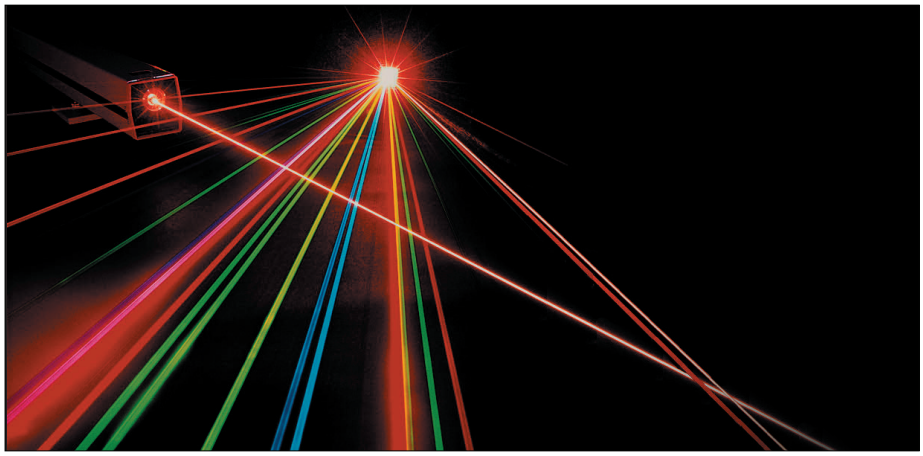
Technology *Opportunity*

Micro Electro-Mechanical Systems (MEMS) Techhnology

MEMS Micro-Translation Stage with Large Linear Travel Capability



NASA's Marshall Space Flight Center (MSFC) is developing a MEMS micro-translation stage (MTS) with large linear travel capability. The MTS uses capacitive electrostatic forces created by stators arranged linearly on both sides of a channel and matching rotors on a moveable shuttle for precise movement of the shuttle. The device, which is essentially a linear motor built from silicon, will be able to rapidly translate across large distances using only three-phase power. The moveable shuttle can be as small as 100 μm and can house a variety of elements, including lenses and mirrors. The shuttle can be tailored to travel distances as small as 10 μm and as large as 300 mm, with as little as 10 μm between adjacent shuttle stops.

Features and Benefits

- Provides the capability to accurately translate an object between 10 μm and 300 mm, in increments as small as 10 μm
- Accommodates translation stages as small as 100 μm, and the nature of the moveable shuttle allows it to carry objects as large as 100 μm and 3 μg
- Operates on three-phase power and requires only four electrical leads to cover the entire range of motion
- Actuator is only 250 μm wide, making arrays of actuators within close proximity possible
- Offers the capability to house a variety of elements on the moveable shuttle, including the following:
  - Absorbers—for modulating light beams
  - Mirrors and lenses—for directing light to specific locations
  - Sampling compartments—for transporting liquids and reaction products such as precipitates
  - Special structures—for pumps, valves, and flow controllers in microfluidic devices

Marshall Space Flight Center

For More Information

For more information about this technology or NASA's technology transfer program, please contact the person listed below.

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The Technology

NASA's MTS technology is an advanced linear motor that is simple to operate, yet extremely flexible. The device consists of a moveable shuttle housed in a linear channel built on a silicon wafer. Stators built into the linear channel and matching rotors on the moveable shuttle provide electrostatic forces that center the shuttle in the channel. Manipulating these capacitive forces with three-phase power enables precise movement of the shuttle in either a stepping mode with many interim stops or in a controlled scanning mode with adjustable speed. The device is built using standard MEMS processing technologies, and the ultimate translation length is determined by the photolithography process and the wafer size that can be accommodated in the MEMS fabrication equipment.

Applications

Optical Communications

- Light modulator
- Optical switches
- Shutters and multiplexers

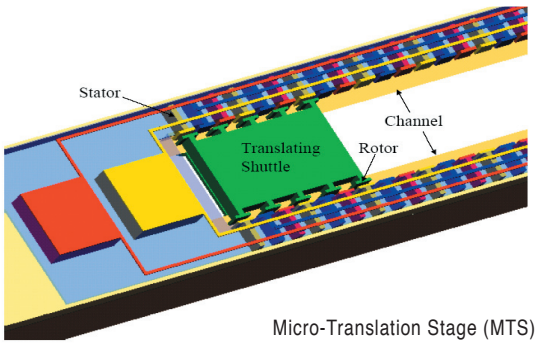
Semiconductor

- Rapid probe and test systems
- Positioning systems and encoders
- Wafer-level inspection units

Biotechnology

- Sample transport mechanisms for microfluidic chips
- Valve mechanisms for microfluidic chips
- Dynamic control mechanisms of microfluidic chips, including flow controllers and pumps

The moveable translation stage at the heart of this device is the key to its flexibility in applications such as optics, communications, sensors, and biotechnology. The translation stage can move at speeds of 25 µm per millisecond, providing a method for rapid modulation of a laser source. The translation stage can also house a variety of elements, including lenses, mirrors, absorbers, and sampling compartments that would be useful in many applications. For example, in optical switching applications, the fast actuation and unrestrained travel capability of this technology would allow the rapid movement of optical mirrors to direct the light output from a fiber optic cable to another connection. In biotechnology, a sampling compartment on the moveable shuttle can transport analytes between different areas of a biochip. This can be useful for the synthesis and analysis of biological products, such as high-purity protein crystals grown in one area of a biochip and analyzed in a different zone of the chip.



Micro-Translation Stage (MTS)

Partnership Opportunities

This technology is part of NASA's technology transfer program, which endeavors to stimulate development and commercial use of NASA's technologies. NASA is flexible in its agreements, and opportunities exist for licensing and/or joint development of this advanced MEMS actuator technology.