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Shear wave filtering in the Mantis Shrimp's dactyl club

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ABSTRACT

We propose that the presence of Bouligand-like structure in the dactyl club of the stomatopod lead the material to exhibit wave filtering in addition to the already known mechanisms of macroscopic isotropy behavior and toughness. We use a propagator matrix approach, earlier introduced to study layered materials to simplify the treatment of the boundary value problem. The periodic nature of the material is then considered in terms of frequency dependent dispersion relations, which are found using Floquet–Bloch boundary conditions for a typical elementary cell. These curves provide as a main result, frequency band-gaps which are then compared with the amplitude spectra for a typical impact sustained by the dactyl-club in the mantis-shrimp. This comparison directly yields fractions of transmitted energy against different parameters of the layered composite.