THE MICRO ET NANO TECHNOLOGIES PLATFORM

The know how
The équipement
The organization
The micro et nanotechnologies platform

> LAAS
  - UPR 8001 from CNRS
  - 20,922 m²
  - 610 people (01/01/2018)
> 2016 Operational budget: 15,257 M€
> Clean room
  - Renatech network member
  - 2,526.72 m²
  - 36 people in the technical staff
> 180-200 regular and active users
> Average of operational budget: 1.2 M€
  - Without investment
> 35 M€ equivalent new equipment
A brief history

- Third generation of platform in LAAS
  - The first academic platform in France
  - 1968: dedicated room
  - 1978: clean room
  - 2006-2007: technology platform
ReNaTech

- French network of open high-end micro & nanotechnology facilities coordinated by CNRS.

- To allow research and industry to benefit from competitive and world-class infrastructure for carrying out research and R&D projects that require top level equipment in micro and nanotechnologies.
The know how domains
Know how domains

> Optics / Photonics

- Photonics on transparent/optical substrates
  - sub-lambdanetworks
  - optical pixelated components
  - organic OLED/OPD components

- III - V multifunctional integrated components
  - III_V optical Sources
  - New III - V materials
  - Optical sensors

- Micro nano electronic
  - Nano-wires based nano components
    - Bottom-up / top-down wires fabrication
    - 3D Si and III-V Nano transistors

- Micro electronic power components
  - MOS and bipolar on SI
  - Large gap (GaN, diamond)
  - Integrated power circuits
Know how domains

> Bioelectronics, Biosystems, biophysics
  - Micro/nano fluidics
    - Polymer multi-layer / integrated operation lab on chip
    - Nano fluidic polymers-silicon-glass
  - Micro sensors
    - Vapour phase
    - Liquid phase
  - Advanced Micro Nanostructures for bio detection
    - Nano probes
    - Nano transistor
  - DNA technology for advanced materials and sensors

> Micro Nanocomponents, micro Nano systems
  - Micro RF switches with capacitive and resistive contact
  - Passive wireless sensors using electromagnetic transduction
  - Energy micro storage
  - Pyrotechnic actuator based on reactive nano materials
  - Integrated systems on flexible substrates
  - Low temperature processes for 3D Integration and interconnection
Know how example: THERMIE

> Open technological offer to multilayer metal/oxide reactive nanomaterials and nanostructures design/integration for embedded thermal sources

> Together with partners we implement all the skills and equipment of micro manufacturing and characterization platforms increased by dedicated equipment funded by the Occitanie Region and Europe Funds

> Dedicated equipment, dedicated technical staff, specific formations, technical reporting available for technological transfer, share development policy

https://www.laas.fr/projects/THERMIE/
Know how example: Multifab

Open 3D printing platform funded by FEDER and Region Occitanie that promotes the development, transfer, training and dissemination of additive manufacturing technologies to both academic and industrial partners

Cutting edge technologies for 3D printing

- **Selective Laser Sintering/Melting**
  - **Materials**: Metals, alloys, ceramics, cermets

- **Inkjet printing**
  - **Geradrop**
  - **Materials**: Colloidal suspensions, chemical compounds, biomolecules

- **Two photons lithography**
  - **nanscribe**
  - **Materials**: Photosensitive polymers, hydrogels

- **Fused deposition modeling**
  - **Leapfrog 3D Printers**
  - **Materials**: ABS, PLA, Nylon

- **Multi-material bio-printing**
  - **LAAS-CNRS**
  - **Materials**: Photosensitive polymers, hydrogels, bioinks

- **Stereolithography**
  - **DWS**
  - **KLOE**
  - **Materials**: Photosensitive polymers, composite materials, hydrogels

https://www.laas.fr/projects/MultiFAB/
The equipment
The technologies

**ELABORATION**
- Thermal treatment
- CVD / ALD
- Ion implantation
- MBE

**PATTERNING**
- Nano impression
- Etching
- Lithography
- Ink jet
- Screen printing

**INTEGRATION**
- Packaging
- Wafer level packaging
- Heterogeneous Integration

**CHARACTERIZATION**
- Electroplating
- PVD

Chemistry / surface Treatment

All the equipment: [https://lims.laas.fr/Default.aspx](https://lims.laas.fr/Default.aspx)  
Menu tools / all tools
INFRASTRUCTURE

- DI water
- Process fluids
  - providing
- Liquid and gaseous nitrogen
- Distribution networks
  - Process gaz
  - General Gaz
  - Dry air
  - …

- Internal modifications
  - Equipment setup
  - adaptation
- Relations with suppliers
  - Air treatment, cleaning …

- Safety
  - Detection
  - Alarm
  - Effluents treatment
  - …
Laser Lithography

> HEIDELBERG DLW200
- Direct pixelised writing on substrates
- Masques and reticules for photolithography
- Metrology

> Dilase 750
- Vectoriel writing on substrates
- 3 optical tubes for resolutions
  - 0.5µm, 2µm, 20µm
- 3 wavelengths for lithography
  - 325 nm, 375nm, 405 nm
- 1 wavelength for surface treatment
- 1 wavelength for 3D lithography

> Dilase 3D
- 3D microstructures lithography
- Resolution 5µm

> Nanoscribe
- 3D Microstructures lithography
- Resolution 100 nm
Photolithography

> Manuel area

- **6 masks aligners**
  - resolution down to 0.9 µm
  - Small pieces to 150 mm wafers

- **3 benches**
  - Spin coating
  - Baking
  - Development

- **HMDS**
> Automatic area

- Spin coating, baking, development EVG 120
- Spray coater
- Automatic alignment EVG 620 (resolution 1-2µm)
- Semi automatic alignment Suss microtec (resolution 1-2µm)
  - MO optics (increased depth of field)
- Polymers ovens
- HMDS
- Projection lithography (resolution 0.35µm)

- GenIsys lithography simulation software
Nano lithographies

- **RAITH 150**
  - Electron Beam Lithography: Résolution: 20 nm
  - Up to 6”
  - Autofocus

- **NANONEX 2500**
  - UV nano imprint
  - Thermal Nano impression
Chemistry

> Secured manual wet benches
  - Acids
  - Solvants
  - RCA 6”
  - KOH, TMAH
  - HF Buffer
  - ....

> 4 mains dedicated areas...
  - MOS
  - MEMS
  - III-V
  - Packaging

> Specific areas
  - Exploration
  - Ink jet
  - Nanolithographies
  - Photolithographies
  - Electroplating
Electroplating

> Laboratoty reactors
  - Au, Cu, Ni,…..

> « Industrial » reactors
  - Au, Cu

> Bathes characterization
  - CVS
  - Polarography
  - Dosimetry

> Wet benches
  - Aluminium anodisation
  - Porous gold
  - …
> **Joules Effect** : Apsy E100

> **Electrons guns**
  - Varian
  - EVA 600
  - Edwards
  - Plassys nano

> **Sputtering**
  - Cluster UNIVEX 450 C
    - 1 plasma cleaning chamber
    - 5 deposition chambers (7 targets)
  - TFE
    - Energetic material deposition

> **OLED**
  - Metal evaporation
  - Organics evaporation
  - Spin coating, baking

> **Polymers outgazing analysis**
Plasma etching

> Deep etching
  - AMS 4200
    - 2 chambers cluster

> ICP etching
  - 2 Avisa Trikon Omega 201
    - Si, GaAs, Polymers / metals

> Nano etching
  - Sentech etchlab
  - Sentech Si500

> EPD systems

> Descuming, stripping, surface treatment
  - Tepla
  - Diener
Molecular Beam Epitaxy

> Riber 2300
  - Ga, In, Al, 2xAs2, CaF2, Bi effusion cells
  - hydrogen plasma effusion cell
  - RHEED 20kV, mass spectrometer (0-100)

> Riber 32P
  - Ga, In, 2xAI, Be, Si, Bi, cracker d’As, differential pumping N plasma effusion cells
  - RHEED 10 kV, mass spectrometer (0-200)
  - Dynamic Accordable Reflectometry
  - Low temperature pyrometer

> Riber MBE 412
  - 2xGa, 2xIn, 2xAI, Sb, Si, CBr4, 2x As cracker, integrated valve N2 plasma effusion cells
  - RHEED 12 kV + camera + KSA400 soft
  - Mass spectrometer (0-200), BandiT, Pyrometer
  - Computerised control (Crystal - Riber)
  - Roboted transfer chamber (cluster), parking, high T° outgazing
> 29 reactors

- AET 4” : Oxydation redistribution
- Tempress 4” : Diffusion, annealing
- Tempress : LPCVD
- AET 4” : annealing
- AET 4” vertical: deposition
- Centrotherm 6” : oxydation, diffusion
- Centrotherm 6” : annealing, LPCVD
- AET AsGa: oxydation
- Annealsys 6”/8” : RTP
- Annealsys 6” : RTP AsGa
- AET 4” : annealing
- Semco 6” : annealing
CVD / ALD

- **STS PECVD**
  - 4”, 6”, 8”
  - LF, HF

- Cambridge nanotechnologies ALD

- Oxford ICPECVD
  - Low temperature
Ion implantation

- IMC 200
  - Upgrade of Axcelis NV 4206
  - Middle current
  - 200 kV max
  - Solid and gaz sources
Ink jet

> Altadrop:
  - Mono hose

> Ceradrop
  - Multi hoses
Surface treatment

- Memstars : SPD
- Tousimis supercritical dryer
- Separex CO2 Functionalization
- Comelec parylene deposition
- Chemical benches (chemical area)
- O2 plasma (plasma etching area)
Packaging

> Dicing
  - Saw
  - Scribbing
  - Cleaning

> Pick and place

> Bonding
  - Wire (Au, Al, Cu, ruban)
  - Flip chip

> Pull shear test

> Wafer Lavel Package
  - CMP
  - Grinding
  - Wafer bonding (Anodic, Direct, Thermal compression) and connected cleaning
  - Screen printing
  - Roll lamination
Characterisation

- **Microscopy**
  - Optical
  - SEM (2)
  - AFM (2)
  - Ionic (in FIB)
  - Confocal

- **FIB**
  - Dual beam
    - Electrons, ions
  - Microscopy
  - Nanofabrication
    - Etching, deposition

- **Profilometry**
  - Optical
  - Mécanical (2)

- **Ellipsometry** (2)
- **X ray diffraction**
- **Photoluminescence**
- **DSC**
- **Spectrometry**
  - UV
  - Visible
  - IR
- **Various**
  - 4 probes
  - R□
  - Water drop
  - Grain size measurement
  - …
The organization

TEAM staff
The offers to users
Projects management
Financial management
- Technics and Equipment Applied to Micro and nanotechnologies
- 36 engineers, and technicians under direct authority of LAAS’s Director
  - Responsibilities in one of 13 technical areas
  - Projects technical coordination

- Laser Lithography Responsible + Experts
- Photolithography Responsible + Experts
- Responsabilities:
  - Equipments
  - Processes
  - Formation
  - Safety
  - …

- Project coordinator
- Exogeneous Project
- LAAS Project
- LAAS Project
- LAAS Project
- LAAS Project
- LAAS Project
- LAAS Project
- LAAS Project
TEAM Responsabilities

- **Infrastructure**
  - Management, development

- **Equipment**
  - Expertise,
  - Management,
  - Maintenance
  - Evolutions

- **Processes**
  - Expertise,
  - Realization,
  - Management,
  - Developments

- **Research projects support**
  - From LAAS research groups
    - 69 in 2018
  - From exogenous (Renatech network)
    - 89 in 2017

- **Formation**

- **Technical management**

- **Know-how**
  - dissemination
  - valorization,
  - transfer
TEAM : Techniques et Équipements Appliqués aux Micro et Nano Technologies

Responsable
Hugues GRANIER, IRHC 90%

36 agents (12 IR, 6 IIE, 16 AI, 1 T, 1 apprenti)

Mise en service, développement, maintenance des équipements / formation encadrement / actions d'intérêt général

La première personne nommée assure la fonction de responsable de zone

**Responsable**

Hugues GRANIER, IRHC 90%

**Responsable d'activité**

La plateforme de micro et nanotechnologies

- **Responsable**
  - Hugues GRANIER, IRHC 90%

- **Membres du comité de pilotage**
  - Pierre-Éric CALMON, IRHC 10%
  - Franck CARCENAC, IRHC 10%
  - Dominique HELLÉ, IRHC 10%
  - Ghislaine RENAUD, IRHC 10%
  - Véronique CONÉDERA, IRHC 30%
  - Monique DIHAN, IRHC 70%

**Mise en service, développement, maintenance des équipements / formation encadrement / actions d'intérêt général**

La première personne nommée assure la fonction de responsable de zone

- **Assemblage**
  - Samuel CHARLOT, IRHC 10%
  - René-David COLIN, AI 40%

- **Caractérisation**
  - Benjamin RIEU, IRHC 70%
  - Emilie DARAN, IRHC 20%

- **Gérance**
  - Jean-Baptiste DUCET, IRHC 30%
  - Alexandre LAVERGNE, AI 50%

- **Dépôts sous vide**
  - Ludovic SALVAGNAC, IECN 20%
  - Guillaume LIBAIDE, AI 40%
  - Adrien LABORDE, AI 10%
  - Séverine VIVES, AI 10%

- **Électrochimie et gravure anisotrope du Si**
  - David BOURBIS, IECN 15%
  - Arnaud DURLACH, AI 50%

- **Épitaxie par jets moléculaires**
  - Alexandre ARNOULT, IRHC 15%
  - Gay LACOSTE, IECN 40%
  - Quentin GRAVELIER, AI 50%

- **Gravure Plasma**
  - Pascal DUFOUR, IRHC 65%
  - Aurélie LECESTRE, IRHC 30%

- **Lithographie laser**
  - Pierre-Éric CALMON, IRHC 25%
  - Vinciane LUCHE, IRHC 40%

**Nanolithographies**

- Frank CARCENAC, IRHC 25%
- Emmanuelle DARIAN, IRHC 40%
- Jean-Baptiste DUCET, IECN 20%
- Alexandre LAVERGNE, AI 50%

**Photolithographies**

- Laurent MAZEN, IECN 50%
- Adrien LABORDE, AI 50%
- Amadou DURLACH, AI 50%
- Julien JONEAU, Altri 30%

**Jet d'encre et traitements de surface**

- Fabien MESNILE, IECN 35%
- Véronique CONÉDERA, IRHC 15%

**Support et soutien**

- Hugues GRANIER, IRHC 10%

**Support**

- Laurent BOUSCAYROL, AI 100%
- Thierry DO CONTO, AI 100%
- Antoine MACRIANO, AI 100%
- Vincent DUCRET, AI 100%

Soutien

- Véronique LUCHE, Altri 30%

**Traitement thermiques et implantation ionique**

- Eric IMBERNON, IRHC 40%
- Jean-Marie MERLOD, AI 40%
- Bernard ROUSSET, IRHC 35%

**Soutien direct aux projets de recherche**

- Alexandre ARNOULT, IRHC 65%
- David BOURBIS, IECN 85%
- Pierre-Éric CALMON, IRHC 65%
- Franck CARCENAC, IRHC 65%
- Samuel CHARLOT, IECN 90%
- René-David COLIN, AI 20%
- Véronique CONÉDERA, IRHC 55%
- Rémi COURSON, AI 80%
- Emmanuelle DARIAN, IRHC 40%
- Alexandre DEZALAY, AI 100%
- Monique DIHAN, IRHC 30%
- Pascal DUFOUR, IRHC 35%
- Jean-Baptiste DUCET, IECN 50%
- Quentin GRAVELIER, AI 50%
- Marion HARRIBFY, AI 100%
- Eric IMBERNON, IRHC 60%
- Julien JONEAU, ALTER 20%
- Adrien LABORDE, AI 40%
- Gay LACOSTE, IECN 60%
- Alexandre LAVERGNE, AI 50%
- Aurélie LECLERC, IECN 70%
- Guillaume LUBAIDE, AI 60%
- Vinciane LUCHE, TON 30%
- Jean-Marie MERLOD, AI 60%
- Laurent MAZEN, IECN 50%
- Marion MEGA, AI 100%
- Fabien MESNILE, IECN 65%
- Benoît RIEU, IECN 30%
- Bernard ROUSSET, IRHC 65%
- Ludovic SALVAGNAC, IECN 80%
- Séverine VIVES, AI 90%

1 Personnel contractuel
2 Personnel UPS
3 Personnel INPT
After apprenti en alternance

Back main menu
Back organisation menu
Positioning to users

**ACADEMIC**

From concept

- Basic technology research
- Research and feasibility Demonstration
- Technology development
- Technology demonstration
- Development system / subsystem
- SystemTest, launch and industrialization

**INDUSTRIAL**

To the publication

- Usages / clients needs
- Support for technological developments
- Research collaborations

**ACADEMIC**

To the application

- Support

**INDUSTRIAL**

To the application

- Support for technological developments
- Research collaborations

**ACADEMIC**

- Basic principle observed or described
- Technology concept and/or application formulated
- Analytical evidence or experimental features or characteristics of the concept
- Components and/or models validation in laboratory
- Demonstration of a prototype or model of systems/subsystem in a representative environment
- Demonstration of a prototype of the systems in an operational environment
- Actual system completed and qualified by tests and demonstrations
- Actual system completed by successful operational missions

**INDUSTRIAL**

- To the publication
Our will for users

> Academic

- support research works since the expression of the idea to go as far as possible in the developments in technology, if possible until technology transfer.
- Support / develop collaborations with LAAS research

> Industrials

- Accompanying technological developments since the expression of needs to go as far as possible in the technological developments to technology transfer
- Direct collaborations with LAAS research, but not mandatory.
The offers to users

> Direct access to
  - Technical expertise,
  - Scientific expertise,
  - Infrastructure,
  - Equipment,
  - Processes

> Hosting
  - Of people
    - Formations
    - Independent or supervised realizations
    - Recruitment on behalf of the industrial
  - Of equipment
    - From the user to benefit the infrastructure and organization.

> Interface tools
  - Dematerialization of
    - Project management
      [https://www.renatech.org/projet/index/en](https://www.renatech.org/projet/index/en)
    - Technology follow up
      [https://lims.laas.fr/Default.aspx](https://lims.laas.fr/Default.aspx)
  - Pre established contracts for fast establishment of direct collaborations
  - Costs traceability
    - Auditable billing of audited costs

> External tool for industrials if a French antenna
  - Eligibility of costs to research taxes credit
Direct partnerships of the platform = projects out of the scope of interest of LAAS researchers
Support = technological activities already existing
Development = needs of technological tuning

Demands evolution

![Graph showing demands evolution from 2006 to 2017.]

84 requests by 2017 including 38 continuing from 2016

Distribution of applications 2017

- Academic support: 43%
- Industrial support: 20%
- Academic development: 21%
- Industrial development: 19%

Abandon: 4 which is 5%
Under 10 which is 12%
Realisation 47 which is 56%
Finished 23 which is 27%
Direct partnerships of the platform at December 1, 2017

Evolution of hosted people

Evolution du of industrial projects average

Back main menu
Back organisation menu
Applying for a project

> Direct contact: renatech@laas.fr to interact about the framework of your project.

> Renatech online application
   - [https://www.renatech.org/projet/](https://www.renatech.org/projet/)
   - Creation of a confidential personal account

> Application
   - Administrative elements
   - Technical elements

> Interactions with a correspondent
   - Technical details
   - How to undertake
   - Tariff proposal
   - IP / privacy
   - Completion document
   - Signed by both parties

NB: LAAS’s members are free from these steps
Projects Realisation

> Who ? : various ways depending
  - Nature and duration of the project
  - Volume and nature of the technological skill
  - Technology expertise of the user

- By LAAS
  - TEAM
  - Permanents or temporary researchers

- Contractual people
  - Provided for in the contract
  - Included in TEAM

- External staff
  - Prior convention

> Monitoring of the process on process sheets of and and online reservations
  - [https://lims.laas.fr/Default.aspx](https://lims.laas.fr/Default.aspx)

NB : LAAS’s members are free from these steps
Users hosting

- **Systematic procedure before open access**
  - Awareness of the documents compiling the rules and essential protocols
  - Inscription on online
    - Renatech project management application
    - MyFab LAAS clean room activities management application
    - Clean room users mailing list
  - Practical training
    - General Introduction
    - Photolithography
    - Introduction to chemistry, its risks
    - Introduction to characterization
    - Plasma stripping, descuming

- **Help during the stay**
  - TEAM technical coordinator
  - Formations
    - Mandatory
      - ½ day Introduction on development, surface treatment, patterning, characterization and integration of materials
      - Lectures on
        - Rules and tools for the manufacture of optical masks
        - Chemical risks prevention
        - Optical lithography
        - Characterization
    - Optionals
      - Lectures (12) on the technics available
      - Practical training on numerous equipment
Financial management

> Auditable billing of audited prices

  ▪ Calculation Method
    • Link between each expense and technology operations
    • Full cost calculation of each operation
    • "Degrade" the full cost in prices (4) acceptable according to the funding source

> Operations billing is done according to the price eligible to the funding origin and/or the applicant.

> A document summarizing the set of operations and the paid amount is produce, and can be use for the financial justification
Many thanks
for your attention