INVESTIGATION ON MEMS BASED THERMAL SENSOR FOR CANCER DETECTION

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Introduction:

A cantilever based thermal sensor was designed to monitor its response for various body temperatures. The cantilever is made of a shape memory alloy, Nitinol. It has the capability of recentering and recovering more than 80% of the induced strains. It is used to investigate the structural change in the sensor for different body temperatures that produces thermal strain which can be detected for diagnosing the disease condition.

Computational Methods:

The cantilever was simulated with the structural mechanics module and with the physics, thermal stress and solid mechanics. The thermal stress due to the applied temperature induces thermal expansion of the nitinol which in turn acts as the boundary load on the piezoresistive material. When temperature changes, it leads to expansion of material and amount of expansion is in linear relationship with coefficient of thermal expansion of that material which can be stated as:

$$\frac{\Delta L}{L} = \alpha_L \Delta T$$

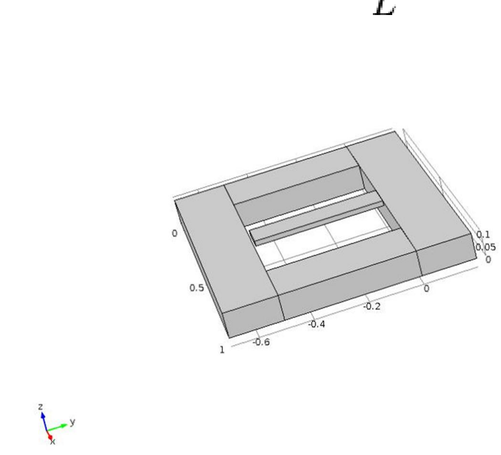


Figure 1a. 3D geometry of thermal sensor

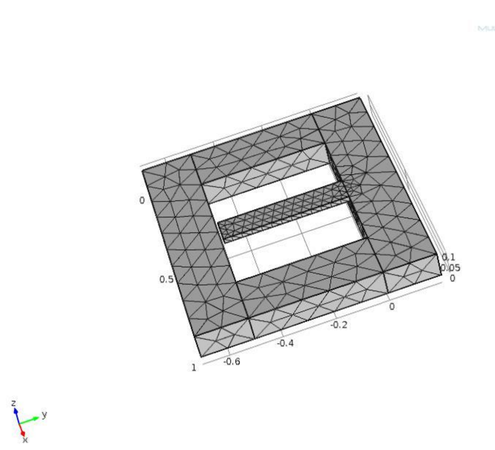


Figure 1b. 3D mesh model of thermal sensor

Nitinol is used as stents which can expand due to the body temperature and thus used for sensing low body temperature. The basic layout of the cantilever based thermal sensor was shown in figure 1a and 1b.

Results:

The response of the nitinol and its effect over the piezoresistive material for different body temperatures were simulated.

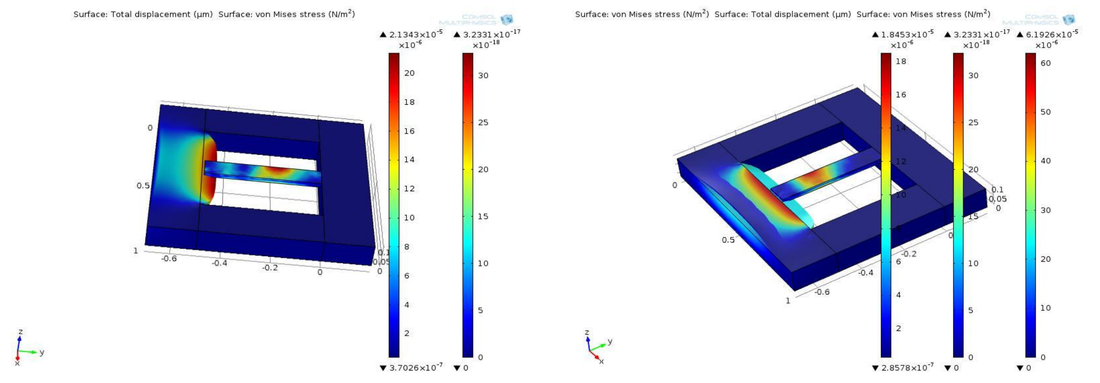
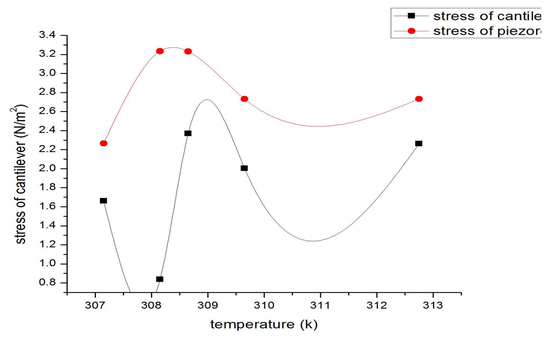
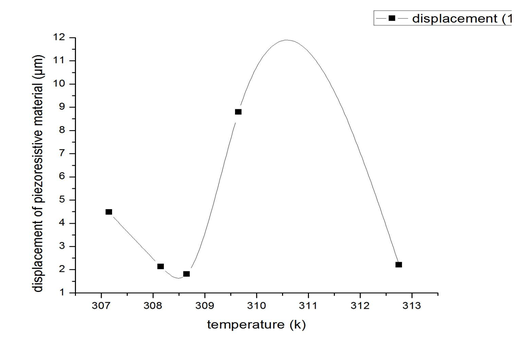


Figure 2 &3. Total thermal stress & displacement of the thermal sensor



Graph 1. temperature Vs Thermal stress



Graph 2. temperature Vs Total displacement

Conclusions:

The simulation of cantilever based thermal sensor for different body temperatures revealed that nitinol can easily detect low body temperature syndrome which helps in diagnosing disease conditions.

References:

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2. Srinivasa Rao Karumuri & P. Sri Sairam, “Design and Analysis of Thermal Expansion in Micro-Electro-Mechanical-System”, IJASETR 1(2): p.26 – 33;2012.