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DESIGN AND ANALYSIS OF THERMAL EXPANSION WITH T-SHAPE GEOMETRY

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ABSTRACT

Today various electrical, industrial & biomedical applications such as thermometer, bimetallic strip, fire alarm, engine coolant which are based on the principle of actuation & sensing components are realized using thermal expansion fabricated using Micro Electro Mechanical Systems (MEMS) technology. This paper studies the termal expansion with new geometry i.e. T shape through comsol. T shape geometry is designed & implemented.

KEYWORDS: MEMS, COMSOL, Fire alarm, MST.

1. INTRODUCTION

Microelectromechanical systems (MEMS), also known as microsystems technology (MST) or micro machines, are integrated micro devices or systems combining mechanical elements, sensors, actuators and electronics on a common silicon substrate through micro-fabrication technology.[4] Applications of microsystems in various areas are pressure sensors, accelerometers, micro engines, micro actuators, fiber optic sensors, piezo polymer infrared sensors, micro mirrors, gyroscopes, fluid pumps, and inkjet print heads, miniature robots.[3] Future and emerging applications include high-resolution displays, high-density data storage devices, etc. Current technology mainly addresses millimeter (mm) to micrometer (μm) level MEMS devices.[6s] The joule heating properties of the actuation mechanism of comb shape thermal expansion with displacement produced in the device. The device is made up of copper Beryllium alloy.[2] Automatic Fire alarm system based on the Wireless Sensor Network. So this type of Thermal Expansion can be used in Fire Alarm.[1]

2. DESIGNING

Thermal expansion is the type of actuator i.e.when we change temperature the material expands. In this paper T shape geometry of thermal expansion is designed & analysed. In this we use two sets of physics:

- A thermal balance with a heat source in the device, originating from Joule heating (ohmic heating). Air cooling is applied on the boundaries except at the position where the device is attached to a solid frame, where an insulation condition is set.
- A force balance for the structural analysis with a volume load caused by thermal expansions.The device is fixed at the positions where it is attached to a solid frame as shown in figure1.[5]

  T shape geometry consists of 3 straight verticle rectangles of 10µm, 80µm and horizontal rectangle of 50µm, 10µm width, height respectively. With two alternate rectangles to connect T as shown in figure 1.

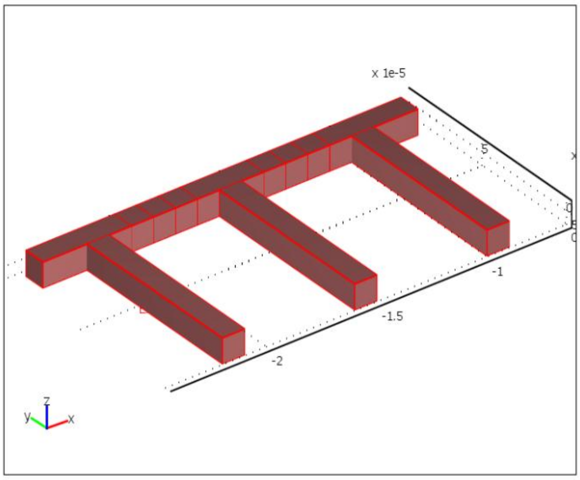

Figure 1: Model Geometry of the Device.

By applying fixed boundaries to lower base of T shape geometry so that expansion only takes place in upward direction as shown in figure 2 coloured red. The remaining region shown as white where heat flows can take place.

We apply the material copper beryllium alloy to the device which is UNSC17500.

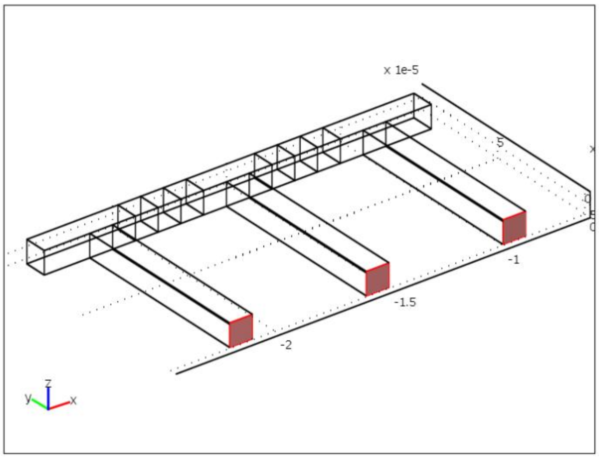

Figure 2: Fixed boundaries (lower base).

Figure 3 shows the meshed geometry. Mesh geometry is the most importanat aspect of engineering simulation.Too many cells may result in long solver runs, & too few may lead to inaccurate results. COMSOL Meshing technology provides a mean to balance these requirements.

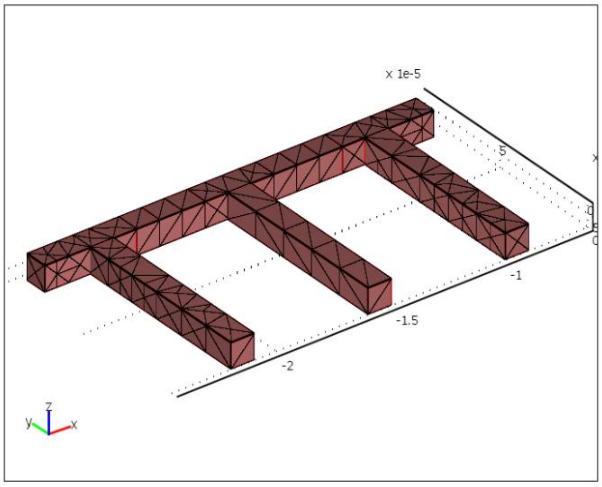

Figure 3: meshed geometry.

3. RESULTS

After meshing the device we solve the device on COMSOL software then the maximum displacement is 1.113e8 m. The Following figure 4 shows the total displacement in the device.

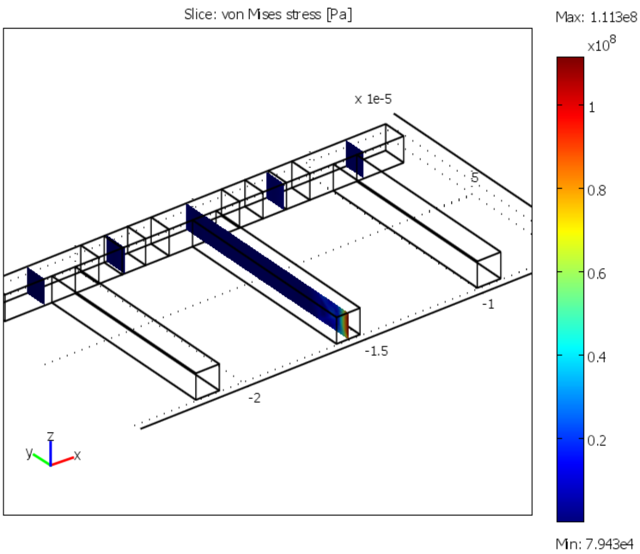

Figure 4: After solving the device.

When we use 298 K as external temperature then the following figure come. Middle T has highest temperature so it is red & extreme T's have low temperatureso they are blue.

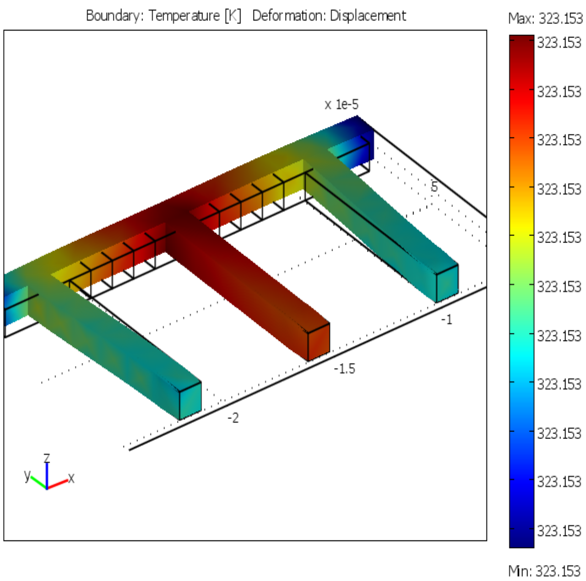

Figure 5: Temperature variation of the device.

Figure 6 shows the displacemsnt of a curve that follows the top inner edges of the device from left to right.

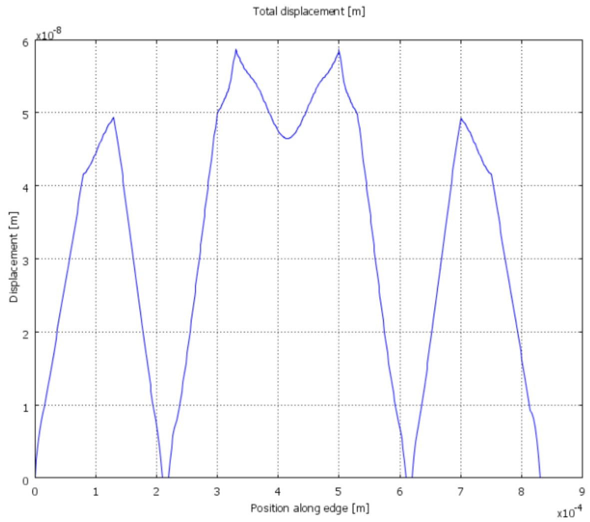

Figure 6: Displacement vs Position graph.

CONCLUSION

From result it is concluded that the When we solve T shape geometry on COMSOL maximum displacement is 1.113e8. The graph shows $6*10^{-8}$. T shape geometry is designed & implemented successfully.

PROPOSED FUTURE WORK

In future we wish to redesign the T shape thermal expansion with reduced its edges (height & breadth). This would change the displacement in the top inner edges of the device. So we would redesign the device.

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