Experimental and Simulation Studies on Electrothermal Microactuators

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Abstract

Electrothermal microactuators are used in many applications including positioning, grasping, and manipulation of small-scale components. With potential applications in medicine, manufacturing, and nanotechnology scientific work, electrothermal microactuators fill an important niche in the world of microrobotics. The principle of operation of these actuators is based on electrical current to heat conversion using the Joule effect. Increases in temperature lead to thermal expansion, and at small scales, actuation occurs at reasonably high frequencies. In this project, we designed, simulated and fabricated several microactuators using Silicon on Insulator (SOI) MEMS technology. Three micron-scale mechanical grippers, all utilizing electrothermal actuators, were designed, and these structures were fabricated on SOI wafers. Fabrication consisted of photolithography, metal deposition, Deep Reactive Ion Etching, and hydrofluoric acid release. Thermo-mechanical models of the microgrippers were prepared in ANSYS simulation software, including boundary conditions reflecting the anticipated operating environment, and simulations were run to predict the static and dynamic behavior of the microactuators. Experiments conducted on fabricated parts measured displacement using optical metrology tools. While simulation models can qualitatively anticipate the performance of MEMS devices in terms of displacement, bandwidth and force, quantitative matching of experiments and simulations requires meticulous tuning of parameters and conditions which is still on-going.

Biography of Presenter

John Ronkainen was born and raised in Kentucky in 1998. After graduating high school, he decided to pursue a B.S. degree in Mechanical Engineering by starting at Elizabethtown Community and Technical College where he received his A.S. in 2018 with an emphasis in Pre-Engineering. While attending Elizabethtown Community and Technical College, he received the 2018 Outstanding Pre-Engineering Student award. Wishing to further his understanding of science, John applied to and was accepted into the 2018 University of Louisville Research Experience for Undergraduates program, where he is currently learning about microrobotics under the mentorship of Dr. Dan Popa. In Fall 2018, John will be transferring to the University of Kentucky and plans to finish his B.S. in Mechanical Engineering there.