Wafer-scale microfactories with assembled MEMS microrobots for nanotechnology applications

Ruoshi Zhang, Andriy Sherehiy, and Dan Popa
Speed School of Engineering
University of Louisville

Abstract

Microfactories have long been envisioned as a stepping stone toward automated nanomanufacturing with the help from microrobots. Among numerous challenges in realizing such miniature systems, the most significant ones are achieving nanometer-level accuracy while maintaining affordable cost, long term reliability and scalability. The Next Generation Systems group (NGS) at the University of Louisville is working on three types of microrobots for the microfactory, including a mm-scale robotic arm (sAFAM), a solar actuated cm-size crawler (SolarPede), and a sub-millimetric laser driven locomotor (ChevBot).

The idea of utilizing laser energy to actuate and control microrobots has been envisioned for several past decades and has already been demonstrated in liquid environments, for instance in optical trapping and thermal convection actuation. ChevBot is a novel microrobot driven by laser energy that targets operation in dry environments, such as in a future microfactory. The microrobot operates using stick-slip locomotion by converting opto-thermal energy from a focused laser source into mechanical energy using opto-thermal "chevron-style" actuators. ChevBot's body components are fabricated by Micro-Electro-Mechanical-System (MEMS) technology and completed using a microassembly process. In this paper, we present modeling and simulation results, validated by experimental measurement of the robot's locomotion performance under varying conditions. The microrobot is automatically tracked through a visual servoing scheme using a microscope, a 3-DOF positioning system, and is powered by a 532nm 2W ND-YAG laser source. Experiments suggest that ChevBot velocities in excess of 100µm/s are achievable.

Biography

Ruoshi Zhang received his Bachelor's degree in Telecommunication Engineering at Tianjin University, China in 2012. Later, he completed an MS at the University of Texas at Arlington in the Electrical Engineering Department. Currently, Ruoshi is a PhD. Candidate in the Speed School of Engineering at the University of Louisville. His research focuses on design, fabrication and validation of silicon based microrobotics, with application of microfactory. Ruoshi is the author of 6 conference papers and 2 journal papers published by IEEE, Springer and SPIE.