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Editorial

Editorial for the Special Issue on "Emerging Trends in Phononic Crystals"

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Over the past three decades, the study of *phononic crystals* (PCs) has rapidly evolved into a prominent research field offering a versatile platform for the creation of structured materials with salient properties. Most recently, a remarkable spurt of innovative studies has given rise to new trends in PCs that exploit dispersion topology, chirality, and spatial symmetry in both physical and reciprocal spaces. In tandem, new ideas on PC-based metamaterials and structures with internally resonant inclusions have demonstrated the ability to intentionally bias the mechanical response and fundamentally change the way materials interact with static forces and incident elastoacoustic waves. In this Special Issue of *Crystals*, we have gathered seven peer-reviewed papers that shed light on recent advances within the domains of these *emerging trends*, culminating in new and enhanced functionalities in a diverse but closely related range of topics including quasiperiodic and dissipative phononics, nonreciprocal waves, and resonant hybridizations. In the early days of periodic structures and phononic crystals, a unit cell was largely construed as two or more materials put together to synthesize a composite-like medium. Nowadays, especially with the advent of additive manufacturing and highly refined fabrication tools, PCs are constantly emerging with intricate configurations and assemblies limited only by our imagination. As a case in point, the papers included in this collection range from Helmholtz cavities and acrylic beams to pillared plates and radial crystals, and span different classes of lattice and structural systems.

Gupta and Ruzzene [1] explore an intriguing class of quasiperiodic metastructures, a family of stiffened and sandwich beams which are generated by varying a single projection parameter. By observing the fractal nature of their bulk frequency spectra, they were able to identify nontrivial edge states that populate bulk spectral band gaps. Farhat et al. [2] show the possibility of obtaining parity–time symmetry in thin, layered buoyant plates using a mechanism of balanced gain and loss which can be adequately tuned via external shunted piezoelectric circuits. Using similarly thin, albeit resonant, plates, Chen et al. [3] propose a metamaterial comprising a combination of symmetrically and asymmetrically sided pillars to intentionally break the symmetry of propagating Lamb waves. Specifically, they reveal a decoupling of A_0 and S_0 modes associated with the symmetric pillars in addition to a hybridization of the same modes using the asymmetric ones. Also aiming to break wave propagation symmetry, Quadrelli et al. [4] report a nonreciprocal behavior in radial sonic crystals that exploits axisymmetric spatiotemporal modulations. Breaking from conventional two-dimensional (2D) crystals where the emergent nonreciprocal behavior is typically limited to prescribed angular ranges, they demonstrate the omnidirectional and isotropic nature of acoustic nonreciprocity unique to radial design. Pechac and Frazier [5], on the other hand, investigate nonreciprocity in nonlinear mechanical networks with a focus on energy transport within band gaps. Employing nonlocal feedback interactions, they utilize an active control technique to realize nonreciprocal supratransmission, i.e., the spontaneous flow of energy within the band gap, in both one-dimensional and 2D pendulum networks. By analogy, Euvé et al. [6] also explore the energy flow control problem but in the context of underwater acoustics with applications in shallow and deep (sea)water regimes. In their work, they experimentally illustrate the utility of resonant Helmholtz cavities as a building block for shielding breakwater structures that can be used to create a sheltered region, protected from incident waves. Finally, Pierce and Matlack [7] tackle the challenging problem of band-gap identification in dissipative phononic systems. They develop an "evanescence indicator" that relates the decay component of a Bloch wave vector to the transmitted wave amplitude in finite PCs. In doing so, they provide an innovative mathematical treatment, and an accompanying visualization tool, which highlight the "fuzziness" of band gaps in dissipative PCs as a result of the smooth (as opposed to abrupt) transition between evanescent and propagating waves in such systems.

As shown in this ensemble of diverse and creative efforts, the study of phononic crystals continues to grow and expand with vigor as we as a community strive to acquire further understanding of the underlying and seemingly never-ending potential of this rich class of material systems. Ultimately, the goal is to bring these and other new concepts and realizations closer to viable engineering applications.

Conflicts of Interest: The authors declare no conflict of interest.

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