ITI HiFunMat Master Internship Proposal

☐ M 1 ☒ M 2

Elaboration and studies of porous and conducting MOF/polymer composites for thermoelectric applications

Internship supervisor

Name, first name	CHAPLAIS Gérald / SIMON Laurent
E-mail, Telephone	gerald.chaplais@uha.fr / laurent.simon@uha.fr 03 89 33 68 87 / 03 89 33 66 03
Laboratory	Institut de Science des Matériaux de Mulhouse (IS2M)
Collaboration with a HiFunMat member (*please indicate their name*)	☐ No ☒ Yes : BINIEK Laure

Student profile looked for

Master program (*more than one box can be ticked)*	☒ Material science and engineering ☒ Chemistry ☒ Physics
Other indications if necessary	Possible starting date: October 2023 otherwise beginning at conventional date, February 2024

Internship description

This project is in the framework of the research of new sources of energy and transitioning towards green technologies. L. Biniek and co-workers (ICS-Strasbourg) have developed a new class of polymer materials (Cryogel) which are able to generate electricity by **thermoelectric effect (TE)**. These materials overcome the drawback of the already existing TE inorganic nanomaterial (based out of semiconducting chalcogenides (Pb, Bi, Te)), such as their toxicity, high cost, scare resources of elements for their fabrication and poor mechanical properties. In general, a TE material is assessed by its dimensionless figure of merit zT; which is defined by the equation $zT = S^2 \sigma T/\varkappa$ [T: absolute temperature (K), S: Seebeck coefficient (V/K), σ: electrical conductivity (S/m), ϰ: thermal conductivity (W/(m.K)]. In that purpose, organic TE (OTE) materials appear as promising candidates as they fix disadvantages previously mentioned and they can harvest low grade heat (below 150°C).

In this project, we aim to synthesis a new class of composite and hierarchical structure which combines MOFs (Metal-Organic Framework) and porous conducting polymers for TE. The combination of the two hierarchical materials should enable the coexistence of micro- (< 2 nm) and meso (< 50 nm) or macro (> 50 nm) porosity. This is expected to play a large role on the phonon scattering and thus limit the thermal conductivity. As MOFs have also, in general, a higher Seebeck coefficient than conducting polymers, a high Seebeck coefficient is thus expected for the composites.

At IS2M, we will **synthesize MOF-type materials** which will be then used by ICS to elaborate MOF/polymer composites. MOFs result from combination of metal sources and organic ligands which lead to 1D, 2D and 3D scaffolds (Figure 1). They are commonly prepared by hydro/solvothermal, microwave or precipitation routes. Another part of the internship will be devoted to the **study of transport properties of the MOF/polymer composites** by using a nanoprobing station under a SEM (FEG-SEM XL30 equipped with a cryo-stage Kammrath®- 77K-600K and 4 nicro-nano-manipulator IMINA®).

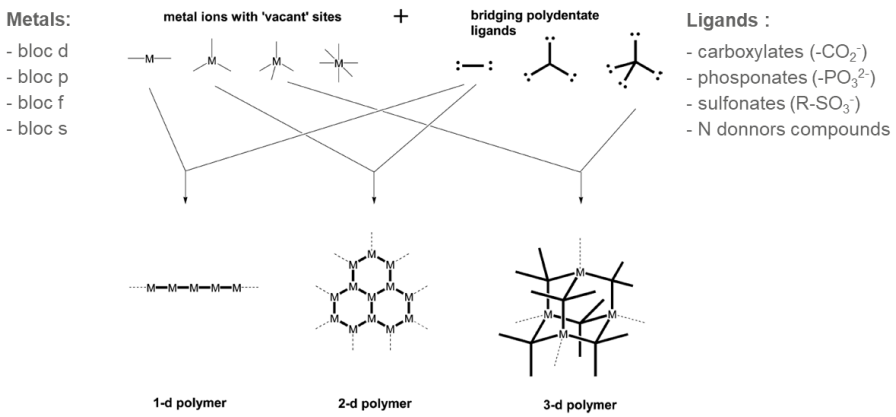

Figure 1. Assembly of inorganic and organic components to form MOFs

Requirements & Application

We are looking for motivated and team-worker master Student (chemist, chemo-physicist) willing to learn about conjugated ligands and MOF synthesis, characterization and thermoelectric properties. Remuneration will be provided for the internship. Collaboration with L. Biniek (ICS) and N. Leclerc (ICPEES) including short stays there (laboratories in Strasbourg), will be possible.

Please send your application including a CV, a motivation letter and Master transcript of records to G. Chaplais [gerald.chaplais@uha.fr] and L. Simon [laurent.simon@uha.fr], from IS2M.

Preliminary discussions by phone are obviously possible and welcome.