Technology from Kyoto University

Noise Reduction through Enhanced Sensitivity in Atomic Force Microscopy

We are looking to out-license the technology for its commercialization.

Integrating the new "Optical Lever 2.1" system into the AFM enhances sensitivity by 2.2× and reduces the displacement-equivalent noise density to one-third.

◆Background

An atomic force microscope (AFM) achieves nanometer-scale resolution by detecting the minute deflection of a cantilever-mounted probe that functions as a force sensor. AFM commonly uses the optical lever method, in which a laser beam measures cantilever displacement. Because smaller laser spots on the photodiode improve sensitivity and reduce noise, minimizing spot size is critical. However, conventional optical systems lack spot-size control, and beam divergence before reaching the photodiode limits sufficient reduction.

◆Description

In the new optical lever 2.1(Fig. 1), the distance C - defined as the cantilever's offset from the beam waist - as an additional adjustment parameter in the optical system. This design expands the illumination area on the cantilever while reducing the laser spot size on the photodiode.

◆Advantages

Compared with commonly used optical lever systems - including Optical Lever 1.1 and the objective lens - based Optical Lever 2.0, which achieve a typical sensitivity of 114 mV/nm with a 1-mW red laser (displacement-equivalent noise density: 9.9 fm/√Hz) - the new Optical Lever 2.1 delivers markedly superior performance. It attains a sensitivity of 254 mV/nm and reduces the displacement-equivalent noise density to 3.1 fm/√Hz, representing a 2.2-fold increase in sensitivity and a threefold reduction in noise (Fig. 2).

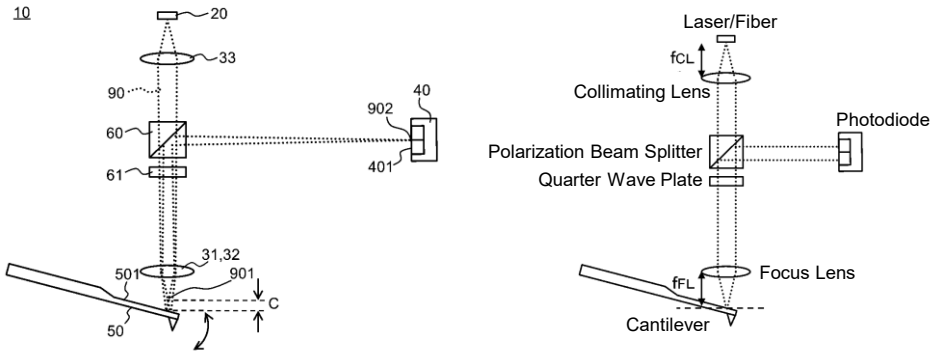

Fig.1 Optical Lever 2.1 of the Present Invention (left) and the Conventional Optical Lever 2.0 Optics (right)

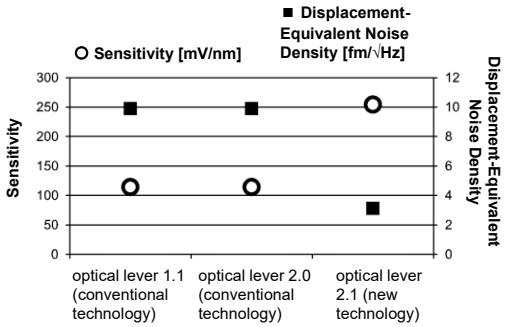

Fig.2 Comparison of Sensitivity and Displacement-Equivalent Noise Density

◆Development Status

Confirmed: Experimental sensitivity and noise performance match theoretical predictions

◆Potential Applications

Scanning Probe Microscope

- Atomic Force Microscope (AFM)
- Scanning Thermal Noise Microscopy (STNM)

◆Offer

- Patent License
- Option for Patent License
- Collaborative Research

◆Contact

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