Controls for Micro-Manipulation Systems

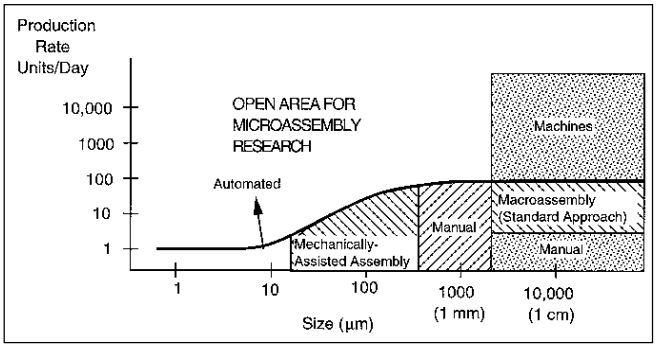
Micro-Assembly for Future Energy Efficient Micro-Machines

Technology Need

Miniaturization of electromechanical systems promises to impact a wide variety of markets (e.g., chemical, medical, pharmaceutical, bio-engineering, 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., micro-assembly.

Research Focus

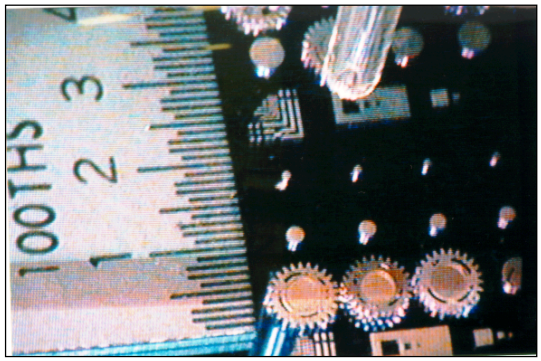
ORNL's approach focuses on understanding the fundamental physics associated with micro-assembly. In particular, we are exploring novel new approaches to force-guided micro-assembly. Of primary concern in the micro-/nano-assembly is the *methodology associated with both the assembly force measurement and strategy for part assembly*. Preliminary research focused on *force reflecting micro-teleoperation*.



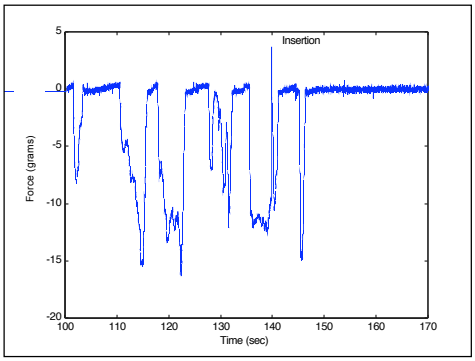
Areas for micro-assembly research.

The focus of this research is directed towards exploring the fundamental *mechanics of assembly of micro components.* Specifically, we consider the impact of scaling on both the forces experienced during manipulation and interaction of micro-components. These components generally range in size with *major dimensions below a millimeter with features below a micron*. Due to the reduction in size, many novel phenomena, such as *surface adhesion and electrostatic forces*, impact the behavior of the components. Of primary concern in the micro-/nano-assembly is the methodology associated with both the assembly force measurement and strategy for part assembly.

Our methodology for micro force measurement exploits very small perturbations and computes the correlation of these perturbations with the excitation to formulate the stiffness matrix of the micro-parts 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 micro-assembly.



Micro components.



Micro-assembly task force profile.

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