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Multilayered Inclusions in Locally Resonant Metamaterials: Two-Dimensional Versus Three-Dimensional Modeling

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Abstract

Locally resonant metamaterials (LRMs) controlling low-frequency waves due to resonant scattering are usually characterized by narrow band gaps (BGs) and a poor wave filtering performance. To remedy this shortcoming, multiresonant metamaterial structures with closely located BGs have been proposed and widely studied. However, the analysis is generally limited to two-dimensional (2D) structures neglecting the finite height of any real resonator. The aim of this paper is the comparison of the wave dispersion for two- and three-dimensional (3D) metamaterial models and evaluation of the applicability ranges of 2D results. Numerical study reveals that dual-resonant structures with cylindrical inclusions possess only a single (compared to two in the 2D case) BG for certain height-to-width ratios. In contrast, the wave dispersion in metamaterials with multiple spherical resonators can be accurately evaluated using a 2D approximation, enabling a significant simplification of resource-consuming 3D models.