Institut d'Electronique, de Microélectronique et de Nanotechnologie
UMR CNRS 8520

MASTER INTERNSHIP POSITION

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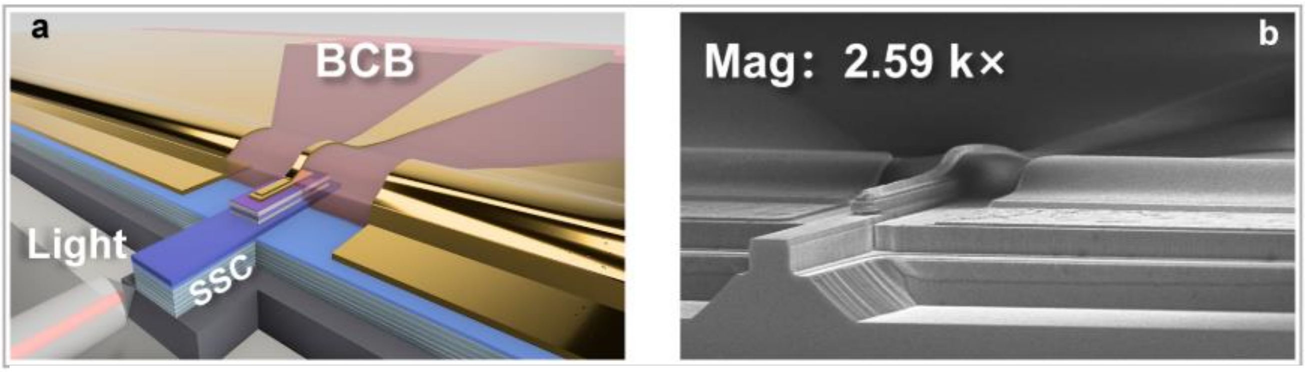
Groupe de Recherche : Photonique THz

Next-Generation Ultra-Fast Telecom Photodiodes for RF & THz Generation"



Sate of the art Waveguide Integrated Photodiode. a, Schematic of the device.. b, SEM image of the fabricated device drawn from Ref[3]

Context : One of the most promising continuous-wave THz sources operating at room temperature is based on photodetection of the frequency beating generated by the spatial superposition of two infrared lasers. Photomixing allows frequency down-conversion from the very high frequencies (~300 THz) of infrared lasers to lower frequencies, around 1 THz, making it inherently broadband. Moreover, photomixing-based sources are potentially compact thanks to the use of laser diodes and semiconductor amplifiers, but they currently suffer from limited output power (~10 µW at 1 THz). The output power is restricted by the trade-off between reducing the photodetector size (to minimize electrical capacitance) and maintaining a sufficiently high photocurrent. Photocurrent density is therefore the key factor for improving output power. The best photomixers currently reach about 200 kA/cm², only one order of magnitude below the best electronic devices. New types of photomixers are thus needed to achieve milliwatt-level THz power. As part of this internship, original structures of high-saturation-current fast photodiodes compatible with 1550 nm telecom lasers will be studied at IEMN. These devices will be based on modified uni-traveling-carrier (MUTC) PIN photodiodes with partially doped absorption regions, in order to optimize the trade-off between bandwidth and linearity at high optical power[12,3]. Several device designs may be investigated, including resonant cavity structures[4], waveguide-based structures, and distributed structures on a THz waveguide. The latter approach consists of integrating multiple photodiodes along a THz waveguide, enabling cumulative current generation and significantly enhanced THz output power.

Mission: The intern will contribute to:

- Performing optoelectronic and electromagnetic simulations of photodiode structures (using SILVACO, Lumerical, CST).
- Assisting with the design and modeling of THz emitters based on integrated photodiodes.
- Supporting the fabrication of components in the cleanroom.
- Taking part in preliminary THz characterizations with the THz Photonics group and technical platform staff.

This internship will provide hands-on experience in optoelectronic device design, simulation, and experimental characterization in the field of photonic THz sources.

Expected Profile: For this internship focused on optoelectronics and semiconductor physics, we are looking for a student who has followed an academic path in Electrical Engineering or Physics with a solid background in Semiconductor Physics and who is motivated by research in applied physics.

Career Opportunities offered by this internship : The intern can then continue with a PhD or move towards the optoelectronics, RF & microwave components and systems industry, which is currently highly promising.

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

Salary : ~600€/month. **Duration : between 4 and 6 months** **Starting date : Mars 2026**

1.Grzeslo, M. *et al.* High saturation photocurrent THz waveguide-type MUTC-photodiodes providing mW output power in the WR3 band. *Optics Express* **31**, 6484–6498 (2022).
2.Li, Z., Pan, H., Chen, H., Beling, A. & Campbell, J. C. High-saturation-current modified uni-traveling-carrier photodiode with cliff layer. *IEEE J Quantum Electron* **46**, 626–632 (2010).
3.Li, L. *et al.* Ultra-fast, high-power MUTC Photodiodes with bandwidth-efficiency product over 130 GHz * 100%. (2025).
4.Tannoury, C. *et al.* Photonic THz mixers based on iron-doped InGaAs embedded in a plasmonic microcavity. *APL Photonics* **8**, 116101 (2023).