Experimental study of elastic wave propagation through metamaterials with dipolar local resonances

Context:

The main utility of metamaterials is to better control the propagation of waves. Acoustic metamaterials are composed of a fluid or solid matrix containing periodic or random distribution of resonators with sub-wavelength size. Numerous potential applications of metamaterials have been considered but the most promising are phonic isolation, vibration control and furtivity. The design and the fabrication of solid samples containing simple resonators are crucial for obtaining these properties. In this context, our goal is to understand and to control shear wave propagation in composites materials displaying original and promising local resonances.

Objectives:

Considering elastic wave propagation in composite materials containing randomly distributed dense beads embedded in a solid matrix, we have recently theoretically shown that the dipolar resonances of the particles have a noticeable influence on the propagation of coherent elastic waves [1,2]. In tis context, the goal is to measure the reflexion and transmission coefficients of longitudinal and shear waves through dispersions of dense beads embedded in an epoxy resin in order to obtain the phase velocity and attenuation of elastic coherent waves.

The sample are produced in the laboratory by controlling the periodic or random distribution of beads. The longitudinal waves will be studied through reflexion and transmission experiments at normal incidence in immersion. The generation and detection of shear waves will be performed using two complementary techniques: a "sandwich" technique developed in the laboratory and longitudnal-transverse conversion at oblique incidence.

The person recruited should have experience in ultrasound experiments and knowledge in signal processing. He will also participate to the supervision of a master student on the measurement of the coherent shear waves.

References:

[1] M. Duranteau, T. Valier-Brasier, J.M. Conoir and R. Wunenberger, Random acoustic metamaterial with a subwavelength dipolar resonance, J. Acoust. Soc. Am. 139(6), 3341-3352, 2016.
[2] T. Valier-Brasier and J.-M. Conoir, Propagation of coherent elastic waves in composite materials containing spherical particles, submitted to J. Acoust. Soc. Am.

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