The Laboratory

The Institute of Electronics, Microelectronics and Nanotechnology (IEMN) was founded in 1992 with the support of three regional partners: The University of Lille, the University of Valenciennes and Hainaut Cambrésis, ISEN-Lille together with the CNRS (National Center for Scientific Research) which is a government-funded research organization, under the administrative authority of France's Ministry of Higher Education and Research.

The main objective at the time was to gather together in a single research structure disciplines contributing to the progress of microelectronics, MEMS, optics and acoustics and their various applications. Such an organization naturally facilitates interdisciplinary research over a wide spectrum of activities ranging from theoretical physics to telecommunications. Twenty years on, IEMN has increased in scope to encompass nanoelectronics, nanotechnologies and nanosciences. In this period, IEMN has doubled its staff and its budget is four times higher than at its creation and we can claim that the original objectives are fulfilled.

Today, nearly 500 people work together in scientific fields ranging from information and communication technologies to micro and nano technologies. The staff is evenly distributed among permanent and non-permanent employees. The contribution of IEMN to higher education is very important; through doctoral and masters programs which encompass around 160 PhD students and 30 masters.

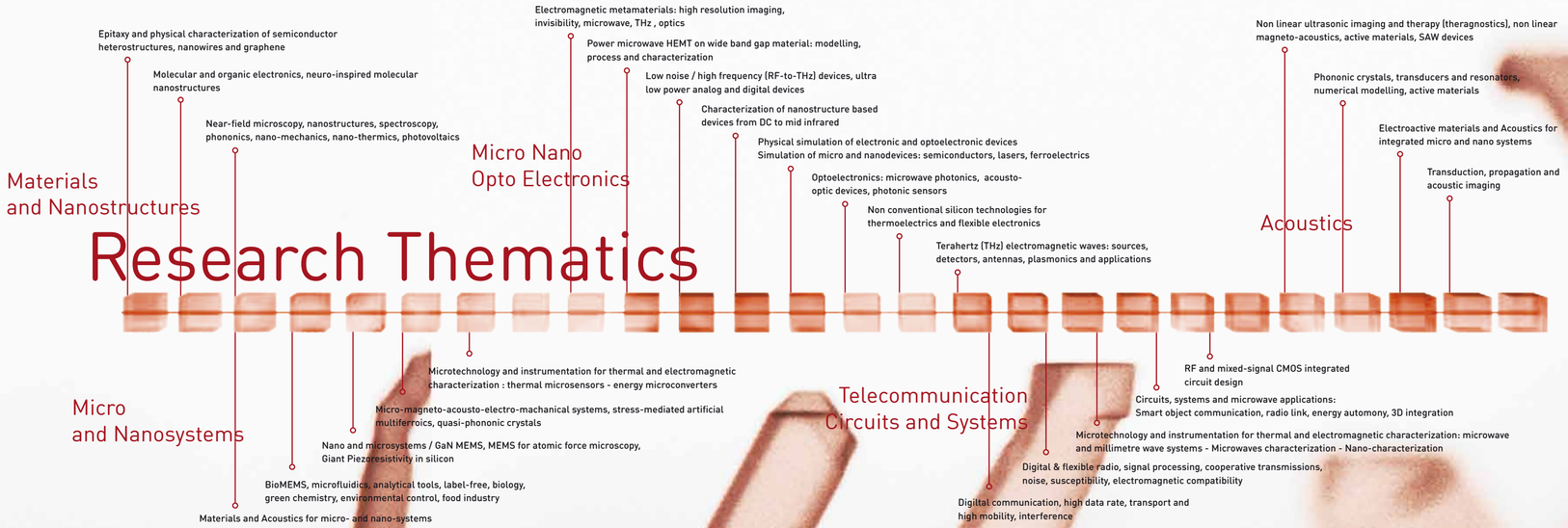
The scientific policy of the laboratory is determined within 20 research groups and emerging activities. This is promoted by 5 research departments:

- Materials and nanostructures
- Micro and nano-systems
- Micro nano and optoelectronics
- Circuits and communication systems
- Acoustics

Medium-term joint programs with industrial partners or other national institutions and long-term research initiatives stimulate the resourcing of our research projects. Due to the constant financial support of the Nord Pas de Calais Regional Council combined with those of our trustees, IEMN can boast exceptional technical facilities:

- Micro and nano fabrication cleanroom (1600m²)
- Very high frequency and MEMS characterization platform
- Near-field microscopy platform (AFM/STM)
- Telecommunication platform

As a member of the French Basic Technological Research Network in micro and nano fabrication, IEMN offers to academic and industrial partners access to technical infrastructure ranking among the best in Europe. In addition to its exceptional equipment, IEMN provides to its partners an outstanding expertise on processes based upon 20 years of experience.
Our scientific policy not only contributes to stimulating exceptional scientific research and its applications but also has the goal of bringing social, cultural and economic benefits for society through our many collaborations with industry.



Materials and Nanostructures

Fundamental studies (electronic structure, optical and mechanical properties, growth, photonics and plasmonics) of advanced materials (semiconductors, nanotubes, graphene, oxides, bio-molecular devices and systems...) and nanostructures are performed within three groups: Physics, Epiphy and Molecular Nanostructures&Devices. Interdisciplinarity (between physics, biology, chemistry and electronics), new concepts and fabrication of innovative devices (using nanotechnology facilities and nanocharacterization), development of green nanotechnologies for energy harvesting (PV, TEG), green materials and ultra low power electronics are the other fingerprints of the department.

Micro and Nano-Systems

The Micro and Nano-Systems department has developed a world renowned expertise in the development of micro and nano-systems. It is composed of a collection of faculty/staff/students (more than 50). It shares a set of world-class design, fabrication, and test facilities, including the 1,200 sq. ft. of cleanrooms, managed by the Institute. The members of the department conduct industry-relevant, interdisciplinary research on materials, processes, micro/nano-scale sensors/actuators and microfluidics that take advantage of progress made in integrated-circuit, bio, and polymer technologies. The major research themes of the department are: i) Materials and Processes for MEMS, ii) Actuators and Power MEMS, iii) Biological MEMS.

Micro Nano Opto Electronics

Technological breakthroughs are targeted, via the development of new materials and device structures, in order to overcome the current limits in micro- and opto- electronic components. Improving noise, power and frequency state-of-the-art boundaries is then the driving force of the different device studies that are carried out in microelectronics whatever the application is placed in the digital or analogue domain. Interactions between high frequency electrical signals and optical waves lead to develop innovative components in optoelectronics and THz domains from telecommunications up to sensors application fields.

Telecommunication Circuits and Systems

With a long experience on circuit design, this department develops innovative systems for telecommunication and instrumentation applications. It covers a wide frequency range from base band up to millimeter wave frequencies (220 GHz) and has been a pioneer in impulse radio systems at 60 GHz. Main contributions concern high rate or/and high mobility communications and ultra low power communications: energy harvesting, storage and management, circuit design, heterogeneous integration, signal processing and cooperative communications for sensor networks and green radio. They rely on a good balance between theoretical works, experimental validations, demonstrations and realizations.

Acoustics

The Department of Acoustics at IEMN aims to develop fundamental knowledge on active materials and acoustic meta-materials, unusual properties of acoustic wave propagation and acoustical micro-systems in order to use this knowledge to design, fabricate and characterize electronic components and systems. Two interdisiplinary subjects illustrate these activities: networks of sensors for which innovative concepts and components providing specific functions for telecommunications, biology or instrumentation are studied; acoustic imaging in a broad sense with the development of new principles for imaging and non destructive evaluation.

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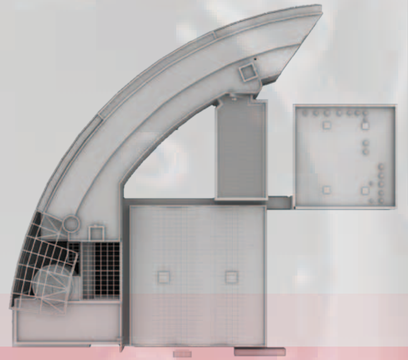

Micro and NanoFabrication clean-room

1,200 sq. ft. of clean room devoted to micro and nanotechnology
Staff: 26 Engineers/Tech
Equipment: about 20 M€

Measurement NanoFabrication clean-room

Staff: 5 Engineers
Equipment: 3,5 M€

Scanning Probe Microscopy Platform

Staff: 3 Engineers
Equipment: 3,3 M€

Telecom Platform

Staff: 3 Engineers/Tech
Equipment: 2,5 M€

Technological Facilities

FRENCH PROGRAM 'INVESTISSEMENT D'AVENIR' - EQUIPEX

- **ExCELSiOR** gathers new and unique equipments in Europe for nanodevices characterization. ExCELSiOR is also a project of shared resources characterization center for nanosciences operating in open access for the scientific and industrial communities.

- **LEAF** project proposes to introduce innovative processing techniques based on laser photo-thermal ablation for heterogeneous integration and interconnect of high-performance device/circuit/microsystems on a flexible substrate. It is backed up by a consistent research program with distinctive focused objectives: the development multi-Ghz flexible electronics and the integration of highly heterogeneous functional materials.

As part of the national Network of Large Technological Facilities and Basic Technological Research (BTR), IEMN Nanolab facilities missions are to support academic organizations and industries that aim international research level in micro and nanotechnology.

- Molecular Beam Epitaxy : III/V material, graphene
- Ion Implantation : more than 30 elements implantable
- Organic Chemistry and Surface Functionalization
- Lithography : Front side and backside alignment, electronic direct writing with pixel size of 1.25 nm.
- Etch : ICP and DRIE dry etch tool, wet chemical etch
- Deposition : PVD, PECVD, ALD, LPCVD
- Electroplating (Au, Cu)
- Characterization : SEM and FIB, physical and electrical characterization
- Device Assembly : wire bonding, dicing , thinning and polishing

Devoted to carry out a full electrical and microwave characterization in a wide temperature range of high speed components such as passive devices (antennas and MEMS) and active devices (HBT, HEMT, MOSFET…)

- 30 kHz-500GHz network analyzers
- DC and Microwave cryogenic probe station (67GHz-5K)
- High temperature probe station (50GHz-600K)
- Microscopic temperature mapping system using Infra-Red camera
- Noise measurements up to 220GHz
- Non linear measurements up to 110GHz with loadpull setup
- HIROX microscope for optical inspection
- Vacuum probe station
- Laser vibrometer instrument
- THz measurements using electro-optic sampling
- Microwave photonics probe station
- Scanning Microwave Atomic Force Microscope
- Solar simulator

- The Scanning probe microscopy platform brings to the scientist the capacity to observe atoms from material surface and nanometric objects with a 3 dimensional sight
- This "nanoprobe" also access to local physical characteristics of materials and nanostructures
- The platform includes 8 microscopes working in ambient or high vacuum condition and cryogenic temperature
- The different probes available interact with the sample thanks to tunneling current or atomic force
- These microscopes are usually based on only one probe but our last new equipment includes 4 probes and a scanning electron microscope, this setup allows nanoscale localization and transport measurement of 1D and 2D nanostructures

This unique academic platform in Europe offers a large set of advanced scientific equipments for the development of new radio modules and communication systems, up to the millimeter wave range. It is particularly suited for wireless ad hoc or mixed radio-fiber networks for smart objects and sensors, towards an ambient intelligence.

- Advanced CAD platform
- Generation of complex analog, digital or mixed signals
- Time and frequency domain analysis of analog, digital or mixed signals
- Real time baseband channel emulator and MIMO analysis
- Optical communications
- Hardware-Software interface
- Quick prototyping station

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