

1

**HUMIDITY CHAMBER FOR SCANNING
STYLUS ATOMIC FORCE MICROSCOPE
WITH CANTILEVER TRACKING**

**CROSS REFERENCE TO RELATED
APPLICATIONS**

This application claims the benefit of applicants' co-pending application having U.S. Ser. No. 60/134,885 filed May 19, 1999.

STATEMENT OF GOVERNMENT INTEREST

The invention described herein was made in the performance of official duties by employees of the United States of America as represented by the Secretary of Commerce, National Institute of Standards and Technology and, thus, the invention disclosed herein may be manufactured, used, and licensed by or for the Government for governmental purposes without the payment of any royalties thereon.

FIELD OF THE INVENTION

The present invention relates to environmental control for atomic force microscopes, and in particular to controlling the humidity level of the environment local to the probe and sample during scanning with a scanning stylus atomic force microscope.

BACKGROUND OF THE INVENTION

The Atomic Force Microscope, or AFM, allows high-resolution imaging at the subnanometer level, and in a liquid environment at the atomic level. The basic objective of the operation of the AFM is to measure the forces (at the atomic level) between a sharp probing tip (which is attached to a cantilever spring) and a sample surface. Images are taken by scanning the sample relative to the probing tip and measuring the deflection of the cantilever as a function of lateral position. The AFM probe is scanned across the sample surface to generate an image. As the scan progresses the AFM measures the small upward and downward movements that are needed to maintain a constant force of contact. Because the AFM senses the surface by "touch", it allows imaging of nonconducting materials such biological and molecules, plastics, ceramics, and insulating materials like glass or diamond, with nanometer resolution.

Because of its unique capabilities, the AFM is widely recognized as an important tool for evaluating materials and materials-enabled engineering systems. In particular, the ability to image materials in a variety of environments, including under ambient conditions and in liquids, enables high resolution imaging of biomaterials and polymers without causing significant deterioration of the materials or introducing artifacts related to the extensive sample preparation used in other high resolution microscopes. However, during imaging in ambient conditions, surface contamination will occur due to the presence of moisture in the form of humidity that will adsorb onto the sample surface. The amount of adsorbed moisture, which will depend on the ambient relative humidity, can affect AFM imaging and force measurements. When the tip of the AFM probe scans over a moist sample, it sometimes takes a hopping motion because of the way the water molecules are layered. This hopping motion, is believed to affect a sample's image quality. Therefore, controlling the humidity level during scanning becomes an important factor when using the AFM.

To date, it is believed that only one commercially available humidity chamber exists for use with an AFM. The

2

existing commercially available humidity chamber, however, is limited to a particular type of scanned sample AFMs, where the AFM probe and detection system are fixed and the sample is moved by the scanners. Thus, the currently available humidity chamber is limited to scanned sample AFMs and cannot be used with scanned stylus AFMs, where the sample is fixed and the probe is rastered across the sample by the scanners. The head of the scanned stylus AFM has a much more complicated geometric design than the scanned sample AFM, thus rendering the design of a humidity chamber a much more difficult task.

The present invention, however, overcomes these problems and provides a humidity chamber which can be used in conjunction with a scanned stylus AFM, and similar microscopes.

SUMMARY OF INVENTION

It is an object of the present invention to provide a novel humidity chamber suitable for use with a scanned stylus atomic force microscope (AFM) and similar microscopes.

It is a further object of the present invention to provide a novel humidity chamber comprising a novel geometrical design configured to accommodate a scanned-stylus AFM having an optical lever.

It is a further object of the present invention to provide a humidity chamber suitable for use with a scanned stylus AFM which also provides for full enclosure of one or more of the AFM scanner, tip assembly, optical lever detection system, sample, and side-mounted optical microscope objective lens (camera), without degrading the ability to operate the AFM or the related systems.

It is a further object of the present invention to provide a humidity chamber suitable for use with a scanned stylus AFM, wherein the humidity chamber comprises a chamber, a spring loaded base and a side entry port.

It is a further object of the present invention to provide a humidity chamber suitable for use with a scanned stylus AFM which allows samples to be loaded and unloaded without removal of the chamber from the AFM scanning head assembly.

It is a further object of the present invention to provide a humidity chamber suitable for use with a scanned stylus AFM which provides a snug, essentially air-tight, fit between the chamber and the AFM scanning head assembly.

It is a further object of the present invention to provide a humidity chamber suitable for use with a scanned stylus AFM which provides easy access to an optical microscope lens.

It is a further object of the present invention to provide a humidity chamber suitable for use with a scanned stylus AFM which allows for the use of an optical system.

It is a further object of the present invention to provide a humidity chamber suitable for use with a scanned stylus AFM which allows for the use of an optical system to locate and focus on a probe and/or sample surface.

It is a further object of the present invention to provide a humidity chamber suitable for use with a scanned stylus AFM which allows humid air to be delivered into the chamber, fill the chamber, and exit the chamber.

It is a further object of the present invention to provide a humidity chamber suitable for use with a scanned stylus AFM which both allows the z-directional motors of the AFM to be used to position the sample just below the probe (scanning tip) prior to scanning, and provides a snug fit between the chamber and the AFM scanning head.