Graduate Research School université de BORDEAUX

I2M BORDEAUX

Proposal of PhD thesis in Mechanical Engineering

Title: Quantitative thermal characterization at micrometric scale by Scanning Thermal Microscopy

Keywords: thermal characterization, thermal properties, Scanning Thermal Microscopy, material science

Starting: September 2019

Location: Institute of Mechanical Engineering, University of Bordeaux, France

Salary: Scholarship from Ministry of Research and Innovation (> 25 et < 35 k€ gross per year)

Summary: Advances in nanoscience and nanotechnology now offer labs and industry the opportunity to develop systems at the nanoscale and give them the desired properties at the macro scale (microelectronics, composite materials). Understanding the operation of these systems requires appropriate measurement tools. It is the same for the thermal properties.

SThM (Scanning Thermal Microscopy) offers today the best spatial resolution among thermal measurement techniques. For a few years, the Thermal Imaging and Characterization team of the I2M lab has been developing SThM for the characterization of thermal properties of materials and interfaces. This device, operating in periodic mode, has already been used on several applications [1, 2, 3]. However, the sensitivity of the SThM measurement remains limited to materials whose thermal conductivity does not exceed 20 W $m^{-1}K^{-1}$. Indeed, the very small contact area between the probe and the material, limits the heat flux exchanged, and makes it difficult to detect differences when the material is a good thermal conductor.

The first objective of the thesis will be to develop an experimental and theoretical approach to improve the sensitivity of the measurement by SThM microscopy. The experimental approach will consist of developing configurations that promote the transmission of heat carriers at the probe-material interface. They will be preceded by the study of the transfer physics at the interfaces for the envisaged configuration. The second objective of the thesis will be to exploit the measurements for quantitative thermal characterization. This objective will require a work of thermal modelling, processing large amounts of data and finally the use of inverse techniques.

This thesis project is part of the European project BeforeHand (www.beforehand.eu), which started in January 2019 and in which I2M lab participates. The application studied in this project concerns the field of microelectronics and more specifically the development of new non-volatile memories, based on nanowires and superlattices of phase-change materials (PC-RAM).

[1] A. Saci, J.-L. Battaglia, A. Kusiak, R. Fallica, M. Longo, Thermal conductivity measurement of a Sb_2Te_3 phase change nanowire, Applied Physics Letters 104, 263103 (2014); doi: 10.1063/1.4884604

[2] J.-L. Battaglia, I. De, A. Saci, A. Kusiak, V. Sousa, Thermal investigation of a phase change memory device at the nanoscale, Journal of Physics: Conference Series, September 2016, 745, 032098, doi: 10.1088/1742-6596/745/3/032098,

[3] I. De, PhD Thesis, Université de Bordeaux (2017).

Scientific and industrial collaborations: CEA Leti Grenoble, CNR-IMM Milano Italy

Required profile: Candidate with a Master degree in Mechanical Engineering, Microelectronics, Material Science, or Physics having some laboratory experience. Candidate having the ability to develop experimentation but also skills in data processing and exploitation using scientific computing tools.

Application elements:

- a curriculum vitae with academic results (2 pages maximum)
- a cover letter
- a transcript of the 1st and 2nd year of Master
- one or two letters of recommendation

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Working language: French, English, Polish