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High Speed Atomic Force Microscope

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Summary

Atomic Force Microscope (AFM) is now a common tool for material analysis in the academic and industrial areas because it enables non-destructive high-resolution images of nanometric objects. However, a main drawback is the slow scan rate that hinders many potential applications. Recently, breakthroughs have been achieved in AFM sensors based on MEMS technology, allowing to extend AFM operation in terms of measurement bandwidth and data acquisition. The present work focuses on developing an electronic controller for AFM featuring the wide bandwidth and the fast data processing rate required to enable the exploitation of the full potential of MEMS AFM sensors.

High frequency AFM probes (MEMS technology)

AFM probes used in the present work were developed at IEMN-CNRS (Lille, FRANCE) and are now available from Vmicro SAS. A silicon ring holding a nanotip vibrates according to the elliptical resonance mode shape at about 13 MHz. Capacitive electromechanical transducers are integrated for driving and sensing the nanotip vibration. Typical measurement resolutions are 1.5 nm/√Hz in displacement and 0.5 pN/√Hz in force.

Contact and informations at: https://www.laas.fr/projects/olympia
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Software architecture

Lean LabVIEW configuration

The controller of the AFM microscope is based on a 6-bit CompactRIO NI-9036.

2-screen wide User Interface

Topography images of diblock copolymers in thin AFM mode:
(a) Image 3 × 1 µm (312 × 312 pix) acquired in 60 s. (b) and (c) images forward and backward 200 × 200 µm (128 × 128 pix) acquired in 5 s.

The topographic contrast is due to elasticity contrast of copolymers strips.

Images of graphite HOPG steps in AM-AFM mode:
(a) Image 2.5 × 2.5 µm (312 × 312 pix) acquired in 130 s. (b) Image 1 × 1 µm (200 × 200 pix) acquired in 40 s. (c) Image 1 × 1 µm (200 × 200 pix) acquired in 20 s.