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A novel Electrostatic Actuator Class

H. Conrad[a]*, B. Kaiser[a], M. Gaudet[a], S. Langa[a], M. Stolz[a], S. Uhlig[a], K. Schimmanz[a,b], H. Schenk[a,b]

[a]*Fraunhofer Institute for Photonic Microsystems IPMS, Maria-Reiche-Str. 2, 01109 Dresden, Germany*
[b]*Brandenburg University of Technology BTU, Chair of Micro and Nano Systems, Konrad-Zuse-Straße 1, 03046 Cottbus, Germany*

Abstract

Common quasi-static electrostatic micro actuators have significant limitations in deflection due to electrode separation and unstable drive regions. These actuators suffer from an operational instability, the so-called pull-in effect that limits the actuators' travel range to one third of the electrode separation. High driving voltages and large electrode gaps are required to achieve large displacements. In our work, we present a novel electrostatic actuator class, which allows high deflections with nanometric electrode separation. The approach presented utilizes a bimorph like effective lever to transform electrostatic forces into deflection. It permits to make use of high electrostatic forces generated in small gaps and thus gives access to large actuator deflections. We demonstrate that quasi-static deflections as large as four times the gap size are possible.

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1. Introduction

Electrostatic actuation is often considered to deflect micro and nano structures because of excellent scaling of electrostatic forces in micro and nano dimensions. Furthermore electrostatic actuators can be fabricated easily by widely spread CMOS compatible processes. The significant drawback of such actuators is the nonlinear deflection of the moveable electrode within the gap which leads to pull-in and limits the stable travel range. Pull-in related effects, such as stiction, adhesion, electrical discharge and dielectric charging, are considered to be the primary causes of device failure [1]. Recent publications have reported various attempts to enhance the controllable travelling range

* Corresponding author. Tel.: +49-351-8823-410; fax: +49-351-8823-266.
E-mail address: holger.conrad@ipms.fraunhofer.de

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