

PhD open position at Institut FOTON and IETR

Optical actuation of Phase Change Material for the realization of versatile microwave functions

A 36 months duration PhD will start at Institut FOTON and IETR labs, on the investigation of the optical and electrical properties of phase change material (PCM), in order to bring new reconfiguration capacities in microwave circuits and antennas, for future civil and military communication systems and satellite constellations.

PhD starting : October 2024

Duration : 36 months

PhD director : E. Fourn / C. Paranthoen **PhD co-supervisor :** M. Perrin

Funding : ANR MACIEO

Keywords : Phase change material, microwave circuits, processing, laser crystallization/amorphization

PhD context

It would be nice to have microwave components whose response can be changed after their fabrication. For instance, filters with a reconfigurable frequency response, or antennas with a reconfigurable radiation pattern. This could impact a large variety of applications in the field of civil and defense communications (satellites, 6G) [1]. While several solutions exist to bring this reconfigurability feature, they usually use electronic command lines which both consume power and may interfere with the signal in the microwave range.

One of the two main ideas of the French national project MACIEO (2024-2028) [2] is to take advantage of the properties of chalcogenide phase change materials (PCM), which can exist in two phases: crystalline and amorphous at ambient temperature. The resistivity changes by up to 5 orders of magnitude from one phase to another, and the transition from one phase to another can be done by moving a pulsed laser beam over the sample.

The MACIEO project gathers several expertise in the phase change material (PCM) fabrication (UMR CNRS ISCR, Rennes), in microwave circuit design (UMR CNRS IETR, Rennes and UMR CNRS Lab-STICC, Brest), and in photonics and device fabrication (UMR CNRS I-FOTON). In the framework of this collaborative project, the main objective is to develop reconfigurable microwave circuits, by combining the RF propagation and a direct laser writing/erasing step on PCM areas to induce phase transformation and thus tuning properties.

The main objective of this PhD project is to build and develop the necessary steps to realize reconfigurable microwave circuits in the [10, 30] GHz frequency range, based on the optical actuation of PCM materials. The PhD candidate will be involved in material characterizations, RF simulation and measurements, device processing. In particular, the PhD candidate will be have to study the laser induced crystallization/amorphization parameters to be implemented in real microwave circuits.

To reach these objectives, the PhD candidate will benefit from Institut FOTON in house facilities (optical/electrical characterizations, cleanroom) [3], IETR facilities (RF designing tools, RF platform characterizations) [4].

About the PhD candidate

The candidate will have a master or engineer degree. As this project is at a frontier between materials, optics and microwave electronics, it covers a wide panel of scientific fields (material science, optical/electrical characterizations, thermal and RF simulation, processing), the candidate will have to show a strong motivation and interests for experimental sciences and theoretical modelling. Moreover, because of the central and essential position of this project, the PhD candidate will have to experiment a good team spirit, as she/he will have to interact regularly with all the project partners (ISCR, IETR, I-FOTON). Basics skills in optoelectronic, microwave devices and processing would be appreciated.

About Institut FOTON laboratory

FOTON Institute (UMR CNRS 6082, <http://foton.cnrs.fr>) has a long expertise in the field of photonic devices based on semiconductors, from the material growth and engineering, processing up to the component. It is organized into three groups, including OHM group which is involved in MACIEO project. Its expertise lies on a state-of-the-art micro-nano fabrication platform NanoRennes (part of the French network Renatech+). It has a long experience in designing and fabricating photonics devices (edge emitting lasers, V(E)CSELs, micro-disks), building complex optical experiments (pump-probe, spectral hole burning measurements).

About IETR laboratory

IETR (UMR CNRS 6164, <https://www.ietr.fr/>) has a strong research expertise in antenna design, microwave and RF architectures and systems, digital communications, remote sensing, image / signal processing, etc. IETR benefits from measurement means at the highest European level for antennas, circuits and radar characterizations. It is organized into 13 teams including Surfwave one involved in MACIEO. Surfwave focuses its activities on periodic and quasi-periodic structures (reflectarray, transmitarray, WAIM, FSS, etc.) and to a lesser extent on microwave filters. Surfwave members have also a strong expertise on reconfigurable components and antennas

Additional information - Contact

More information by contacting :

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How to apply

Contact: cyril.paranthoen@insa-rennes.fr and Erwan.Fourn@insa-rennes.fr

Documents asked for :

- Motivation letter
- Detailed curriculum vitae (CV)
- Educational grades and marks (at university level)
- Recommendation letters or people to contact for recommendation.

Deadline for submission : 30th April 2024

References :

[1] International Telecommunication Union, "Future technology trends of terrestrial international mobile telecommunications systems towards 2030 and beyond", Report ITU-R M.2516-0, Nov. 2022 (<https://www.itu.int/pub/R-REP-M.2516-2022>).

[2] MACIEO project web site: macieo.insa-rennes.fr

[3] <http://nano-rennes.insa-rennes.fr/>

[4] <https://www.ietr.fr/en/experimental-resources-center>