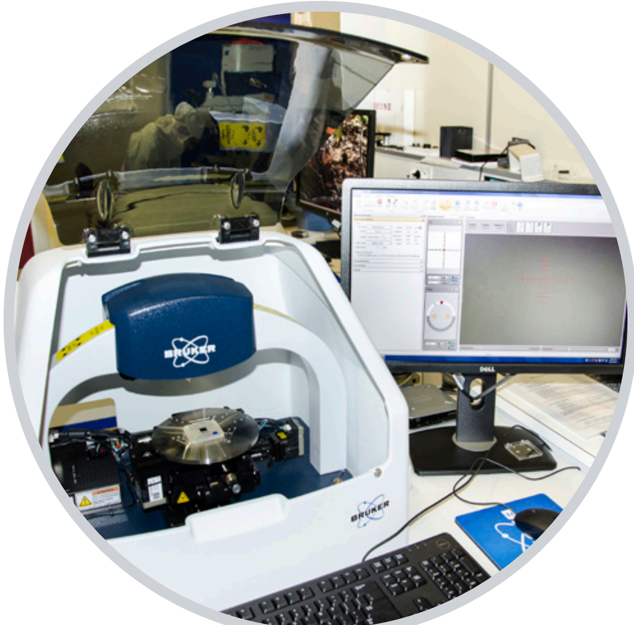
Contour GT X Optical profiler (Bruker)

The Contour GT-X is a stand-alone optical surface-profiling system. It measures surface topography with high accuracy in a range from fractions of a nm up to approximately 10mm. The system contains motorized x/y, tip/tilt and z stages to enable automated production monitoring. It is equipped with four interferometric objectives of magnification 2.5x, 10x, 50x and 115x.



3 Mechanical profilometers

They are used for measuring step heights from 10 nm to 1 mm. A stylus on a capacitive cantilever scans the profile of various types of matérials (resists, metallic plots and so on...). Scan range up to 6 inches are available.



MECHANICAL and PHYSICAL

Marc Dewitte

FSM 500TC

The FSM 500TC is a thin film stress measurement system that can test the stress of different films on reflective substrates. The system uses a Non Destructive Optilever™ Laser Scanning technique to measure the change of curvature induced in a wafer due to a deposited film. It can measure stress hysterisis changes in the film during a heat cycle. It has an N2 ambient and a programmable temperature control system, allowing the evaluation of the thermal properties and stability of the films.

- Manual mapping possible
- Film Stress measurements with repeatability of 1.5%.
- Temperature range from room temperature to 500 °C.
- Wafer size from 2inch to 8inch.

Soft Lithography Manager : Aude Sivery

The Soft-lithography resource enables the development and characterization of microfluidic devices.
1 Full time employee

MACHINING STATION

CNC milling machine, DATRON NEO

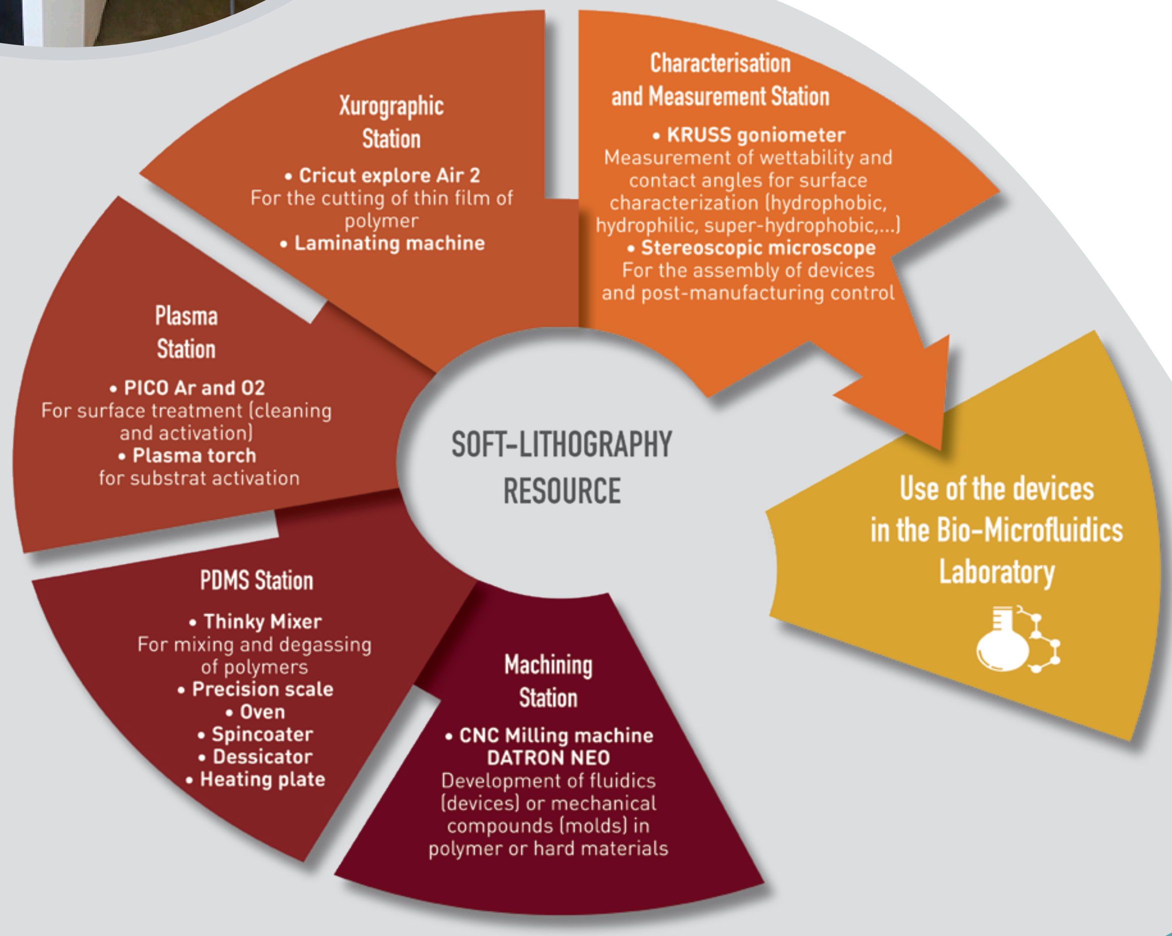
Development of fluidics (devices) or mechanical compounds (molds) in polymer or hard materials

The DATRON neo is a CNC milling machine which enables the ultra-fast and efficient machining of different materials.

Whether for 3, 3 + 2 or 5 simultaneous, high precision or economical machining.

Compatible materials:
- Composites
- Aluminum
- Light alloys
- Wood
- Plastics
- Carbon fiber reinforced plastic
- Stainless steel
- Green ceramics

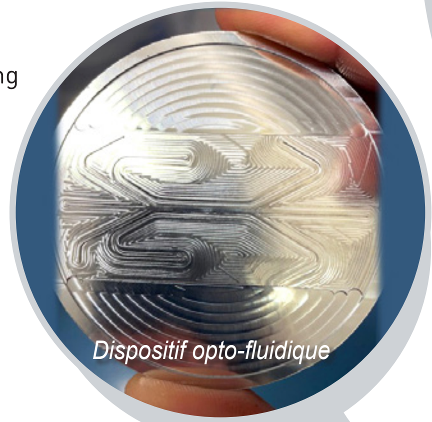
Machine capabilities:
- Milling
- Drilling
- 3D engraving



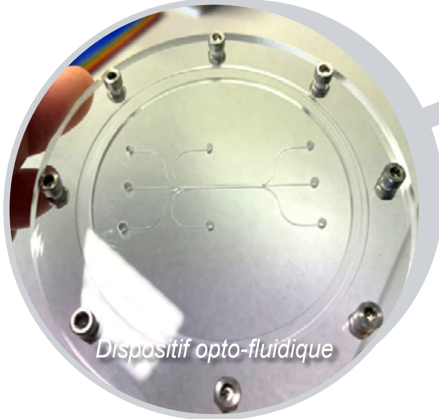
SPIN-PROCESSOR LAURELL WS-650-23 B

The Laurell WS-650-23 B spin coater system will accommodate up to ø150mm wafers and 5» × 5» (127mm × 127mm) substrates, and features a maximum rotational speed of 12,000 RPM (based on a ø100mm silicon wafer).

The WS-650 series is typically employed for Solvent, Base or Acid-based processing:
- Coating
- Etching
- Developing
- Rinsing-Drying
- Cleaning


Dispositif opto-fluidique


Plateforme microfluidique


Dispositif opto-fluidique

THINKY MIXER ARV 310

The association of the vacuum function with the rotary and revolutionary movements allows the complete deaeration of almost all fluids.

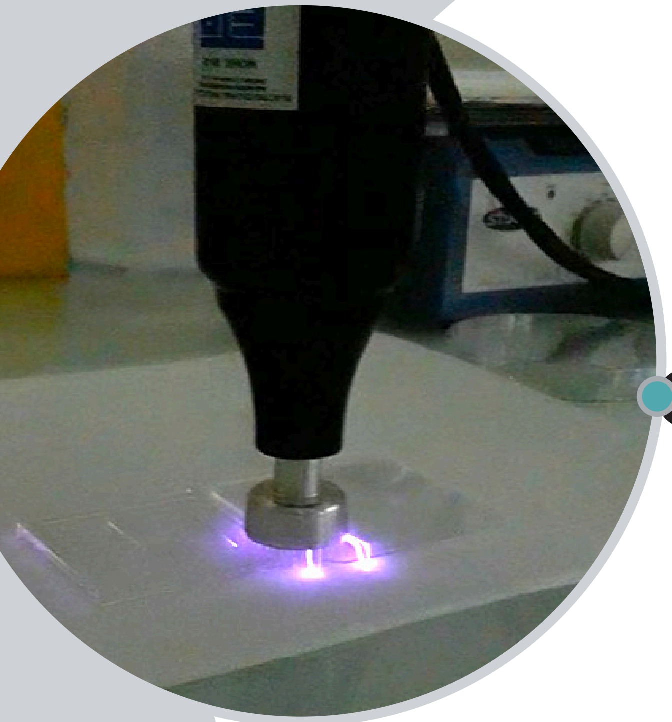
The memory mode allows the user to reproduce the optimal conditions of their own mixes for high repeatability

Technical Description:
- Vacuum function: optimal bubble-free dispersion
- Deaerated mixture of highly viscous materials
- Guaranteed without flow, sedimentation or foam during the operation
- Modifiable RPM for mixtures of all types
- Viscosity regulator

Soft Lithography Manager : Aude Sivery

PLASMA STATION: Ar and O_2 plasma Station

- Cleaning of surfaces
(before bonding, soldering or gluing)
- Activation of surfaces
(before printing, varnishing or gluing)
- Etching of surfaces
(microstructuring of silicon or etching of PTFE)
- Coating of surfaces - plasmapolymerization
(deposition of hydrophobic/hydrophilic layers)

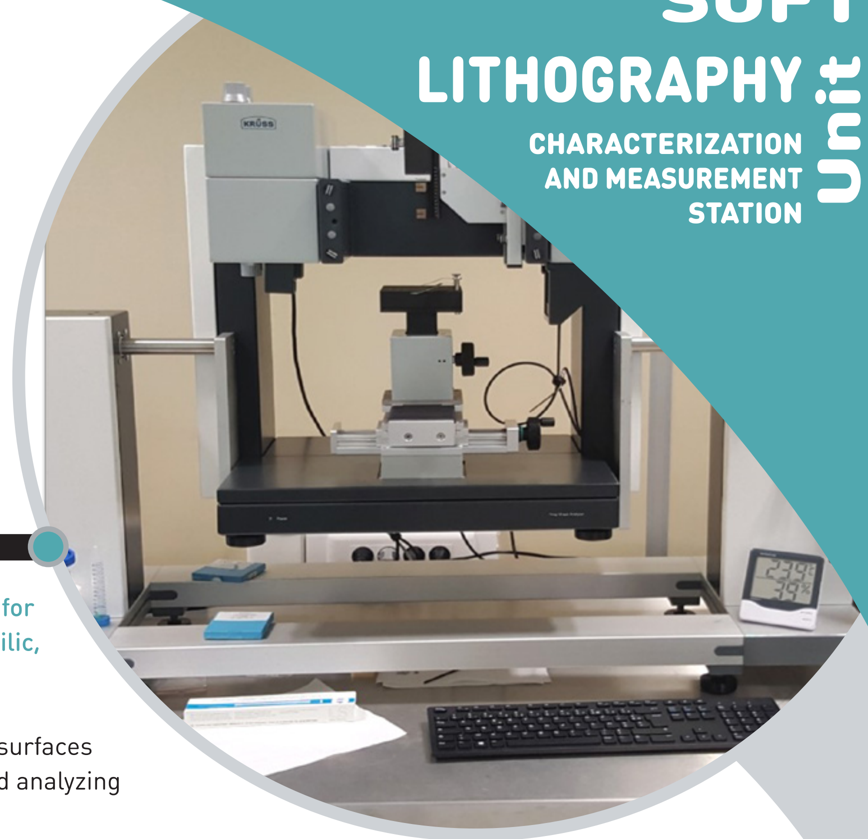


PLASMA TORCH ElectroTechnicProducts MODEL BD 20V

The Corona equipment enables a quick and easy treatment surface, and can be used to bond PDMS with glass or PDMS with PDMS very quickly (a few minutes).
Indeed the Corona tool will change the surface properties in much the same way as a traditional plasma cleaner treatment.
The corona produces a high voltage and high frequencies sparks at the tip of an electrode to ionize the air.

Main Characteristics:

- Device adapted for Soft-lithography applications
- Manual PDMS bonding
- Quick and easy PDMS bonding
- Create quickly strong link between PDMS with glass and PDMS with PDMS



KRUSS GONIOMETER DSA 100

Measurement of wettability and contact angles for surface characterization (hydrophobic, hydrophilic, super-hydrophobic ...)

For wettability and wall angles measurements, surfaces characterization (hydrophilic, hydrophobic...) and analyzing wetting and coating processes
The Drop Shape Analyzer DSA100 is a system solution for tasks in the analysis of **wetting** and **adhesion** on solid surfaces.

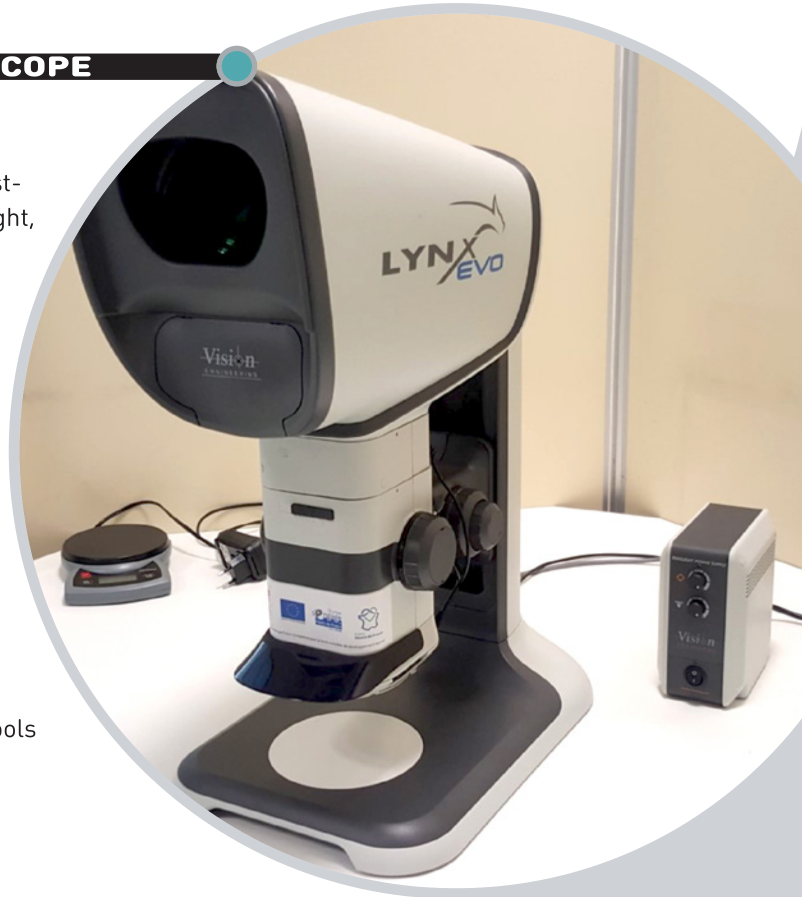
Comprehensive analysis of solids and liquids

The DSA100 measures the surface tension of liquids using the **Pendant Drop** method.
The results can be used to analyze the relationship between the wetting of the solid and the liquid properties.

LYNX EVO STEREOMICROSCOPE

For devices assembly and control post-production

- Used for inspection, production, or retouching post-production and gives a 3D depth perception and bright, high-resolution, high-contrast images
- Magnifications from 2.7 X to 240 X
- Very reliable for working in fine detail with magnifications up to 240x, with top and bottom lighting for working on opaque, translucent or perforated subjects.
- The absence of eyepieces removes the adjustment necessary for different users and make it possible to wear safety glasses
- Offering an angular view of the subject, with the microscope head raising and lowering, sliding and rotating, this setup enables the inspection and retouching, with generous space for working with tools



BIO MiCRO FLUIDIC

Unit

CELL CULTURE FACILITIES

Bio Micro Fluidic Manager : Aude Sivery

The Biomicrofluidic resource includes all the equipment necessary for cell culture, microscopy and microfluidics experiments.
1 Full time employee

BIOLOGICAL SAFETY CABINET, MSC ADVANTAGE

A Biological Safety Cabinet is a ventilated enclosure offering protection to the user, the product and the environment from aerosols arising from the handling of potentially hazardous micro-organisms. The continuous airflow is discharged to the atmosphere via a HEPA filter. This class 2 cabinet is used when working with **low to moderate risk biological agents.**

The primary purpose of a BSC is to serve as a means to protect the laboratory worker and the surrounding environment from pathogens. All exhaust air is **HEPA**-filtered as it exits the biosafety cabinet, removing harmful **bacteria and viruses.**

The three States of Protection :

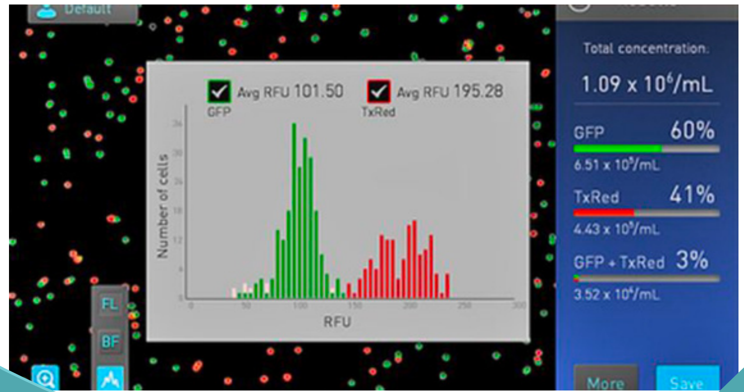
- Personal Protection from harmful agents within the cabinet
- Product Protection to avoid contamination of the samples
- Environmental Protection from contaminants contained within the cabinet

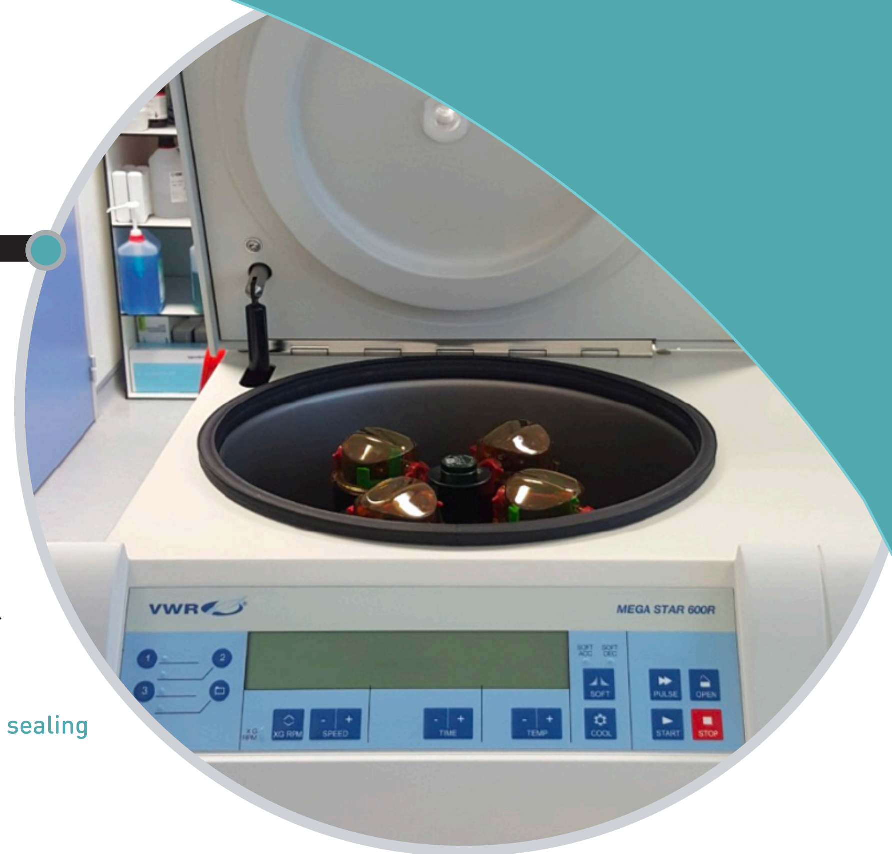
AUTOMATED CELL COUNTER, LIFE TECHNOLOGIES COUNTESS II

The Countess™ II Automated Cell Counter is a fully automated cell counter and assay platform that uses state-of-the-art optics and image analysis algorithms to analyze trypan blue-stained cells in suspension.

- The cells to be counted are loaded into the instrument in disposable Countess™Cell Counting Chamber Slides. Each chamber slide contains two enclosed chambers to hold the sample to allow to measure two different samples or perform replicates of the same sample.

- The Countess™ II Automated Cell Counter takes 10 seconds per sample for atypical cell count and is compatible with a wide variety of eukaryotic cells. In addition to cell count and viability, the instrument also provides information on cell size





CENTRIFUGE VWR MEGA STAR 650

This centrifuge is used as a laboratory apparatus, to separate mixtures of substances of different density. The centrifuge is suitable for temperature-sensitive sample processing with control between −10 and +40 °C.

- Auto-Lock® III rotor system:

Tool-free rotor exchange system enables quick rotor exchange; with just the push of a button users can quickly change rotors and easily access the rotor chamber for cleaning.

- Aerosol-tight ClickSeal® bucket caps and rotor lid sealing system:

Glove friendly one-handed open/close capability.

- Two rotors are available on this centrifuge:

-TX-150 swing out rotor: It offers high speed and high capacity (e.g. 24× 5/7 ml blood tubes or 8x 15 ml conical tubes) combined with the flexibility of a wide range of adapters.

- MicroClick 24 x 2 angle rotor:

This high speed rotor has a max. capacity of 24× 1,5/2,0 ml micro tubes and reaches a max. RCF of 30279 ×g. Ideal for microvolume protocols such as nucleic acid preparation, PCR reaction set up and filtration columns.

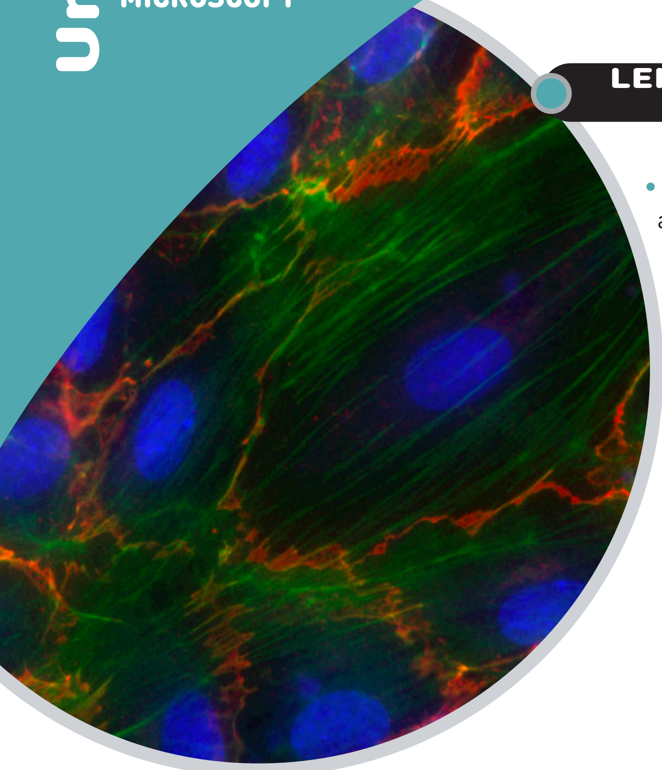
AUTOCLAVE, SYSTEC VX95

Enable to Sterilize solids, liquids and hazardous biological substances.
The autoclave is used to sterilize solids and liquids trashs coming from cell culture experiments.
It can also be used to sterilize microdevices before using them in microfluidic experiments.

Standard Features

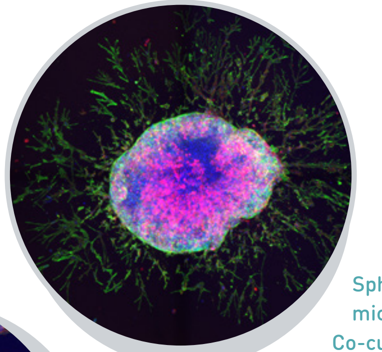
- Integrated, separate steam generator
- Temperature: Up to 140°C
- Pressure: Up to 4 bar
- Number of sterilization programs: Up to 25
- Code-secured access rights for changing parameters and further safety-relevant intervention
- Autofill: automatic demineralized water feed for steam generation

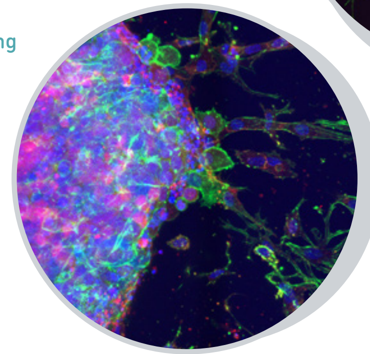
LEICA DMI8 MICROSCOPE ENVIRONMENTAL



HUVEC cells. Hoechst staining for the nucleus (blue). Alexa fluor 546 staining for VE-cadherin (red) and Alexa fluor 488 staining for actin staining (green). 100X immersion oil objective

- This microscope makes it possible to make acquisitions in phase contrast and epi-fluorescence
- It is equipped with a motorized X, Y and Z stage
- The Adaptive Focus Control (AFC) allows long-term acquisitions without focus drift over time
- The temperature and CO2-controlled environmental enclosure allows real-time imaging of devices possibly coupled to microfluidics. The large chamber incubation system is used for the stabilization of temperature and humidity which is designed for pre-heating cell and tissue cultures

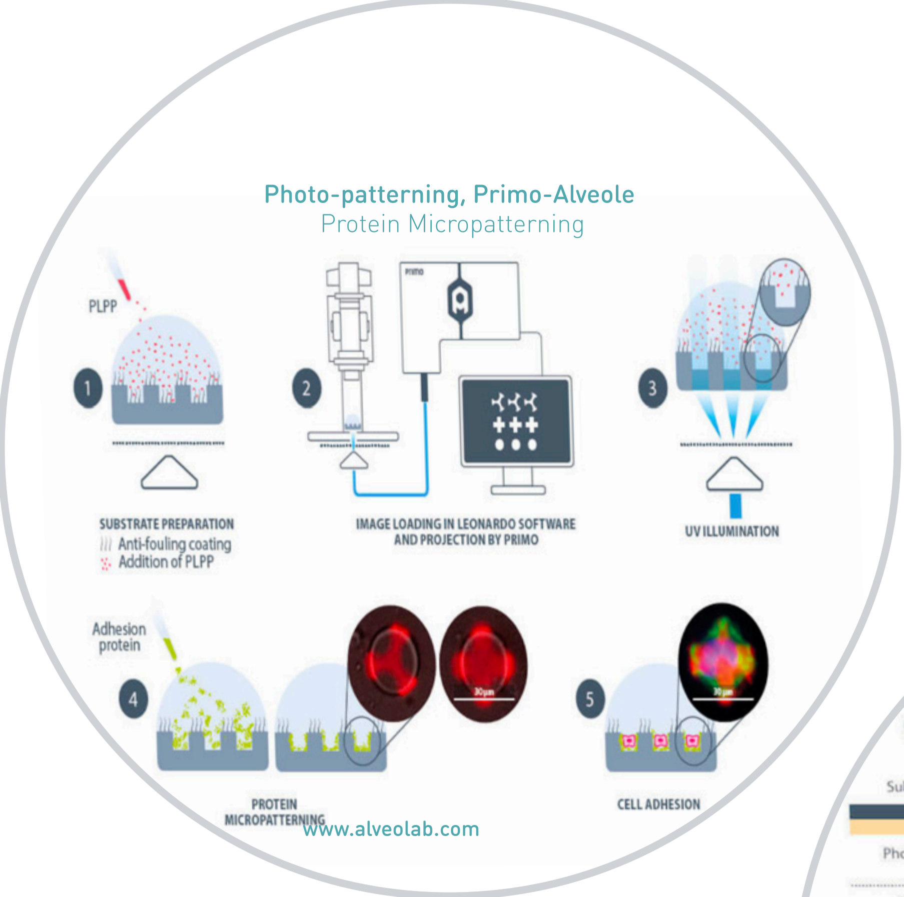




Spheroid inside a 3D perfusion microfluidic device from Ibidi. Co-culture of HUVEC and MCF7 cells. MCF7-mcherry cells appear in red, Actin filament in green and cells nucleus in blue

Filter Cubes	Excitation (nm)	Emission (nm)	Associated LED (nm)
DAPI	325-375	435-485	365
FITC	460-500	512-542	460, 470, 490, 500
Rhodamine	541-551	565-605	550
Y5	590-650	662-738	595, 635

Microscope Lens	Magnification	Numerical Aperture	Immersion	Correction Collar	XY resolution	Z resolution	Working Distance	Serial number
HC PL Fluotar L	63 X	0,7	Dry	0,1-1,3	0,479 µm	1,122 µm	2600	11506216
HC PL APO	100 X	1,44	Oil	0,10-0,22	0,233 µm	0,403 µm	100	11506325
HC PL APO	63 X	1,4	Oil	0,17	0,240 µm	0,426 µm	140	11506379
HC PL Fluotar L	40 X	0,6	Dry	0-2	0,559 µm	1,528 µm	3300	11506203
HC PL Fluotar L	20 X	0,4	Dry	0-2	0,839 µm	3,438 µm	6900	11506243
HC PL Fluotar	2,5 X	0,07	Dry	-	4,793 µm	112,245 µm	9400	11506523



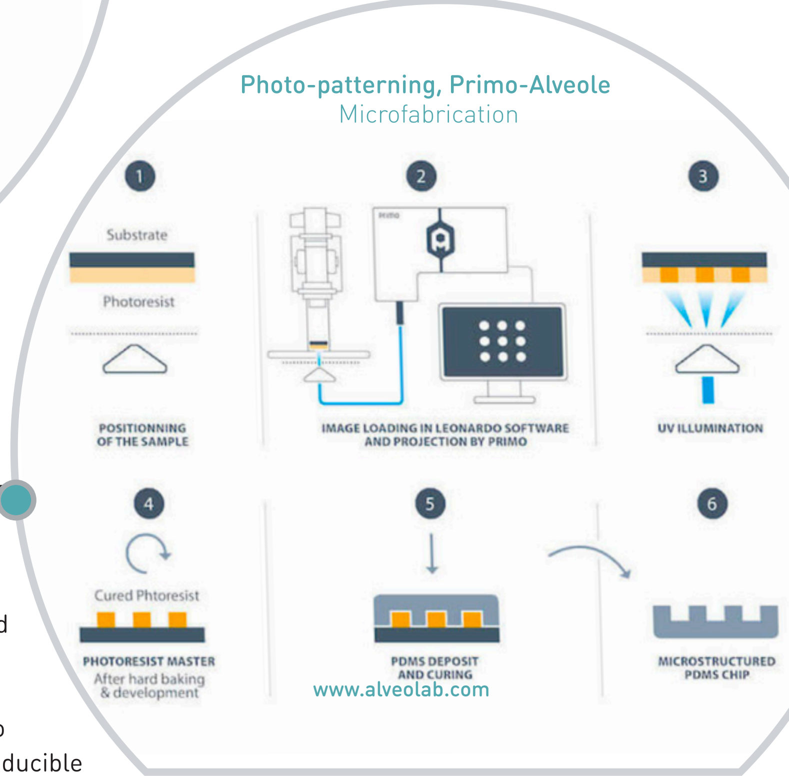


PHOTO-PATTERNING, PRIMO-ALVEOLE

The PRIMO maskless photopatterning system (DMD based) can engineer custom in vitro cell microenvironments through three techniques: micropatterning, hydrogel structuration and microfabrication.

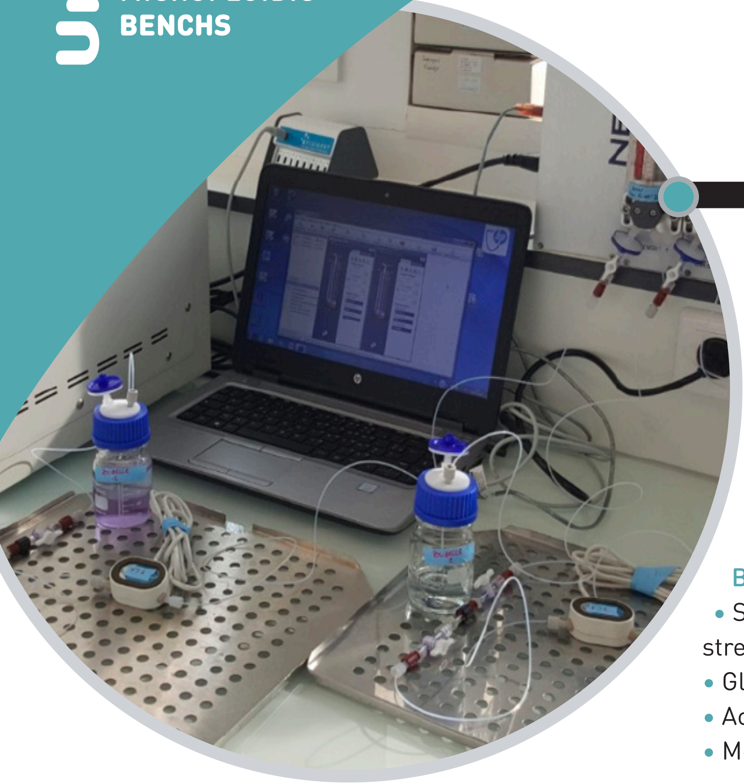
- **Micropatterning:** Allows to precisely control cell adhesion to mimic in vivo phenotypes, isolate them or place them in reproducible conditions for standardized assays.

- **Microfabrication:** PRIMO maskless DMD-based photopatterning system can perform greyscale photolithography on greyscale resists to create complex 3D molds such as ramps, curving wells or microfluidic chips for organ-on-a-chip applications.

- **Hydrogels:** As a photopatterning system, PRIMO can also polymerize and photo-scission most commonly used hydrogels for applications such as 3D cell culture or permeable hydrogel membranes polymerization within microfluidic chips.

- **Fields of application:** The system allows to better study the behavior and development of living cells in a broad range of applications, such as: cytoskeleton dynamics, cell adhesion force measurement, cell confinement, cell migration, tissue engineering, spheroids.

Bio Micro Fluidic Manager : Aude Sivery



SYRINGES PUMPS NEMESYS

Nemesys medium pressure pumps are used for the precise injection of liquids into systems operating at higher pressure levels or with viscous liquids.

The NeMESYS syringe pumps allow emptying and filling syringes by the relative linear movement of a syringe-and a piston holder.

The NeMESYS syringe pump serves for precise and pulsation-free dosing of fluids in the range of nanoliters per second up to milliliters per second.

Benefits:

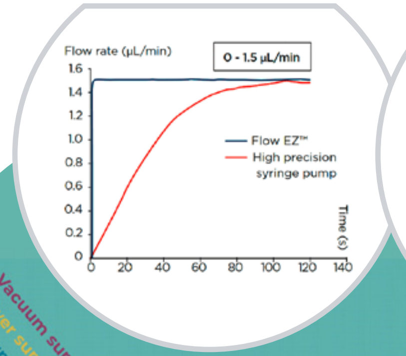
- Support of high-pressure valves for the creation of continuous fluid streams
- Glass syringes or four sizes of stainless steel syringes are available
- Accurate dosing for pressure levels of up to 200 bar
- Modular system: multiple modules can be plugged together

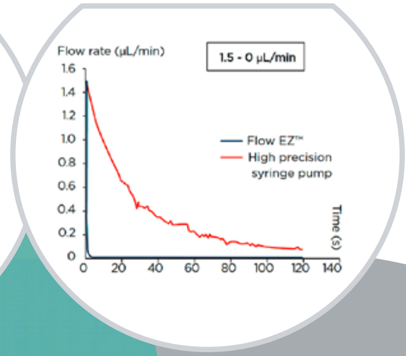
PRESSURE AND VACUUM CONTROLLER : LINEUP PUSH-PULL FLUIGENT

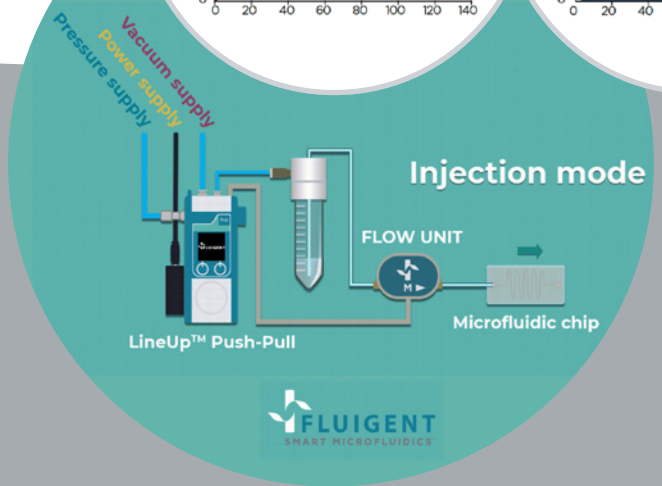
www.Fluigent.com

The **LineUp™ Push-Pull** is a standalone controller with the ability to deliver **finely regulated pressure** or a **vacuum** through a single outlet over the range of **-800 to +1000 mbar**. It can be used **without a PC** or controlled with **Fluigent Software Solutions** to benefit from **control in real-time**, protocol **automation**, graphic displays and **custom integration**. Combined with a **FLOW UNIT** it allows for **direct control of flow rate**.

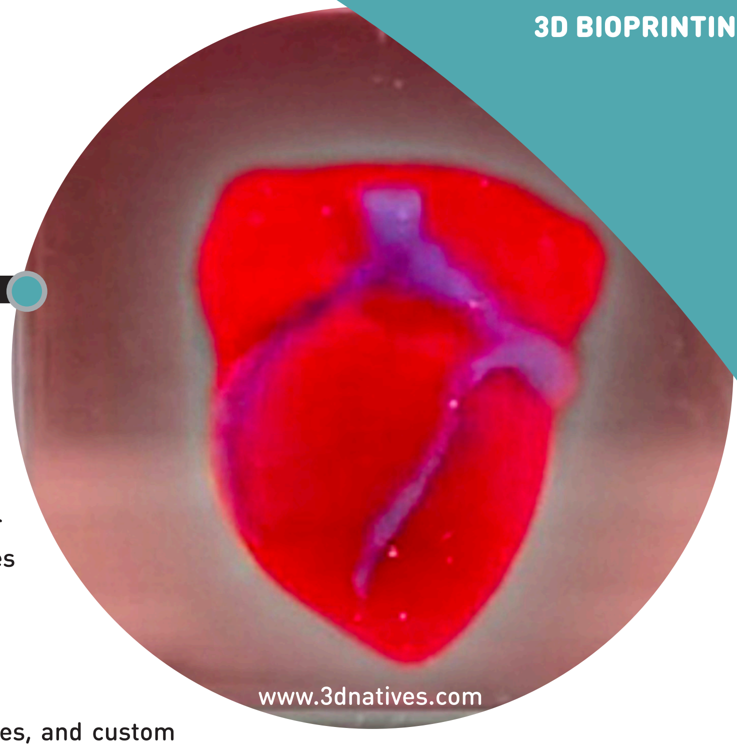
www.Fluigent.com







3D BioInk PRINTER



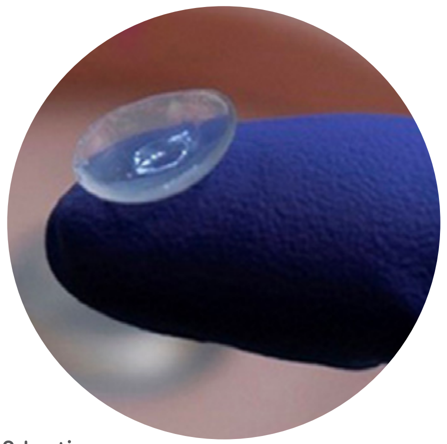
www.3dnatives.com

3D bioprinting is the utilization of 3D printing like techniques to combine cells, growth factors, and biomaterials to fabricate biomedical parts that maximally imitate natural tissue characteristics.

The 3D BioX from CellInk utilizes the layer-by-layer method to deposit bioinks to create tissue-like structures that are later used for biological research.

Features

- Temperature Controlled Printbed (4 C to 60 C)
- Compatible with standard petri dishes, multi wellplates, and custom inserts
- Compatible with a **wide range of bioinks in CellInk library**
- Clean chamber technology with UV-C germicidal lamps and HEPA H14 dual-filter system
- Exchangeable Photocuring Modules : 365 nm and 405 nm



www.3dnatives.com

www.cellink.com

www.cellink.com

Unit PACKAGING

Back end process refers to the process done outside cleanroom at chip level from wafer backgrinding to packaging.

Packaging Manager : FLAVIE BRAUD

LAPPING, POLISHING

for a slow lapping and a soft polishing

A plate in rotation carries a cloth impregnated of an abrasive micro suspension. The sample, laid out on a head in rotation and translation, is brought to the contact with a controlled pressure.

PM5 (LOGITECH)

Main Characteristics:

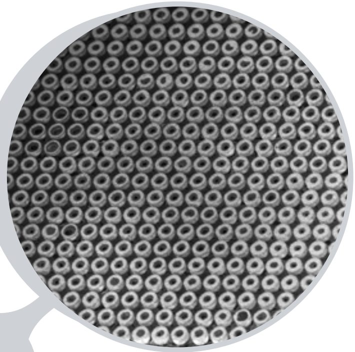
- Materials: III-V Materials (InP, AsGa), Si, Lithium Niobate ...
- Up to 4'' wafers and small pieces
- Sample maximum thickness: 2 mm
- Plate speed: 0-70 rpm
- Applied pressure: 0 to 2 kg
- Removed material mesured by a dial gauge - 1 to 5 µm/min
- Autofeed system
- Automatic lapping plate flatness control
- Thickness resolution : +/- 5 µm
- Roughness of the order of nm

Wafer Substrate Bonding Machine (LOGITECH)

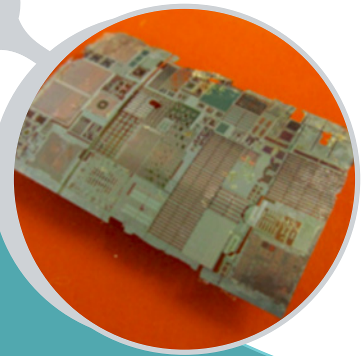
- Up to 4'' wafers and small pieces
- Automated process cycle
- Excellent wafer to support disc parallelism
- Process repeatability

Applications →

- Preparing the surface prior to fabrication,
- Thinning the device after fabrication,
- Providing defect free face polishing on substrate.



Ni pillars thinning and planarization



Silicon components reported on flexible substrate after grinding and chemical etching

MEGASONIC CLEANING SYSTEM

At the end of the lapping and polishing operations, the surfaces of the samples are contaminated by particles from slurries.

The Polos Spin-Meg Pie is dedicated for the cleaning of substrates, especially for the silicon wafers after CMP process. A spinner with a megasonic transducer composes it. The suitable wafer size is 3 or 4 inches. The standard fluid is desionized water but chemistry can be used also for a better decontamination.

CMP

E 460 (ALPSITEC)

CMP: for a soft and precise polishing and planarisation process

Chemical mechanical planarization is a process of smoothing and planing surfaces with the combination of chemical and mechanical forces, in order to prepare them for the following steps.

The CMP tool consists of a rotating platen, covered by a pad. The wafer is mounted upside down in carrier. The platen and the carrier are rotating. Pressure is applied by down force on the carrier.

A slurry is supplied from above on the platen.

Main characteristics:

- Authorized substrates: from 2 to 4 inches, possibility to work with small sized-samples
- Substrate rotation speed: 5-130 rpm
- Plate rotation speed: 5-120 rpm
- Applied pressure: 0-950 mdaN/cm2
- 10 steps per recipe
- 4 slurries possible during the process
- Materiels: Si, poly Si, SiO_2, metals (Cu, W...)
- Maximum removed thickness: 20 µm

Applications →

- Interlevels dielectrics ILDs
- Shallow trench isolation STI technology
- Damascene process

GRINDER

MPS 2 R300 (G&N)

For a fast and agressive mechanical thinning of substrates

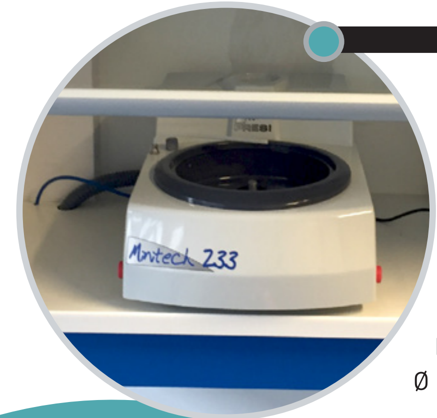
A rotation abrasive wheel removes the material on a sample itself in rotation.

Main characteristics:

- Substrate: from 2 to 8 inches
- Five 4 inches substrates max
- Substrate rotation speed: 0-30 rpm
- Head max rotation speed: 2600 rpm
- Height precision: 3 µm
- Grinding speed: 1-30 µm
- Materials: Silicon SiC glass

Ultra pure deionized water allows cooling during the process.

POLISHING

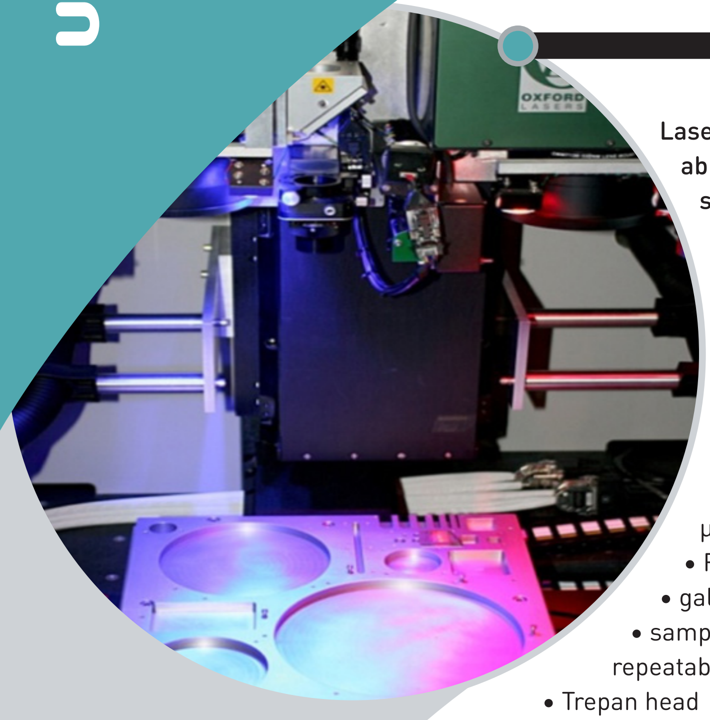


MINITECH 233 (PRESI)

The MINITECH Polishing machine is robust, powerful and reliable, it allows an easy use and simple maintenance. The machine provides a constant rotation of the plate, whatever the force applied, giving the possibility to polish large sized samples. MINITECH range can be equipped with plates Ø 200mm or Ø 250mm.

PACKAGING

Unit

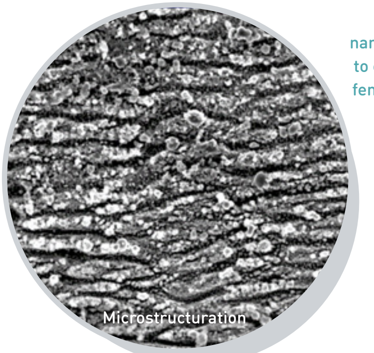


LASER ABLATION

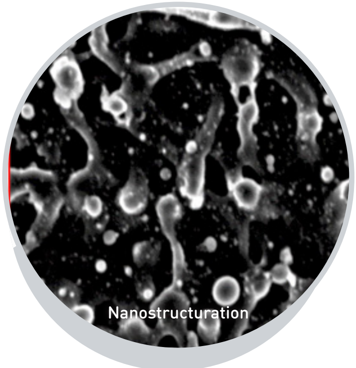
Laser micromachining is emerging as a key technology for structuring, ablating, scribing, cutting, drilling a wide range of materials as diverse as semiconductor crystals, metals and plastics. Ablation selectivity betwen materials can be achieved with a proper selection of wavelength, laser shot repetition rate and beam velocity. Two laser micromachining equipments are available, operating in the nanosecond and femtosecond pulse regimes, respectively.

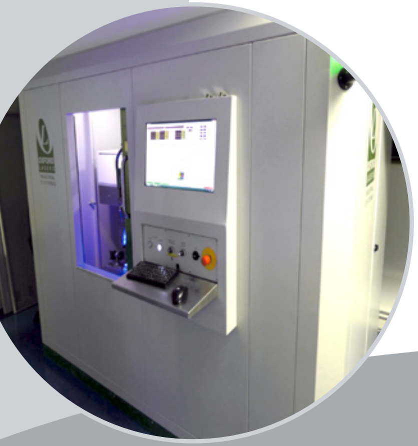
Oxford Laser Equipment #1, Photonics Industries DS UV Series

- Multi-wavelength femtosecond (300fs) diode-pumped (DPSS) lasers source (UV 343,GR 515,IR 1030 nm)
- Average power up to 20 W @ 200 kHz and pulse energy up to 100 μJoule in IR
- Repetition rate up to 2 MHz
- galvanometer deflection with extended field of 50×50mm2
- sample stage up to 300×300 mm2 with linear accuracy +/- 0.5 μm, repeatability +/- 0.2μm
- Trepan head
- Position synchronized output (PSO)



Micro and nanostructuration of metal to create black metal with femtosecond laser system

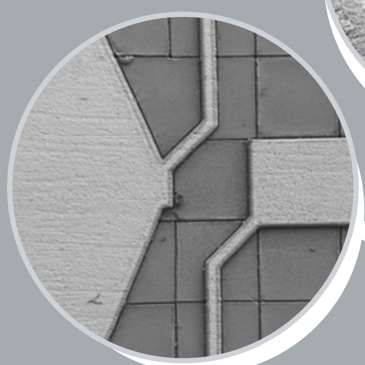




Oxford Laser Equipment #2, Amplitude Tangerine laser

- UV nanosecond (35 ns) diode-pumped (DPSS) lasers source (351 nm)
- Average power up to 8 W @ 4 kHz and pulse energy up to 5 mJoule
- galvanometer deflection with extended field of 50×50 mm2
- sample stage up to 300×300 mm2 mm2 with linear accuracy +/- 0.5 μm, repeatability +/- 0.2μm

AlN micromachining : Blind and pass-through via (nanosecond laser system)



μ-PCB for mmW applications (laser femto system)

DICING SAW DAD 3240

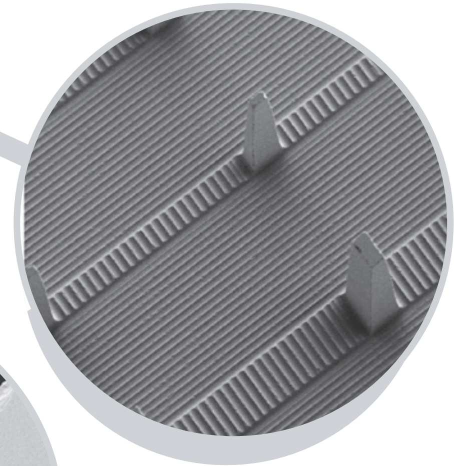
Diamond saw for substrates dicing, components individualisation

The substrate to be diced is positionned on a flexible adhesive film and fixed on the chuck. After alignment between the cutting ways on the substrate and the blade, the substrate moves at a selected speed under the blade. The blade is cooled by water jet and its rotation speed is controlled. Dicing can be made in manual or automatic ways.

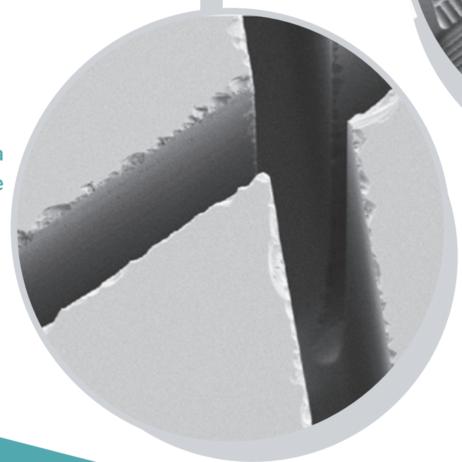
Main characteristics:

- Rotation speed of the blade: 6,000 - 60,000 rpm
- Chuck displacement speed: 0.1 - 600 mm/s
- Substrates size: up to 8 inches max
- Materials: III-V materials, silicon, glass, ceramics, SiC saphir
- Optical alignnment of the blade

Dicing & Patterning



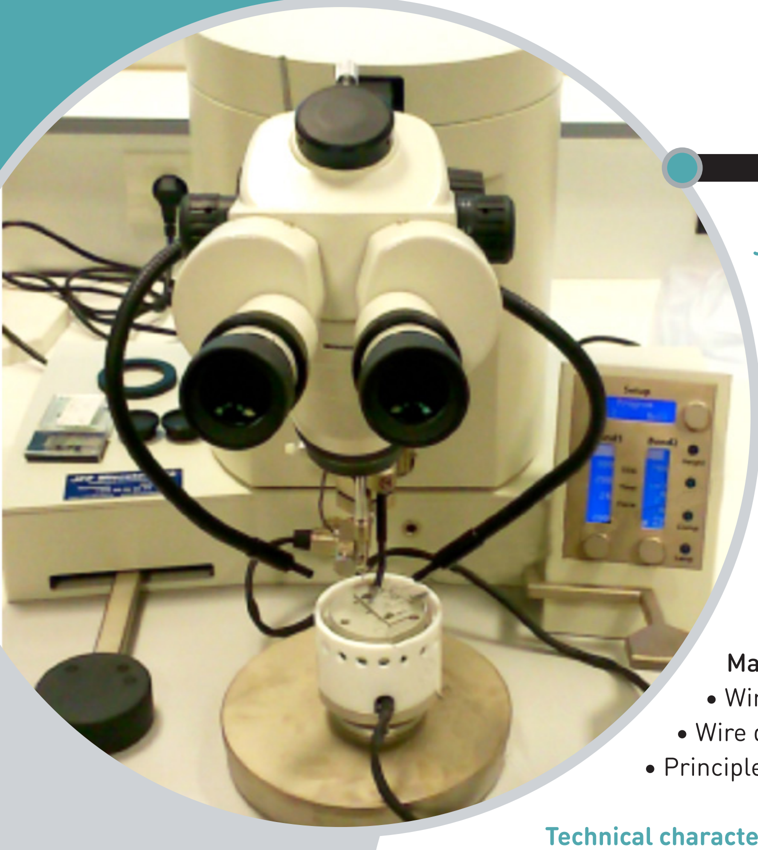
Pillars carried out by DISCO dicing saw



SEM picture of a cutting line

PACKAGING

Unit



WIRE BONDING

JFP WB-100 wire bonder

Wire Bonding: Realisation of electric connections between the component and its support

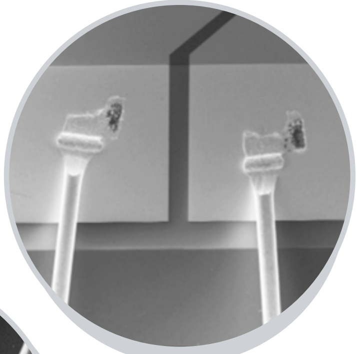
Wire bonding is a method to make interconnections between a semiconductor device and its packaging during semiconductor device fabrication. A conductor wire is positionned using a specific tool (ball or wedge) to the top of the metal pad of the component contact. A welding is created by the application of force and ultrasounds. An heating effect can be added according to the nature of wire.

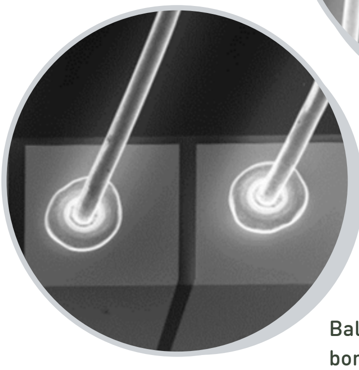
Main characteristics:

- Wire types: Au, Al
- Wire diameters: 12 to 76 microns
- Principle: ultrasonic and thermosonic

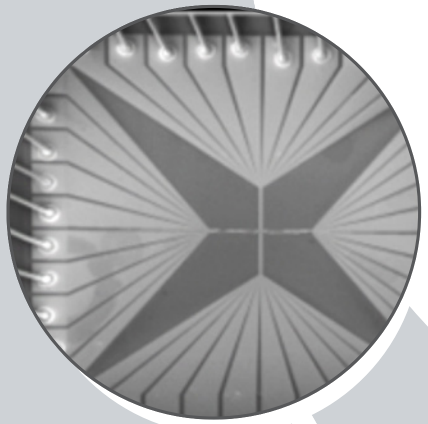
Technical characteristics of the WB100:

- Wedge, ball, bump bonder
- Bond force: 15 - 100 cNm
- Bond time: 15 - 5000 ms
- Gold wire diameter: 17 µm to 50 µm
- Motorized Z travel: 20 mm
- Throat depth: 165 mm.
- Fitted with a heated work holder, a motorized wire spool, and a digital position pattern generator coupled with a video cam





Ball bonding (left) and wedge bonding on Si (right), 180 x 180 µm pads



Micro-solder in ball mode on a crossbar device 100nm

WAFER SCRIBER/BREAKER

Wafer Scriber/Breaker: Realisation of a seed in a preferred crystallographic direction to force the cleavage

The scriber is a machine designed scribing & breaking of delicate die, such III-V materials & silicon chip. It keeps the finished die clean and damage-free.

After positioning the substrate on the Mylar film, it aligns the diamond tip on the cutting or along the desired axis lines. Then, it strongly supports the diamond peak on the surface by dragging the substrate to create a fracture line.

Main characteristics:

- Diamond peak
- Substrate up to 4 inches
- Materials type: Si, AsGa, InP
- Resolution of position: 1 µm
- Vision system allowing a programmable or manual alignment
- Break mode: operator control or automatic
- Scribing length programmable and scribing repeatable
- Robust, vibration free, requiring minimal training to operate

JFP Model 100

PICK AND PLACE

JFP Model PP6-6:

The Flip Chip Die Bonder model PP6 is designed for accurate placement of delicate devices on substrate. It achieves high accuracy placement using high magnification optical device.

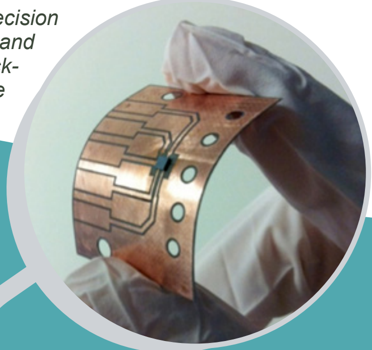
The machine provides for single collet vacuum pick and place of die from waffle pack, wafer, Gel-Pak or bulk die media and features adjustable and repeatable subsonic scrub. The placement accuracy is < 3µm, upon configuration.

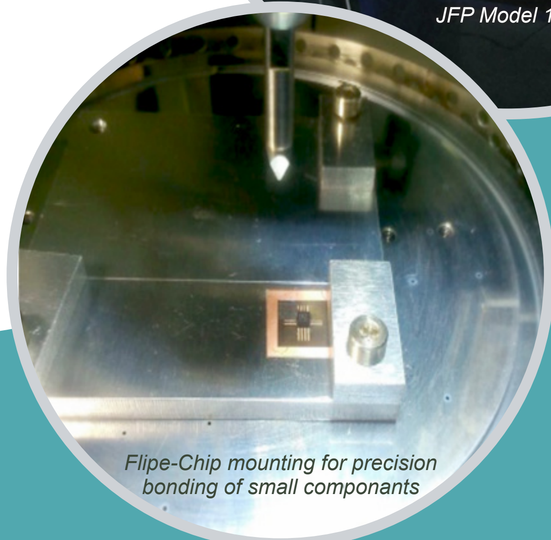
Small and large devices can placed with flipped vision.

A robust, and reliable mechanical concept, designed to be external vibration free.

JFP Model 100

High precision positioning and connecting by pick-and-place





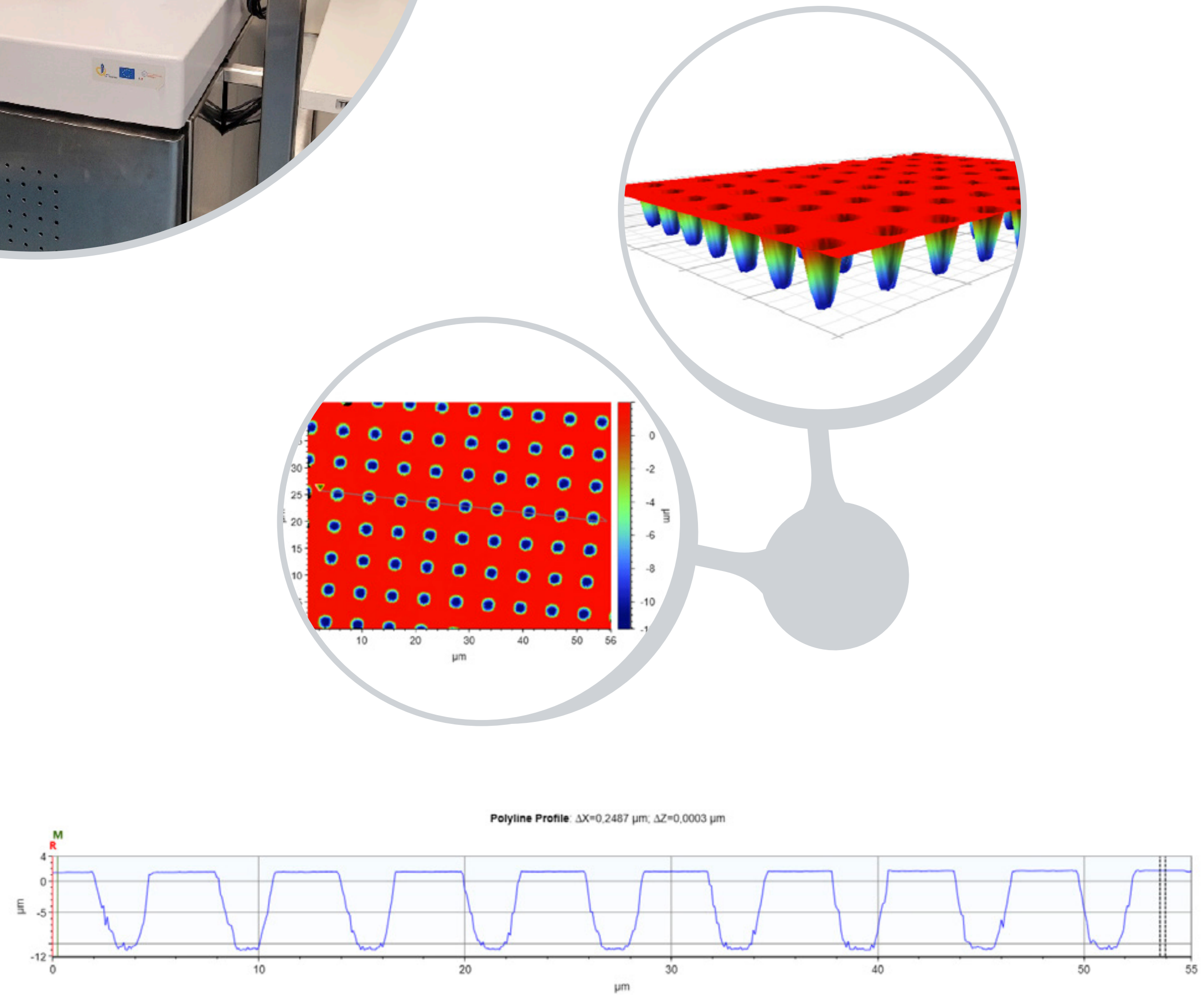
Flipe-Chip mounting for precision bonding of small componants

PACKAGING
Unit

OPTICAL PROFILER

Contour GT-X, Bruker

The Contour GT-X is a stand-alone optical surface-profiling system. It measures surface topography with high accuracy in a range from fractions of a nm up to approximately 10mm. The system contains motorized x/y, tip/tilt and z stages to enable automated production monitoring. It is equipped with four interferometric objectives of magnification 2.5x, 10x, 50x and 115x



Topographic analysis of 2 µm holes in a silicon substrate

THROUGH-HOLE COPPER PLATING LINE

Bungard compacta 30 ABC

For laboratory prototyping of through-hole plated PCBs up to 210 x 300 mm size.
Clean system including built-in rinsing compartment.

- 5 treatment tanks, 2 of them with heaters
- 1 galvanic copper bath
- 1 triple-cascade rinse with flow control
- 1 spray rinse tank with magnetic valve, foot switch and flow control
- 1 free tank (i.e. for chemical tinning)

DRY FILM LAMINATOR

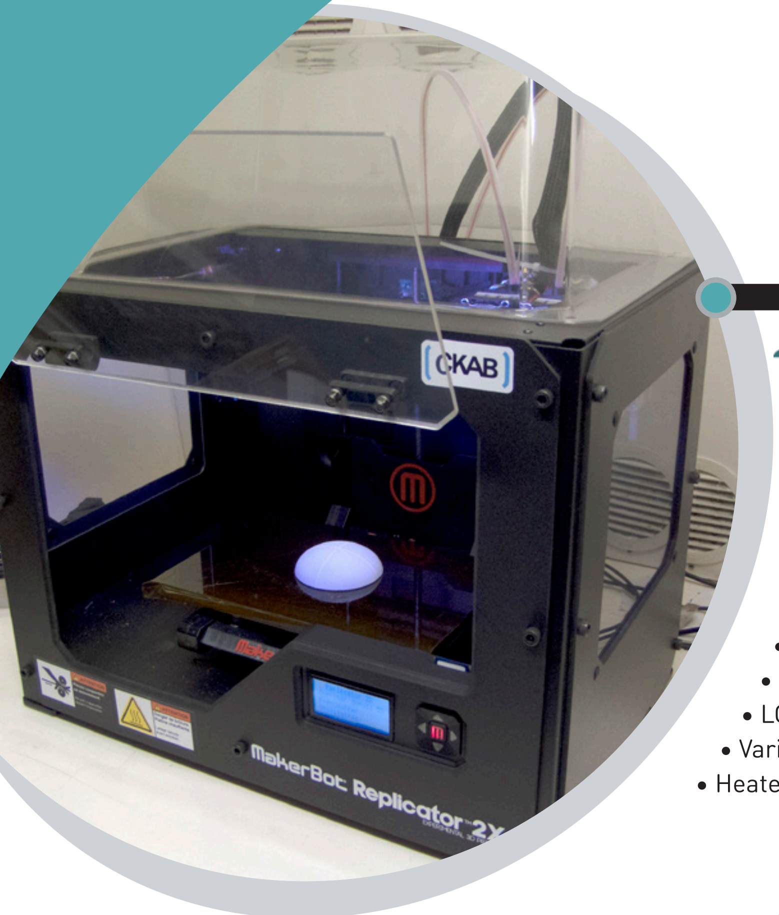
This equipment is suitable for the application of dry film resist containing a very thin temperature and/or pressure sensitive adhesive layer.

Bungard RLM419P

- Sample size: up to 400mm large and up to 8mm thick
- Hot rolls digitally controlled in the 20-200°C temperature range
- Pressure adjustable through the control of the edge gap between rolls

PACKAGING

Unit



3D PRINTER

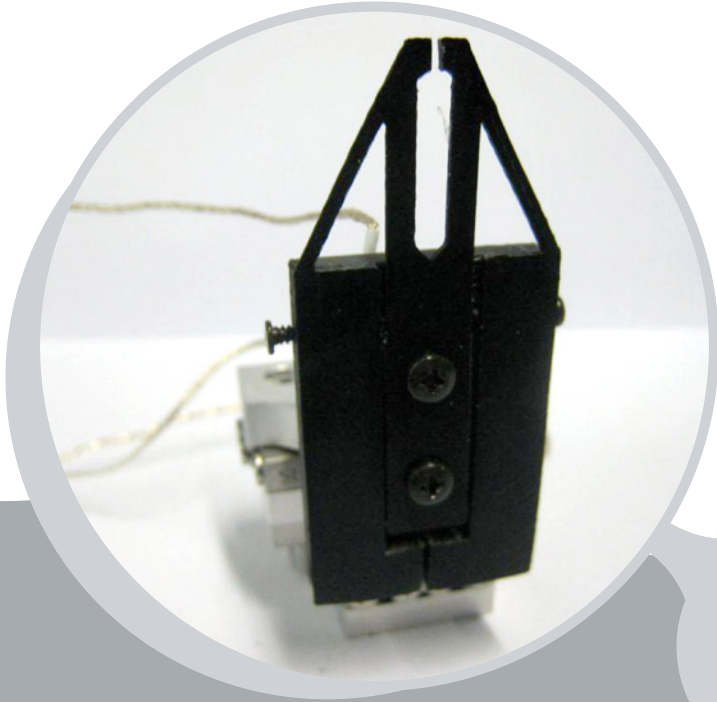
Christophe BOYAVAL

The dual-extruder MakerBot's Replicator 2X 3D printer produces good-quality objects.

MakerBot Replicator 2X

- Two extruders
- ABS, PETT, HIPS (dissolvable) filaments
- 100 µm layer resolution
- SD card / USB
- User-friendly software
- LCD navigation screen
- Various print modes
- Heated platform (110°C – 120°C)

devices by 3D printing



MACHINING STATION

Jean-Michel MALLET

CNC milling machine, DATRON NEO
Development of fluidics (devices) or mechanical compounds (molds) in polymer or hard materials

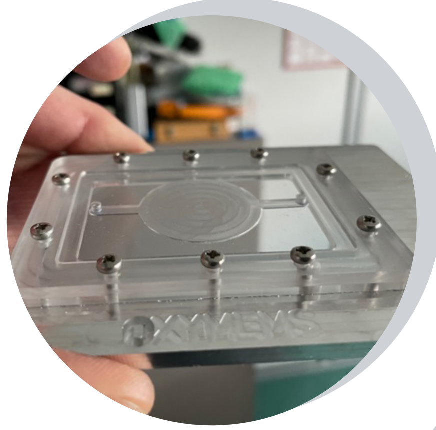
The DATRON neo is a CNC milling machine which enables the ultra-fast and efficient machining of different materials.
Whether for 3, 3 + 2 or 5 simultaneous, high precision or economical machining.

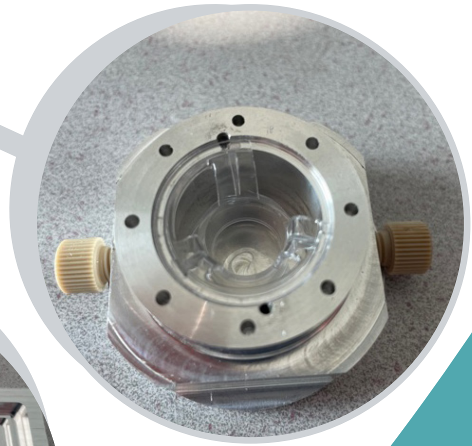
Compatible materials:

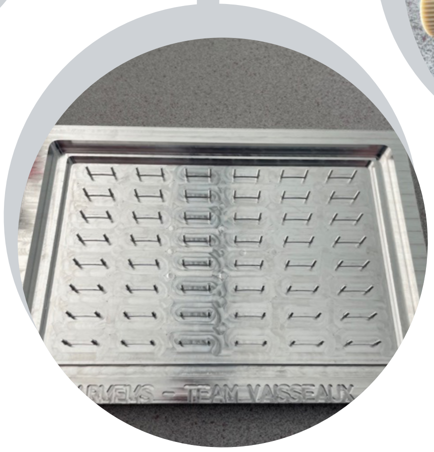
- Composites
- Aluminum
- Light alloys
- Wood
- Plastics
- Carbon fiber reinforced plastic
- Stainless steel
- Green ceramics

Machine capabilities:

- Milling
- Drilling
- 3D engraving







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