INVESTIGATION AND/OR MANIPULATION DEVICE FOR A SAMPLE IN FLUID

TECHNICAL FIELD

The invention relates to an investigation and/or manipulation device for a sample which is located in a fluid. More particularly the invention relates to an atomic force microscope for investigating the surface of a sample that is placed in a fluid.

BACKGROUND OF THE INVENTION

U.S. Pat. No. 5,463,897 is related to a scanning stylus atomic force microscope with cantilever tracking and optical access. The AFM can be provided with a removable fluid cell allowing operation with the sample and the cantilever covered by fluid. The deflection of the cantilever is detected with light.

Another scanning force microscope is disclosed in U.S. Pat. No. 5,319,960. This microscope has the capability of scanning a sample in contact with a fluid. The sample as well as the whole cantilever is positioned in the fluid. Also here, the detection of the cantilever detection is achieved by using light.

In U.S. Pat. No. 4,935,634 is described an atomic force microscope with a replaceable fluid cell.

All the above embodiments of atomic force microscopes have in common that the cantilever immerses completely into the fluid in which the sample is located.

OBJECT AND ADVANTAGES OF THE INVENTION

In the following the fist side of the cantilever where the tool is located is called underside and the opposite side is called upper side. This is for better understanding only. If the arrangement is used in an upside-down position or any other position the more general definition of the sides may be more suitable.

The investigation and/or manipulation device of the invention shows the advantage that due to the fact that the upper side of the cantilever does not completely immerse into the container fluid, the cantilever can be provided with electronic equipment without risking failure e.g. due to electrical shorts. Hence, electrical deflection sensors, such as piezoresistive sensors can be used for detecting the cantilever deflection. Furthermore, generally fewer parts of the investigation and/or manipulation device come into contact with the container fluid. This is advantageous since the parts that do not contact the container fluid can be designed independent from the properties of the container fluid. Also, any modification of the already installed cantilever is easier because the cantilever is easily accessible without the need to remove other protecting means, e.g. a sag means. Also, the mechanical properties of the cantilever remain more unamended without such additional protecting means.

In the dependent claims various modifications and improvements of the investigation and/or manipulation device are contained.

Using a gap between the cantilever and a flow-limiting means proves advantageous since this represents a simple and easily realizable solution of the problem how to prevent the container fluid from flowing to the upper side of the cantilever. Hence, no complicated and expensive controlling of the cantilever's height is needed.

Using a movable means brings the advantage that the risk that the container fluid flows through the gap is minimized since the movable means provides a stable gap even impermeable for gaseous molecules of the container fluid, functioning as well in non-horizontal positions, useable for container fluids with a very low surface tension and also stable against mechanical shock.

Using the surface tension of the container fluid is particularly advantageous because by this exploit of natural behavior, the costs for the realization of the inventive solution are reduced. No extra flow-limiting bridge element, e.g. a movable means, over the gap is needed.

If one chooses the gap dimensions such that the container fluid does not flow through the gap, one has more possibilities of choice of container fluid types. Even container fluids with a low surface tension can then be used. The gap may even be designed to have a variable gap width and may have a gap-width-adjusting means therefor.

Using counter pressure, again broadens the range of usable container fluids. Counter-pressure is furthermore usable for balancing pressure exerted by the container fluid or for exerting a pressure on the container fluid to simulate certain pressure conditions for the sample immersed in the container fluid.

Using an assistant fluid is a cheap alternative to a movable means or a counter-pressure-exerting means. This assistant fluid may even serve for other purposes, e.g. as a damping fluid for the cantilever. It suffices if the assistant fluid does not mix with the container fluid.

To connect the cantilever to an adjacent flow-limiting means, either directly or indirectly via a bridging member, is an advantageous solution since this arrangement needs fewer parts and hence has a facilitated manufacturing process.

Positioning a sensing means on the cantilever has the advantage that the sensing means can be used to measure the deflection though sensing of the mechanical bending of the cantilever instead of measuring e.g. via optical means.

Locating the sensing means at the upper side uses the advantage of the invention that this upper side is not in contact with the container fluid and it hence is possible to choose for the sensing means e.g. the location at the cantilever which is undergoing the highest deformation, such that the best sensitivity is achieved. Furthermore, the sensing means can be designed without taking care of negative effects of the container fluid on the sensing means.

Adding a supply and/or removing means to the investigation and/or manipulation device means to provide the investigation and/or manipulation device with the capability to be used for samples immersed in a container fluid without having to take care of how the container fluid is brought to the investigation and/or manipulation device. The supply and/or removing means can hence be optimally designed and adjusted for minimal negative effect on the device's behavior and precision and then be installed for multiple use.

SUMMARY OF THE INVENTION

The invented investigation and/or manipulation device comprises an investigation and/or manipulation tool, such as a tip which is mounted at the underside of a cantilever. With a positioning means the tool can be scanned over the surface of a sample and the tool can either be used to investigate the surface by measuring a deflection that occurs due to interactive forces between the tool and the sample, or to manipulate the sample, i.e. to modify the surface, e.g. by creating indentations. The investigation and/or manipulation device is particularly suited for samples that are positioned in a