Abstract of the doctor thesis

Refractive devices for acoustical and flexural waves

by

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The aim of this work has been the design and demonstration of refractive devices, not only for acoustic waves, but also for flexural waves in thin plates.

Mathematically these problems have been treated by means of the multiple scattering theory, because the geometries of the problems were mainly circular and such theory is the best one in these cases. The multiple scattering theory, previously stated, is here explained. Additionally, a multilayer scattering theory for flexural waves is here introduced and successfully used to numerically simulate their behavior. Therefore, this PhD thesis is divided in two parts.

The first part is devoted to describe two acoustic refractive devices: a gradient index lens and an omnidirectional broadband acoustic absorber, or "acoustic black hole". Both are based on sonic crystals consisting of of rigid cylinders immersed in a fluid background. As the homogenization method states, the desired refractive index can be obtained by tailoring the radii of the cylinders. Thereafter, numerical simulations and measurements were conducted to test the behavior of each device. For this purpose, two specific measuring systems were developed: the two-dimensional chamber and the impedance chamber. Both are here explained in detail.

The second part describes the design of refractive devices for flexural waves. Instead of using "platonic crystals", we made use of the peculiar dispersion relationship of flexural waves. As the equation states, the wave speed is modified not only by the elastic properties of the plate, but also from its thickness. Using the latest approach a set of numerical simulations of known circularly symmetrical gradient index lenses have been performed. Addition-

ally, an omnidirectional broadband insulating device for flexural waves has been designed. It consist of a well-like thickness profile in an annular region of the plate, that mimics the combination of an attractive and repulsive potentials. The waves are focused at its bottom and dissipated by means of an absorptive layer placed on top. Numerical simulations are here presented and discussed.

Finally, we present an in-plane flexural resonator, consisting of a hole in a thin plate traversed by a beam. Here, a closed form of the transfer matrix is obtained by coupling the Kirchhoff-Love and the Euler-Bernoulli motion equations. Numerical simulations, tested against a commercial finite element simulator, prove its efficiency.