8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 4, 2008
Venice, Italy

Influence of the Casimir force on electrostatically actuated MEMS and NEMS

André Gusso

DCET – Santa Cruz State University

UESC, km 16 Rodovia Ilhéus-Itabuna, CEP 45662-000, Ilhéus, BA, Brazil

agusso@uesc.br/andre_gusso@yahoo.com

Key Words: *Casimir force, torsional actuator, pull-in.*

ABSTRACT

Resulting from the quantum fluctuations of the vacuum electromagnetic field, the Casimir force can be understood as the long range analog of the van der Waals force, resulting from the propagation of retarded electromagnetic waves [1]. It manifests itself as an attractive force between closely separated bodies, whose separation distance ranges from a few nanometers up to a few micrometers. Therefore, MEMS/NEMS whose moveable parts are separated by distances in the submicron range are likely to be significantly affected by the presence of this force that may alter their static or dynamical operational parameters.

In the present work we firstly perform a comparative analysis between the magnitude of electrostatic and Casimir forces between parallel plates, as a function of plates separation, providing a simple way to estimate the impact of this force on a large variety of electrostatically actuated MEMS/NEMS made from different materials like silicon, gallium arsenide, silicon nitride and silicon carbide amongst other materials of interest in micro and nanodevices fabrication [2,3]. Subsequently, we present a thorough analysis of the influence of the Casimir force on a specific MEMS, namely, electrostatic torsional actuators (ETAs). We extend the analysis performed in [4] for silicon based ETAs by considering also ETAs made from gold, silicon carbide and silicon nitride using the finite conductivity correction factors derived in [3].

The results presented are intended to serve as a general guide on the relative importance of the Casimir force for the design of MEMS/NEMS. While a comparatively weak force, it becomes relevant when the separation between MENS/NEMS components is in the range of tens up to a few hundreds of nanometers, and are actuated by voltages compatible with CMOS technology.

REFERENCES

[1] O. Bordag, U. Mohideen, V. M. Mostepanenko, "New developments in the Casimir effect", *Phys. Rep*., Vol. **353**, pp. 1–205, (2001).

[2] B. Bushan (editor), *Springer handbook of nanotechnology*, 1st Edition, Springer, 2004.

[3] A. Gusso, G. J. Delben, "Dispersion force for materials relevant for micro and nanodevices fabrication", preprint available at the http://xxx.lanl.gov as arXiv:0802.2124 [cond-mat.other].

[4] A. Gusso, G. J. Delben, "Influence of the Casimir force on the pull-in parameters of silicon based electrotatic torsional actuators", *Sens. Actuators* A, Vol. **135**, pp. 792-800, (2007).