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Robust design of multimodal piezoelectric transducers

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Abstract

This paper aims to present an elegant way to design multimodal piezo transducers, i.e., piezoelectric sensors/actuators that succeed in filtering a set of desired eigenmodes among those belonging to a bigger set prescribed beforehand. That can be efficiently done by regarding the design problem as one of the topology optimization, where the design variable taking on the values either -1 or 1 physically represents the polarity of the electrodes. It can be analytically proved that this optimization problem has classical solution, and indeed it is unique. Motivated by fabrication issues happening at the micro scale, it is also considered the robust version of that problem, that is, the design of such devices whenever the feature size of both polarity phases are underneath limited.

Keywords: piezoelectric effect, multimodal transducers, topology optimization, robust design

1. Introduction to the piezoelectric effect

Piezoelectricity is the ability of some materials to transform mechanical energy into electrical one and vice versa [1]. Whenever a piezoelectric material does the former, that is, to produce an electrical signal on deforming, it is said it works as sensor and conversely, it does as actuator whenever it strains under an applied voltage. Typically, these sensors/actuators or just transducers are

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