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Some topics on elastic metamaterials

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Acoustic metamaterials are composite materials that exhibit effective material properties beyond those of their constituent materials. By engineering negative properties, such as modulus, mass density, refractive index, and thermal expansion coefficient from positive constituents, these materials offer a range of mechanical and acoustic properties, as well as transport and stimuli-responsive characteristics. Wave mitigation and vibration suppression are popular applications of acoustic metamaterials, with band gap formation and artificial damping being the primary strategies. Recent research has also leveraged the principles of topological insulators in electronics and photonics to realize phononic topological phases, leading to robust mechanical boundary modes that are resistant to defects and geometric perturbations. Additionally, the emergence of acoustic nonreciprocity has led to new wave-related strategies such as acoustic diodes, unidirectional invisibility, and autonomous robots.

The articles in this issue highlight the recent advances in acoustic metamaterials and their applications in realizing exotic topological phase, extreme mechanical wave properties, and high-performance wave mitigation and noise control. This issue begins with the concerns regarding topological elastic waves in continuum. Huang et al. [1] give a comprehensive review of the recent progress on elastic topological phase, including elastic quantum spin Hall effect, valley Hall effect, Weyl semimetal, higher-order topology, and many other related phenomena. Aside from these, they also envision the utilization of active elements in elastic topological systems for further tunability, high-performance acoustic and elastic wave mitigation with great tunable degree of freedom. Wang et al. [2] develop a 3D lattice metamaterial decorated with a complexity of nonlocal reciprocal interactions between non-adjacent sites to visualize the 3D acoustic roton-like dispersion, which is a step further than the previous 1D and 2D predecessors. Numerical examination of the dispersion diagrams for both theoretical and real models confirm this exotic behavior, namely multiple wave numbers taking place at the same eigenfrequency in 3D. As a promising underwater sound control technique, Zhang et al. [3] provide an inverse design framework for designing acoustic metamaterials that deliver high-performance waterborne sound absorption over a wide frequency range (1000-10000 Hz). The proposed forward and trained inverse networks together ensure excellent inverse design accuracy and are proven capable of finalizing high-performance designs by spontaneously adopting beyond-range structures not yet considered in training data. As the second contribution of this issue in the topological phase, Laude et al. [4] take a different route to discuss robust interface wave propagation at a graded interface with local glide-reflection symmetry. They consider quarter-lattice-constant glide-reflection symmetry and apply a continuous grading along the horizontal direction for mostly maintaining the band structure of a conventional glide-reflection symmetric system. This treatment makes the glide-reflection symmetry valid locally on the interface and therefore corresponds to an extension of the conventional glide-reflection symmetric crystal waveguide. Wei et al. [5] study the band gap characteristics and nonreciprocal transmission of a nonlinear elastic metamaterial consisting of a curved diatomic particle chain. Both numerical and experimental investigations evidence the existence of the nonlinear band gaps and the resulting diode behaviors. In recent decades, origami-based structures have been intensively studied by mathematicians and engineers for their rich, controllable mechanical properties and deployability owing to their complex geometries. In this issue, Miyazawa et al. [6] utilize Kresling origami, a type of non-rigid origami, and a double-stitch perforation compliant mechanism to showcase various compliant mechanisms and the correlation between the design parameters of compliant mechanisms and the mechanical properties of origami. They discover that

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modifying the crease parameter has a significant and unique impact on each spring element, indicating that compliant mechanisms could be finely tuned based on the mode of deformation. For flexural wave mitigation applications with broadband operability, Wu et al. [7] theoretically and experimentally propose dynamical phononic crystals modulated with spatially and temporally modulated circuit networks. The modulated systems can possess multiple forbidden bands induced by the interplay of mechanical and electrical modes, which is favorable for practical applications. The employed modulation relies solely on the modification of circuit components, thereby easing the dynamic tunability and retaining the structural integrity of the entire system. Last but not least, Wang et al. [8] show a design approach generically for 2D extremal materials with rank-deficient elastic tensor. The involved design principle is based upon truss lattices, and a homogenization method covering nonaffine deformation induced by local mechanisms is also proposed.

As Guest Editors, we express our gratitude to the editorial team for their support in assembling this special issue to meet the Journal's standards. We also appreciate the Editor in Chief for his encouragement and guidance. Above all, we extend a heartfelt thanks to the authors and reviewers for submitting excellent manuscripts that showcase the ever-growing scope of research in these domains. Our hope is that this compilation inspires further research in these areas, and we eagerly anticipate future submissions to the Journal.

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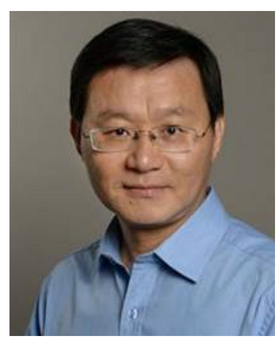

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