Controls for Micromanipulation Systems (Microassembly for Future Energy Efficient Micromachines)

The Next Generation of Micromachines and Micromanipulators

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Technology Need

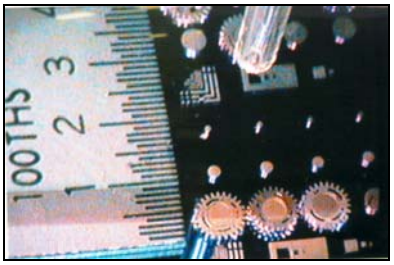
Miniaturization of electromechanical systems promises to impact a wide variety of markets (e.g., chemical, medical, pharmaceutical, bioengineering, appliances, automotive). However, a fundamental element in miniaturization that has yet to be addressed is bridging the gap between the micro- and macro-worlds (e.g., microassembly).

Research Focus

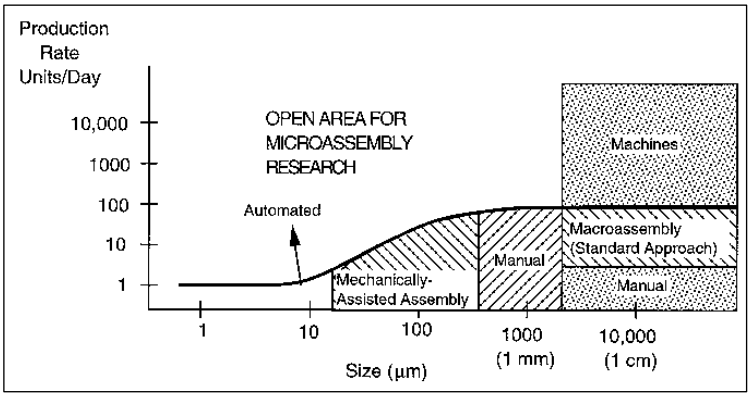
The Oak Ridge National Laboratory's (ORNL's) approach focuses on understanding the fundamental physics associated with microassembly. In particular, we are exploring new approaches to force-guided microassembly. Of primary concern in microassembly / nanoassembly is the methodology associated with both the assembly force measurement and strategy for part assembly. Preliminary research has focused on force reflecting micro-teleoperation.

The focus of this research is directed toward exploring the fundamental mechanics of assembly of microcomponents. These components generally are smaller than a millimeter, with features under a micron. Due to the reduction in size, many phenomena such as surface adhesion and electrostatic forces, typically negligible at the macroscale, impact the behavior of the microscale / nanoscale components.

Our methodology for microforce measurement exploits very small perturbations and computes the correlation of these perturbations with the excitation to formulate the stiffness matrix of the microparts during assembly. Preliminary experiments show that this approach is presently feasible for systems in which the perturbation is above 0.1 mg, that is, in the range expected for assembly of components in excess of 100 µm in size. The grand challenge is to develop a fundamental methodology that uses this information for automated force-guided microassembly.



Microcomponents.



Areas for microassembly research.

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