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Omnidirectional phononic reflection and selective transmission in solid/fluid superlattices

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We present a theoretical analysis of the occurrence of omnidirectional reflection in one-dimensional phononic crystal. We discuss the conditions for a one-dimensional layered structure, made of alternating solid and fluid layers, to exhibit total reflection of acoustic incident waves in a given frequency range for all incident angles. In general, this property cannot be fulfilled with a simple finite superlattice if the incident wave is launched from an arbitrary fluid. Therefore, we propose two solutions to obtain such an omnidirectional band gap, namely: (i) cladding of the superlattice with a layer of high acoustic velocities that acts like a barrier for the propagation of phonons, or (ii) the association in tandem of two different superlattices in such a way that the superposition of their band structures exhibits an absolute acoustic band gap. We discuss the appropriate choices of the material and geometrical parameters to realize such structures. The behavior of the transmission coefficients is discussed in relation with the dispersion curves of the finite structure embedded between two fluids. By inserting a defect layer in the structure, we show that selective transmission may occur in the forbidden bands.