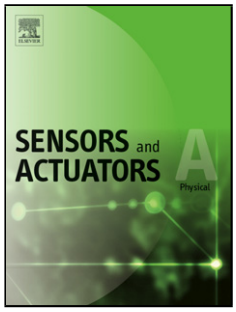

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Achieving Wideband Micromechanical System using Coupled Non-Uniform Beams Array

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Abstract

Uniform cantilever microbeam has been at the helm of affair since the advent of micromechanical system (MEMS) technology to develop sensitive MEMS based sensors and actuators. Since then, several improved designs were incorporated to improve their sensitivity and bandwidth. In the work described in this paper, we focus on improving the frequency bandwidth by utilizing a unique characteristics of non-uniform beams. To do the study, we first fabricated single non-uniform diverging and converging beams and characterize them to find their resonance frequency variation with respect to uniform beams under ambient and vacuum conditions. Subsequently, we took two mechanical coupled beams with different combinations of uniform and non-uniform beams. We measured their first in-phase and out-of-phase modes. We found that a combination of diverging and converging beam can tune the difference between these frequencies from 278 Hz to 8.8 kHz with respect to the frequency difference of 316 Hz for a combination of two uniform beams. A frequency tuning of about 2685% signifies the importance of non-uniform beams. After showing the coupling effect of arrays of mechanically coupled three, four and five uniform beams, we numerically demonstrated the tuning for a specific combination of uniform beam, diverging beam and converging beam in five beams array. The obtained results can be applied to increase the frequency band of various MEMS resonators based on the combinations of uniform and non-uniform coupled beams.

Keywords: Non-Uniform beams, Resonance frequency, Coupled beams, Quality factor.

1. Introduction

Frequency tuning has been studied in controlling the operating bandwidth of microelectromechanical system (MEMS) and nanoelectromechanical systems (NEMS) through various mechanisms [1, 2, 3, 4, 5, 6, 7, 8, 9]. In MEMS and NEMS devices, such effect can be brought in by utilizing different types of coupling mechanisms such as linear and nonlinear mechanical coupling [10, 11, 12], electromechanical coupling [13, 14, 15], thermoelastic coupling [16], etc. However, these coupling mechanisms have been studied using either

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