

4.7 Ultra High Vacuum Scanning Force Microscopy with Piezoresistive Cantilevers

(A. Kündig, I. Brüngger, L. Eng and T. Dietrich)

A scanning force microscope (SFM) for operation in an ultra-high vacuum (UHV) has been designed, built and successfully tested in the contact mode in air using a calibration grid and a polycrystalline gold sample. With this SFM it will be possible to characterize thin organic films in-situ which were grown previously by organic molecular beam deposition or by organic molecular layer deposition techniques.

The specially designed SFM-head enables measurements in both the contact and the non-contact mode. For SFM operation the cantilever deflection is sensed making use of the piezoresistive effect. Therefore, cantilevers are built from a single crystal silicon structure having a diffused conductive (p-doped) channel on top as well as an integrated ultra sharp asymptotic silicon tip. Deflection of the cantilever changes the resistance of the conductive channel (the piezoresistive effect). Two wires connect the piezoresistive cantilever to an external Wheatstone bridge which directly measures the deflection by measuring the resistance of the cantilever. The vertical sensitivity therefore is determined by the resolution of measuring the variable resistance of the cantilever R which theoretically has been determined to 0.2 Å.

Different types of cantilevers may be used for the in-situ investigations by exchanging the tip holder as a whole. A combined rotary and linear manipulator therefore allows detaching the tip holder from the piezo scanner and mounting the tip holder in a specially designed 3-inch support, carrying 8 tip holders in maximum. The tip holder support may easily be introduced into the vacuum chamber passing the ordinary load lock for 3" samples.

In the non-contact mode the mechanical resonances of the cantilever are activated using three piezodisks which are directly integrated in the small (1 cm³) exchangeable tip holder. Tip holders are mounted on a 4-quadrant piezo tube scanner. Additionally the tube scanner may laterally be displaced by an x-y translation stage allowing repositioning of the tip within a 25 x 32 mm² area. Thus, a fairly large area of the 3" samples may be inspected.