FIG. **11**A is a schematic drawing showing a process of etching a sacrificial film **58** embedded in a hollow **56** using wet or dry etching, and forming a membrane **64**. FIG. **11**B is a schematic drawing looking at the element from the direction of the insulating film **59**. FIG. **11**A is a cross section taken along the dotted line in FIG. **11**B. If the sacrificial layer is, for example, amorphous silicon dioxide, it is possible to use hydrogen fluoride as a wet etching fluid. The temperature of the fluid can be room temperature. Etching of amorphous silicon dioxide is performed using isotropic etching, which means that it does not depend on the arrangement and shape of the membrane **64**. In order to obtain thermal insulation between the membrane **64** and the substrate **54**, etching is preferably carried out until the amorphous silicon dioxide is completely removed. Also, in order to completely thermally insulate the membrane and the substrate **54**, the etching layer **51** is preferably continuously etched until the etching stop layer **52** appears.

As described above, a calorimeter has an absorber for converting energy of radioactive rays into heat, and a resistor for converting heat into an electrical signal using superconducting transition and arranged on a membrane for determining thermal conductivity, the membrane being attached to a substrate having a tri-layer structure of an etching layer, an etching stop layer and a support substrate. By providing a hollow at part of the etching layer, depositing a sacrificial layer, flattening a surface of the etching layer, and etching the etching layer from the etching layer side, and by wet etching the etching layer beneath the membrane regardless of the shape of the membrane, it is possible to easily perform etching, and the membrane can be arranged separated by the thickness of the support substrate and the etching layer. Particularly, if the sacrificial layer is amorphous silicon dioxide, it is possible to simply perform etching using hydrogen fluoride, and it is possible to etch the sacrificial layer in a reduced time. By using a substrate having a tri-layer structure, patterning is only performed on one surface, and there is no danger of the pattern surface being contaminated. Also, since only etching layer of the tri-layer structure substrate is etched, the mechanical strength is improved, and it becomes easier to handle.

In order to achieve these objects, according to the present invention, by using a calorimeter having an absorber for converting energy of radioactive rays into thermal energy, and resistor for converting thermal energy into an electrical signal using superconducting transition and arranged on a membrane for determining thermal conductivity, the membrane being attached to a substrate having a tri-layer structure of an etching layer, an etching stop layer and support substrate, with the membrane being arranged separated by the thickness of the etching stop layer and the etching layer, it is possible to obtain a calorimeter that has large element mechanical strength compared to using the silicon substrate of the related art, and which is suitable for making into an array.

Also, the present invention provides a method of manufacturing a calorimeter having an absorber, for converting energy of radioactive rays into thermal energy, and a resistor for converting thermal energy into an electrical signal using superconducting transition arranged on a membrane for determining thermal conductivity, the membrane being attached to a substrate having a tri-layer structure of an etching layer, an etching stop layer and a support substrate, comprising the steps of arranging the membrane in a specified direction and etching the etching layer from the etching layer side, and wet etching the etching layer beneath the membrane. By this method, it is possible to easily perform etching, and it is possible to arrange the membrane separated by the thickness of the support substrate and the etching layer. In particular, by forming the etching layer from planar (100) oriented silicon, and arranging the orientation of the membrane to <100>, it is made possible to etch the etching layer in a short time. By using a substrate having a tri-layer structure, patterning is only performed on one surface, and there is no danger of the pattern surface being contaminated. Also, since only the etching layer of the tri-layer structure substrate is etched, the mechanical strength is improved, and handling becomes easier.

Also, the present invention provides a method of manufacturing a calorimeter having an absorber for converting energy of radioactive rays into thermal energy, and a resistor for converting thermal energy into an electrical signal using superconducting transition and arranged on a membrane for determining thermal conductivity, the membrane being attached to a substrate having a tri-layer structure of an etching layer, an etching stop layer and a support substrate, comprising the steps of providing a hollow at part of the etching layer, depositing a sacrificial layer, flattening a surface of the etching layer, etching the etching layer from the etching layer side, and wet etching the etching layer beneath the membrane regardless of the shape of the membrane. By this method, it is possible to easily perform etching, and the membrane can be arranged separated by the thickness of the support substrate and the etching layer. Particularly, if the sacrificial layer is amorphous silicon dioxide, it is possible to simply perform etching using hydrogen fluoride, and it is possible to etch the sacrificial layer in a reduced time. By using a substrate having a tri-layer structure, patterning is only performed on one surface, and there is no danger of the pattern surface being contaminated. Also, since only the etching layer of the tri-layer structure substrate is etched, the mechanical strength is improved, and handling is made easier.

What is claimed is:

1. A calorimeter comprising: an absorber for absorbing radiation energy and converting the radiation energy into thermal energy; a resistor connected to the absorber for converting thermal energy into an electrical signal; a membrane connected to the resistor for controlling a thermal discharge from the resistor; and a substrate connected to the membrane and having a tri-layer structure comprised of an etching layer having a preselected thickness, an etching stop layer and a support substrate, the membrane being spaced-apart from an upper main surface of the etching stop layer by the preselected thickness of the etching layer.

2. A method of manufacturing a calorimeter, comprising the steps of: providing a substrate having a tri-layer structure comprised of an etching layer having a preselected thickness, an etching stop layer and a support substrate; disposing an absorber over the substrate for converting radiation energy into thermal energy; connecting a resistor to the absorber for converting thermal energy into an electrical signal; disposing a membrane on the resistor in spaced-apart relation from an upper main surface of the etching stop layer by the preselected thickness of the etching layer and in a given direction for controlling a thermal discharge from the resistor; and etching the etching layer.

3. A method of manufacturing a calorimeter, comprising the steps of: providing a substrate having a tri-layer structure comprised of an etching layer formed from silicon with a planar orientation of (100), an etching stop layer and a support substrate; disposing an absorber over the substrate for converting radiation energy into thermal energy; connecting a resistor to the absorber for converting thermal