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Hybrid Design Electro thermal Polymeric Micro gripper with Integrated Force Sensor

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Abstract:

Micro grippers are typical MEMS devices used to pick, hold and transport micro-objects. Micro grippers are widely used in the field of micro-assembly, micro-surgery and manipulation of micro-particles. This force sensing resolution provides feedback in the range of the forces that dominate the micromanipulation process. The micro gripper, fabricated by electro-discharge machining, features force sensing capability, large force output, and large displacements to accommodate objects of various sizes. The design parameters for the embedded electromagnetic actuators were selected on the basis of finite element sensitivity analysis. The concept is also demonstrated with HeLa cells, thus providing a useful tool in biological research and cell assays.

Keywords — **Hybrid, micro gripper,sensor.**

I. Introduction:

The need for microgrippers with high precision and reliable operation has recently increased for such applications as assembling and testing micro system components and/or measuring mechanical properties of biological cells and tissues. MEMS technology allows for the fabrication of such devices that meet these requirements. Both suitable end-effectors and actuators can be fabricated with MEMS technology. The handling and assembly of the micro components is highly challenging due to their small size. To manipulate the micro-components, microgripper are used. The microgripper is an important component of the system to hold, pick, manipulate and assemble mechanical micro components. The general requirement of a microgripper is that it should be able to pick up and release a component at a specified position. The positional uncertainty during assembly should be well defined and components should not be damaged during assembly. Microgripper applications include assembly of micro components in manufacturing, electronics, information technology, optics, medicine and biology areas like diagnostics, drug delivery, biopsy tissue sampling, tissue engineering and minimally invasive surgery.

II. Design and Simulation

Basically, a good micro gripper must be able to firmly hold the object of interest with a force that is sufficiently high to keep it within the grips but at the same time sufficiently low to avoid damaging the material. In this paper two different designs of electrothermal microgripper have been proposed. The geometry of the proposed electrothermally actuated Microgrippers. The novel electrothermal microgrippers are designed using COMSOL Multiphysics Software.

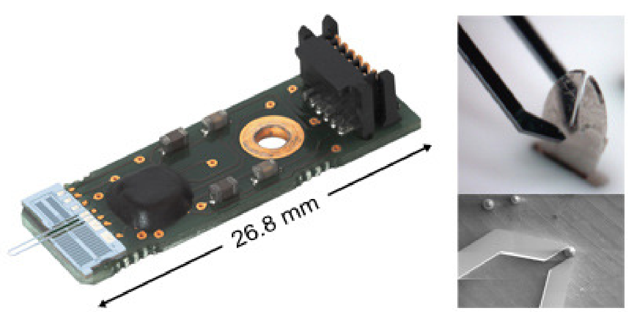


Fig1. Micro Grippers

III. simulation and analysis results

The hybrid design microgripper is designed using Comsol Multiphysics software. The hybrid design is a combination of asymmetric arm and bi-layer structure. The major parts of the microgripper are the fixed part (anchor), hot and cold under arms, flexure, gripper arms and heaters. In such case, the fringe electric fields are assumed to be constant considering that the comb fingers are very large with respect to their displacement. Thus, the resulting actuating force is approximately fixed within a range of input voltages.The modeling and analysis of the proposed gripper was conducted using the Autodesk's MDT (mechanical desktop power pack).

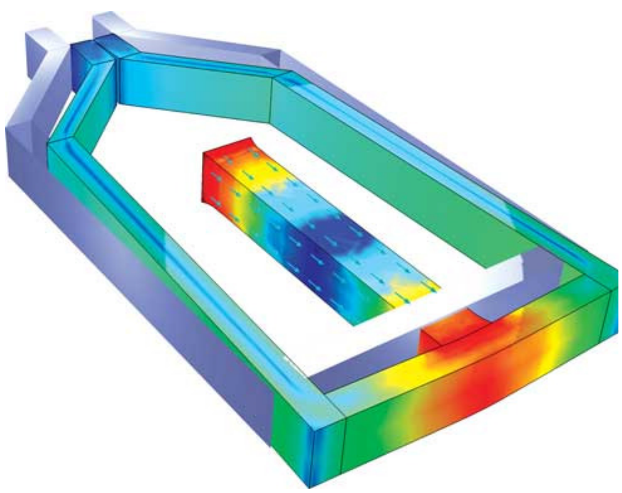


Fig 2.Simulation and analysis

IV.Design of force sensor:

Quartz Force Sensors are recommended for dynamic force applications. They are not used as 'load cells' for static applications. Measurements of dynamic oscillating forces, impactor high speed compression/tension under varying conditions may require sensors with special capabilities. Fast response, ruggedness, stiffness comparable to solid steel, extended ranges and the ability to also measure quasi-static forces are standard features associated with PCB quartz force sensors.

I. The following information presents some of the design and operating characteristics of PCB force sensors to help you better understand how they function, which in turn, will "help you make better dynamic measurements".

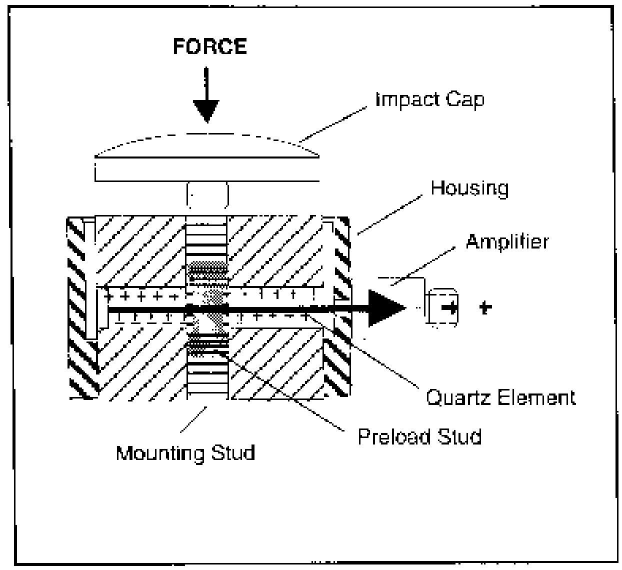
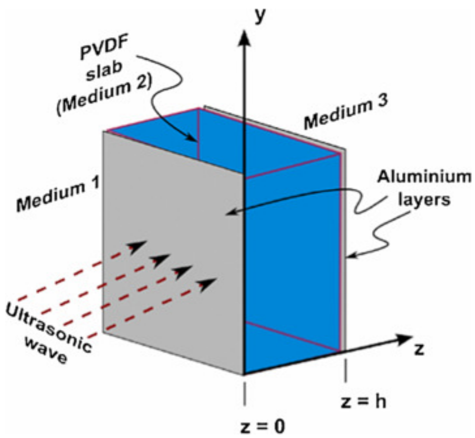


Fig 3.Sensor design

Polyvinylidene fluoride (PVDF) is valued for its toughness, stability, and distinct engineering advantages. For example, if you need a polymer that will withstand exposure to harsh thermal, chemical, or ultraviolet conditions, porous PVDF offers superior stability similar to the performance of fluoropolymers in these environments.

PVDF is the homopolymer of 1, 1-di-fluoro-ethene. Its highly desirable insolubility and electrical properties result from the polarity of alternating CH_2 and CF_2 groups on the polymer chain. An extremely hard material, porous PVDF may be used at temperatures from -80 to 300°F (-62 to 149°C). No oxidation or thermal degradation occurs during continuous exposure to 300°F (149°C). It is available for custom molded shapes.



V. Imperfections in Fabrication:

Structural steelwork cannot be fabricated to exact dimensions and some degree of imperfection is bound to occur during fabrication process. The limits of various imperfections are spelt out in the specifications. In the design, these are accounted by adopting a factor of safety for material. However, in some components an increase of imperfection beyond these limits may lead to reduction in the strength and durability of the structure e.g., imperfections on the straightness of the individual flanges of a rolled beam or a fabricated girder results in the reduction of strength of the girder due to lateral tensional buckling which may cause an overall bow in the girder. This, in turn, may generate twisting moments at the supports.

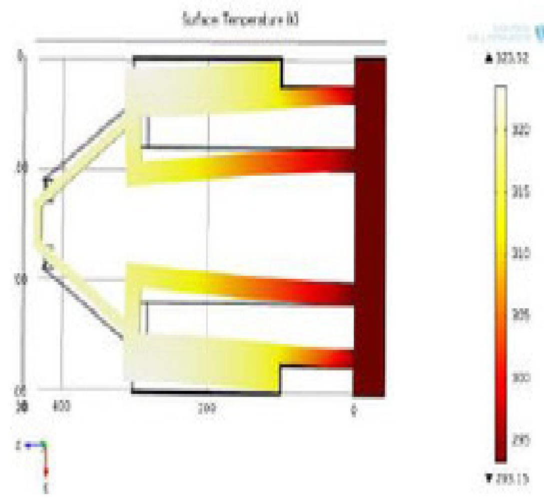


Fig4.Imperfections in Fabrication

VI.Measurement Setups:

There are two methods for inducing a temperature change in this electro thermal micro actuator: applying a current through the self-contained metal heater or using an external heat source. Measurement calibration is discussed in Calibration. The static displacement of the micro actuator at any actuating voltage is then obtained by enlarging the picture and comparing it with the picture of the initial position. The external mechanical vibration causes a blur on the static picture which determines the inaccuracy of the measurement. This inaccuracy is about voltage.

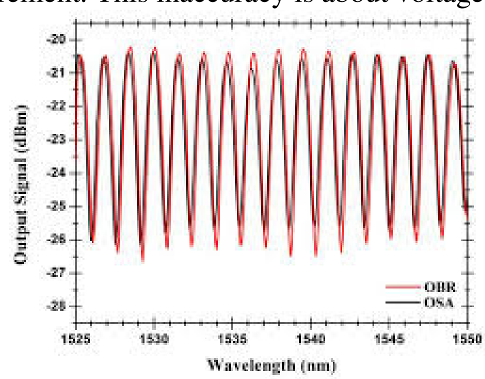


Fig 5. actuator movement in air versus the applied voltage.

VII. Conclusion:

A novel design and simulation of an electrothermally actuated microgripper was presented here, which was classified under two different microgrippers. It has been found that the performance of electrothermal micro grippers is greatly affected by the dimensional and material variation. Longer hot arms and narrower gap between the hot and cold arm results in larger displacements. Similarly materials with high thermal conductivity and coefficient of thermal expansion show more deflection. This design of microgripper can be used for manipulation purposes ,micro robotics, micro surgery etc . the dual microgripper is more effective and efficient than any other microgripper as it shows more deflection at very low electrical potential and temperature is also relatively low.

VIII. Reference :

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