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Intrinsically biased, resonant NEMS–MEMS oscillator and the second law of thermodynamics

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Abstract

An experimentally testable NEMS–MEMS resonant cantilever oscillator is examined theoretically for compliance with the second law of thermodynamics. The device consists of a p–n semiconductor parallel-plate capacitor, with one plate fixed (p-doped) and the other (n-doped) mounted on a flexible double cantilever spring. The built-in potential across the n–p depletion region is expressed as an electric field between the capacitor plates, providing negative pressure capable of closing the plates. For matched electrical and mechanical time constants ($\tau_e \simeq \tau_m$), the device is predicted to execute steady-state electromechanical oscillation, powered solely by the p–n diodic electric field, thereby challenging the Kelvin–Planck formulation of the second law. Prospects for laboratory tests are discussed.

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Keywords: Second law of thermodynamics; NEMS; MEMS; Oscillator; Cantilever

1. Introduction

The second law of thermodynamics—in its various formulations[1]—enjoys nearly universal support from the scientific community.[2] No experimental violation of it has been exposed during its 150-year history. Many believe it to be inviolable even in principle. Over the last decade, however, more than two dozen challenges to it have appeared in the refereed scientific literature [1–27]. While most are theoretical [3–14], several invite direct experimental test [15–27]. One broad

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[1]There are many formulations of the second law, not all of which are equivalent. For example, 21 versions are cited by Čápek and Sheehan [1].

[2]Imprimaturs by eminent scientists like Einstein, Eddington and Brillouin are legion. See [1, Chapter 10].

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