

Hybrid Design Electrothermal Polymeric Microgripper with Integrated Force Sensor

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Abstract

Microgrippers are typical MEMS devices used to pick, hold and transport micro-objects. Microgrippers are widely used in the field of micro-assembly, micro-surgery and manipulation of micro-particles. Thermal microgrippers are widely used for large displacement, high accuracy and repeatability. In this paper, a hybrid design electrothermal microgripper (Figure 1), based on Poly Methyl Methacrylate (PMMA) with integrated force sensor is designed and analysed using COMSOL Multiphysics software. The new design is designed by combining asymmetric arm structure and bi-layer structure to minimize the undesired out of plane displacement of the microgripper. The in-plane, out of plane and curl displacements, stress, strain and temperature has been analysed and the results are discussed (Figure 2). A piezoelectric force sensor (Figure 3), based on Poly Vinylidene Fluoride (PVDF), which is to be integrated with microgripper to resolve the gripping force exerted by the microgripper on the micro-objects, is also designed and analysed. The force sensor is analysed for charge density for various gripping forces, stress, strain and displacements along X,Y, and Z axis (Figure 4). The hybrid design gives 1.6 μm in-plane displacement and 0.3 μm out of plane displacement at 0.1 V applied voltage. The maximum temperature of the microgripper is 323 K. The fabrication method for the hybrid design electrothermal polymeric microgripper is discussed.

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Figures used in the abstract

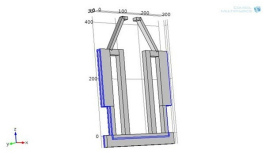


Figure 1: Hybrid design electrothermal polymeric microgripper

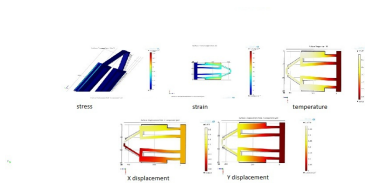


Figure 2: Results of microgripper

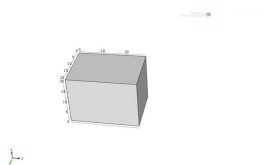


Figure 3: Piezoelectric force sensor

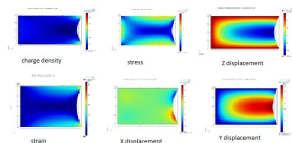


Figure 4: Results of force sensor