RENATECH

French national nanofabrication network

news

Septembre 2015

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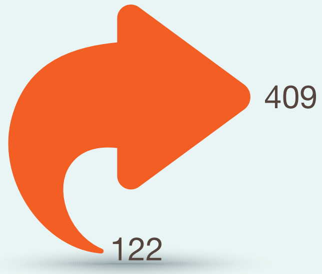
2014 RENATECH's Key figures

847 projects were underway in 2014 in Renatech's clean room.
Of which 48% of exogenous projects

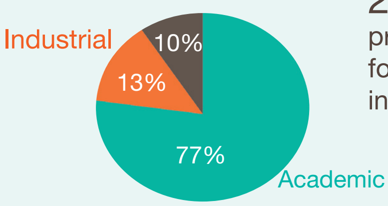
Growth of exogenous projects (2004 to 2014)

x3 in 10 years



Exogenous project corresponds to a realization carried out for the account of one (or several) external laboratory (academic or industrial) such that the driver of the project is not from the laboratory supporting the technological facility.

Type of projects' driver



23% of exogenous project were realized for one or several industrials

More than half projects required technological developments

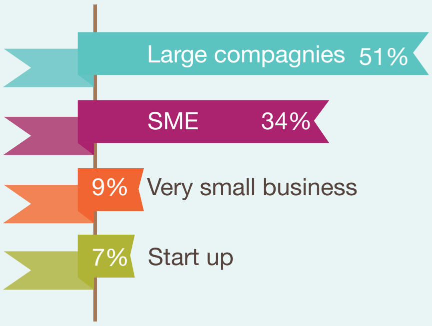
57% with process development

43% without

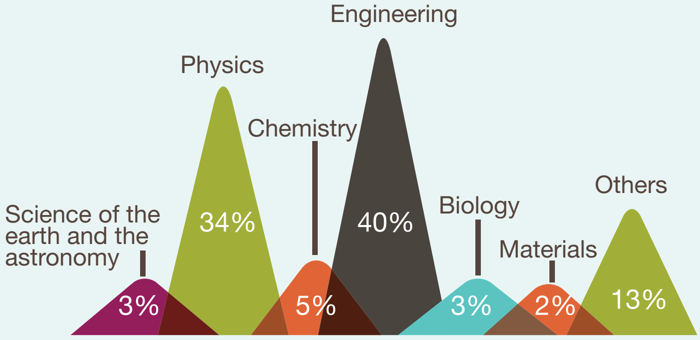
This kind of project requires one extra clean room engineer

140 clean room engineers & technicians

Renatech worked with all companies



Renatech worked with various industries



International projects : 7% of exogenous projects

Renatech worked with 25 countries

70% of international projects required specific technologic developments

60% of international partners are European

1st: Germany
2nd: Great Britain
3rd: Italy
4th: Sweden

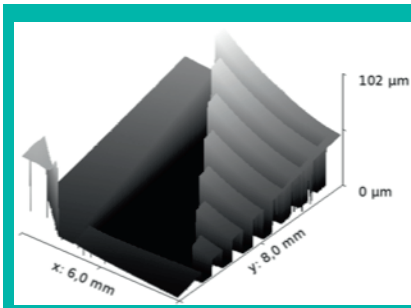
Average duration of exogenous projects : 27 months

Scientific results

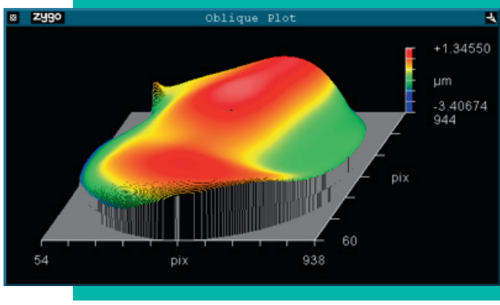
- > 975 publications thanks to Renatch's facilities
- > 166 invited paper from Renatch's laboratories at national or international conferences
- > 4 ERC
- > 1 CNRS **silver medal**

02 New metrology tools for surface characterization

The Mimento facility has enriched its portfolio of characterization service inside the clean-room, with the recent acquisition of 3 new tools, particularly dedicated to surface characterization. First a GBX Digidrop contact angle measurement system has been acquired for the characterization of surface energy using sessile drop contact angle measurement. The tool is a welcome addition, particularly useful for studying surface energy modification process in the context of multi-wafer assembly. Then cterizationinterferometer system and a Nanojura/Digitalsurf confocal microscope platform. The Fizeau interferometer with a flat reference plane can be used for measuring continuous profile of full wafer (up to 100 mm diameter) in a few seconds with sub-nanometer resolution in Z. In particular it may check planarity before wafer bonding process, or help evaluate internal stress after thin-film deposition. Special techniques have been developed for measuring profile of transparent or birefringent wafers. The scanning confocal microscope is used also for surface profile measurement, using point by point measurement with white light confocal microscopy. This system is relatively slow as the number of points can grow fast, but achieves high resolution in Z (below 1nm within a range of 600µm) and in the XY plane (0.1µm) over a full 100x100mm2 area.



Profile of stress-bent cantilevers with Nano-Jura confocal microscope



Continuous profile of a stressed wafer with Zygo Fizeau interferometer

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femto-st SCIENCES & TECHNOLOGIES

03

Low-loss LiNbO3 tapered-ridge waveguides

We have produced low-loss vertical tapers for efficient coupling between confined LiNbO3 optical ridge waveguides and single mode fibers. The tapered-section is fabricated simultaneously with the ridge waveguide by means of a circular precision dicing saw implementing our “dice & polish” process, so that the full fabrication procedure takes only two dicing steps. The total insertion losses through a 1.6 cm long ridge waveguide are measured to be improved by 3 dB in presence of the taper. These tapered-ridge waveguides open the way to the low-cost production of low-loss phase modulators or resonators. In 2014, this work has resulted in 2 invited conferences (17th ECIO European Conference on Integrated Optics – ECIO-MOC and Photonics West Opto) and one French patent.

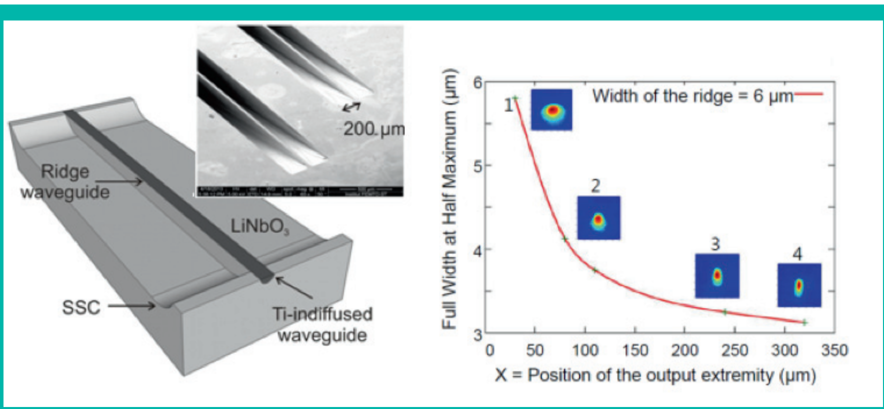

Fig. 1. (a) Schematics of the tapered-ridges. (b) Scanning Electron Microscope view of a fabricated taper (c) Measurement of the output optical mode at the extremity of the tapered-ridge, done with an infrared camera @ 1550 nm wavelength

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04

Selective area epitaxy of InAs/AlGaSb tunnel diodes

The AlGaSb/InAs heterostructure is a very promising system for tunnel field effect transistors (TFET) as its highly staggered band line-up can lead to a tunnel current density as high as 1 MA/cm2. Various configurations have been used to control the tunneling current through the InAs/(Al)GaSb heterostructure from gate all around vertical nanowires grown in the (111) direction to planar gate controlling the vertical tunneling of charges. Those devices exhibit promising characteristics in term of ON-state current density but may be further improved to achieve a sub-threshold slope well below 60 mV/decade. In this study, selective area (SA) growth of InAs by molecular beam epitaxy (MBE) is used to define small area near broken gap AlGaSb/InAs tunnel diodes grown on a GaSb:p+ (001) substrate. Combining PECVD, e-beam lithography, RIE and chemical etching, apertures in a SiO2 layer deposited at the surface of the wafer are designed and serve as a mask for the selective epitaxy of InAs nanostructures. The tunneling heterojunction is achieved by growing AlGaSb/GaSb over the InAs nanostructure. The current-voltage curves of the vertical diodes exhibit a negative differential resistance characteristic of an Esaki diode. The peak current density is larger than 1 MA.cm-2 for 2µmx2µm diodes but is reduced to a few tens of kA.cm-2 for 50 nmx50 nm SiO2 apertures. This phenomenon is attributed to the particular incorporation of Si dopant with respect to the facets of the InAs nanostructure [1].

[1] L.Desplanque et al, Nanotechnology 25, 465302 (2014)

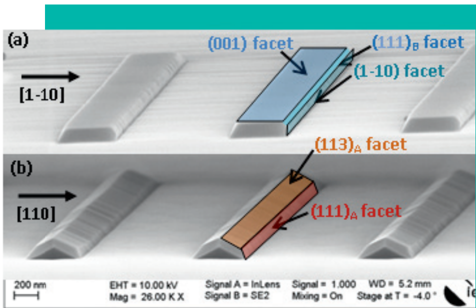

Figure 1 – SAMBE of InAs nanostructures on GaSb

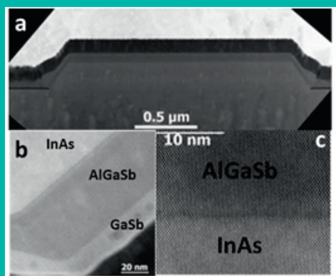

Figure 2 – InAs/AlGaSb heterojunctions

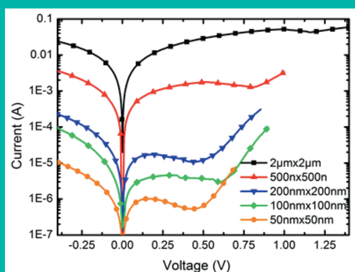

Figure 3– Current-voltage characteristics of tunnel diodes

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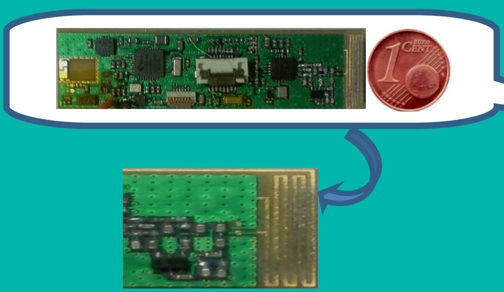
05

SACHA - Development of a flexible patch for elderly monitoring

SACHA (Search And Computerize Human Acts) is a project that aims the monitoring of elderly suffering from declining mental capacity like Alzheimer disease that causes grave memory loss, problems in thinking and changes in behaviors. Falls and fugues of elderly people with this kind of disease constitute a very serious problem, be lost in streets ends generally in a tragic way, hence the need to develop a monitoring system able to detect dangerous cases like falls and provide accurate details about the location of the lost person in case of exceeding a predefined security zone. With the partnership of SIGFOX, TELECOM DESIGN, AXIBLE TECHNOLOGIES, and the hospital CHIVA (Centre Hospitalier Du Val D'ariège), we are working on the development of a flexible tracking patch designed to be worn on the skin between scapulae. This patch is equipped with a microcontroller, a GPS module, an accelerometer for falls detection, a transceiver and two antennas: the first one has an operational frequency of 868 MHz and must ensure communication with the various stations of SIGFOX for data transmission and the second is used to communicate with the Global Positioning System (GPS) satellites (1575.42 MHz) for the recovery of the geographical position of the person carrying the patch.
The first prototype of the tracking patch was developed on FR4 substrate (Fig 1), we have designed the 868 MHz antenna and used a commercial one for the GPS, this patch was tested in real case and proved that it had good performances for falls detection and geolocalization, then the following step was the design of our own GPS antenna, the both antennas were simulated using Advanced Design System (ADS) and presented very good reflection coefficient (Fig 2).
In aim to ensure an ease of use and be compatible with the new trend of integration of different systems to provide the contactless energy transfer, we have tested the possibility to integrate a wireless charger compatible with the Qi standard (Fig 3). We have designed our own antenna for the energy recovery and used BQ51050B from Texas Instruments to manage the communication and control the battery charging. This charger is fully compatible with the existing commercial products, it was tested with several base stations and provided very good performances.
For the next step, the final system including all functionalities will be tested, and then we will pass to the development of the flexible version (Kapton) of the tracking patch in the cleanroom of LAAS-CNRS.



Measured S11=-30.8 dB @ 868 MHz
Fig. 1. First prototype of the tracking patch.

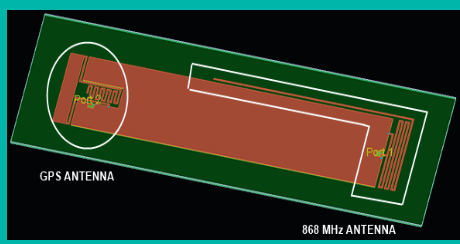


Fig. 2. Simulation of antennas with ADS

Antenna	Simulated S11
868 MHz	-40 dB
GPS (1575.42 MHz)	-44 dB

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Fig. 3. Integration of Qi wireless charger

LAAS-CNRS

06

3D laser lithography by two photon polymerization

Three-dimensional (3D) nanostructures and devices have great interest in wide applications areas.
Recently LPN CNRS installed a compact and easy 3D lithography machine from Nanoscribe, GmbH. (figure 1a). The operating principle is based on two photon polymerization by direct laser writing, a non-linear optical effect.
This technique allows for the fabrication of almost arbitrary 3D nanostructures in suitable photoresists. The center wavelength of the laser is chosen so that the photoresist is transparent since the one photon energy lies well below the absorption edge of the material. By tightly focusing the light of an ultra-short pulsed laser, the intensity within the very focus is sufficiently high to expose the photoresist by multi-photon absorption. This process causes a chemical and / or physical change of the photoresist within a small volume pixel ("voxel") that can be scaled by the laser power. This voxel typically is of ellipsoidal shape and is the basic building block for the fabrication of 3D structures. By moving the sample relative to the fixed focal position, arbitrary paths can be written into the material. The movement of the sample and the adjustment of the laser intensity are synchronized by a computer. After exposure, the material change due to exposure to the laser light and potentially a subsequent thermal treatment lead to a chemical selectivity between unexposed and exposed volumes inside a developer bath. Depending on the photoresist, either exposed (positive-tone resist) or unexposed regions (negative-tone resist) are removed.

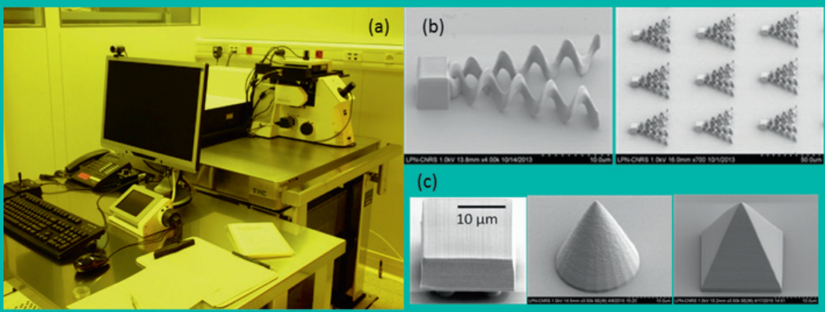
.../...

3D laser lithography by two photon polymerization

The advantages of multi-photon polymerization are:
- Ability to structure truly three-dimensional, no matter how complex your structure may be.
- Superior resolution due to the non-linear response of the photoresists.
- Flexibility: planar structuring (2D) or complex surface topologies suited for mass fabrication via pattern transfer techniques (2½ D).

The lateral resolution can reach down to 100 nm. The writing area can reach by both piezoelectric stage (300µm×300µm×300µm) and motorized stage (10cm×10cm).
The system is currently being utilized for the applications of microfluidics and photonics with more open applications to other fields.
The figure 1-b shows the first example of 3D helical nanostructures for LPN (G. Hwang) develops and studies swimmers micro/nanorobots based on micro/nanostructures form of propellers and different size. These innovative micro-objects can be used to run as mechanical sensors [1] or microfluidic tools for carrying various biomolecules such as drugs in a perfectly controllable manner [2,3]. The study of these swimming objects in microfluidic channels and chambers can explore and understand their dynamic propulsion in an environment at low Reynolds number.
The second example of 3D nanostructures for collaborating with ENS-Cachan (M. Lebental) on the topic of the 3D optical resonators is shown in the figure 1-c. We have realized cubic, conical and pyramidal structures using 3D lithography. This will allow to study 3D organic cavity micro lasers.
We plan to upgrade the current 3D lithography system in LPN to increase the writing speed (up to 100 times) by adding rapid writing module based on the galvo mode.

Fig.1- (a), 3D laser lithography system based on two photon polymerizations (b), 3D helical nanostructures and (c)3D cavity micro laser



References :
1] S. Alvo, D. Decanini, G. Hwang, Micro and Nano Engineering 2013
[2] A. Barbot, D. Decanini, G. Hwang, Proc. IEEE IROS 2014, 4662-4667
[3] A. Barbot, D. Decanini, G. Hwang, Proc. IEEE ICRA 2015

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EVENTS MNE 2015 – 21th to 24th September 2014 in The Hague - Netherlands

MNE (Micro and Nano Engineering) is a major annual international conference, devoted to micro and nano engineering, held in a European country every September. The conference brings together engineers and scientists from across the world to discuss recent progress and future trends in the fabrication, manufacturing, operation and application of micro and nano-structures and devices. Applications in electronics, magnetics, photonics, electromechanics, environment and life sciences are also discussed.
http://mne2015.org/

MNE2015

As usual, RENATECH will participate to this event. You will find us at the booth 14

JNTE 2015 - French Symposium on Emerging Technologies for micro-nanofabrication November 18-20, 2015 - Ecole Centrale de Lyon, Ecully, France

With the first workshop on French-Japan technological research in micro-nanofabrication is organized in collaboration with JNTE 2015 & The 2nd RENATECH technology prize will be awarded at the JNTE 2015 symposium.
http://inl.cnrs.fr/jnte2015/

JNTE - 2015

1 Registrer on www.renatech.org/projet/

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2 The application will be worked through and evaluated by the reception team

...

3 Realize your project

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