according to the invention are shown. The first variant, as depicted by FIG. **4**A, an electrostatically excited version of the invention as described above (FIG. **3**A), is provided with switching means **474**. When the switch is in position **1**, the detection of the higher harmonic is used for deflection control. In position **2** however the microwave source is connected to the gap between the cantilever **420** and the sample holder **430** making a dopant profiling possible. It is also possible to provide a second microwave source with a second base frequency. Using this particular embodiment it is possible to simultaneously detect the deflection of the cantilever and inspect the surface of a sample.

With respect to the example described above, the dopant profiler of FIGS. **4**B and **4**C comprises additional means to detect the deflection of the cantilever, said means being based on methods known in principle and partly described above. Examples are shown wherein the deflection of the cantilever is either measured by a piezoresistive method (FIG. **4**B) or by a beam deflection apparatus measuring the intensity of a laser beam, reflected by the back of the cantilever (FIG. **4**C). However, any other known deflection detection method can be applied instead.

In both embodiments the metal coating **422** of the cantilever **420** is connected to a current/voltage converter **490** to operate the cantilever in an STM mode. A switch **416** now is provided with the feedback circuit **470** which allows to choose automatically between different input signals. The switch can be either programmed or controlled by an external device, if for example the topology of the sample is accurately known, which is the case in IC manufacturing. As an alternative, the deflection is monitored with at least a second defection detection method, parallel to the one which currently supplies the input signal to the feedback circuit **470**. In the latter case the switch **476** automatically alters its position when the currently applied signal deviates significantly from its expected values.

Both variants as shown in FIGS. **4**B and **4**C differ in the way, in which the radiation emanating from the gap area is received: The embodiment of FIG. **4**B includes a tunable cavity **465** as described for example by Michel et al., allowing a preselection of the signal frequency and a very sensitive detection of radiation with a narrow bandwidth. The cavity has conductive walls enclosing the cantilever with one of the walls **491** being moveable relative to the others. In this embodiment the use of a deflection measurement method is preferred which does not interfere with the properties of the cavity as a resonator. Therefore, a piezoresistive layer **423** is incorporated into the cantilever body **420**. The piezoresistive element is part of mainly a Wheatstone bridge arrangement **480** to measure its resistance and therewith derive the deflection of the cantilever **420**. The piezoresistive layer can be replaced by piezoelectric elements, which produce a voltage in sympathy with the bending of the cantilever.

In the embodiment of FIG. **4**C, no cavity is used and the antenna is formed by the conductive coating **422** of the cantilever. Input and output paths of the high frequency signal are separated from the DC circuit **450** by bias-tee elements **441**, **466**. As said above, the absence of a cavity allows to use a broader variety of deflection measuring methods. In the shown embodiment the intensity of a reflected laser beam **482** is measured, whereby this intensity depends on the bending of the cantilever **420**.

It is seen as an obvious task for a skilled person to combine different elements of the aforedescribed embodiments, in particular to select a specific way of coupling the input signal to the gap and coupling the output signal to the amplifier cascade, to replace the conductive coating of the cantilever by a cantilever made of conductive base material, or to replace the coating by a piggybacked tip as shown in FIG. **3**A.

As said above, the new microscope in accordance with the invention is advantageously used to characterize the surface of integrated circuits (IC). FIGS. **5** shows results obtained by investigating an n-type silicon sample doped with boron ions. FIG. **5**A depicts the sample structure consisting of alternating stripes of n and p+ doped silicon. Each stripe has a width of approximately ten μm. Such a grating can be found in a similar form as source/channel/drain area of the PMOS device. In FIG. **5**B the intensity of the second harmonic signal is shown as a function of the bias voltage and the position of the tip along a line running perpendicularly to the n and p+ doped stripes. The line-scans are taken at −1.45 V (a), −0.55 V (b), and 1.2 V (c), respectively. For reasons of clarity, the origins of the curves are shifted and curve b is enlarged by a factor of 5. Using these scans regions having a high concentration of dopants can be distinguished from regions with a low concentration, or from depletion zones. FIG. **6** shows similar results gained by investigating a sample doped with arsenic (n+). The lines-scans, taken with a bias voltage of 1.15 V (a), −1.15 V (b), and −1.50 V (c), respectively, clearly show the lateral dopant profile. The peak amplitude is much larger in the low-doped regions than it is in the high-doped regions. The resolution found lies below 35 nm. The resolution can be enhanced by controlling the humidity within the microscope. A simultaneously recorded line-scan (d) shows the physical height of the sample as measured in the STM and AFM operation mode of the microscope. The measurement is also depicted in a three-dimensional plot (FIG. **6**C) with the horizontal axes being the bias voltage in volts and the position in nanometer, respectively. The vertical axis gives the second harmonic signal in nanoVolts (nV).

We claim:

1. An apparatus for measuring a force exerted upon or a deflection of a flexible cantilever used in atomic force microscopy, comprising means for providing a single high fundamental frequency signal w between the flexible cantilever and a second surface, antenna means for receiving radiation produced during atomic force microscopy of a sample using said cantilever, amplifying means for detecting from the radiation received by the antenna a higher harmonic nw of the fundamental frequency and generating a signal therefrom for use to measure a characteristic of the sample, and means to apply in operation a DC voltage to said cantilever.

2. The apparatus in accordance with claim **1**, wherein the amplifying means are designed to operate in a frequency range of 10 Mhz to 100 Ghz.

3. The apparatus in accordance with claim **1**, wherein either one of the cantilever, a holding means for the sample, or a reference plane or tip form a part of the antenna means.

4. The apparatus in accordance with claim **1**, further comprising means for exciting oscillations of the cantilever.

5. The apparatus in accordance with claim **1**, further comprising means for applying a high frequency electrical signal to a gap between the cantilever and the sample, or to a gap between the cantilever and a reference plane or tip.

6. The apparatus in accordance with claim **1**, further comprising a cavity with conductive walls enclosing the cantilever, one of said walls being movable relative to other of said walls.

7. The apparatus in accordance with claim **1**, wherein the cantilever comprises electrically conductive material.