Proposition de Stage M2 pour l'année 2016-2017

Equipe d'accueil (Nano)matériaux pour l'Energie (Energy)
http://ilm.univ-lyon1.fr/
Institut Lumière Matière
Campus LyonTech-La Doua
en collaboration avec l'Università di Padova (Italie)
et le CEA-LETI (Grenoble)

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Intitulé du stage **Transport properties in amorphous composites**

Mots-clés thermal transport, electric transport, nanocrystallization, glasses, thermal conductivity, laser ultrasonics

Thermal management has become today one of the most urgent challenges that modern society has to face in order to keep increasing its technological level and positively respond to the energy crisis. Indeed, it represents the bottleneck for next generation device development in many technologies such as nanoelectronics, data storage and energy harvesting, where one of the most urgent needs is to limit heat spread and dissipation while keeping good electric properties. To solve this issue, a recently aroused strategy is to use *heterogeneous architecture materials*[1], as is the case of composites made of nanocrystalline inclusions embedded in an amorphous matrix. Such composites are expected to provide an ultra-low thermal conductivity (κ_T), such as an amorphous, but electric or optic properties specific to the crystalline phase. As such, they are most promising for applications as phase change materials (PCM), now at the forefront of research for optical and electronic storage, where nanocomposites with low κ_T but a good electric contrast with the amorphous phase are foreseen[2], and thermoelectric materials (TE), for which the intertwining of the low κ_T amorphous phase with the high electric conductivity crystalline phase on the nanoscale has shown to be promising[3].

In this context, in order to develop such composites and integrate them in modern technologies, it is essential to understand the impact of a partial nanocrystallization onto thermal and electronic transport. This internship deals with such understanding, through an experimental investigation of thermal and electronic transport in amorphous/crystalline composites prepared as thin films at the CEA-LETI, Grenoble and at the University of Padova, Italy. Parameters such as the crystalline volume fraction and crystallites size will be tuned for understanding their effect on the propagation of electrons and phonons (the quasi-particles responsible for heat transport in non-metallic systems).

Macroscopic measurements such as electric resistivity and thermal conductivity will be performed, with the support of the technological pole Transport, and coupled with microscopic information on the velocity and attenuation of the phonons, as measured by laser ultrasonics in collaboration with the FemtoNanoOptics group at the ILM. The trainee will benefit of a daily and lively debate with other experimentalists and theoreticians working on very similar subjects, within the Energy group.

The internship would ideally continue into a PhD thesis for high quality candidates.

References:

[1] O. Bouaziz, Y. Bréchet and J. D. Embury, "Heterogeneous and Architectured Materials: A Possible Strategy for Design of Structural Materials", Adv. Eng. Mat., 10, n.1-2 (2008)
[2] T. Matsunaga et al., "Phase-Change Materials: Vibrational Softening upon Crystallization and Its Impact on Thermal Properties", Adv. Funct. Mater. 21, 2232–2239, (2011)
[3] M. Verdier, K. Termentzidis, and D. Lacroix "Crystalline-amorphous silicon nano-composites: Nano-pores and nano-inclusions impact on the thermal conductivity" J.Appl. Phys. 119, 175104 (2016)