SCANNING PROBE MICROSCOPE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of co-pending U.S. patent application Ser. No. 08/388,068, filed 10 Feb. 1995 and entitled "Scanning Probe Microscope For Use in Fluids", in the name of the same inventors and assigned to the same entity. It is hereby incorporated herein by reference as if set forth fully herein.

BACKGROUND OF THE INVENTION

This invention relates to scanning probe microscopes, such as the scanning tunneling microscope (STM) and atomic force microscope (AFM), used for profiling the surface of a sample at high resolution. More particularly, the present invention relates to scanning probe microscope apparatus having a hinged motor drive apparatus, video optical microscope, bow correction, a desk-top isolation chamber, a gas sparging system and/or a glove box loading system.

Scanning probe microscopes make use of a fine probe tip which is scanned over the surface of a sample in order to record the topography of the surface by means of the interaction between the probe tip and a sample. A typical layout of an atomic force microscope **10** is shown in FIG. **1**. Here, the sample surface **12** of sample **14** is sandwiched between a top sensing assembly **16** and a bottom scanning assembly **18**. Sensing assembly **16** contains a laser **20** which emits a beam **22** that is reflected off of the back of a flexible cantilever assembly **24** to generate a reflected beam **26**. Small motions of cantilever **28** of cantilever assembly **24** modulate the position of beam **26** and are detected by a position sensitive detector **30** which may be a bi-cell, multi-cell, or other type of light beam position sensitive measuring device. Scanning of the sample surface **12** is achieved by a piezo-electric transducer or "scanner" **32** which moves the sample both up and down (i.e., towards and away from flexible cantilever assembly **24** in the "Z" axial direction) and side to side in the "X-Y" planar direction (normal to the Z-axis), so as to generate a raster-scan of sample surface **12** under the cantilever **28**. Scanner **32** is attached to a base **34** and positioning screw drives **36**, **38** are used to position top sensing assembly **16** so that cantilever **28** is close to sample surface **12**.

While fit for its intended purpose, the foregoing arrangement suffers from a number of drawbacks, most notably the fact that the sample **14** must be sandwiched between bottom scanning assembly **18** and top sensing assembly **16**. Access to sample **14** is therefore restricted, so that the use of an optical microscope to examine sample **14** while in position on scanner **32** is made difficult. Sample mounting is also somewhat complex as is sample translation. It is desirable to be able to examine the scanning probe with an optical microscope as an aid to alignment of laser beam **22** onto the cantilever while the sample **14** and cantilever **24** are in place. In the past, this has been achieved by clearing a path for viewing as illustrated in FIG. **2**. In FIG. **2**, the incident laser beam **40** is now incident from one side, and deflected down onto the cantilever **42** by a beam-splitter **42** which is mounted on an optical window **44**. The reflected beam **46** from the back **48** of cantilever **42** is picked off by a mirror **50** which transmits reflected beam **52** to the detector (not shown in FIG. **2**, but disposed along the path of beam **52**). A long-working-distance objective **54** of an optical microscope **56** is placed over the top of optical window **44** and focused onto the back **48** of cantilever **42**. This arrangement requires that the scanning probe microscope be situated at the position normally occupied by the optical microscope stage. This requires the use of an optical microscope considerably larger than the scanning probe microscope itself. In addition, the whole assembly must then be set on a large table located so that an operator can have access to the eyepieces of the optical microscope. Since vibration isolation is required for high resolution scanning probe microscopy, an expensive and cumbersome air-table is usually required for optimum results.

It is often desirable to observe the sample from below while it is scanned from above. This may be done if the sample is transparent by placing the scanning assembly on the optical stage of an inverted optical microscope. An example of such an arrangement is the BioScope™ available from Digital Instruments, Inc. of Santa Barbara, Calif. It is shown schematically in FIG. **3**. A massive frame **58** holds a scanning probe assembly **60** with a probe **62** lowered down onto the sample **64** which is on the stage **66** of an inverted optical microscope **68**, the objective lens of which is shown as **70**. The detector **72** for reflected light **74** from laser beam **76** is held off to one side of the probe assembly **60** and both are rigidly attached to a rigid and massive frame **58** which is also rigidly attached to the stage **66**. Once again, a large support such as an air table is required to support the whole assembly in order to achieve optimum results.

Many of the problems associated with the conventional scanning probe microscope of FIG. **1** were solved by an invention disclosed by S. M. Lindsay and T. Jing in U.S. patent application Ser. No. 08/388,068 entitled: "Scanning Probe Microscope for Use in Fluids" The scanning probe microscope arrangement of the above-identified disclosure is illustrated generally in FIG. **4**. Here, a single microscope body **78** holds both mechanical vertical tripod adjustments **80**, **82** and **84** and sample stage **86** which is held on to the bottom of the mechanical adjustments by magnetic balls, two of which are shown at **88** and **90**. The scanning assembly **92** scans either an STM probe or an AFM probe over the surface of a sample which is attached to the upper surface **94** of sample stage **86**. In this way, the sample may be accessed from below. A containment may be used to surround the sample so as to control the sample environment. A motor **96** which drives at least one of the mechanical adjustments **80**, **82**, **84** (here, **80**) is housed on an assembly **98** which is seated on top of the microscope body **78**. Motor **96** is coupled to mechanical adjustment **80** which may be a screw driven by a sleeve **100** which permits translation of the screw **80** as it is rotated. In order to gain access to the other adjustments **82**, **84**, it is necessary to have an opening **102** in the housing **104**. Even so, it can be difficult to make adjustments to the scanning assembly **92**.

In order to realize this top-down scanning arrangement for the AFM, a tracking method is required so that the laser beam remains aligned on the force sensing cantilever as it is moved over the surface of the sample. Such an arrangement has been achieved by a prior invention disclosed by P. S. Jung and D. R. Yaniv in U.S. Pat. No. 5,440,920, hereby incorporated herein by reference. A general arrangement of this optical tracking scheme is shown in FIG. **5A**. A lens **106** is used to focus a collimated beam **108** from a laser (not shown) onto the reflective back **110** of a cantilever-type probe **112**. Both the lens **106** and the cantilever-type probe **112** are physically coupled to or constrained to move with the scanning transducer **114**. In this way, a focused laser spot from beam **108** tracks and follows cantilever **112** as it is moved over the surface of the sample. This action is