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Broadband Wave Polarization Engineering based on single-polarized solid

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ABSTRACT

As we know, it's more difficult to achieve broadband wave engineering in elastic metamaterials (EMMs) than that in the acoustic or electromagnetic counterparts because of the complex polarizations of waves in elastic media. In this work, a special elastic metamaterial to support only one polarized wave is developed and we call this single polarized solid "SPS". As a degenerated solid, SPS has a very peculiar wave characteristics and it can provide a solution for selected wave mode transmission or isolation. Specifically, in a negative SPS, the only longitudinal (L) wave or transverse (T) wave can be permitted to propagate along a specific direction. Therefore, SPS offers a flexible way to manipulate elastic waves with different polarizations at a subwavelength scale in a broad frequency range. Inspired by the selective wave mode filtering of SPS, we propose a generalized impedance matching condition and design a 2D elastic wave mode splitter. Besides, we also explore a gradient SPS whose own impedance can change asymptotically with material parameters to achieve the broadband perfect wave mode conversion (from L (T) wave to T (L) wave).

In summary, the proposed SPS can greatly enrich the family of artificial materials and expand the horizon of subwavelength-scale elastic wave control and therefore, open a new avenue for potential wave engineering applications in the fields of non-destructive evaluation (NDE) and structural health monitoring (SHM).

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