Fast Microscale Actuators for Probe Microscopy (#3916)

A probe microscopy method to perform time-resolved single-molecule force spectroscopy

Researchers at Georgia Tech have developed an invention that provides a probe microscopy method to perform time-resolved single-molecule force spectroscopy by constructing a fast actuator with integrated displacement sensing capability based on a technology called force-sensing integrated readout and active tip (FIRAT). This FIRAT-based structure for actuation and displacement sensing includes a flexible micromachined membrane spaced apart from the detection surface so that a predetermined displacement from the detection surface can be achieved when a corresponding potential is applied. This displacement can be precisely calibrated and detected with an integrated optical interferometer such as a grating structure or capacitive sensor. Samples or molecules can be placed on the membrane which is electrostatically actuated by using a top electrode buried in the membrane and patterned bottom electrodes fabricated on the detection surface. In addition, membranes can be built as an array and combined with other force sensors, such as cantilever based or FIRAT based sensors, for parallel force spectroscopy and fast imaging applications.

Benefits/Advantages

- Enables fast and parallel actuation with integrated electrostatic actuators and built-in optical displacement sensors
- Accurate force measurement with nanometer resolution in parallel single-molecule mechanics experiments
- Novel FIRAT structures for high speed AFM imaging in liquid environments
- Could be arranged in an array for high-throughput drug discovery and screening

Potential Commercial Applications

This invention would be useful in the field of probe microscopy for a range of applications including the probing of the kinetic landscape of transient protein-ligand interaction and determination of mechanical properties of biomolecules as well as high speed imaging of a variety of samples with sub-nanonewton and sub-nanometer sensitivities.

Background/Context for This Invention

Many single-molecule experiments in biosciences require applying controlled forces on molecules and measuring these inter- and intramolecular forces and time-resolved dynamics in liquid environments. In addition, both parallel actuation and parallel force sensing are required for parallel single-molecule force spectroscopy, which is important in drug discovery and screening. However, conventional atomic force microscopy (AFM) probes and their actuation mechanism lack these speeds and sensitivities.

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More Information

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Publications

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/fast-microscale-actuators-probe-microscopy

Images:

The automated sequential delivery of multiple fluids. A varying number of delay gates imprinted in the branches are shown in the figure.

COVID-19 and flu saliva test on paper: (A) The automatic sequential delivery of multiple reagents required for virus test; (B) Water pouring into the device triggers the virus assay, allowing the presence of SARS-CoV-2 and influenza A & B viruses to be visually identified by the color changes in the corresponding detection spot