PhD offer

New Paradigm for Energy Harvesting based on Acoustic Metamaterials

Hosting University and Lab **: University of Lorraine – CNRS, Institut Jean Lamour – France**
Supervisor **:** Badreddine ASSOUAR (Badreddine.Assouar@univ-lorraine.fr).

Subject:

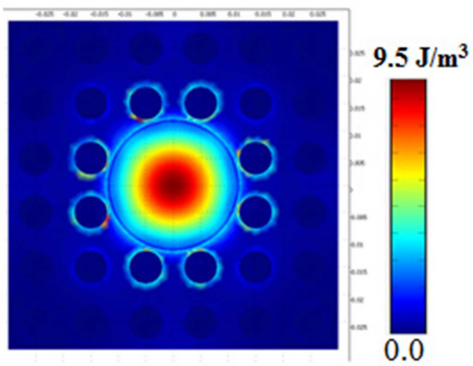
Growing interests have been devoted to Acoustic Metamaterials (AM) during this past decade thanks to their unusual physical properties to manipulate, control and steer the acoustic and elastic waves. They are considered to be very promising for new applications and technologies based on acoustic wave propagation. These engineered materials have actually provided new appealing applications such as: sound and noise mitigation, acoustic cloaking, acoustic super-focusing or more recently energy harvesting. Acoustic metamaterials can be defined as artificial materials formed usually by using sub-wavelength building blocks (resonators) distributed in a hosting material. For wavelengths much larger than the resonators dimension where the homogenization assumption can be considered, these artificial structures can provide new physical properties completely in rupture with what is found in conventional materials, namely: negative effective mass density, negative bulk modulus ... AM can also offer new physics to open a new way for innovative technologies such as acoustic energy harvesting. The energy harvesting concept based on the acoustic metamaterial approach forms the main axis of this thesis project.

For many years, the harvesting of renewable energy from different sources was intensively investigated since many years, and researches in this matter both on the scientific and technological sides are even increasing every year. Most of the efforts are dedicated to wind, solar and biomass energies. Meanwhile, noises and mechanical vibrations form an abundant source of energy which exists around us continuously. This source was not exploited and even was not investigated to explore the possibility of its harvesting. In the frame of this PhD project, we will focus our interest on the creation and the study of new technological solutions and approaches based on hybrid acoustic metamaterials to collect and to harvest the acoustic energy from the surrounding noises and vibrations. An illustration of the researches associated to this PhD project are given in the figure below.

In details, this project will include both theoretical and experimental researches. The PhD candidate will deal with physical analyzes as well as technological aspects. Below, the main axes of this thesis project are listed:

1. Development of numerical and analytical models for energy harvesting based of AM.
2. Creation and optimization of concepts and designs of AM structures equipped with a piezoelectric material enabling an efficient confinement and harvesting of acoustic/elastic energy.
3. Study of the non-linearity and the anisotropy effects on the designed structures.
4. Fabrication and characterization of the optimized AM structures.
5. Development and optimization of an electrical circuit to generate electrical current from the acoustic/elastic harvested energy.

Regarding the hosting lab, in the Institut Jean Lamour lab, the group "*Phononic crystals and Acoustic metamaterials*" develops researches on both theoretical and experimental studies of AM for different applications including, low-frequency sound isolation, acoustic super-focusing and energy harvesting. The latter presents a new topic initiated recently in the group and aiming to propose new concepts for harvesting the energy of the acoustic noise and vibrational disturbances making use of AM. The team members have the expertise in this field and possess solid background on theoretical analysis and numerical simulation as well as computation equipments (cluster, computing machines). The group has also experimental equipments for structures fabrication and characterization (Scanning Laser Doppler vibrometer, dual impedance tube…).



Numerical simulation of the strain energy density confinement by an AM from an acoustic sound pressure of 1Pa.

Candidate profile

- Master degree in one of these specialties: acoustics, applied physics, material physics, applied mechanics, energy.
- For the Master students who are interested, please send me your CV, a cover letter and your marks for the Master **by May 6 (deadline)**.
- Benefit: 1300€ net/month + health insurance.
- To start by: October 2015.