GROUND STRUCTURE, AND HEATER AND CHEMICAL VAPOR DEPOSITION APPARATUS INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 USC § 119 to Korean Patent Application No. 2006-116542, filed on November 23, 2006 in the Korean Intellectual Property Office (KIPO), the contents of which are herein incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

Example embodiments of the present invention relate to a ground structure, and a heater and a chemical vapor deposition (CVD) apparatus including the same. More particularly, example embodiments of the present invention relate to a ground structure of a heater used for heating a semiconductor substrate, and a heater and a CVD apparatus including the same.

2. Description of the Related Art

Generally, a semiconductor device may be manufactured by a FAB process for forming electric circuits on a semiconductor substrate, by an electrical die sorting (ESD) process for testing electrical characteristics of the semiconductor device, and by a packaging process for encapsulating the semiconductor device with an epoxy resin and singulating the semiconductor substrate into semiconductor chips.

The FAB process may include a deposition process for forming a layer on the semiconductor substrate, a chemical mechanical polishing (CMP) process for planarizing the layer, a photolithography process for forming a photoresist pattern on the layer, an etching process for forming a pattern having electrical characteristics from the layer, an ion implantation process for implanting impurities into the semiconductor substrate, a cleaning process for removing foreign substances on the semiconductor substrate, a dry process for drying the cleaned semiconductor substrate, and a test process for detecting defects in the layer or the pattern.

Nowadays, a plasma processing apparatus, which may excite a process gas into a plasma state to form the layer or the pattern, may be widely used in the FAB process. Korean Patent Laid-Open Publication No. 2005-87405 discloses a plasma-enhanced chemical vapor deposition (PE-CVD) apparatus.

The conventional PE-CVD apparatus may include a process chamber having a space where a semiconductor substrate is processed, a heater in the process chamber to heat the semiconductor substrate, and an electrode for forming a plasma gas from a reaction gas introduced into the process chamber. The heater may include a heating block, a heating electrode built into the heating block, and a ground structure built into the heating block.

The conventional ground structure may include an electrode built into the heating block, a ground terminal connected to the electrode, a ground mount mounted on the heating block, and a resilient holder surrounding the ground terminal to fix the ground terminal to the ground mount. Here, the ground

terminal may be inserted into the ground mount. Further, the ground terminal may be fixed to the heating block by a brazing process.

However, in the conventional ground structure, the elasticity of the resilient holder may be gradually decreased proportionally with an increasing of a temperature in the heating block. This may cause a gap between the resilient holder and the ground terminal so that an oxide layer may be formed on an outer face of the ground terminal due to arcing. The oxide layer may increase the contact resistance of the ground terminal. As a result, the ground terminal may be damaged owing to the increased contact resistance.

Further, the conventional ground terminal may not be moved along a lengthwise direction of the ground terminal. Thus, when the ground terminal thermally expands at a high temperature, the ground terminal may be frequently cut.

SUMMARY OF THE INVENTION

Example embodiments of the present invention provide a ground structure that is capable of suppressing damage to a ground terminal.

Example embodiments of the present invention also provide a heater having the above-mentioned ground structure.

Example embodiments of the present invention still also provide a chemical vapor deposition (CVD) apparatus having the above-mentioned ground structure.

A ground structure in accordance with one aspect of the present invention

includes a ground mount, a ground terminal, a conductive holder and a connection member. The ground terminal is movably inserted into the ground mount. The conductive holder is arranged in the ground mount to holding the ground terminal. The connection member electrically connects the conductive holder to the ground mount.

According to one example embodiment, the ground mount may have a receiving groove for receiving the conductive holder. Further, the receiving groove may be covered with an insulation cover.

According to another example embodiment, the conductive holder may include a resilient material. The resilient conductive holder may have a U-shape configured to receive the ground terminal. The U-shaped conductive holder may have both ends fixed to each other using fixing members. Further, the conductive holder may have a holding groove that has a diameter substantially the same as that of the ground terminal to hold the ground terminal.

According to still another example embodiment, the connection member may include a flexible cable for movably supporting the conductive holder along a lengthwise direction of the ground terminal. The connection member may include an annular insulation cable, and a single conductive wire in the annular insulation cable. The single conductive wire has a meshed portion formed at a surface of the single conductive wire. Alternatively, the connection member may include an annular insulation cable, and a plurality of conductive wires in the annular insulation cable.

According to yet still another example embodiment, an insulation member

may be interposed between the ground mount and the conductive holder. The insulation member may include a first insulator interposed between a bottom face of the ground mount and the conductive holder and having a hole into which the ground terminal is movably inserted, and a second insulator interposed between a side face of the ground mount and the conductive holder.

A heater in accordance with another aspect of the present invention includes a heating block, a heating element, an electrode, a ground mount, a ground terminal, a conductive holder and a connection member. The heating element is built into the heating block. The electrode is built into the heating block. The ground mount is mounted on the heating block. The ground terminal is movably inserted into the ground mount. Further, the ground terminal is electrically connected to the electrode. The conductive holder is arranged in the ground mount to hold the ground terminal. The connection member electrically connects the conductive holder to the ground mount.

A CVD apparatus in accordance with another aspect of the present invention includes a chamber, a heater, a reaction gas-providing member, and an upper electrode. The chamber receives a substrate. The heater is arranged at a lower space of the chamber to heat the substrate. The reaction gas-providing member is located at an upper space of the chamber to provide a reaction gas onto the substrate. The upper electrode is arranged in the chamber to form plasma from the reaction gas. The heater includes a heating block, a heating element, a lower electrode, a ground mount, a ground terminal, a conductive holder and a connection member. The heating element is built into the heating

block. The lower electrode is built into the heating block. The ground mount is mounted on the heating block. The ground terminal is movably inserted into the ground mount. Further, the ground terminal is electrically connected to the lower electrode. The conductive holder is arranged in the ground mount to holding the ground terminal. The connection member electrically connects the conductive holder to the ground mount.

According to the present invention, both of the ends of the conductive holder surrounding the ground terminal may be firmly fixed so that the conductive holder may closely make contact with the ground terminal. Thus, an arc may not be generated between the conductive holder and the ground terminal. As a result, damage to the ground terminal caused by the arc may be prevented. Further, the conductive holder connected to the ground mount using the flexible cable may be moved along the lengthwise direction of the ground terminal. Therefore, cutting of the ground terminal caused by a thermal expansion may be prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages of the invention will become readily apparent by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein:

FIG. 1 is a perspective view illustrating a ground structure in accordance with an example embodiment of the present invention;

FIG. 2 is a top view illustrating the ground structure in FIG. 1;

FIG. 3 is a side view illustrating the ground structure in FIG. 1;

FIG. 4 is a partially cut perspective view illustrating a connection member of the ground structure in FIG. 1 in accordance with an example embodiment of the present invention;

FIG. 5 is a partially cut perspective view illustrating a connection member of the ground structure in FIG. 1 in accordance with an example embodiment of the present invention;

FIG. 6 is a cross-sectional view illustrating a heater in accordance with an example embodiment of the present invention; and

FIG. 7 is a cross-sectional view illustrating a chemical vapor deposition (CVD) apparatus in accordance with an example embodiment of the present invention.

DESCRIPTION OF THE EMBODIMENTS

The present invention is described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, the size and relative sizes of layers and regions may be exaggerated for clarity.

It will be understood that when an element or layer is referred to as being

"on," "connected to" or "coupled to" another element or layer, it can be directly on, connected or coupled to the other element or layer or intervening elements or layers may be present. In contrast, when an element is referred to as being "directly on," "directly connected to" or "directly coupled to" another element or layer, there are no intervening elements or layers present. Like numbers refer to like elements throughout. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

It will be understood that, although the terms first, second, etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present invention.

Spatially relative terms, such as "beneath," "below," "lower," "above," "upper" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or

features. Thus, the exemplary term "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a," "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "includes" and/or "including," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

Ground Structure

FIG. 1 is a perspective view illustrating a ground structure in accordance

with an example embodiment of the present invention, FIG. 2 is a top view illustrating the ground structure in FIG. 1, FIG. 3 is a side view illustrating the ground structure in FIG. 1, FIG. 4 is a partially cut perspective view illustrating a connection member of the ground structure in FIG. 1 in accordance with an example embodiment of the present invention, and FIG. 5 is a partially cut perspective view illustrating a connection member of the ground structure in FIG. 1 in accordance with an example embodiment of the present invention.

Referring to FIGS. 1 to 3, a ground structure 100 of this example embodiment includes a ground mount 110, a ground terminal 120, a conductive holder 130 and a connection member 140.

The ground mount 110 may have a cylindrical shape. A hole 114 is vertically formed through the ground mount 110. A heating element (not shown) of a heater (not shown) is received in the hole 114. A receiving groove 112 is formed at a side face of the ground mount 110. The receiving groove 112 is exposed through an upper face of the ground mount 110. In this example embodiment, the receiving groove 112 may have a quarter-circular cross-section. Further, a hole (not shown) connected to the receiving groove 112 may be vertically formed through the ground mount 110. Additionally, an insulation cover 160 may cover the receiving groove 112 in consideration of worker safety. The ground mount 110 may include a conductive material such as aluminum.

The ground terminal 120 is inserted into the hole. The ground terminal 120 in the hole is protruded into the receiving groove 112. In this example embodiment, the ground terminal 120 is placed movably in a vertical direction

through the hole. The ground terminal 120 may include nickel. Further, the ground terminal 120 may be connected to an electrode (not shown) of the heater by a brazing process.

The conductive holder 130 is arranged in the receiving groove 112. The conductive holder 130 may include a resilient plate having a thin thickness. Further, a middle portion of the resilient plate may be bent to provide the conductive holder 130 with a U-shape. Both ends of the conductive holder 130 are fixed to each other using a fixing member 150 such as a bolt. The ground terminal 120 is received in the bent conductive holder 130. A holding groove 132 is formed at the bent portion of the conductive holder 130. Here, the holding groove 132 may have a diameter substantially the same as that of the ground terminal. Thus, the ground terminal 120 is received in the holding groove 132. Further, the ground terminal 120 in the holding groove 132 closely makes contact with an inner face of the conductive holder 130. That is, the conductive holder 130, which elastically holds the ground terminal 120, may closely make contact with substantially the entire outer face of the ground terminal 120. Particularly, an upper end of the ground terminal 120 may have a diameter longer than an inner width of the conductive holder 130. Therefore, the ground terminal 120 may not be downwardly released from the conductive holder 130 without releasing the fixing member 150. In this example embodiment, the conductive holder 130 may include beryllium (Be), copper (Cu), an alloy thereof, etc.

The connection member 140 electrically connects the conductive holder

130 to the ground mount 110. The connection member 140 includes a first end fixed to the conductive holder 130, a second end, which is opposite to the first end, secured to the ground mount 110. Particularly, in order to allow the conductive holder 130 to vertically move, the connection member 140 may include a flexible cable. Thus, since the conductive holder 130 is vertically moved due to the connection member 140, a thermal expansion of the ground terminal 120 caused by a high temperature of the heater may not be restricted. As a result, an end of the ground terminal 120 brazed to the heater may not be cut.

Referring to FIG. 4, the connection member 140 may include an annular insulation cable 142 and a single conductive wire 144. The annular insulation cable 142 surrounds the conductive wire 144. Here, a transmission efficiency of a radio frequency (RF) or a high frequency, which flows through the conductive wire 144, may be proportional to a surface area of the conductive wire 144. Thus, in this example embodiment, to enlarge the surface area of the conductive wire 144, the conductive wire 144 may have a meshed portion 145 formed at the surface of the conductive wire 144.

Alternatively, with reference to FIG. 5, the connection member 140 may include an annular insulation cable 142 and a plurality of conductive wires 146. The annular insulation cable 142 surrounds the conductive wires 146. Thus, the connection member 140 may have an enlarged surface area due to the conductive wires 146.

An insulation member 170 may be interposed between the ground mount

110 and the conductive holder 130 to electrically insulate the ground mount 110 and the conductive holder 130 from each other. The insulation member 170 includes a first insulator 171 arranged between a side face of the ground mount 110 and the conductive holder 130, i.e., on a side face of the receiving groove 112, and a second insulator 172 arranged between a bottom face of the ground mount 110 and the conductive holder 130, i.e., on a bottom face of the receiving groove 112.

According to this example embodiment, both of the ends of the conductive holder may be fixed to each other using the bolt so that the conductive holder may closely make contact with ground terminal without releasing the bolt. Thus, an arc may not be generated at the ground terminal. As a result, the ground terminal may not be damaged. Further, the conductive holder may be vertically moved due to the flexible cable so that the thermal expansion of the ground terminal may not be restricted. As a result, the brazed portion of the ground terminal may not be cut.

Heater

FIG. 6 is a cross-sectional view illustrating a heater in accordance with an example embodiment of the present invention.

Referring to FIG. 6, a heater 200 of this example embodiment includes a heating block 210, a heating element 220, an electrode 230 and the ground structure 100. Here, the ground structure 100 is illustrated in detail with reference to FIGS. 1 to 3. Thus, any further illustrations with respect to the

ground structure 100 are omitted herein for brevity.

The heating block 210 includes a circular plate on which a semiconductor substrate is placed, and a vertical shaft connected to a bottom central portion of the circular plate. The ground mount 110 of the ground structure 100 is mounted on a lower end of the vertical shaft. In this example embodiment, the heating block 210 may include a ceramic material.

The electrode 230 is built into the heating block 210. The heating element 220 is built into the vertical shaft of the heating block 210. In this example embodiment, the heating element 220 may be arranged in a concentric circle pattern in the circular plate of the heating block 210. The ground terminal 120 of the ground structure 100 is electrically connected to the electrode 230.

Chemical Vapor Deposition (CVD) Apparatus

FIG. 7 is a cross-sectional view illustrating a CVD apparatus in accordance with an example embodiment of the present invention.

Referring to FIG. 7, a CVD apparatus 300 of this example embodiment includes a chamber 310 into which a semiconductor substrate is loaded, an upper electrode 320, a reaction gas-providing member 330, a gas line 340, and the heater 200. In this example embodiment, the CVD apparatus may include a plasma-enhanced CVD (PE-CVD) apparatus. Here, the heater 200 is illustrated in detail with reference to FIG. 6. Thus, any further illustrations with respect to the heater 200 are omitted herein for brevity.

The gas line 340 for introducing a reaction gas into the chamber 310 is

connected to an upper face of the chamber 310. The upper electrode 320 is positioned at an upper space of the chamber 310 to apply a high voltage to the reaction gas, thereby generating plasma. The reaction gas-providing member 330 is arranged under the upper electrode 320 to uniformly distribute the plasma toward the semiconductor substrate. In this example embodiment, the reaction gas-providing member 330 may include a showerhead.

The heater 200 is arranged on a bottom face of the chamber 310. The semiconductor substrate is placed on the heating block 210 of the heater 200.

According to the present invention, both ends of a conductive holder surrounding a ground terminal may be firmly fixed so that the conductive holder may closely make contact with the ground terminal. Thus, an arc may not be generated between the conductive holder and the ground terminal. As a result, damage to the ground terminal caused by the arc may be prevented.

Further, the conductive holder connected to a ground mount using a flexible cable may be moved along a lengthwise direction of the ground terminal. Therefore, cutting of the ground terminal caused by a thermal expansion may be prevented.

Having described the preferred embodiments of the present invention, it is noted that modifications and variations can be made by persons skilled in the art in light of the above teachings. It is therefore to be understood that changes may be made in the particular embodiment of the present invention disclosed which is within the scope and the spirit of the invention outlined by the appended claims.

WHAT IS CLAIMED IS:

1. A ground structure of a heater for a chemical vapor deposition apparatus, the ground structure comprising:

a ground mount having a receiving groove;

a ground terminal inserted in the ground mount and movable perpendicularly to the ground mount, the ground terminal exposed to the receiving groove;

a conductive holder holding the ground terminal such that the conductive holder is arranged in the receiving groove and makes contact with a whole outer surface of the ground terminal; and

a connection member electrically connecting with the conductive holder and the ground mount such that the conductive holder moves in a longitudinal direction of the ground terminal due to a thermal expansion of the ground terminal.

2. The ground structure of the heater of claim 1, further comprising an insulation cover for covering the receiving groove.

3. The ground structure of the heater of claim 1, wherein the ground mount comprises aluminum.

4. The ground structure of the heater of claim 1, wherein the ground terminal comprises nickel.

5. The ground structure of the heater of claim 1, wherein the conductive holder comprises a resilient material.

6. The ground structure of the heater of claim 5, wherein the conductive holder has a U-shape for receiving the ground terminal, and both ends of the U-shaped conductive holder are fixed to each other using a fixing member.

7. The ground structure of the heater of claim 6, wherein the conductive holder has a holding groove, which has a diameter substantially the same as that of the ground terminal, for holding the ground terminal.

8. The ground structure of the heater of claim 1, wherein the conductive holder comprises beryllium (Be), copper (Cu) or an alloy thereof.

9. The ground structure of the heater of claim 1, wherein the connection member comprises a flexible cable.

10. The ground structure of the heater of claim 1, further comprising an insulation member interposed between the ground mount and the conductive holder.

11. The ground structure of the heater of claim 10, wherein the insulation member comprises:

a first insulator interposed between a side face of the ground mount and the conductive holder; and

a second insulator interposed between a bottom face of the ground mount and the conductive holder, the second insulator having a hole into which the ground terminal is movably inserted.

12. A heater for a chemical vapor deposition apparatus, the heater comprising:

a heating block;

a heating electrode built into the heating block;

an electrode built into the heating block;

a ground mount mounted on the heating block and having a receiving groove;

a ground terminal inserted in the ground mount and movable perpendicularly to the ground mount, the ground terminal exposed to the receiving groove;

a conductive holder holding the ground terminal such that the conductive holder is arranged in the receiving groove and makes contact with a whole outer surface of the ground terminal; and

a connection member electrically connecting with the conductive holder and the ground mount such that the conductive holder moves in a longitudinal direction of the ground terminal due to a thermal expansion of the ground terminal.

13. The heater of claim 12, wherein the heating block comprises a ceramic material.

14. A chemical vapor deposition (CVD) apparatus comprising:

a chamber into which a substrate is loaded;

a heater arranged in a lower space of the chamber to heat the substrate;

a reaction gas-providing member arranged in an upper space of the chamber to providing a reaction gas to the substrate; and

an upper electrode provided in the chamber to form plasma from the reaction gas,

wherein the heater comprises a heating block, a heating electrode built into the heating block, a lower electrode built into the heating block, a ground mount mounted on the heating block and having a receiving groove, a ground terminal inserted in the ground mount and connected to the lower electrode such that the ground terminal moves perpendicularly to the ground mount and is exposed to the receiving groove, a conductive holder arranged in the receiving groove and makes contact with a whole outer surface of the ground terminal to thereby hold the ground terminal, and a connection member electrically connecting with the conductive holder and the ground mount such that the conductive holder moves in a longitudinal direction of the ground terminal due to a thermal expansion of the ground terminal.