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Title

Investigations of Phononic Bandgap in a 3D Quantum-Dot Crystal

Source

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Abstract

We theoretically study the phononic band-gap effect of an artificial nanocrystal composed of three-dimensionally (3D) ordered quantum dots. The calculated phonon dispersion indicates the existence of high-order longitudinal acoustic modes propagating along the growth direction due to the low aspect ratio of the unit cell. The observed phononic band gaps in the sub-THz frequency range result in high acoustic reflectivity of the nanocrystal at the band-gap frequencies. In addition to the phononic band gaps, the acoustic transmission spectrum reveals remarkable scattering loss at several specific frequencies, which could suggest the coupling between the longitudinal acoustic phonons and confined modes of isolated quantum dots. Our investigation provides a theoretical insight into the lattice dynamics of the quantum-dot crystal, complementary to the recent femtosecond ultrasonic experiment [Appl. Phys. Lett, 96, 123113 (2010)]. (12 References).