Architected Squirt-flow Materials for Energy Dissipation

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Architected Squirt-flow Materials for Energy Dissipation

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Abstract

In the present study we explore material architectures that lead to enhanced dissipation properties by taking advantage of squirt-flow - a local flow mechanism triggered by heterogeneities at the pore level. While squirt-flow is a known dominant source of dissipation and seismic attenuation in fluid saturated geological materials, we study its untapped potential to be incorporated in highly deformable elastic materials with embedded fluid-filled cavities for future engineering applications. An analytical investigation, that isolates the squirt-flow mechanism from other potential dissipation mechanisms and considers an idealized setting, predicts high theoretical levels of dissipation achievable by squirt-flow and establishes a set of guidelines for optimal dissipation design. Particular architectures are then investigated via numerical simulations showing that a careful design of the internal voids can lead to an increase of dissipation levels by an order of magnitude, compared with equivalent homogeneous void distributions. Therefore, we suggest squirt-flow as a promising mechanism to be incorporated in future architected materials to effectively and reversibly dissipate energy.

Keywords: reversible energy dissipation, squirt-flow, relaxation

1. Introduction

From space crafts, cars and buildings to cell phones, tablets and micro-scale electric devices, the ability of a structure to both dissipate and mitigate energy upon impact and vibration is imperative to its functionality. Some engineered structures are equipped with dedicated devices, such as hydraulic pistons and rubber bearings, to damp unwanted vibrations or to absorb shocks.

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