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PROCEEDINGS

Design of 3D Printable Microlattices for Sound Absorption

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ABSTRACT

The emergence of 3D printing opens new possibilities for the development of advanced and innovative metamaterials, particularly in the realm of microlattices. Microlattices are characterized as periodic cellular solids with submillimeter-sized features, such as struts, shells, or plates, arranged spatially in a three-dimensional way. Herein, based on four published studies, we provide a perspective on the design, employing analytical and numerical methods, as well as the performance of 3D-printed microlattices for sound absorption.

The first study focuses on face-centered cubic-based plate and truss structures [1]. Impedance tube measurements reveal that all the microlattices display absorption curves with characteristic resonance peaks. These peaks depend on the pore and cavity morphologies, as well as the number of layers along sound incidence. Given the structural similarity to Helmholtz resonators, we propose a Multilayered Helmholtz Resonance (MLHR) analytical model that accurately models sound absorption coefficient curves.

Using this model, we then design and optimize the pore and cavity geometries in a heterogeneously structured plate-and-strut microlattice for broadband absorption [2]. This structurally optimized design demonstrates excellent broadband absorption, with an averaged experimental absorption coefficient of 0.77 across a broad frequency range from 1000 to 6300 Hz. Leveraging the MLHR model, we also optimize the heterogeneous structure of a cuttlefish bone-inspired design, exhibiting impressive absorption alongside inherent mechanical toughness [3]. Beyond porosity heterogeneity, we introduce variability in the dissipation mechanism by hollowing the struts of the truss lattices [4]. This introduces an additional sound dissipation mechanism via structural resonance on top of the MLHR, resulting in an increased absorption bandwidth.

Beyond their capacity for sound absorption, microlattices also showcase customizable and unique mechanical properties attributable to their distinct morphology. This paves the way for multifunctional applications.

KEYWORDS

Microlattice; finite element analysis; acoustics; mechanical properties; optimization

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