NÉEL INSTITUTE Grenoble

Posts doctoral position

Growth and thermal characterization of electron crystal phonon glass system

General Scope:

Phonons are the quasi-particles responsible for most of the heat transport in semiconductors and insulating materials. The physics of phonons is now attracting more and more attention due to its implication in the design of nanomaterials having tailored thermal properties and in the emerging field of phononic which aims to build thermal logic devices using phonons.

The main step to overcome in order to build such a device is to succeed in manipulating phonons. Phonons are described by two characteristic lengths that are their mean free path (mfp) and their wavelength. Phonon mfp in semi-conductor is typically 100 nm at 300 K and 1 mm at 4 K. Phonon wavelengths distribution in crystalline solids is very broad (1 nm< λ< 1 µm @ 300 K) and centered on small values (λ ~ 1 nm @ 300 K and λ ~ 100 nm @ 3 K). Phonons are then very difficult to manipulate as compared to other quasi-particles like photons or electrons since they exist over a broad range of length scales. However, by playing with the size and the concentration of nanoinclusions distributed inside a perfectly crystalline matrix (see fig. 1.a) it is possible to probe the influence of nanostructuration on all the characteristic of phonons transport and thermal properties. That knowledge would permit to design semiconductors nanomaterial for demonstrating phonons manipulation.

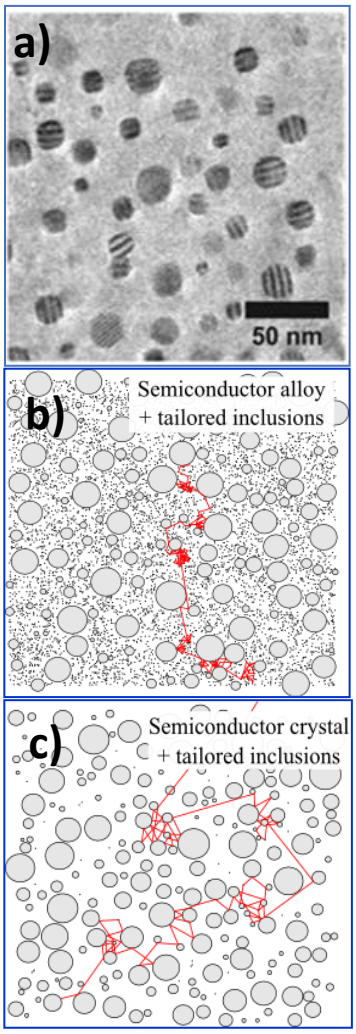

Figure 1 : a) TEM image of GeMn thin layers including nano-inclusions. b, c) sketches of phonons transport in GeSnMn vs GeMn samples showing the expected influence of superdiffusivity.

Research topic and facilities available:

In order to evidence such effects, the candidate will first grow very high quality nanostructured thin films by MBE in strong collaboration with CEA/INAC (see fig1.b). These films are made of GeMn nano-inclusions having a size of 10 to 20 nm surrounded by perfectly crystalline Ge matrix. MBE and annealing post-treatment will be used in order to produce crystalline and alloy (e.g. GeSn) thin layers that can incorporate nano-inclusions.

Besides growing samples, the candidate will work on the thermal conductivity measurement of thin films grown in CEA. Our team has a strong expertise in the "3omega" thermal conductivity measurement and experiments are already running. The candidate will adapt the existing setup for low temperature measurement (4-10 K), run the first low temperature experiment and participate to the interpretation of results.

Possible collaboration and networking:

The post-doctoral fellow will work in partnership with CEA INAC team SiNaPS for the growth of nanostructures. Our team is involved in French and European network of heat transfer at nanoscale and engineering. This work will be done in the frame of ANR projects MESOPHON and SPIDERMAN in close collaboration with researchers from LEMTA laboratory (theory and modeling) and from LOMA (spectral sensor).

Required skills: A Master level in basic or material physics is required. An experience in semi-conductor material growth by MBE during the PhD is mandatory. An experience in thermal measurement would be a plus but it is not mandatory.

Starting date: Spring 2019
Salary : from 2050 to 2250 euros after tax, depending on experience
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