Laboratoire d'Energétique et de Mécanique
Théorique et Appliquée - UMR 7563

Post-Doctoral Researcher (2018-2019)

Investigations of three-dimensional thermoelectric nanomaterials

Starting date: Early 2018; duration: 12 months + possibly 6 months

The LEMTA (Laboratoire d'Energie et de Mécanique Théorique et Appliquée), Nancy, France, opens a position of postdoctoral fellow in the area of nanostructured thermoelectric (TE) materials. The work will be done in the frame of a French-Swiss collaborative project funded by the ANR-PRCI program. Topics of materials elaboration, thin films electrodeposition and multiscale modelling of TE composite materials are covered by this project.

Context

Thermoelectricity has seen a renewed emphasis in the last decade due to significant advances in materials nano-fabrication processes with improved performances. This growing interest is reinforced by the fact that the solid-state thermoelectric (TE) devices can convert waste heat from sources such as power plants, motor vehicles, computers or human bodies to electric power using the Seebeck effect and then contribute to a sustainable development. Candidate materials have to exhibit large Seebeck coefficients, reduced thermal conductivity and high electrical conductivity. Over the past decade, most progresses in thermoelectric materials have been made by reducing lattice thermal conductivity through the surface and interfaces scattering of phonons of nanostructured materials. However, reducing device size to the nano-world (nanowire, nanofilms, etc.) has a main drawback which is the ability to use such devices in energy system designed at the macroscale. The goal of the current research project is to provide original solutions of new TE devices that combine the material efficiency observed at the nano into 3D materials based on hierarchically structured porous materials (see Fig. 1).

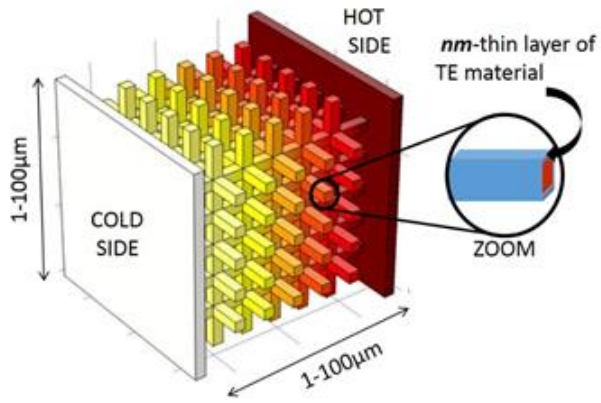

Figure 1 : 3D Thermoelectric materials obtained by two photons lithography (3DTEmat-2L). All the segments of the host polymer material are covered by a thin electroplated thermoelectric material

Objectives of the proposed work

Work program is divided in two stages. The first one will start at the beginning of the project and will to provide optimal design of micro-structure that could be suitable for the elaboration of efficient 3D thermoelectric materials. The second stage will last all along the project and will aim to evaluate through numerical simulations thermal transport in elaborated structures using models and tools developed during the first stage.

Two kinds of microstructures will be achieved in the frame of this research project using electrodeposition of TE materials on templates achieved by colloidal lithography (3DTEmat-CL) or two photons lithography (3DTEmat-2L).

LEMTA
ENSEM - 2 avenue de la Forêt de Haye
BP 90161
54505 VANDOEUVRE-LES-NANCY CEDEX - FRANCE
Tél : 03 83 59 59 59 - Fax : 03 83 59 55 51

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In the case of 3DTEmat-CL the achieved structure is close to the one of open foam with very large porosity (ϕ>90%) for which extensive literature exist concerning thermal transport as material based on this geometry are often used for insulation purpose. Thus, 3DTEmat-CL will be modeled using analytic relations that provide effective thermal conductivity according to the length and cross section of "ligaments" that links the "nodes" of the material. In order to evaluate the reliability of our model, comparisons of calculated effective thermal conductivity with measurements on a set of chosen samples will be done.

For 3DTEmat-2L (Fig. 1), investigations will be based on direct modeling by FEM of architecture micro-lattice using COMSOL. Here, a set of promising sample topologies will be chosen at the beginning of the project, numerical simulations will allow to play with length and diameter of the ligaments to lower as much as possible the thermal conductivity without degrading its mechanical properties. This modeling will take into account the thin film deposition of TE compounds on the polymer skeleton.

Regular interactions with the material leaders (polymer structure elaboration and electrodeposition) of the project are expected as numerical simulations can help to understand and evaluate the thermal properties of the elaborated micro-lattices. Besides, other simulation approaches like molecular dynamics might be considered to describe thermal properties at the polymer/TE interface (Kapitza resistance).

Education / Competences / Strengths

- PhD, preferably on material thermal properties modelling,
- Experience in simulations and theory of heat transport (macro and microscales),
- Knowledge of COMSOL and Matlab is a plus,
- Strong willingness to work in collaborative environment, both locally and internationally,
- Mastering French would be a plus.

Position and associated conditions

- Type of position: Post-doctoral researcher,
- Net salary per month: ~ 2000-2100€,
- Type of contract: Non-permanent full-time position during 12 months, with possibility to be extended for 6 additional months,
- Starting date: April 1st, 2018. Possibility of shifting this date depending on the availability of the selected candidate,
- Localisation : LEMTA, 2 Avenue de la forêt de Haye, BP 90161, 54505 Vandoeuvre les Nancy cedex, France.

Applications (Resume, letter of motivation, names of two references) should be sent by email before 15-3-2018 to:

Pr. David LACROIX

Email: david.lacroix@univ-lorraine.fr