heater of each sensor element along the periphery of the sensor element, temperature gradients are minimized.

The support for the catalyst and the resistors is the polysilicon structure. A silicon nitride encapsulation is applied to the polysilicon structure for protection during the fabrication of the paired sensing elements. Back-etching isolates the polysilicon plate from the silicon frame surrounding the paired elements of the sensor. The polysilicon elements can be accurately micromachined using reactive ion etching (RIE), a well known process, thereby adapting the process to high volume manufacturing. Further, the size of the sensing elements can be made larger than the corresponding elements of prior art sensors that may comprise more fragile membrane structures made of dielectric films.

The etching process isolates the sensing elements by providing through openings to the back surface of the sensor. The openings provide thermal isolation of the sensing elements and permit the reactants to diffuse through the sensor to the back surface. Therefore, the sensitivity can be increased by depositing the catalyst both on the top and bottom surfaces of the sensor plate.

BRIEF DESCRIPTION OF THE FIGURES OF THE DRAWINGS

FIG. **1** is an isometric view of a microcalorimeter including polysilicon plates supported on a bulk silicon frame with metal resistors, such as platinum resistors, that serve as heaters and temperature sensing elements.

FIG. **2A** is a schematic cross-sectional view of the polysilicon plate, the silicon frame and the silicon nitride layer between the silicon and the polysilicon, which are assembled in earlier steps of the fabrication process.

FIG. **2B** is a schematic cross-sectional view of the components of the sensor element after the second step in the fabrication process involving polysilicon patterning and a passivation of silicon nitride.

FIG. **2C** is a schematic cross-sectional view of the components of the sensor during a third step in the fabrication process involving platinum deposition and patterning.

FIG. **2D** is a schematic cross-sectional view of the components of the sensor during a fourth fabrication step involving a passivation layer of silicon nitride.

FIG. **2E** illustrates the fifth step in the fabrication process, which involves selective etching of the passivation applied in the step illustrated in FIG. **2D**.

FIG. **2F** is a schematic cross-sectional view of a finished sensor following a deep etch of the silicon base.

FIG. **3** is a graph showing the relationship between the resistance difference of the platinum resistors in the active and in the reference temperature sensing elements plotted as a function of four different combustible gas concentrations by volume, together with the corresponding average temperature rise produced by the reaction of each of the gases.

PARTICULAR DESCRIPTION OF THE INVENTION

In FIG. **1**, we have shown a sensor comprising a bulk silicon frame **10** and a polysilicon layer **12** attached to one side of the frame **10**. Located within the boundaries of the polysilicon layer are two polysilicon plates **14** and **16**. These are located in openings **18** and **20**, respectively, in layer **12**. Plate **14** is held in place within the opening **18** by four polysilicon arms **22**, **24**, **26** and **28** extending from the polysilicon layer **12**. The arms are integral with layer **12**.

The polysilicon plate **16** of the companion sensor is suspended in opening **20** and is held in place by four polysilicon arms shown at **30**, **32**, **34** and **36**. These correspond to the polysilicon arms for the plate **14**.

Platinum resistors are deposited on the polysilicon layer **12**. Platinum conductor resistor **38** forms a heater resistance element and is provided with a heater terminal **40**. A terminal **42** for the heater resistance element **38** is located also on the polysilicon layer. The resistance element **38** follows a circuitous path around the holes or openings for the sensor element plate **14** and over the sensor plate supporting arms **22** and **28**. The mid-region of the resistor **38** surrounds the periphery of the plate **14**, as shown at **44**. The mid-region **44** of the resistor thus forms a heater element circuit between terminals **40** and **42**.

A temperature-sensing resistance in the form of a metallic resistor, preferably a platinum resistor, is shown at **46**. Resistor **46** extends over the arm **26**. The intermediate portion of the resistor **46** is located on the inboard region of the plate **14**, as shown at **48**. The portion **48** thus forms a part of a complete circuit between resistor terminal **50** and resistor terminal **52** carried on the polysilicon layer **12**.

The polysilicon plate **16** of the companion sensor element also has a heater resistor **54** with an intermediate portion **56** that surrounds the periphery of the plate **16**. Intermediate portion **56** forms a part of a complete heater resistance circuit for the resistor **54** extending from heater terminal **58** to heater terminal **60**.

The central region of the plate **16** carries intermediate portion **64** of resistor **62**. The sensor resistor terminals for the resistor **62** are shown at **66** an **68**. These correspond to terminals **50** and **52** of the companion sensor element.

A catalyst layer **70** is deposited on the polysilicon plate **16**. No catalyst, however, is applied to the companion polysilicon plate **14**.

It is thus seen that each sensor plate supports two platinum resistors. Resistors **38** and **54** serve as heaters, and the resistors **46** and **62** serve as thermometers. The location of the heater pattern at the periphery of the plates, with the thermometer pattern at the central part of each of the plates, provides uniform heat distribution for each of the plates. The high thermal conductivity of the polysilicon material compensates for thermal energy loss to the ambient gases, thus minimizing the temperature drop at the center of each of the plates. The resistance of the temperature sensing conductor is preferably ten times larger than that of the electrical interconnects that are provided by extending the platinum resistor material on the four polysilicon arms for each of the sensor element plates.

As seen in FIGS. **2A** through **2F**, the plates and the platinum resistors are covered by a layer of silicon nitride for passivation with the exception of the terminals, where electrical contact can be established by wire bonding.

Referring next to FIGS. **2A** through **2F**, we have illustrated the various fabrication steps that are carried out in the manufacture of the sensor. FIG. **2A** shows the starting materials, which comprise a bulk silicon frame **10**. A polysilicon layer **12** is deposited on top of the silicon frame **10**, and a corresponding layer **72** is deposited on the other side of the frame **10**. As indicated also in FIG. **2A**, the frame **10** is passivated on both sides by