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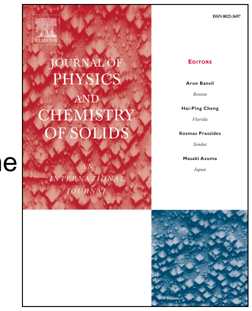

Investigation on the band gap adjustment of the compound phononic crystal using the insertion of elliptical cylinder

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Investigation on the band gap adjustment of the compound phononic crystal using the insertion of elliptical cylinder

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Abstract: This computational study focuses on a kind of two-dimensional steel cylinder/gas square lattice phononic crystal with an elliptical cylinder inserted into the primitive cell. The crystal's energy band structure is calculated using plane wave expansion (PWE) method. The irreducible Brillouin zone (IBZ) is found to have undergone significant changes with the insertion of elliptical cylinder: the energy band extrema deviated from their original positions, and the wave vector's scanning range needs to be expanded in order to obtain reliable energy band structure. Since the elliptical cylinder is less symmetrical than the cylinder, low frequency band gap is more readily formed with the insertion. Greater filling ratio yields wider band gap. The band gap can be tuned within a wide frequency range by varying the orientation of the inserted elliptical cylinder. The band gap can form at a relatively low filling ratio by moving the inserted elliptical cylinder along y-axis.

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Keywords: band gap; compound phononic crystal; Brillouin zone

1. **Introduction**

Periodic functional materials have long been a research subject of interest for applications in various fields such as semiconductor devices and photonic crystals. Recently, the concept of phononic crystal, which is a kind of composite functional materials consisting of different elastic materials in periodic arrangement similar to photonic crystals in structure, has been proposed. Both theoretic and experimental results revealed that, under certain appropriate conditions, band gap would formed for elastic waves propagating in phononic crystals[1-6], which is similar to the band gap for electromagnetic waves in photonic crystals. The major mechanisms proposed for the formation of such band gap are Bragg scattering principle[7], localized resonance principle[8] and inertial amplification mechanism[9]. This specific property has endowed phononic crystals with great application prospects in vibration and noise reduction as well as phononic functional devices[10]. The electromagnetic wave propagating in the photonic crystals has only a transverse component. By contrast, the polarization state varies when the elastic waves propagate in different phononic crystals: while only longitudinal wave exists in the fluid, transverse wave, longitudinal wave and even their coupling can all propagate in the solid. Thus, the formation and calculation of band gap in phononic crystal are rather complex.

The application of phononic crystals relies heavily on the formation and tuning of band gaps. The two-dimensional (2D) solid/gas phononic crystals based on Bragg scattering mechanisms have attracted considerable attention owing to their simple preparation processes, readily-produced band gaps and abundant physical implications. More specifically, ultra-low-frequency band gap are readily found in

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