Proposition de Stage M1/M2 pour l'année 2018-2019

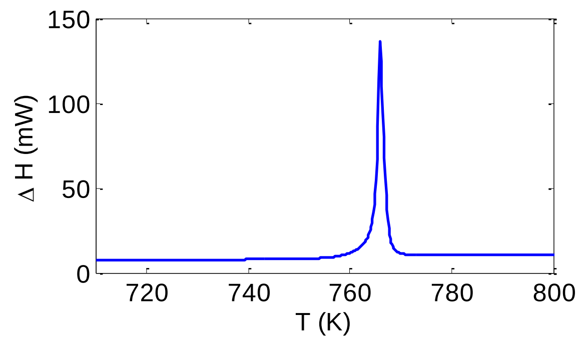
Equipe d'accueil (Nano)matériaux pour l'Energie (Energy)
http://ilm.univ-lyon1.fr/
Institut Lumière Matière

Responsable de stage Valentina Giordano valentina.giordano@univ-lyon1.fr
Regis Debord regis.debord@univ-lyon1.fr
Intitulé du stage **Crystallization kinetics and transport properties in amorphous semiconductors**
Mots-clés electric transport, nanocrystallization, glasses, nanocomposite

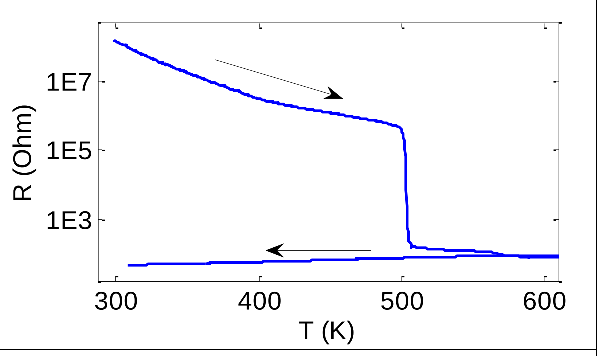
Thermal management has become today one of the most urgent challenges that modern society has to face. Indeed, it represents the bottleneck for the development of many technologies such as nanoelectronics, data storage and energy harvesting, where one of the most urgent needs is to limit heat spread and dissipation while keeping good electric properties.
In this context, composites made of nanocrystalline inclusions embedded in an amorphous matrix have proved to be of interest, thanks to their extremely low thermal conductivity, such as an amorphous, and electric properties specific to the crystalline phase.

We propose here an experimental study of the crystallization kinetics and transport properties of semiconducting nanocomposites, promising for memory storage and energy harvesting applications.
Starting from an amorphous film, the nanocomposite can be prepared by a controlled annealing, leading to a partial crystallization. In chalcogenides, crystallization involves a decrease of the electrical resistivity by orders of magnitude, as the amorphous phase is insulating, while the crystalline one semiconductive. The nanocomposite will have intermediate electrical properties. Still their dependence on the crystal-to-amorphous ratio is not straightforward, as many factors enter in electric transport when the composite is made of nanometric units (interface density, grain dimensions..).

In this internship we propose to investigate the relation between crystallization kinetics and electric resistivity, coupling calorimetric and transport measurements. The trainee will use a novel setup integrating in-situ electric transport measurements in a Differential Scanning Calorimeter (DSC), which allows for the measurement of the crystallization enthalpy, from which the crystallization kinetics can be deduced. Being able to simultaneously measure crystalline fraction and resistivity evolution during crystallization will allow to understand electric transport in this nanocomposite.



Enthalpy change during annealing in a prototype metallic glass. The peak corresponds to the crystallization enthalpy



Resistance drop during crystallization in a chalcogenide glass. Arrows give the time direction during a heating/cooling protocol

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