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To Analyse T-shape Thermal Expansion with Reduced Length

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Abstract-In this paper we compare the T-shape thermal expansion with varying its length using COMSOL Tool. Thermal expansion is very imperative device used in MEMS. When we change the length of the device than the displacement produced in the device is changed which is further used in Fire Alarm & Bimetallic strips. The change in length also causes shift in position vs displacement graph.

Keywords: MEMS, COMSOL, Bimetallic Strip, Fire alarm

I INTRODUCTION

Microelectromechanical systems (MEMS) devices contain both electrical and mechanical components and are in use and under development for applications in the consumer products, automotive, environmental sensing, defense, and health care industries. Thermal microactuators are standard components in microsystems and can be powered electrically through Joule heating.[1] Thermal actuator designs using a single material are both symmetric, referred to as bent-beam or V-shaped, structures.[2,3] Z shaped thermal actuator are used for force or displacement sensor.[4] Rectangular shape thermal expansion is used for Bimetallic strips.[5] Automatic Fire alarm system based on the Wireless Sensor Network.. So this type of Thermal Expansion can be used in Fire Alarm.[6]

II DESIGNING

T shape geometry consists of 3 straight verticle rectangles of 10µm, 80µm and horizontal rectangle of 30µm, 10µm width, height respectively. With two alternate rectangles to connect T as shown in figure 1.

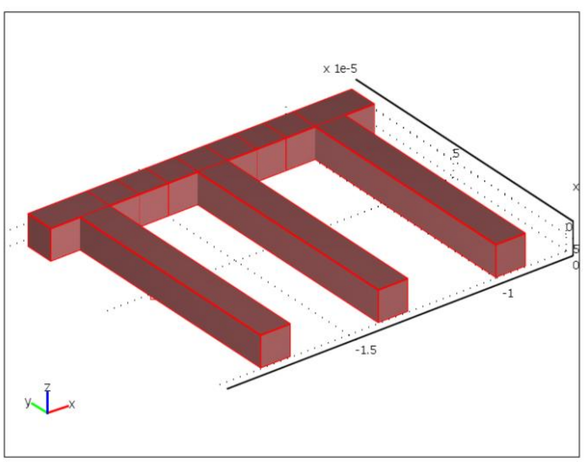

Figure1: Model Geometry of the Device

T shape geometry consists of 3 straight verticle rectangles of 10µm, 70µm and horizontal rectangle of 30µm, 10µm width, height respectively. With two alternate rectangles to connect T as shown in figure 2.

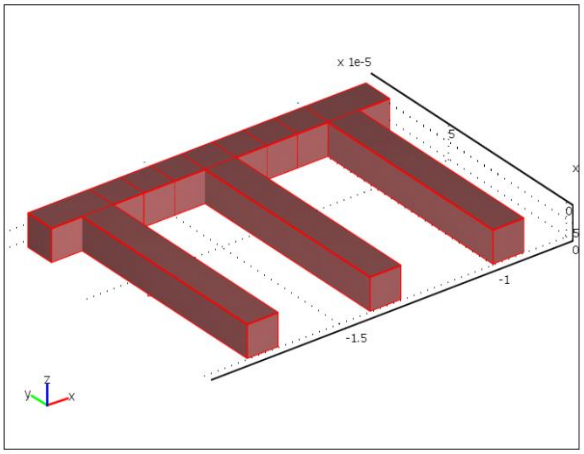

Figure 2: Model Geometry of the Device

When length is reduced to 60µm & whole dimensions are same which is shown in figure 3.

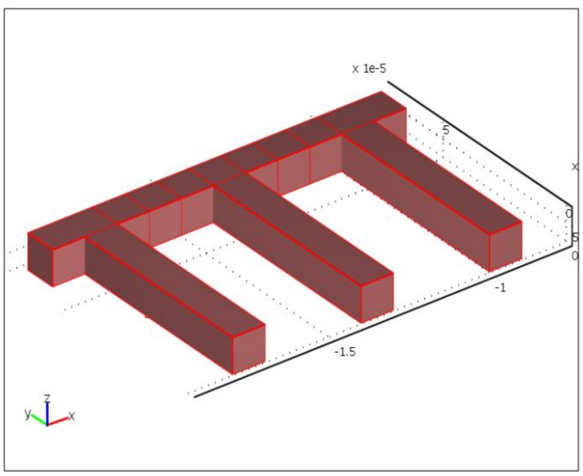

Figure 3: Model Geometry of the Device

When length is reduced to 50µm & whole dimensions are same which is shown in figure 4.

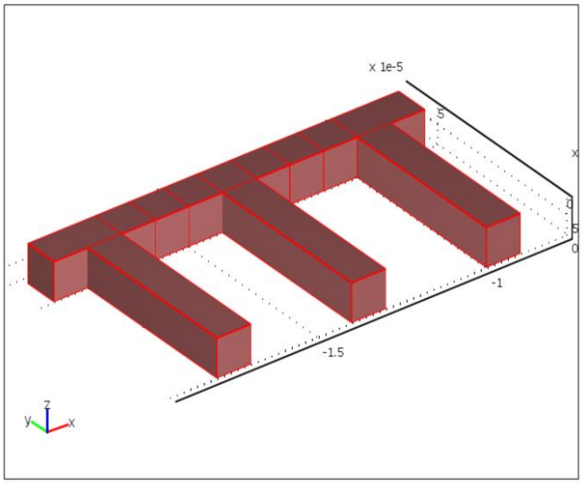

Figure 4: Model Geometry of the Device

When length is reduced to 40µm & whole dimensions are same which is shown in figure 5.

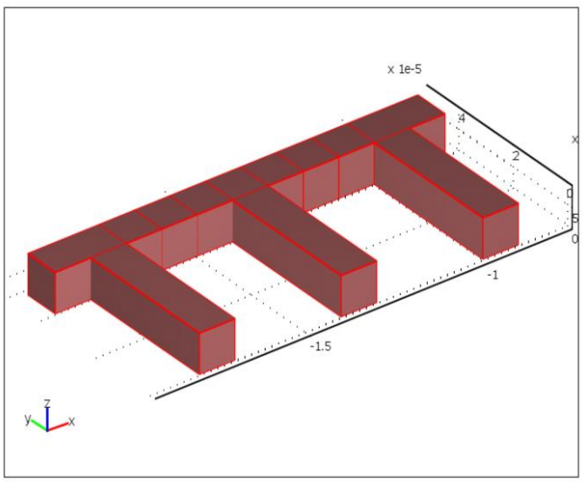

Figure 5: Model Geometry of the Device

III RESULT

When we use 298K as external temperature then the maximum displacement is $5.5*10^{-8}$. The figure 6 shows the temperature distribution in the device. The heat source increases the temperature to 323.18 K from an ambient temperature of 298 K. The temperature varies less than 1/100 of a degree in the device.

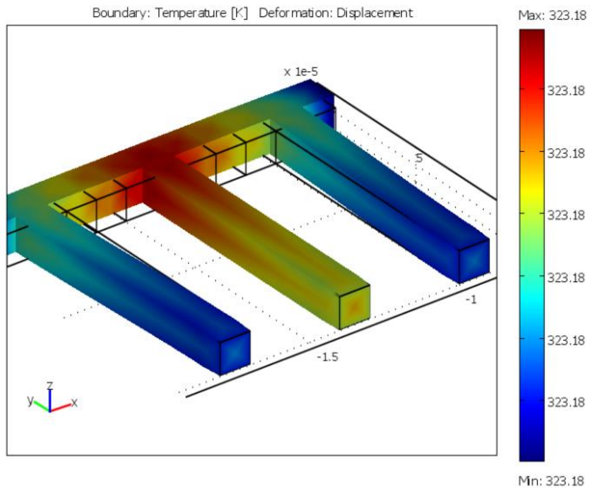

Figure 6: Temperature distribution of the Device at 298K

The figure 7 shows the displacement of a curve that follows the top inner edges of the device from left to right.

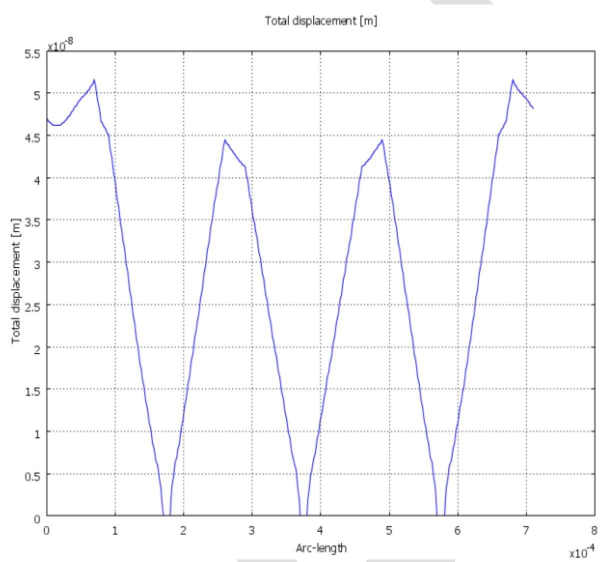

Figure 7: Displacement Vs Position graph

Figure 8 shows the temperature distribution of the device when length is reduced to 70 µm.

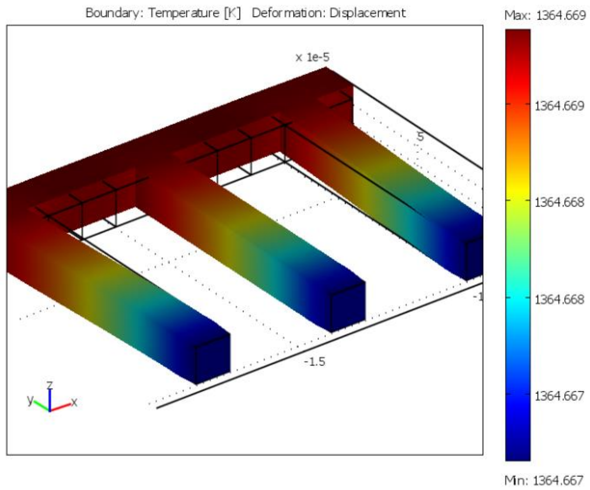

Figure 8: Temperature distribution of the Device at 298K

The figure 9 shows the displacement of a curve that follows the top inner edges of the device from left to right.

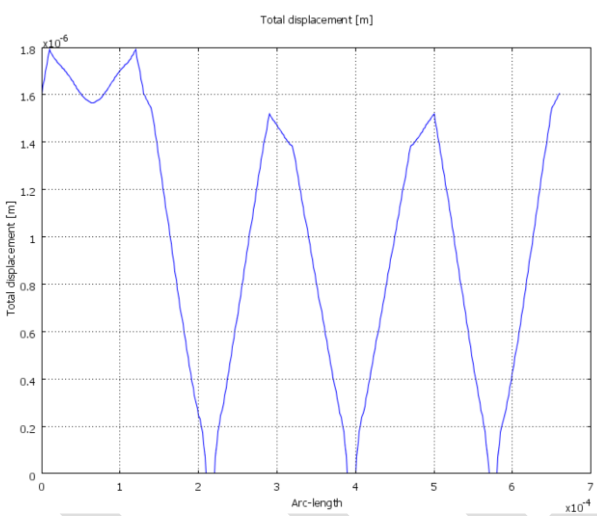

Figure 9: Displacement Vs Position graph

Figure 10 shows the temperature distribution of the device when length is reduced to 60 μm.

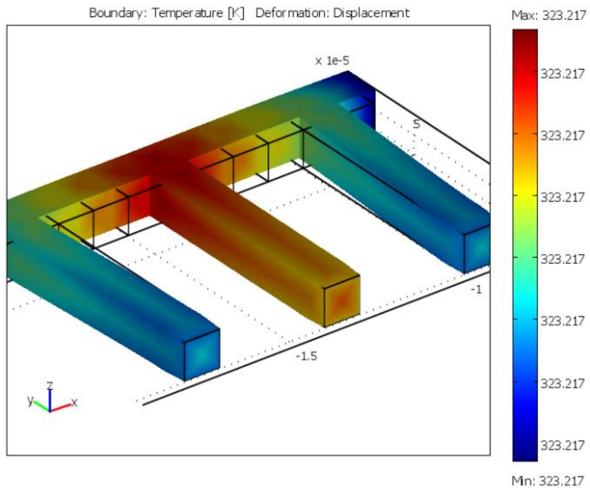

Figure 10: Temperature distribution of the Device at 298K

The figure 11 shows the displacement of a curve that follows the top inner edges of the device from left to right.

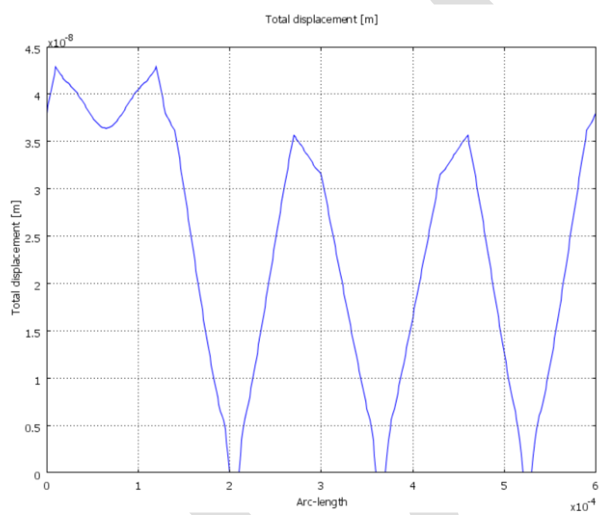

Figure 11: Displacement Vs Position graph

Figure 12 shows the temperature distribution of the device when length is reduced to 50 µm

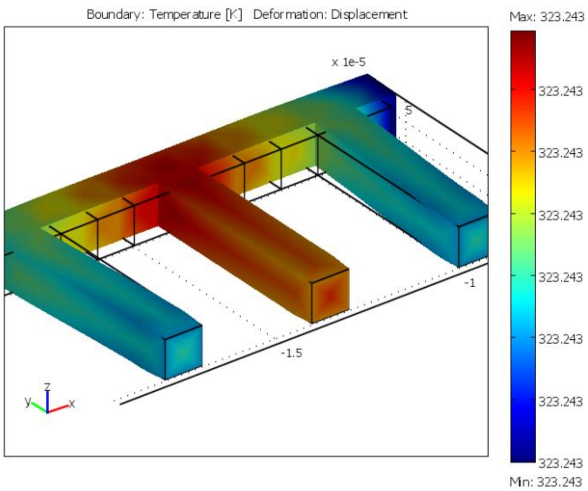

Figure 12: Temperature distribution of the Device at 298K

The figure 13 shows the displacement of a curve that follows the top inner edges of the device from left to right.

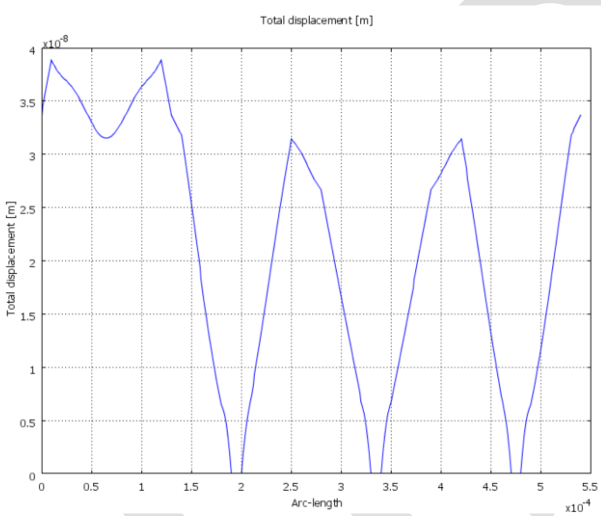

Figure 13: Displacement Vs Position graph

Figure 14 shows the temperature distribution of the device when length is reduced to 40 μm

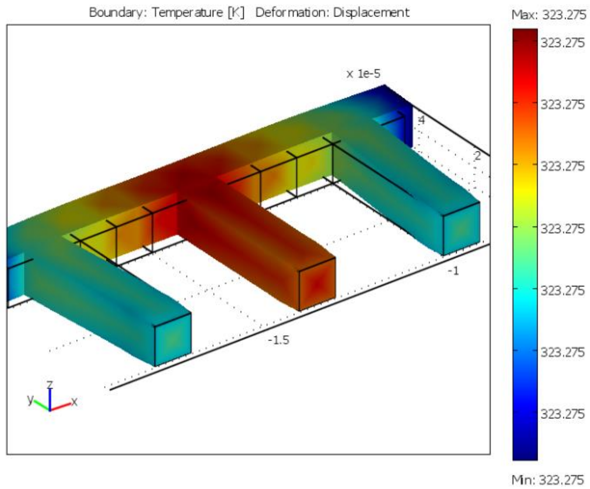

Figure 14: Temperature distribution of the Device at 298K

The figure 15 shows the displacement of a curve that follows the top inner edges of the device from left to right.

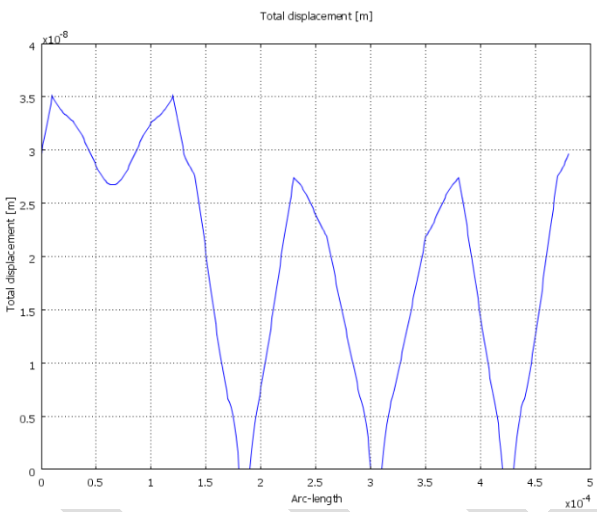

Figure 15: Displacement Vs Position graph

COMPARATIVE ANALYSIS

When we compare all the cases listed above (with reduced length) we noted that when length decreases by 80μm to 70 μm displacement increases by large amount & the graph is also shifted towards right.

Table1: Displacement at different length

Length of device	Displacement
8e-5	4.7e-8
7e-5	1.6e-6
6e-5	4e-8
5e-5	3.5e-8
4e-5	3e-8

When we decrease further length of the device then first there is large decrease in displacement & then there is small decreament as shown in figure 16.

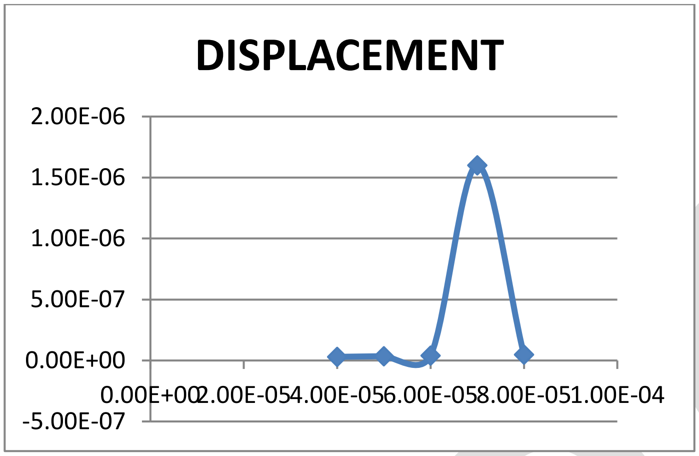

Figure 16: Displacement Vs Length grap

CONCLUSION

From result it is concluded that when we change the length of the device then displacement is also changes. First displacement increases & then decreases by large factor & then decreases by small factors. When displacement changes from 8e-5 to 7e-5 the displacement vs position graph also shift towards right.

PROPOSED FUTURE WORK

In future we wish to redesign the T shape thermal expansion with its reduced width. This would change the displacement in the top inner edges of the device. So we would redesign the device. We can reshape the device from T to H or any other.

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