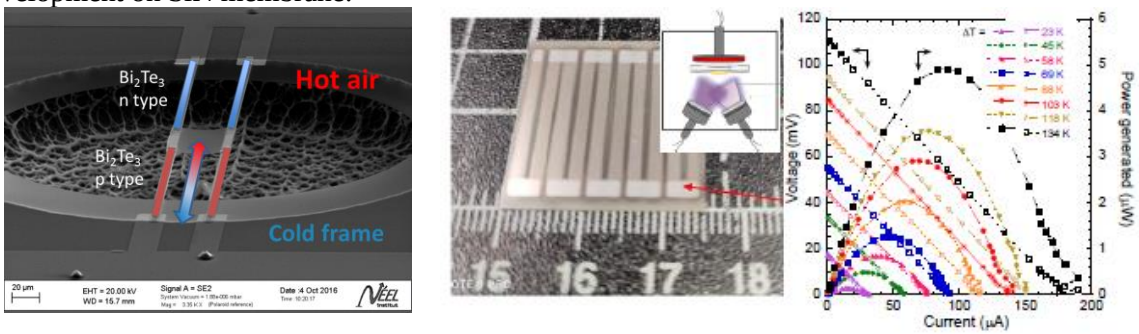
NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2023-2024

Suspended Fe_2VAl thermoelectric micro-generators

General Scope :
With the rise of IoT, wireless sensors capturing small energy (100 µW to 1 mW) for autonomy have have seized the interest of both scientific community and industrial sector. Thermal energy, though modest, offers near-ubiquitous availability. In this context, several teams developed planar thermoelectric generators with suspended membranes, enhancing sensitivity to temperature fluctuations. Thermoelectric microgeneration on suspended SiN membrane was validated by TPS (Thermodynamique et Biophysique des Petits Systèmes) team at Neel Institut using Bi_2Te_3 thin films (Figure 1a). Recently, high power factors were achieved with Heusler-type Fe_2VAl (Figure 1b), more abundant, unexpensive, and less toxic than Bi_2Te_3, and these results make it possible to envisage development on SiN membrane.



a) b)

Figure 1 : a) SEM image of an individual micro-thermogenerator developed usinfg Bi_2Te_3 thermoelectric thin films. b) Microwatt power output obtained in thermoelectric microgenerators based on cost-effective and non-toxic Fe-V-Al thin films deposited by a DC magnetron co-sputtering process.

Research topic and facilities available :
The aim of this internship is to deposit and characterize Heusler Fe-V-Al thermoelectric thin films on SiN suspended membrane for electrical microgeneration applications. Thin films will be developed by magnetron sputtering and annealed under various conditions. Carrier concentration and mobility measurements will be carried out on the thin films obtained. These experiments, coupled with thermoelectric properties (Seebeck S effect, electrical resistivity ρ, and thermal conductivity λ for the best samples), will enable us to optimize the figure of merit $ZT=S^2T/\rho\lambda$, which is characteristic of thermoelectric efficiency. The compositions, phases and microstructures of thin films will be analyzed by X-ray diffraction, SEM-FEG and EDX. Part of the internship will also be dedicated to measuring contact resistances between metal and n-type and p-type thermoelectric materials using the CTML (Circular Transmission Line Method).

Possible collaboration and networking :
Strong interaction with the start-up MOÏZ in the frame of an ANR project.

Possible extension as a PhD : Yes. Thesis funding to continue this work has been secured.

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 2024

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