

Postdoctoral fellow (M/F): Study of the tunability under electric field of the thermal conductivity of ferroelectric materials by thermoreflectance (H/F)

General information

Number of position : 1

Workplace : TOURS

Date of publication : 12 February 2024

Type of Contract : FTC Scientist

Contract Period : 24 months

Expected date of employment : 3 June 2024

Proportion of work : Full time

Remuneration : between 2800 and 3300€ gross / month depending on experience (CNRS grid)

Desired level of education : Niveau 8 - (Doctorat)

Experience required : Indifferent

Section(s) CN : Condensed matter: organisations and dynamics

Missions

The main mission of the postdoctoral fellow will be to study the field tunability of the thermal conductivity of ferroelectric materials. The measurement of thermal conductivity will be done by thermoreflectance as a function of temperature and electric field. These measurements will be carried out both with a commercial thermoreflectance device from Netzsch at GREMAN (Tours) and laboratory thermoreflectance benches developed at LOMA (Bordeaux).

Context: the development of thermal switches to control heat flows [1] would significantly improve the efficiency of thermoelectric devices and solid refrigeration systems. As part of this project, the postdoctoral researcher will explore an original mechanism based on the interaction between phonons and spontaneous planar defects in ferroelectric materials, to design thermal switches. Ferroelectric materials spontaneously exhibit regions of uniform polarization called domains. They are separated by planar defects called domain walls [2]. The polarizations can be switched, and therefore the number of domains and their orientations controlled, by applying a voltage. Domain walls have complex deformation profiles and interact with phonons as defects do [3]. Thus, as the density of domain walls increases, the number of collisions between domain walls and phonons increases and the thermal conductivity is reduced. Controlling the density of domain walls via the application of an electric field would therefore ultimately make it possible to develop a compact and efficient thermal switch over a wide temperature range.

[1] Wong et al. A review of state-of-the-art thermal diodes and their potential applications. Int. J. Heat Mass Transfer. 164, 120607 (2021) [2] Nataf et al. Domain-wall engineering and topological defects in ferroelectric and ferroelastic materials. Nat. Rev. Phys. 2, 634–648 (2020) [3] Limelette et al. Influence of ferroelastic domain walls on thermal conductivity. Phys. Rev. B 108, 144104 (2023).

Activities

The project will focus on the study of heat transport at small scales of time and space in ferroelectric materials in the form of single crystals, thin films, and superlattices, which will be produced by other members of the team or obtained via already existing collaborations. The domain structure of these materials will be controlled in-operando by applied voltages. Thermal conductivity will be measured by thermoreflectance as a function of temperature and applied voltage.

Skills

The candidate must hold a doctorate in physics or materials science, and have experience in thermoreflectance measurements and/or with pulsed lasers. Knowledge of ferroelectric materials would be appreciated. Good communication and writing skills, including English, are required.

Work Context

The postdoctoral researcher will work in two laboratories: GREMAN (UMR CNRS 7347) in Tours and LOMA (UMR CNRS 5798) in Bordeaux. GREMAN has strong expertise in ferroelectric oxides (from their growth to their integration into devices, including their complete characterization) and in the measurement and modelling

GREMAN

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<https://greman.univ-tours.fr/>

of thermal transport. LOMA activities aim to explore and characterize the properties of matter from a fundamental and applied point of view. The laboratory develops techniques based on the use of atomic force microscopes and femtosecond pulse lasers to characterize materials, and in particular energy transport at small scales.

This project is part of the ERC Starting Grant "DYNAMHEAT".

The position is located in a sector under the protection of scientific and technical potential (PPST), and therefore requires, in accordance with the regulations, that your arrival is authorized by the competent authority of the MESR.

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<https://emploi.cnrs.fr/Offres/CDD/UMR7347-GUINAT-003/Default.aspx?lang=EN>