Elastic properties of finite three-dimensional solid phononic-crystal slabs

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We study theoretically, by means of layer-multiple-scattering techniques, the propagation of elastic waves through finite slabs of solid phononic crystals consisting of solid spheres in a solid matrix and we emphasize new aspects not encountered in two-dimensional phononic crystals. In particular, we focus on the study of modes localized on the surfaces of the structure and we investigate in detail the origin and the behavior of such modes, as well as the physical parameters which influence and determine their appearance. We also present results concerning the existence of absolute phononic frequency gaps in these finite structures, and we demonstrate the possibility, under an appropriate choice of the parameters, of tunable regions of frequency free of propagating and/or surface-localized modes. This could be very useful in the design of devices related to frequency filtering, waveguiding, etc.