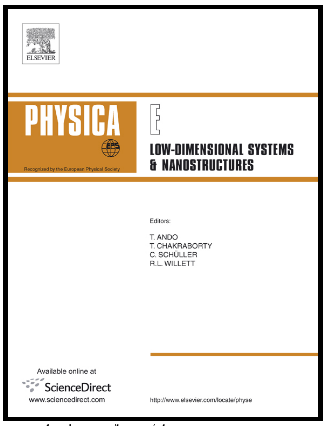
Author's Accepted Manuscript



www.elsevier.com/locate/physe

Theoretical modeling of the effect of Casimir attraction on the electrostatic instability of nanowire-fabricated actuators

A Farrokhabadi, J Mokhtari, R Rach, M Abadyan

PII: S1386-9477(14)00431-7
DOI: http://dx.doi.org/10.1016/j.physe.2014.12.003
Reference: PHYSE11794

To appear in: *Physica E: Low-dimensional Systems and Nanostructures*

Received date: 10 June 2014
Revised date: 22 August 2014
Accepted date: 2 December 2014

Cite this article as: A Farrokhabadi, J Mokhtari, R Rach and M Abadyan, Theoretical modeling of the effect of Casimir attraction on the electrostatic instability of nanowire-fabricated actuators, *Physica E: Low-dimensional Systems and Nanostructures,* http://dx.doi.org/10.1016/j.physe.2014.12.003

THEORETICAL MODELING OF THE EFFECT OF CASIMIR ATTRACTION ON THE ELECTROSTATIC INSTABILITY OF NANOWIRE-FABRICATED ACTUATORS

A Farrokhabadi[1], J Mokhtari[2], R Rach[3], M Abadyan[4]

[1] Department of Aerospace Engineering, Semnan University, Semnan, Iran.
Email: amin.farrokh@profs.semnan.ac.ir
[2] Department of Mechanical Engineering, Shiraz University, Shiraz, Iran
Email: javadmokhtari67@yahoo.com
[3] 316 South Maple Street, Hartford, Michigan 49057-1225, U.S.A.
Email: tapstrike@gmail.com
[4] Shahrekord Branch, Islamic Azad University, Shahrekord, Iran
Email: abadyan@yahoo.com

Abstract:

The presence of the quantum vacuum fluctuations, i.e. the Casimir attraction, can strongly affect the performance of ultra-small actuators. The strength of the Casimir force is significantly influenced by the geometries of interacting bodies. Previous research has exclusively studied the impact of the vacuum fluctuations on the instability of nanoactuators with planar geometries. However, no work has yet considered this phenomenon in actuators fabricated from nanowires/nanotubes with cylindrical geometries. In our present work, the influence of the Casimir attraction on the electrostatic stability of nanoactuators fabricated from cylindrical conductive nanowire/nanotube is investigated. The Dirichlet mode is considered and an asymptotic solution, based on scattering theory, is applied to consider the effect of vacuum fluctuations in the theoretical model. The size-dependent modified couple stress theory is employed to derive the constitutive equation of the actuator. The governing nonlinear equations are solved by two different approaches, i.e. the finite difference method and modified Adomian-Padé method. Various aspects of the problem, i.e. comparison with the van der Waals force regime, the variation of instability parameters, effect of geometry and coupling between the Casimir force and size dependency are discussed. This work is beneficial to determine the impact of Casimir force on nanowire/nanotube-fabricated actuators.

***Keywords*:** Nanowire/Nanotube fabricated actuator; Casimir attraction; Electromechanical instability; Continuum model;

1. Introduction

In recent years, due to the outstanding mechanical and electrical properties of nano materials, scientists have become able to innovate new generations of miniaturized advanced structures.