Optimizing the Performance of MEMS Electrostatic Comb-Drive Actuator with Different Flexure Springs

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Abstract

Electrostatic comb drives are widely used in MEMS (Micro Electro Mechanical Devices). These comb drives having rectangular comb fingers which produce a stable and a constant force. Silicon has been the dominant mechanical material for MEMS fabrication. Comb drive actuators are used as resonators, electromechanical filters, optical shutters, micro-grippers etc. This paper explores the different spring designs of Micro actuators for its restoring force which improves its reliability. Due to large displacement and high stiffness springs of the actuator tend to crack from weak points and gives non linear effect. Stress distribution over different spring designs are simulated by using a standard comb drive with 4 movable comb fingers and by varying spring length device displacement could reach up to maximum of 2.85μm under 130V drive voltage. With increase in flexure length from 220μm to 280μm displacement and capacitance increases from 1.063μm to 2.85μm and 327pf to 352pf respectively at 130V. Capacitance increases with increasing finger overlap from 1μm to 3μm whereas finger overlap increases by increasing flexure length. The result concludes that the folded flexure spring beam is best for large deflections at low driving voltage due to its low stress, low stiffness, high sensitivity and low spring constant. It can also remove the side sticking. Simulation for different 2D structures is done by using COMSOL Multiphysics 3.5a as it provides advanced methods of solving moving boundaries with FEM as shown in Figure.1, Figure.2, Figure.3 and Figure.4.

Reference

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4) Liu Fengli and Hao Yongping, “Polysilicon Electrostatic Comb MEMS Actuator Design and Analysis” R&D Center of CADICAM Technology Shenyang Ligong University Country Shenyang, China, 978-1-4244-4669-8/09/$25.00 IEEE (2009).

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Figures used in the abstract

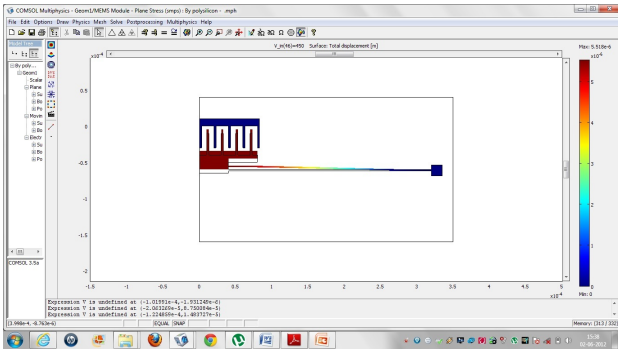

Figure 1: Comb Drive Actuator using Fixed – Fixed beam.

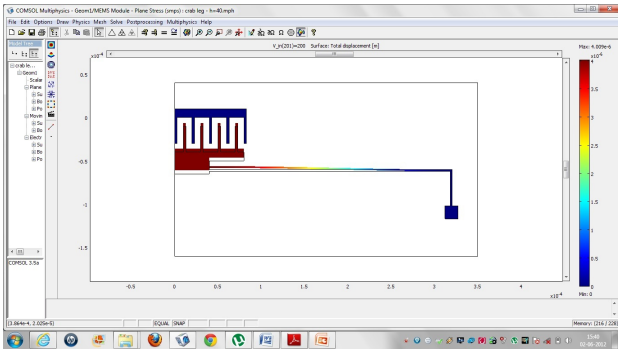

Figure 2: Comb Drive Actuator using Crab Leg Flexure beam.

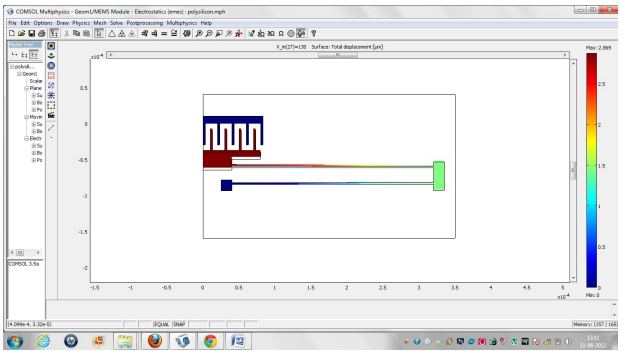

Figure 3: Comb Drive Actuator using Folded Flexure beam.

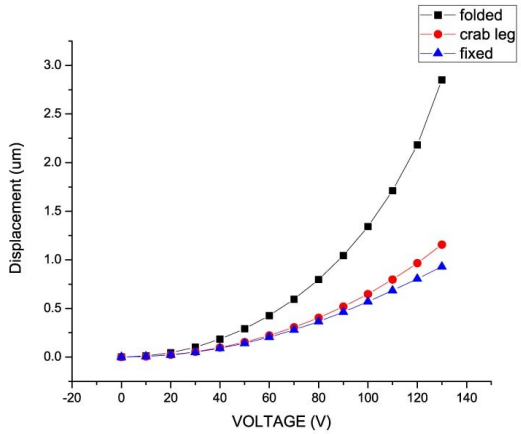

Figure 4: Comparison of three Flexures beams.