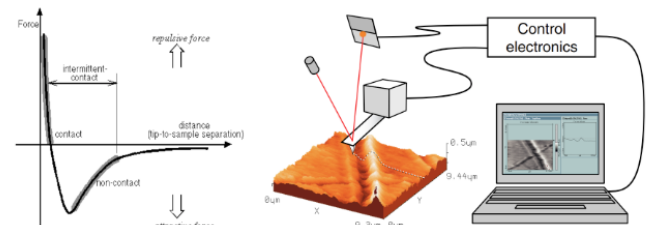


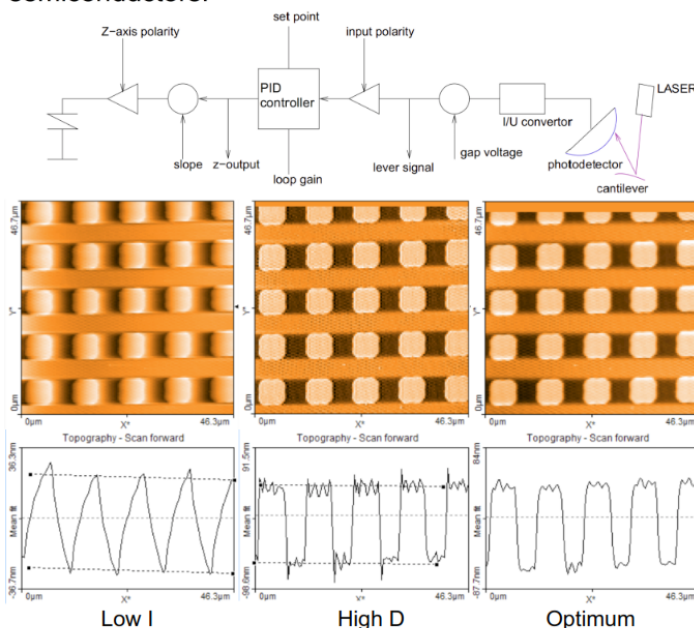
Atomic Force Microscope

Abstract

The atomic force microscope (AFM), invented in 1986, probes the surface of a sample with a sharp tip, located at the free end of a cantilever. The force acting between the sample surface and the tip causes the cantilever to bend. An optical apparatus measures the cantilever deflection as the tip is scanned over the sample, the measured cantilever deflections allow a computer to generate a map of the surface topography. The force that acts on the tip and causes the cantilever to bend is the well known van der Waals force, whose distance dependence is depicted on the right. With respect to the scanning tunneling microscope (STM) the AFM can be used not just to study electrical conductors, but also insulators and semiconductors.



The easyScan 2 AFM from Nanosurf is used for the experiment. The system is operated in contact mode. The vertical resolution is high enough to be able to detect single atomic steps, while the lateral resolution depends on the tip radius of (usually 10 nm). A PID feedback controller is employed to maintain a constant force (set-point) between the tip and the surface. The PID parameters and the set-point can be controlled by the students (see the picture on the left).



Results:

The students quickly learn how to image surfaces and use the software to measure the physical dimensions of the sample. They get confident with the use of the PID controller observing in real time the effects of the feedback parameter on the scanned profile. The students understand the reason for the appearance of various measurements artifacts and, if possible, know how to compensate for them.

During the experiment it is possible to measure a great variety of samples. Few examples are the atomically flat surface of graphite (where one can look for atomic steps) or rougher surfaces such as gold or marble. One can investigate complex structures like the surface of a CD, commercial microelectronic circuits and advanced semiconductor nanostructures. The great feasibility of the AFM allows the student to bring his own samples and perform topography measurements on them.

