Groupe de Recherche en Informatique, Image,
Automatique et Instrumentation de Caen

CNRS – UMR 6072
Université de Caen Normandie & ENSICAEN

PhD thesis proposal 2021 (3 years – Sept. 2021)

Development of innovative radiation detectors based on functional oxides for applications in IR and THz ranges

We are particularly interested in the composition $La_{0.7}Sr_{0.3}MnO_3$ (LSMO), which exhibits a strong variation of electrical resistance as a function of the temperature around 300 K, as well as a low electrical noise, for the realization of uncooled radiation sensors such as bolometers [1]. The targeted areas of use are space missions dedicated to earth monitoring, and meteorology. They could be extended to applications in various fields such as security, medical or military.
Currently, in order to achieve the ultimate performance in the millimeter band, submillimetric to far-infrared, all receivers use superconducting material-based detectors whose low critical temperature (superconducting transition temperature) requires cooling powers that are often incompatible with long-term space missions. Our preliminary results obtained with LSMO suspended structures are very interesting because Noise Equivalent Power (NEP) of the order of 1 $pWHz^{-1/2}$ was obtained at 300 K [2-5]. Under optimized temperature and current conditions, bolometer noise measurements show that they can be phonon noise limited, very close to the theoretical limits for thermal detectors at 300 K. Optical characterizations (visible at 655 nm and IR 3.39 µm using a HeNe laser) made in our laboratory have confirmed that we can manufacture sensitive IR uncooled bolometers based on suspended LSMO thin films. Finally, recent preliminary measurements carried out at the SOLEIL synchrotron demonstrated that LSMO bolometers are sensitive in different wavelength ranges ([8µm-12µm], [1µm-20µm], [16µm-1000µm]) even if they were not coupled to an antenna [6].
It is therefore interesting to continue at first the optimization of suspended bolometers based on LSMO thin films for detection in the near / medium infrared and THz. Then, the objective is to work on the coupling radiation - detectors in order to adapt the detectors to the ranges of wavelength where it lacks performant uncooled detectors. Indeed, LSMO bolometers coupled to adapted integrated planar antennas should in particular be able to meet the detection needs in the THz and far infrared range where there are no efficient uncooled solutions. This work will be done within a national project ANR called BOLOTERA (2021-2024) which involves two others partners: a lab[1] and a start-up company[2] at Lille. Several missions in Lille are planned within this consortium. New measurement campaigns at the SOLEIL synchrotron are also planned to refine the results.
The points to be addressed during the thesis will be:
a) Evaluation of potential performance, design and manufacture of clean room components (thin film structuring coupled to broadband planar micro antennas)
b) Electrical and optical characterization, modeling of the physical phenomena appearing in the devices. Measurements in the THz frequency range will complete the knowledge on the optical properties of ultra-thin LSMO far-infrared layers.
c) Implementation of the detector: in this final step, a detector system will be designed and implemented in the framework of collaborations.

[1] V. Nascimento, " Détecteurs de rayonnement (IR → THz) innovants à base d'oxydes fonctionnels", thèse Université de Caen Normandie, Déc. 2019.
[2] V. Nascimento *et al.*, J. Phys. D: Appl. Phys, 54 055301 (2021)
[3] L. Mechin *et al.*, J. Phys. D: Appl. Phys. - Fast Track, Communication 46 202001 (2013)
[4] S. Liu *et al.*, Microelec Eng. 111, 101 (2013);
[5] S. Liu *et al.*, J. Micromech. Microeng., 29, 065008 (2019);
[6] SOLEIL Synchrotron, AILES line - proposal 20181598, July 2019

[1] IEMN (UMR 8520)
[2] Vmicro

Groupe de Recherche en Informatique, Image,
Automatique et Instrumentation de Caen

CNRS – UMR 6072
Université de Caen Normandie & ENSICAEN

Requested skills:
Master diploma or equivalent diploma. For this strong multidisciplanary subject, profiles based on/or merging competencies of electronics, sensors, physics, material physics and / or micro-technology clean room will be considered with a great attention. The proposed thesis is for curious, inventive, dynamic candidates having a strong scientific background and a sense of collaborative works. Experience of research and experimentation will be appreciated extra points.

Funding:
3 years duration doctoral contract, The PhD thesis beginning is expected in September 2021.

Application:
Please send your application documents including a detailed CV and a motivation letter dedicated to the proposed position as soon as possible and before **March 1, 2021**. You may add additional documents such as the marks and ranks you obtained during your master degree or engineering school, and reference letters.

Contact:
Bruno Guillet
Associate professor University Caen, HDR,
bruno.guillet@unicaen.fr
+33 2.31.45.26.93

Laboratory:
GREYC (UMR 6072)
ENSICAEN
6 boulevard Maréchal Juin
14050 CAEN cedex (FRANCE)
www.greyc.fr