

detector 16. It is of course possible to use other lenses using standard optical practice to adjust the rate of convergence of beams 102 to make the convergence point 104 occur at other desired locations. A mirror could also be used in this embodiment anywhere between the cantilever and the position sensitive detector in the same manner as shown in FIG. 11 to direct the point of convergence to a different position.

FIG. 13 shows an alternate embodiment that uses a single concave mirror 120 to redirect the point of convergence shown in FIGS. 11-12 to a more convenient position. In this case the single concave mirror 120 replaces the flat mirror 103 shown in FIG. 11 and the relay lens 110 shown in FIG. 12.

A method of operating the AFM according to present invention will now be described. As shown in FIG. 4, for example, a light beam is generated and then directed onto cantilever 14 using optical assembly 43 so that the light beam strikes substantially a fixed point on cantilever 14, during movement of the scanning mechanism. The striking of substantially a fixed point is illustrated in FIG. 13, where light beams 101 strike cantilever 14 while it is scanned across sample 13. The light beam reflected from cantilever 14 (47 in FIG. 4) is received by position detector 16 which can detect deflections of cantilever 14.

Also illustrated in FIG. 4 is the splitting of beam 44 using splitter 45 and the cut out in mounting member 42 to allow access of an optical microscope 46, while in FIG. 7 the beam 68 is split using splitter 65 to direct a portion of the beam 68 to a second position detector 66.

FIG. 14 is a flowchart of a modification of the method of the invention where the location of the position detector is determined. First, in step 14-1, the light beam reflected from the cantilever is measured while the scanner 12 is scanned over a full extent of its movement on a very flat surface or while actually not touching any sample. The change in position in the measured signal is then determined using position sensitive detector 16 (step 14-2). The amount of change in this signal is a measure of the amount of "false deflection" being seen by the system. The position sensitive detector is then moved closer or further from the cantilever (along the optical axis of the reflected beam) and the scanning process repeated (step 14-3) a desired number of times until these "false deflections" are minimized (step 14-4). Position detector 16 is then placed at this location of minimum change (step 14-5).

While the invention has been described with reference to several specific embodiments, those skilled in the art will be able to make various modifications to the described embodiments without departing from the true spirit and scope of the invention. For example, an AFM that scans using other optical elements such as prisms instead of lenses or mirrors, or other combinations of such elements to keep the laser focused on a scanning cantilever, is within the intended scope of the invention. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced other than as specifically described herein.

Although what has been described is a contact AFM, where the stylus is in constant contact with the surface, the described invention can also be used in applications where the cantilever is oscillated, such as magnetic force microscopy (Martin and Wickeramasingle, Appl. Phys. Lett., 50, pg. 1455 (1987), Non-contact Topography, Durig et al, Phys.

Rev. Lett., 53, p. 1045, (1988)) and as a jumping probe microscope where the stylus is repeatedly lifted off the surface during a scan (U.S. pat. application Ser. No. 08/009, 076, now U.S. Pat. No. 5,266,801).

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An atomic force microscope comprising:
  - a scanning mechanism;
  - a light source;
  - a cantilever moved by said scanning mechanism so that the cantilever may be scanned over a sample;
  - an optical assembly comprising focusing means for forming a point source of light between a fixed end and a free end of said scanning mechanism, and at least one steering lens mounted on said scanning mechanism to guide a light beam emitted from said light source onto said cantilever and to follow substantially a fixed point on said cantilever during movement of said scanning mechanism; and
  - a position detector which receives a reflected light beam from said cantilever and detects a deflection of said cantilever.
2. An atomic force microscope as recited in claim 1, where said reflected light beam does not pass through said steering lens.
3. An atomic force microscope, comprising:
  - a scanning mechanism;
  - a light source and focusing means positionally decoupled from a scanning motion of the scanning mechanism and arranged to emit a light beam that converges to a focus point and then diverges;
  - a cantilever moved by said scanning mechanism so that the cantilever may be scanned over a sample;
  - an optical assembly comprising at least one steering lens mounted on said scanning mechanism to guide said light beam on said cantilever and to follow substantially a fixed point on said cantilever during movement of said scanning mechanism; and
  - a position detector which receives a reflected light beam from said cantilever and detects a deflection of said cantilever.
4. An atomic force microscope as recited in claim 3, wherein said focus point of said light beam is located between a fixed end and a free end of said scanning mechanism.
5. An atomic force microscope, comprising:
  - a scanning mechanism;
  - a cantilever moved by said scanning mechanism so that the cantilever may be scanned over a sample;
  - a light source and focusing means comprising one or more lenses that emit a beam of light onto said cantilever;
  - a position detector which receives said reflected light beam from said cantilever and detects a deflection of said cantilever; and
  - at least one additional lens, positionally decoupled from a scanning motion of the scanning mechanism, and placed in the path of said reflected light beam between said cantilever and said position detector.
6. The atomic force microscope of claim 5, wherein said at least one additional lens is arranged at a position between said cantilever and said position detector to create at the position detector a point of convergence of beams reflected off the cantilever when the cantilever is undeflected by the sample, thereby to minimize false deflection signals result-