Vibrations of the ANPxyz100 Positioning Unit Measured with an Interferometric Setup

The force detection scheme atto**cube** systems uses for scanning near-field optical microscopy (SNOM), atomic force microscopy (AFM) applications or vibration measurements of a positioning unit is based on an all fiber low-coherence interferometer (Figure 1). A laser diode (SLD source) beam coupled into a single mode fiber is used to illuminate a Michelson interferometer based on a 50/50% fiber coupler. At the end of the second interferometer arm 4% of the light is reflected at the glass-air interface. 96% of the light is transmitted and partially reflected at the cantilever or vibrating unit. The distance d between the cantilever or vibration unit and the end interface of the control fiber is typically 20 microns. Therefore, the tip interface or the surface of the vibrating unit and the fiber end face form a Fabry-Perot interferometer of low finesse. Monitoring the intensity of the interference fringes allows measuring the vibration amplitude. The low coherence of the SLD source has the advantage to eliminate spurious interference signals resulting from other reflections in the set-up (e.g., the coupler), thus leading to an increase of the signal-to-noise ratio of about 30 dB. The excitation is supplied by a digital lock-in amplifier. The measured optical interference signal can be amplified by the lock-in amplifier. The precision of the vibration amplitude measurement is 160 fm/Hz$^{1/2}$.

Figure 2 illustrates schematically the interference signal measured with the system described above. By positioning the fiber at half maximum of the signal, a change in distance will change the signal significantly.

This simple setup allows to measure the vibrations of the ANPxyz100 in the Z direction. The vibration spectrum recorded at room temperature is illustrated in Figure 3. The main vibrations observed around 600 Hz were determined to be always smaller than 20 pm.
In the DC regime (if the noise is integrated over the entire spectrum), the noise is always smaller than 33 pm!

This ultra-high stability of the ANPxyz100 positioners permits atomic resolution in scanning probe microscopy applications.

The ANPxyz100 positioning unit.

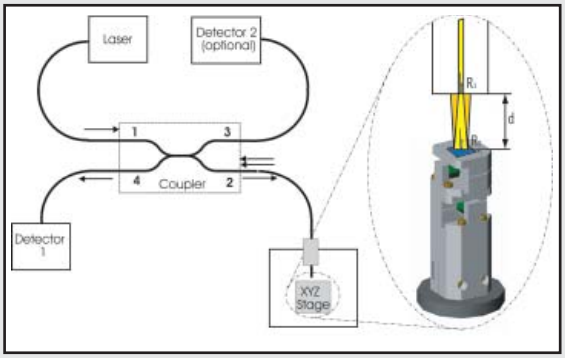

Fig. 1: *Schematic representation of the interferometric setup. R1 (=4%) and R2 (=96%) are the reflection coefficients at the end of the control fiber and the vibration unit.*

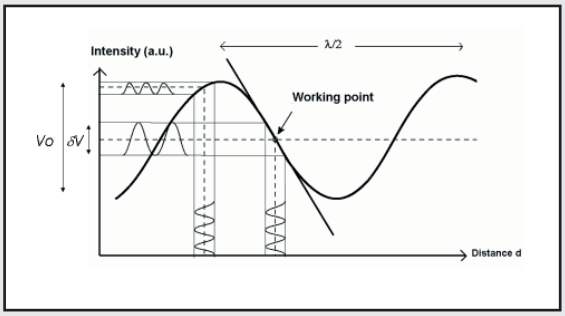

Fig. 2: *Schematic drawing of the interference signal.*

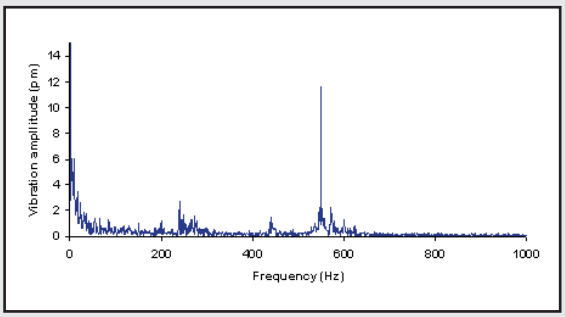

Fig. 3: *Spectrum of the vibrations of the ANPxyz100 positioning unit recorded at 300 K.*

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ANPxyz100	high precision, piezo electric, inertial positioner
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