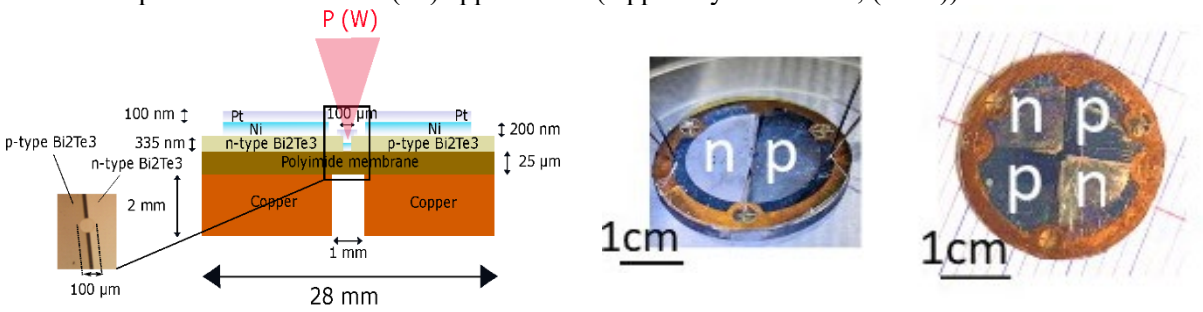
NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2024-2025

Highly-sensitive infrared thermoelectric detectors

General Scope :

At Institut Néel in Grenoble, we are developing materials for the Energy such as thermoelectric thin films with high performance at ambient temperature. These thin films from the bismuth telluride family form the core of innovative micro-devices such as energy micro-generators or ultra-sensitive thermal detectors. A thin suspended polyimide membrane coupled to thermoelectric thin films with figure of merit ZT~1 ($ZT=S^2T/\rho\kappa$ with ρ electrical resistivity, κ thermal conductivity, S Seebeck coefficient and T temperature) is used to ensure the sensitivity of thermal detectors. To date, single-pixel sensors measuring 1 mm in diameter have been developed and characterized, showing remarkable potential for infrared (IR) applications (Appl. Phys. Lett. **125**, (2024)).



a) **b)** **c)**

Thermoelectric detector characteristics : principle of detector in cross section (a) (Scales are not respected) and optical pictures of Bi_2Te_3 detectors constituted of single (b) and dual-junctions (c).

Research topic and facilities available :

The aim of the internship is to develop an array of thermoelectric pixels 150 microns in diameter and to characterize them under IR radiation. One of the objectives of the work will be to determine parameters such as responsivity, noise equivalent power (NEP), thermal constant τ, and specific detectivity, D*, of representative pixels. These measurements will be carried out for a polyimide membrane thickness of 25 microns, then for smaller thicknesses after carrying out an etching process using plasma oxygen technique. A study of the absorption of IR radiation as a function of polyimide thickness will also be carried out.

The trainee will be responsible for :
-carring out a bibliographical review of infrared sensors, in particular thermoelectric sensors
-developing the pixel matrix using clean-room processes at the NANOFAB pole and EpiCM pole facilities
-characterizing the responsivity and detectivity performances under IR radiation.

He (or she) will be integrated into the TPS team (Thermodynamique et Biophysique des Petits Systèmes) in strong collaboration with the 'transfert-cell' for valorization purpose. The trainee will be supported and trained by the technical staff involved in the project.

Possible extension as a PhD : Yes

Required skills :

The candidate should have a basic knowledge of solid-state physics and a strong interest in experimentation. Knowledge of thin-film deposition will be particularly appreciated, but not necessarily required.

Starting date : February-March 2025

Contacts :

Daniel Bourgault et Jean Luc Garden
Institut Néel - CNRS
Phone: 04 76 88 90 31 / 04 76 88 90 61 ; E-mail :daniel.bourgault@neel.cnrs.fr / jean-luc.garden@neel.cnrs.fr ; More information: http://neel.cnrs.fr