Sustainable sonic crystal made of Helmholtz resonators in the audible frequency range.

C. Lagarrigue, J.-P. Groby, and V. Tournat
LAUM , UMR6613 CNRS/Univ. du Maine, Le Mans, France.

With the growing interest for sustainable development, research is brought to find some new acoustics materials more respectful for environment. In acoustic, usual absorbing and insulating materials, that can be found in buildings for example, come from the petrochemical industry and can be health hazardous. However, some more ecological and natural solutions exist like sonic crystals made with reclycled materials [3].

In the same time, phononic crystals have received much more attention from the acoustical community in the last decade because of their particular acoustic wave properties, including bandgaps [5]. With a periodic arrangement of solid rods in air, acoustic waves can not propagate for frequency bands depending on the lattice characteristics of a unit cell [2]. This is due to multiple scattering leading to destructive interferences between cells. By acting on the characteristics of individual cells, it is possible to combine transmission loss related to the period with additional resonant effects at low frequencies [1].

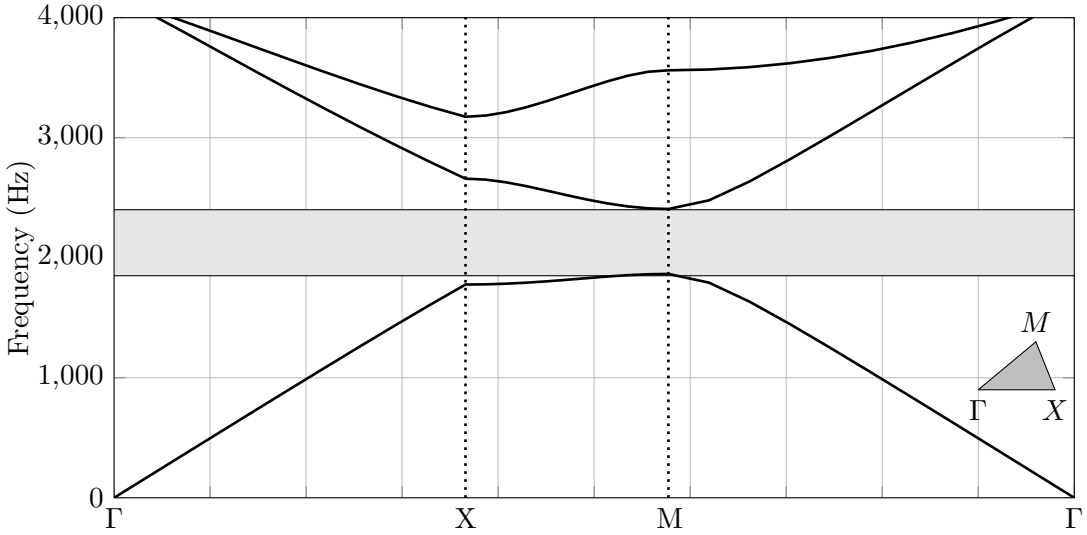

Figure 1: Band diagram calculated with the Plane Wave Expansion method, for an infinite sonic crystal composed of 3.8 cm mean diameter rods. The grey rectangle shows an absolute forbidden band gap between 1750 Hz and 2400 Hz and a band gap between 1700 Hz and 2600 Hz in normal incidence (ΓX).

A triangular lattice crystal (arranged in 7 lines of 12 rows with a lattice constant of 9 cm) consisting of 84 bamboo rods, with a length of 2.60 m and a radius arround 2 cm has been designed. The first band gap is located between 1700 and 2600 Hz in normal incidence (see FIG. 1). The experimental results, obtained in the anechoic room available in LAUM, are consistent with the calculations carried out by multiple scattering method [4] modified in order

to account for the low frequency resonances. Bamboos were drilled between each node with a hole of 10 mm in diameter to create natural resonant Helmholtz resonators between 200 to 300 Hz (see FIG. 2).

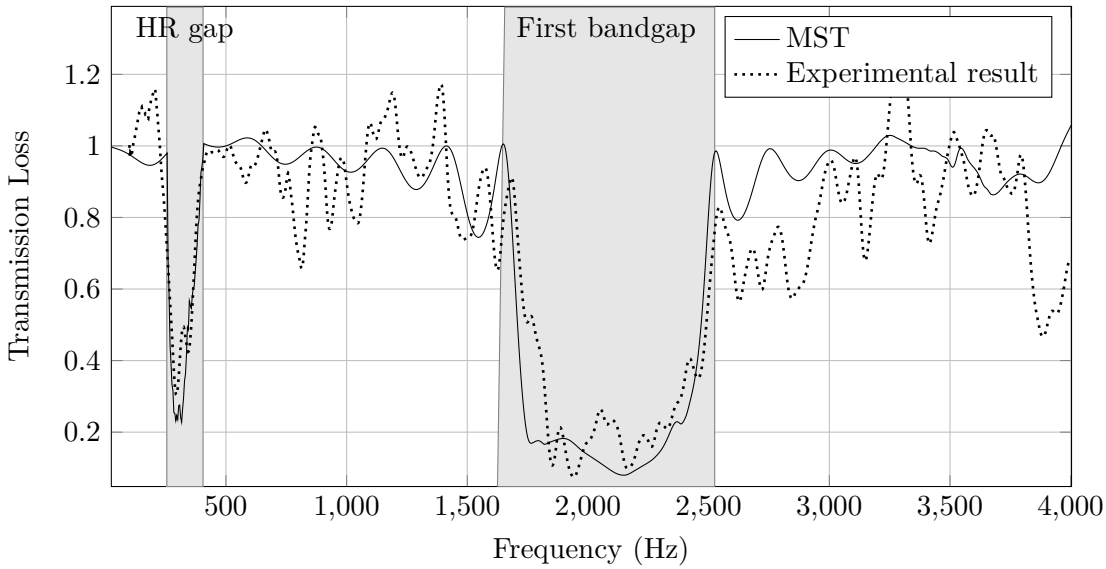

Figure 2: Transmission loss of a resonant sonic cristal with triangular lattice of 9 cm. Experimental results are compared with Multiple Scattering Theory in normal incidence.

The sonic crystal combines the transmission loss, due to the bandgap, with the one of the Helmholtz resonator. We have created a phononic crystal consisting of natural Helmholtz resonators operating in the audible range whitch exhibits very low frequency loss.

References

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