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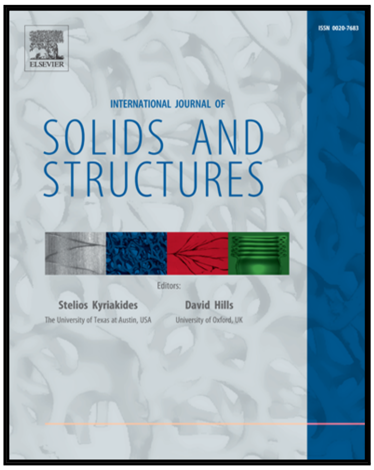

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Topology optimization of dielectric elastomers for wide tunable band gaps

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Abstract

Dielectric elastomer composites exhibit band gaps—ranges of frequencies at which elastic waves cannot propagate—that are tunable by electrostatically-controlled deformations. We show how topology optimization of such composites can widen these gaps and improve their tunability. Our case study focuses on anti-plane shear waves in fiber composites, across a designated frequency range. Employing a genetic algorithm approach, we maximize the gap width when the composite is actuated by prescribed electric fields, as well the relative change in the gap width with respect to an unactuated composite. We present optimization results for a composite whose constituents agree with commercial products. We compare these results with the performance of a composite of the same constituents arranged in circular fibers, to demonstrate the improvement achieved by the optimization. We expect that the performance of dielectric elastomer composites can be further improved, by employing a larger design space than the exemplary space in this study.

keywords: Dielectric elastomer composite, tunability, phononic crystal, topology optimization, band gap, finite deformation, wave propagation

1 Introduction

The propagation of elastic waves in periodic structures is frequency dependent. Importantly, at certain frequency bands, the way in which waves scatter and interfere results with the annihilation of their propagation (Sigalas and Economou, 1992, Kushwaha et al., 1993, Hussein et al., 2014). Based on this *band gap* phenomenon, different applications with the objective to filter undesired

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