PhD Position in Phononics

Surface coupled phononic resonators

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Context

In this era of micro- and nano-technology, mechanical resonators have again emerged as rich physical objects now at the core of thriving research fields such as micro- and nano-mechanical systems (MEMS/NEMS) or optomechanics. This resurgence of interest has been partly motivated by the prospects opened by the realization of high-quality factor mechanical resonators at the micro- or nano-scale with tailorable properties. In addition to their obvious use as low-mass objects allowing for the realization of highly sensitive detectors ranging from motion sensors or accelerometers to chemical or biological detectors, MEMS/NEMS resonators open exciting vistas for the investigation of basic quantum mechanical concepts [1-3]. The new avenues opened by these optomechanical oscillators have conversely inspired the MEMS/NEMS community where controlling the mechanical properties of the resonators, their quality factor in particular, is of great interest [4-6].

In parallel, mechanical resonators have also made their way towards phononics where they lie at the heart of acoustic or elastic metamaterials. It has in particular been shown that phononic crystals, based or not on resonant inclusions, could be used to strongly confine elastic waves and more specifically elastic waves propagtaing at the surface of a solid substrate [7-9].

Objectives and work description

We here propose to unveil the potential lying behind microscale phononic resonators through the merging of the usually dissociated concepts of phononics and micro- nanomechanics. We will aim at investigating and exploiting the rich physics offered by the different coupling mechanisms that come into play when combining hybridization of phononic eigenstates to a continuum of surface states in view of designing resonator systems capable to confine, control and transport the elastic energy.

The thesis work will first focus on the investigation of the coupling mechanisms allowing energy transfer between neighboring resonators. We will aim at the realization of phononic circuits implementing signal processing functions such as multiplexing. These experiments could be transposed on metal resonators exhibiting dimensions in the hundred of nanometer range hence opening interesting prospects, in the long run, for interactions with surface plasmons.

It will also be possible to make this thesis project drift towards a more ambitious perspective through the investigation of the non-linear properties of such resonators. The expertise acquired during the first part of the thesis will allow us to design a viable resonator or set of coupled resonators fulfilling the required energy (i.e. eigenfrequency) and lifetime (i.e. quality factor) conditions to obtain parametric interactions.

The successful candidate will mostly devote his work to the investigation of the coupling mechanisms at play between resonators and with the surface. The PhD project will involve numerical simulations (especially using the finite element method), clean room technology and metrology (optical instrumentation in particular) but remains resolutely oriented towards an experimental approach of the different phenomena involved.

Host Institution

The FEMTO-ST Institute (Franche-Comté Electronique Mécanique Thermique et Optique - Sciences et Technologies ; www.femto-st.fr) is a large scale public research laboratory which is active in various areas of engineering research: mechanics, optics, time & frequency metrology, micro and nano technologies, energy, control and computer sciences. The institute is under the quadruple authority of the Université de Franche-Comté (UFC), the Centre National de la Recherche Scientifique (CNRS), the École Nationale Supérieure de Mécanique et Microtechniques (ENSMM) and the Université de Technologie Belfort-Montbéliard (UTBM). Located in Besançon in France, FEMTO-ST is one of the largest French laboratories in the fields of engineering sciences (about 700 members including 230 researchers, 95 enginnering and technical staff members and more than 220 PhD students). The Institute hosts high-level technological facilities in the MIMENTO Technology Center, a nation-wide recognized micro-fabrication technology cluster part of the French Basic Technological Research (BTR) network. The successful applicant will join the Phononics and Microscopy group in the Micro Nano-Sciences & Systems department. The group has a well-established expertise in the fields of phononics, instrumentation and microsystems.

Background

Interested candidates should have a master of science degree in physics, engineering physics or equivalent. A good background in general physics and a strong will to bring together computational analysis with experiments are required. Strong collaboration spirit and good communication skills in spoken and written English are essential.

Contact and additional information

FEMTO-ST website : http://www.femto-st.fr.
Phononics and Microscopies group website : http://teams.femto-st.fr/phononics-microscopy/.

References

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