ELECTRON-PHONON DRAG EFFECTS AT THE INTERFACES

LABORATORY : Institut Lumière Matière
IN COOPERATION WITH : ILM and ILM

LEVEL : M2
TEAM(S) : ENERGIE

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KEYWORD(S) :

SCIENTIFIC CONTEXT :

Thermoelectricity (TE). In recent years, the exploration of new types of energy has been fueled by the advent of green energy, resulting in the development of thermoelectric (TE) modules emerging as promising alternatives to recover heat lost which represent about 70% of the energy produced through all kinds of processes.[1] Because of their small size and lack of moving parts, TE devices are unsurpassed in terms of converting heat and electricity in the same module which can be used either as a power generator (Seebeck effect) or as a cooler (Peltier effect). However, the limiting factor to large scale industrialization and uses is their relatively low yield which is mostly limited by the efficiency of the thermoelectric materials contained in the TE-modules. A measurement of TE materials' efficiency is based on the dimensionless Figure of merit (zT), which can be expressed as zT=S2σT/κ. In the equation, σ is the electrical conductivity with the unit S cm–1; T is temperature with the unit K; κ is the thermal conductivity with the unit W m–1 K–1, and S is the Seebeck coefficient with the unit V K–1. To tap this mostly unused resource, efficient thermoelectric materials need to be developed to convert waste heat into renewable electricity. The ideal thermoelectric material is viewed as a “phonon-glass electrical-crystal” that is a material in which the heat conduction is low while the electronic conductivity is large.

MISSIONS :

The challenges of the internship. As a result of new physical concepts, particularly those linked to nanotechnology, TE efficiency was significantly increased in the 90s, with no further rebound since then. Today, fundamental studies are needed to identify new concepts for enhancing thermoelectric efficiency. In M2 internship (6 months), we propose to test a physical concept for exalting the Seebeck coefficient. To a first approximation, the Seebeck coefficient is of purely electronic origin and is associated with the asymmetry of the electronic state occupancy (Fermi statistic) when the material is subjected to a high temperature. In this research internship, we propose as final objective to test a new physical effect involving the electron-phonon coupling at the quasi-perfect interface between a thermoelectric material (doped-SrTiO3) and diamond (electrical insulator with one of the highest thermal conductivity).

OUTLOOKS :

Skills: various research equipments and tools at the state-of-the-art (RHEED, AFM, XRD, XPS, PPMS)

BIBLIOGRAPHY :

J. Ramousse and S. Pailhès, « Les systèmes à effets thermoélectriques comme alternative aux machines à cycle inverse » chapter in the book « Thermodynamique et optimisation des machines à cycle inverse » Ed. M. Feidt (2020)

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