Numerical Simulation of Phonon Dispersion Relations for Phononic Crystals

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Abstract

In previous work, a two-dimensional (2D) model was carried out to simulate the phononic band structure of a phononic crystal with square lattice structure, but this model did not account for the out-of-plane phonon dispersions [1]. In fact, for 2D films used for coating materials, it is more interesting to understand their cross-plane properties. In this work, the phonon dispersion relation of 2D phononic crystals was investigated using the finite element method. COMSOL Multiphysics LiveLink™ for MATLAB® is employed with periodic boundary conditions on unit cells. By using the Plane Strain and Mindlin Plate physics in COMSOL, we carried out simulations to determine both the in-plane and out-of-plane phonon dispersion relations. The obtained simulation results show good agreement with previous reported results computed using other numerical methods [2, 3]. In addition to the 2D structures presented in this study, the same simulation method can be extended to compute the phonon dispersion relations for both 2D and 3D phononic crystals having any arbitrary structural design.

Reference

1. C. Y. Koh, T. Gorishnyy, and E. L. Thomas, Proceedings of the COMSOL Conference Boston (2007).
2. S. Mohammadi, A. A. Eftekhar, A. Khelif, and A. Adibi, Optics Express 18(9), 9164 (2010).
3. M. Maldovan and E. L. Thomas, Periodic Materials and Interference Lithography, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim (2009).

Figures used in the abstract

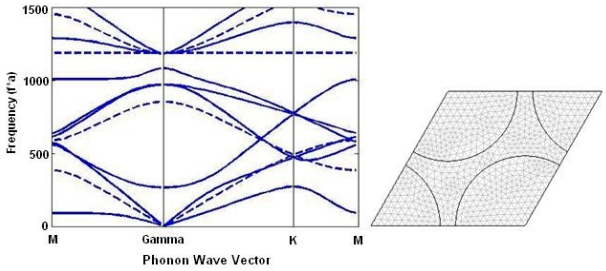

Figure 1: The phonon dispersion relation for an epoxy-vacuum phononic crystal with triangular lattice structure.