

MASTER INTERNSHIP POSITION

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Groupe de Recherche : Photonique THz

Characterization of Fe-doped AlInGaAs Epitaxial Layers and Development of Ultrafast Optoelectronic Devices for Terahertz Emission and Detection

Context : Terahertz (THz) technologies have attracted considerable attention over the past two decades due to their strong potential for applications in time-domain spectroscopy, non-destructive testing, security screening, biomedical imaging, and high-speed wireless communications. THz time-domain spectroscopy (THz-TDS) in particular relies on the generation and detection of sub-picosecond electromagnetic pulses, requiring ultrafast optoelectronic devices with high resistivity and extremely short carrier lifetimes. Photoconductive emitters and detectors based on III–V semiconductors remain among the most efficient and versatile solutions, especially when driven by femtosecond laser sources operating at 1 μm or 1.55 μm . The development of optimized materials compatible with these laser wavelengths is therefore a key scientific and technological challenge for next-generation THz systems.

Mission: The objective of this internship is to investigate Fe-doped AlInGaAs epitaxial layers grown at IEMN (Institut d'Électronique, de Microélectronique et de Nanotechnologie) and to assess their suitability for ultrafast photoconductive THz emitters and detectors operating at 1 μm and 1.55 μm excitation wavelengths. Fe doping is expected to induce deep levels in the bandgap, leading to semi-insulating behavior and reduced carrier lifetime, both of which are essential for efficient THz generation and detection. The work will first focus on a comprehensive electrical and structural characterization of the epitaxial layers. Resistivity, carrier concentration, and mobility will be determined using Hall effect measurements. Compositional and structural analyses will be performed using energy-dispersive X-ray spectroscopy (EDX) in order to verify alloy composition and doping homogeneity. Ultrafast carrier dynamics will be investigated through optical pump–probe measurements to extract carrier lifetime and recombination mechanisms as a function of Fe concentration.

In a second phase, the student will contribute to the microfabrication of high-speed optoelectronic devices in a cleanroom environment. This will include photolithography, metallization, and device processing steps required to realize photoconductive antennas or related THz components. The fabricated devices will then be electrically and optically characterized, with particular attention paid to their temporal response, dark resistivity, and THz emission or detection performance. The overall goal is to establish clear correlations between material properties, doping conditions, and device efficiency.

Expected Profile: The candidate should be enrolled in a Master 2 program in physics, materials science, electrical engineering, or a closely related discipline. A strong background in semiconductor physics and solid-state materials is required, along with knowledge of electrical characterization techniques such as Hall effect measurements and resistivity analysis. Familiarity with optical characterization methods, particularly ultrafast pump–probe techniques and carrier dynamics in semiconductors, will be highly appreciated. An understanding of III–V semiconductor materials and an interest in cleanroom microfabrication processes are essential. The candidate should demonstrate autonomy, scientific rigor, analytical thinking, and good communication skills in English, both written and oral.

Research Environment

The internship will be conducted at IEMN, a leading research institute in microelectronics, nanotechnology, and optoelectronics. The project is part of ongoing research activities dedicated to high-speed optoelectronic materials and devices for advanced THz systems. The student will work within a multidisciplinary environment combining epitaxial growth, advanced material characterization, ultrafast optics, and device fabrication, offering a comprehensive training at the interface between fundamental semiconductor physics and applied THz technology.

NOTE: TWO MONTHS DELAY BETWEEN APPLICATION AND INTERNSHIP STARTING (ZRR CLEARANCE DELAY)

Salary : ~600€/month.

Duration : between 4 and 6 months

Starting date : Mars 2027