These and other objects are accomplished by a sensor including a bridge heater. The sensor is constructed to have a heating portion bridging a depression in a substrate to which the heating portion is mounted. The heating portion includes a first insulating film mounted directly on the substrate, a conductive film mounted on the first insulating film, and a second insulating film on the conductive film. Preferably, the first and second insulating films are made of tantalum oxide (Ta_2O_5) of the same thickness. The conductive film is made of platinum or a platinum alloy.

Both the second insulating film and conductive film may be covered with a third insulating film made of the same material as the second insulating film.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. **1** is a top view of a conventional sensor including a micro-bridge heater;

FIG. **2** is a cross-sectional view at line X–X' of the sensor shown in FIG. **1**;

FIG. **3** is a cross-sectional view at line Y–Y' of the sensor shown in FIG. **1**;

FIG. **4** is a top view of a sensor including a micro-bridge heater constructed according to the present invention;

FIG. **5** is a cross-sectional view at line U–U' of the sensor shown in FIG. **4**;

FIG. **6** is a cross-sectional view at line V–V' of the sensor shown in FIG. **4**; and

FIG. **7** is a cross-sectional view of a sensor having a third insulating film surrounding the second insulating film.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views and more particularly to FIGS. **4–6** thereof, there is illustrated a sensor including a micro-bridge heater constructed according to the present invention. FIG. **4** shows a top view of the sensor, FIG. **5** shows a cross-sectional view at line U–U' of FIG. **4**, and FIG. **6** shows a cross-sectional view at line V–V' of FIG. **4**. In FIGS. **4–6**, there is illustrated a semiconductor substrate **21** such as silicon having a first surface with a depression **30** formed therein, as illustrated in FIGS. **5** and **6**. There is a first insulating film **22** formed on the semiconductor body **21**, a conductive film **24** formed directly on the first insulating film **22**, and a second insulating film **25** formed on the conductive film **24**. The first insulating film **22**, the conductive film **24**, and the second insulating film **25** form a heating portion **27**.

The conductive film **24** is preferably a platinum or platinum alloy film which is 5,000 angstroms thick. The first insulating film **22** and the second insulating film **25** are formed of tantalum oxide (Ta_2O_5) and have the same thickness of approximately 1.25 microns but may be in the range between 1.0 and 1.5 microns in thickness. The sensor is about 165 microns in width, 165 microns in length and the height depends on the thickness of the semiconductor body **21**. The depth of the depression ranges from 150 microns to 250 microns. The first insulating film **22** must have sufficient mechanical strength to support the heating portion **27** over the depression **30**. Further, the second insulating film **25** must cover the conductive film **24** and protect the conductive film **24** against oxidation.

Tantalum oxide (Ta_2O_5) is used as the first and second insulating films because of its properties including a low amount of thermal expansion in response to an increase in temperature, low internal stress (e.g. changes in size due to thermal changes), and high resistivity to cracking. Furthermore, a tantalum oxide film is highly adhesive to both platinum and silicon and is therefore suitable as a connecting film between the silicon semiconductor body **21** and the platinum or platinum alloy conductive film **24**. Therefore, even though the present invention does not use an adhesive or foundation metal film such as film **3** illustrated in FIGS. **2** and **3**, there are no separation problems between the conductive film **24** and the insulating film **22**.

Both ends of the heating portion **27** are fixed on the silicon body **21**, although it is possible to have only one of the heating portion **27** fixed to the silicon body **21**. Electrode pads **28** are connected to each end of the heating portion **27** in order to apply an electric current and to measure the voltage across the heating portion.

The method of fabricating the present invention is similar to the fabrication of the device disclosed in Japanese Laid-Open Patent Application No. 57-94641. The method of fabrication and features of the invention can also be created according to the teachings set forth in U.S. Pat. No. 4,343,768, which is incorporated herein by reference. The present invention is constructed by starting with the silicon substrate **21**. Sputtering is used to form the first insulating film **22** using tantalum oxide, a platinum (Pt) film and then the second insulating film **25** are formed by spattering thereon. Etching is performed in order to construct the layers as illustrated in FIGS. **4–6**. Furthermore, etching of the silicon semiconductor body **21** is performed in order to form the depression **30** as illustrated in FIGS. **5** and **6**. The portions above the electrode pads **28** are also etched in order to expose the conductive film **24** at the electrode pads **28**. The depression **30** creates a space and allows gases or liquids to pass between the underside of the heating portion **27** and the semiconductor body **21**. This allows the thermal time constant of the device to be reduced.

As a variation of and an addition to the embodiment disclosed in FIGS. **4–6**, a third insulating film **31** can be used to cover both the second insulating film **25** and both sides of the conductive film **24**, as illustrated in FIG. **7**. The third insulating film **31** provides additional protection to the conductive film **24** against oxidation which is a characteristic deterioration. The third insulating film **31** is preferably formed of tantalum oxide (Ta_2O_5) by spattering and the construction of the embodiment illustrated in FIG. **7** is similar to the construction of the embodiment illustrated in FIGS. **4–6**, except for the addition of the third insulating film **31**. The embodiment of FIG. **7** may also be constructed based on the teachings of JP 57-94641.

In addition to using tantalum oxide (Ta_2O_5) as the first, second, and third insulating films in either of the embodiments, silicon dioxide (SiO_2) or silicon nitride (Si_3N_4) may also be used for these insulating films.

In the present invention, there is no foundation film serving as an adhesive between the first insulating film **22** and the conductive film **25** and the first insulating film **22** and the second insulating film **25** are formed of the same material. Therefore, resistance to heat, rates of expansion due to heat applied to the first and second insulating films which sandwich the conductive film **24** and other effects on