PASSIVE TEMPERATURE REGULATOR FOR AN ELECTRONIC DEVICE USING CONDUCTIVE BIMORPH CANTILEVERS

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Abstract:
Many electronic devices need to be kept at a stable temperature to ensure reliable operation. Active heating and cooling methods can be used to achieve accurate temperature control. However, there are many cases in which the power consumed by the heater and cooler exceeds the limited power budget of the device. With a small power budget, it is particularly difficult to keep an electronic device at a constant temperature if the ambient temperature varies over a large range.

One potential solution to this problem is to use an array of thermally conductive bimorph cantilevers that deflect with changes in temperature. When the ambient temperature is high, the cantilevers contact the electronic device and pull heat away. When the ambient temperature is low, the cantilevers pull away from and insulate the electronic device. An illustration of the electronic package is shown below:

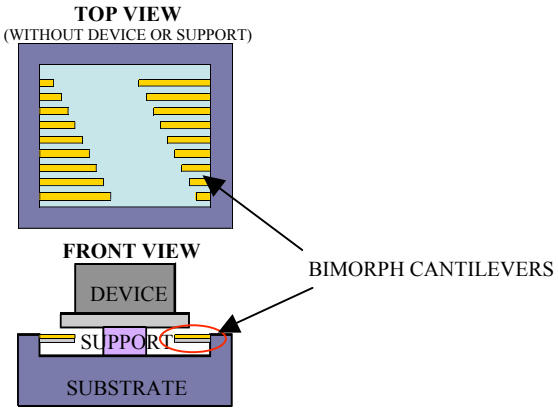

Figure 1. Illustration of conductive bimorph cantilever package

To test this theory, several cantilever designs were fabricated in the Stanford Nanofabrication Facility using a three-mask process to deposit and etch three thin film layers on SOI wafers: 1) a 0.5um layer of aluminum that acts as the heat conducting layer, 2) a 7um layer of a low-CTE polyimide that acts as a thermally insulative layer, and 3) a 3um layer of aluminum whose difference in CTE from the silicon layer acts to force the cantilever to bend upwards with changes in temperature. The following images were taken of a finished cantilever at two different ambient temperatures. Additional testing will determine the ability of these cantilevers to conduct heat away from the electronic device.

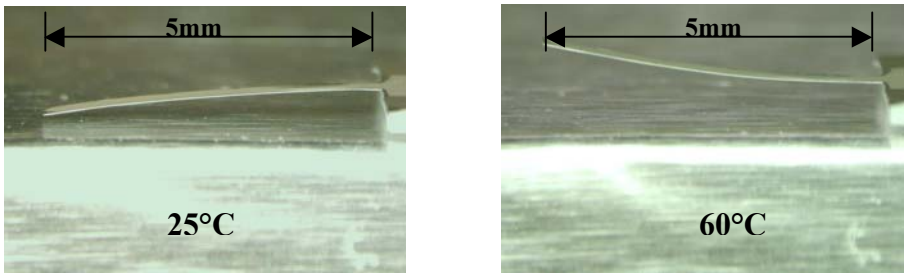

Figure 2. Bimorph Cantilever at 25°C and 60°C ambient temperature