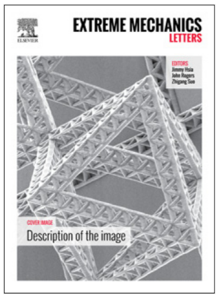
Accepted Manuscript



Metadamping and energy dissipation enhancement via hybrid phononic resonators

D. DePauw, H. Al Ba'ba'a, M. Nouh

PII: S2352-4316(17)30145-1
DOI: https://doi.org/10.1016/j.eml.2017.11.002
Reference: EML 324

To appear in: *Extreme Mechanics Letters*

Received date : 31 August 2017
Revised date : 21 October 2017
Accepted date : 4 November 2017

Metadamping and Energy Dissipation Enhancement via Hybrid Phononic Resonators

D. DePauw[a], H. Al Ba'ba'a[a], M. Nouh[a,*]

[a]*Dept. of Mechanical & Aerospace Engineering, University at Buffalo (SUNY), Buffalo, NY*

Abstract

A novel metamaterial configuration is presented that combines hybrid attributes from acoustic metamaterials and phononic crystals. The dispersion characteristics of the system, referred to as the phononic resonator (PR), is shown to vary across a wide spectrum of behaviors that can, via optimal selection of inertial and stiffness parameters, be tuned to resemble a locally resonant mechanism, a phononic system, as well as a uniform homogeneous lattice. When coupled with damping elements, the emergent dissipative effect, known as the metadamping phenomenon, of the PR is shown to exceed that of a statically equivalent acoustic metamaterial under certain conditions which are highlighted here. The metadamping amplification is verified in finite PR systems via a power flow approach that depicts the spatial rate of energy dissipation along the length of a 100 cells phononic resonator.

1. Introduction

The physics of periodic structures have received considerable attention lately owing to their unique abilities to manipulate elastic wave propagation within their media [1]. Such abilities culminate in intriguing features including band gaps (frequency ranges of blocked wave propagation) [2, 3], directional patterns [4, 5], and amplified energy dissipation [6, 7]. As such, periodic structures with unconventional dispersive characteristics have been mostly classified into two main categories: Phononic Crystals (PCs) and Acoustic Metamaterials (AMs). Both categories have been heavily investigated in the context of discrete (spring-mass) systems [8, 9, 10, 11], bars [12, 13, 14, 15], flexural beams [16, 17, 18] and plates [19, 20, 21, 22].

The interplay between wave dispersion in periodic systems and material and/or viscous damping have been shown to onset interesting traits [23, 24, 25, 26, 27, 28]. One of these is the generation of enhanced damping properties, or *metadamping*, that goes beyond the conventional dissipation provided by the damping elements. The emergence of metadamping in an AM in particular has been shown to quantitatively yield higher damping ratios across the entire wavenumber spectrum when compared to a statically equivalent PC with an

*Corresponding author
Email address: mnouh@buffalo.edu (M. Nouh)