AFM Cantilevers for Operation in Air and Immersion (#3629)

A AFM cantilever structure with integrated electrostatic actuators and electrode pairs

A Georgia Tech inventor has developed a AFM cantilever structure with integrated electrostatic (or piezoelectric) actuators, which employ electrostatic electrode pairs that are micromachined together with the AFM cantilever using thin film deposition and patterning techniques such as photolithography. Extra capacitive detection electrodes can be also integrated for enhanced sensitivity. Furthermore, optical interferometric detection, which yields information of direct tip displacement, can be added as a feature to the integrated electrostatic actuators by fabricating actuation electrodes and a reflective diffraction grating on transparent AFM cantilevers. This novel cantilever structure simplifies the operation of AFM. It provides accurate force measurements with nanoscale lateral resolution and enables operation in both air and liquid environment. Such an integrated structure is especially suitable for AFM array operation, where each cantilever can be individually actuated in DC-MHz frequency range. In addition, all of these AFM cantilevers can also be used with conventional optical beam-bounce technique available in commercial AFM systems. The technology could be used for scanning probe microscopy, force spectroscopy of molecules, or nanoindentation measurements of mechanical properties.

Benefits/Advantages

- **Efficient —** enables fast actuation with integrated electrostatic actuators
- **Accuracy —** accurate force measurements with nanoscale lateral resolution
- **Improved speed —** improvement for both speed of actuation and accuracy of detection
- **Multiple applications —** could be used both in gas and liquid media
- **High-throughput —** arranged in an array for high-throughput drug discovery and proteomics

Potential Commercial Applications

- Genomics
- Proteomics
- Drug discovery
- High speed 1-D/ 2-D array for probe lithography

Background/Context for This Invention

Atomic force microscopy (AFM) has become a powerful tool to study surface properties. However, the performance of conventional AFM is still limited by its slow speed of imaging due to the requirement of an

external z-axis actuator. Thus, it is desired that an integrated sensing mechanism can be incorporated with the AFM cantilever so that higher scanning rate and sensitivity can be achieved.

Dr. F. Levent Degertekin
George W. Woodruff Chair in Mechanical Systems and Professor - Georgia Tech School of Mechanical Engineering

More Information

U.S. Patent Issued - 8321959

Publications

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/afm-cantilevers-operation-air-and-immersion

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