Platform Isolation Using Out-of-Plane Complaint Mechanisms

A. Arevalo[1], E. Rawashdeh[1], I. G. Foulds[2]

[1]Computer, Electrical & Mathematical Sciences & Engineering Division (CEMSE), King Abdullah University of Science & Technology, Thuwal, Saudi Arabia
[2]School of Engineering, University of British Columbia - Okanagan, Vancouver, BC, Canada

Abstract

In this work we present the simulation of a MEMS platform, using polyimide as the structural material, that is lifted up by two opposing Tsang suspensions [1]. A Tsang suspension is a MEMS mechanical structure that is composed by two anchors, two springs and a central plot, see Figure 1. The assembly of this structure is done by using a microprobe and could be integrated in a manufacturing process by using a wire bonder tip [1]. In comparison to previous work for out-of-plane structures [2, 4-7], the Tsang suspension does not require a mechanical stop due to its assembly principle [1,8]. When the plate is in its upright position at 90 degrees, from its original position the connected springs generate a force towards the substrate, creating a self-locking mechanism. A Tsang suspension can provide a desired orientation of an in-plane device, in respect to the substrate. Moreover, with the combination of two of these structures we can develope a platform parallel to the substrate which can be used for thermal and electrical isolation while maintaining electrical routing to the substrate, which could be useful for several devices like: antennas [2], gyroscopes, accelerometer, flow sensors, micro-heaters [6], among others. Figure 2 show an SEM image of an assembled Tsang Platform fabricated in our group using polyiimide as the structural material.

We are implementing our simulations in COMSOL Multiphysics® software, in order to select the best parameters for the proposed platform. The platform will be lifted up to a height of at least the length of the Tsang central plate. By using COMSOL we can create virtual prototypes to select the correct parameters for the final application. Figure 3 shows a simulation of an assembled Tsang suspension with the platform. From the simulation results we intend to collect important information regarding the platform height and the stresses in the spring links. For instance, in the Figure 3, the platform is being lifted in the Z-axis for approximately 420 μm while the height of both Tsang suspension plates are of 350 μm.

Reference

1. S. H. Tsang, D. Sameoto, I. G. Foulds, R. W. Johnstone, and M. Parameswaran, “Automated assembly of hingeless 90 degrees out-of-plane microstructures,” Journal of Micromechanics and Microengineering, vol. 17, no. 7, pp. 1314-1325, Jul 2007.

2. L. Marnat, A. A. A. Carreno, D. Conchouso, M. G. Martinez, I. G. Foulds, and A. Shamim, "New Movable Plate for Efficient Millimeter Wave Vertical on-Chip Antenna," IEEE Transactions on Antennas and Propagation, vol. 61, pp. 1608-1615, April 2013 2013.

3. S. H. Tsang, D. Sameoto, and M. Parameswaran, "Out-of-plane electrothermal actuators in silicon-on-insulator technology," Canadian Journal of Electrical and Computer Engineering, vol.31, no.2, pp.97-103, Spring 2006.

4. A. Alfadhel, A. A. A. Carreno, I. G. Foulds, and J. Kosel, "Three-Axis Magnetic Field Induction Sensor Realized on Buckled Cantilever Plate," Ieee Transactions on Magnetics, vol. 49, pp. 4144-4147, Jul 2013.

5. S. Oak, G. F. Edmiston, G. Sivakumar, and T. Dallas, "Rotating Out-of-Plane Micromirror," Journal of Microelectromechanical Systems, vol.19, no.3, pp.632-639, June 2010.

6. A. A. A. Carreno, E. Byas, and I. G. Foulds, "UHeater on a Buckled Cantilever Plate for Gas Sensor Applications", COMSOL Conference, Milan, Italy, 2012.

7. A. A. A. Carreno, D. C. Gonzalez, and I. G. Foulds, "Optimized Cantilever-to-Anchor Configurations of Buckled Cantilever Plate Structures for Transducer Applications", COMSOL Conference, Milan, Italy, 2012.

8. D. Castro, A. Arevalo, E. Rawashdeh, N. Dechev, I. G. Foulds, "Simulation of Tsang Suspension", COMSOL Conference, Cambridge, England, 2014.

Figures used in the abstract

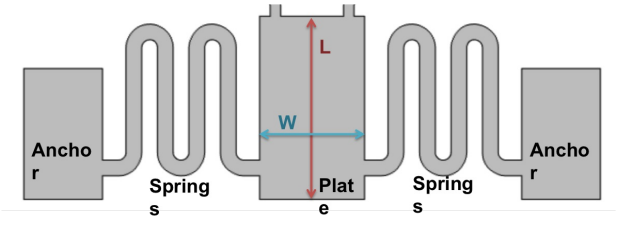

Figure 1: Basic Tsang suspension. The structure can vary its spring count and dimensions.

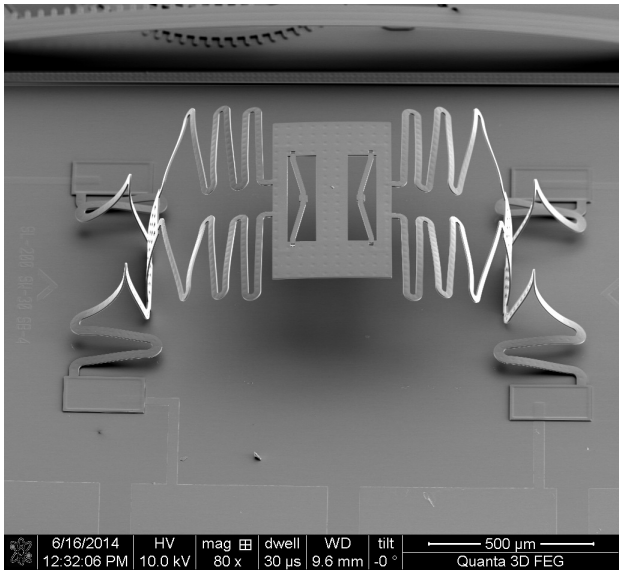

Figure 2: SEM image of an assembled Tsang platform structure.

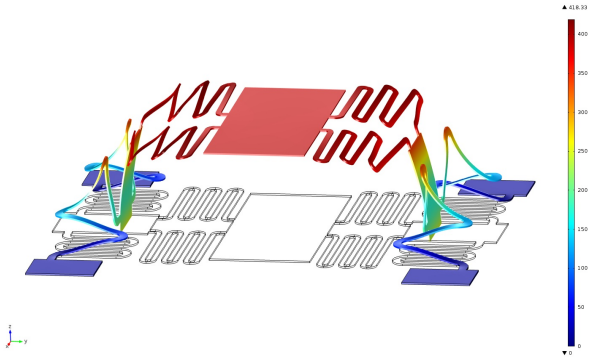

Figure 3: Simulation of Tsang platform structure. Platform displacement of approximately 420 µm.