Offer for PhD position
October 2017

Controlling Guided Waves through Piezoelectric Acoustic Metamaterials

Topic :	Physical Acoustics
Keywords :	Metamaterials ; piezoelectricity; phononic crystals.
Laboratory :	Laboratoire Ondes et Milieux Complexes, LOMC UMR CNRS 6294 University Le Havre Normandie, FRANCE
Research Group :	Phononic Structures Group
Grant :	Normandy Region (about 1370 €/month)

Candidate skills

MsC in Wave Physics, skills in Mathematical Physics and in analytical modeling are required.
Knowledge in Acoustics, Ultrasound and Piezoelectricity are welcome.

PhD Subject Description:

During the last decade, a new class of structured materials, namely metamaterials, has emerged, with unusual elastic properties, allowing for innovative devices in a variety of technological domains. Use of active materials, such as piezoelectric components, in metamaterials, can provide additional functionalities through electromechanical coupling, thus offering a mean of controlling electrically –in a non-destructive manner– the effective elastic properties of the device. As a consequence, tunability in the frequency response (modification of the dispersion and attenuation of waves), as well as creation of supplementary modes, originating from the coupling between the electric circuit and the piezoelectric component, can be realized.

Our recent studies at LOMC have validated a number of concepts in a model device made of a phononic piezoelectric plate with a periodic array of metal strips (electrodes) structured in parallel, on both sides. Simple electric tests (connection of resistive, inductive, or capacitive load impedances) [1,2,3] have been used to demonstrate the frequency agility of the device. This kind of hybrid (electro-mechanic) 1D piezoelectric phononic crystal (PPC) offers a variety of perspectives in developing tunable components (resonators, filters, (de)multiplexers,…), but can also find application in vibration damping and acoustic shielding.

The proposed PhD subject aims to explore the possibilities of controlling guided waves through use of complex electric circuits (active, non-linear,…) and to extend the concepts already studied in 1D PPC to their 2D counterparts. The PhD research will involve two distinct tasks: first, the development of an analytic model describing the propagation of guided waves in a 2D PPC, and, second, the elaboration and experimental characterization of a prototype device combining a PPC with a driving electronic component. LOMC has all necessary equipment for the realization (laser micro-machining, 3D printer, photolithography bench) and characterization (microscopes, SEM, roughness tester,…) of piezoelectric metamaterials.

Contacts :		
	Bruno Morvan (bruno.morvan@univ-lehavre.fr)	Tel. +33 (0)2 35 21 72 67
	Pascal Rembert (pascal.rembert@univ-lehavre.fr)	Tel. +33 (0)2 35 21 72 70
	Rebecca Sainidou (reveka.sainidou@univ-lehavre.fr)	Tel. +33 (0)2 35 21 72 70

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[2] N. Kherraz, L. Haumesser, F. Levassort, P. Benard, and B. Morvan, *Controlling Bragg gaps induced by electric boundary conditions in phononic piezoelectric plates*, Appl. Phys. Lett. **108**, 093503 (2016).
[3] S. A. Mansoura, P. Benard, B. Morvan, P. Maréchal, A.-C. Hladky-Hennion and B. Dubus: *Theoretical and experimental analysis of a piezoelectric plate connected to a negative capacitance at MHz frequencies*. Smart Mater. Struct. **24,** 115032 (2015).