

REFLECTOR AND CRYSTAL PULLING APPARATUS FOR PULLING CRYSTAL INGOT USING CZOCHRALSKI METHOD

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims a priority of the Chinese patent application No. 202310611770.9 filed on May 26, 2023, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to the field of semiconductor wafer manufacturing, in particular to a reflector and a crystal pulling apparatus for pulling a crystal ingot using a Czochralski method.

BACKGROUND

[0003] The silicon wafer for manufacturing a semiconductor electronic element, e.g., integrated circuit, is mainly fabricated through slicing a single crystal silicon ingot pulled using the Czochralski method. The Czochralski method comprises melting polycrystalline silicon in a quartz crucible to obtain a silicon melt, immersing a seed into the silicon melt, and continuously lifting the seed to move away from a surface of the silicon melt to generate the single crystal silicon ingot at a phase interface during the movement.

[0004] The concentration of oxygen in the obtained single crystal silicon ingot is an important factor that affects the performance of the silicon wafer. Due to the presence of oxygen in the single crystal silicon ingot, strength of the silicon wafer is increased, or a Bulk Micro Defect (BMD) is formed within the silicon wafer. The BMD functions as to absorb metallic impurities generated during the machining process. However, oxygen precipitation may also adversely affect the performance of the electronic element, e.g., it easily leads to such damages as leakage currents and breakdowns of the element. Hence, for the electronic elements with varying

applications, there are different requirements on oxygen contents and oxygen distribution, and these requirements are relatively strict, necessitating a more precise control of oxygen contents within the crystal during the growth process..

[0005] Oxygen in the single crystal silicon ingot mainly derives from the melting of the quartz crucible, and the rate of melting is influenced by both temperature and the conditions of melt convection. Currently, the oxygen contention in the single crystal silicon ingot is usually regulated by controlling a heating temperature of the quartz crucible. But on the other hand, the heating temperature of the quartz crucible must align with production efficiency requirements, so there is an interference between the requirement on the oxygen concentration in the single crystal silicon ingot and the demands for the production efficiency. Hence, there is an urgent need to provide a method for regulating the oxygen concentration in the single crystal silicon ingot in a way different from the approach used to control the heating temperature of the quartz crucible.

SUMMARY

[0006] In order to solve the above-mentioned technical problem, the present disclosure intends to provide a reflector and a crystal pulling apparatus for pulling a crystal ingot using a Czochralski method, so as to regulate the oxygen concentration in the single crystal silicon ingot in a way different from that for controlling the heating temperature of the quartz crucible.

[0007] The present disclosure provides the following technical solutions.

[0008] In a first aspect, the present disclosure provides in some embodiments a reflector for pulling a crystal ingot using a Czochralski method. A bottom of the reflector is provided with notches, and the notches are used to provide differentiated flow rates of a protective gas that flows over a liquid surface of a melt in a reference radial direction, based on varying angular orientations of the reflector about a longitudinal axis of the reflector.

[0009] In a case that a horizontal magnetic field is applied to the melt in the above-mentioned reference radial direction and the reflector is arranged at a position where the notches are opposite to each other in a radial direction of the liquid surface of the melt parallel to the horizontal magnetic field in a vertical direction, the protective gas flows through the notches at the bottom of the reflector in a direction of the horizontal magnetic field, so the flow rate is relatively large, the volatilization of oxygen in the melt is facilitated, and less oxygen reaches a solid-liquid interface between the crystal ingot and the melt. In this way, it is able to reduce an oxygen concentration in the crystal ingot. In a case that the reflector is arranged at a position where the notches are opposite to each other in the radial direction of the liquid surface of the melt not parallel to the horizontal magnetic field in the vertical direction, the protective gas cannot flow through the notches at the bottom of the reflector in the direction of the horizontal magnetic field, and instead it flows through a gap between a portion at the bottom of the reflector without the notch and the liquid surface of the melt, so the flow rate is relatively small, the volatilization of oxygen in the melt is suppressed, and more oxygen reaches the solid-liquid interface between the crystal ingot and the melt. In this way, it is able to increase the oxygen concentration in the crystal ingot.

[0010] Optionally, the quantity of notches is two, and the two notches are arranged opposite to each other in a radial direction of the reflector.

[0011] For the volatilization of oxygen in the melt, a region affected by the flow rate of the protective gas flowing over the liquid surface of the melt extends throughout the entire radial direction, so the region can be fully utilized by the two notches arranged opposite to each other in the radial direction. For example, in a case that the oxygen concentration in the pulled crystal ingot needs to be low, as compared with a reflector with merely one notch, through a reflector with the two notches arranged opposite to each other in the radial direction, it is able to facilitate the volatilization of oxygen from the melt in a better manner, thereby to reduce the oxygen concentration.

[0012] Optionally, the reflector is configured such that a connection line between the two notches is parallel to a horizontal magnetic field applied to the melt.

[0013] In this case, for the protective gas flowing over the liquid surface of the melt, the flow rate of the protective gas is maximum in the direction parallel to the horizontal magnetic field, because the protective gas flows through the notches at the bottom of the reflector. In other words, in an entire circumferential direction of the reflector, a gap between a portion with the notch at the bottom and the liquid surface of the melt is maximum. In this way, it is able to obtain the crystal ingot with the oxygen concentration as low as possible.

[0014] In addition, this approach effectively minimizes the non-uniformity of the oxygen concentration in the crystal ingot along the circumferential direction to the greatest extent.

[0015] Optionally, the reflector is configured such that a connection line between the two notches is perpendicular to a horizontal magnetic field applied to the melt.

[0016] In this case, for the protective gas flowing over the liquid surface of the melt, the flow rate of the protective gas is minimum in the direction parallel to the horizontal magnetic field, because the protective gas merely flows through a gap between the portion without any notch at the bottom and the liquid surface of the melt. In other words, the protective gas merely flows through a gap between a protruded portion at the bottom of the reflector relative to the notch and the liquid surface of the melt, and this gap is minimum in the entire circumferential direction of the reflector. In this way, it is able to obtain the crystal ingot with the oxygen concentration as high as possible.

[0017] Optionally, the notch is of a rectangular shape. In this way, for the protective gas flowing over the liquid surface of the melt, it is able to simplify the calculation in a case that it is necessary to calculate the flow rates at different positions in the circumferential direction of the reflector.

[0018] Optionally, the notch is gradually enlarged toward the bottom of the reflector. In this way, in a case that the notch is obtained through removing part of a material, it is able to form the reflector with the notch more easily.

[0019] In a second aspect, the present disclosure further provides in some embodiments a crystal pulling apparatus for pulling a crystal ingot using a Czochralski method, including the reflector in the first aspect.

[0020] Optionally, the crystal pulling apparatus further comprises: a body defining a chamber; and a crucible arranged in the chamber. The melt is received in the crucible.

[0021] Optionally, the crystal pulling apparatus further comprises a heater. The heater is arranged within the chamber and along a periphery of the crucible, and configured to heat the crucible to allow a solid-state material received in the crucible to be melted into the melt.

[0022] Optionally, the crystal pulling apparatus further comprises a thermal insulation element, and the thermal insulation element is arranged on an inner wall of the body to inhibit heat generated by the heater from being dissipated via the body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Fig. 1 is a schematic view showing a conventional crystal pulling apparatus for pulling a crystal ingot;

[0024] Fig. 2 is a schematic view showing flow paths of a melt under the effect of a heater in Fig. 1 and a horizontal magnetic field;

[0025] Fig. 3 is a solid view of a reflector for pulling a crystal ingot using a Czochralski method according to an embodiment of the present disclosure;

[0026] Fig. 4 is a sectional view of the reflector at a first position relative to the horizontal magnetic field according to an embodiment of the present disclosure;

[0027] Fig. 5 is a sectional view of the reflector at a second position relative to the horizontal magnetic field according to an embodiment of the present disclosure;

[0028] Fig. 6 is a schematic view showing temperature distribution of the melt in a plane parallel to a liquid surface under the effect of the heater in Fig. 1;

[0029] Fig. 7 is a front view of the reflector for pulling the crystal ingot using the Czochralski method according to an embodiment of the present disclosure; and

[0030] Fig. 8 is a schematic view showing a crystal pulling apparatus for pulling a crystal ingot using a Czochralski method according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0031] The technical solution of the present disclosure will be described hereinafter in a clear and complete manner in conjunction with the drawings.

[0032] Fig. 1 shows a conventional crystal pulling apparatus 1A for pulling a crystal ingot R, and the crystal pulling apparatus mainly comprises: a body 20A; a crucible 30A arranged inside the body 20A and configured to receive a melt M; a heater 40A configured to heat the crucible 30A to melt a solid-state raw material, e.g., solid-state polycrystalline silicon, into the melt M and maintain the melt M at a desired temperature; and a reflector 10 configured to guide a protective gas not shown in Fig. 1, e.g., argon gas, toward a liquid surface of the melt M to prevent the occurrence of any unexpected chemical reaction for the melt M.

[0033] Oxygen in a pulled crystal ingot R mainly comes from the crucible 30A. To be specific, the crucible 30A is melted under the effect of a high temperature of the melt M, and oxygen in the crucible 30A enters the melt M. In a case that oxygen in the melt M reaches a solid-liquid interface between the crystal ingot R and the melt M, it enters the crystal ingot R.

[0034] On the other hand, in the crystal pulling apparatus 1A, under the effect of the heater 40A, thermal convection occurs within the melt M in the crucible 30A, and crystal pulling is adversely affected by the instability of the melt M due to the thermal convection. In order to reduce the strength of the convection within the melt M, a magnetic field is applied to the melt M, so as to relieve the convection within the melt M through a Lorentz force. The applied magnetic fields include a vertical magnetic field, a horizontal magnetic field and a cusp magnetic field, and each of these magnetic fields possesses distinct advantages and disadvantages. The horizontal magnetic field HM in Fig. 1 has a maximum intensity of up to 0.4 T, which is attributed to a coil with

a diameter smaller than that for the other two types of magnetic fields. However, as compared with the other two types of magnetic fields, the horizontal magnetic field H_M is non-centrosymmetric, so complex asymmetry occurs for the convection in the melt M .

[0035] Oxygen generated due to the melting of the crucible 30A at a high temperature of the melt M mainly exists at an inner wall of the crucible 30A, and it flows along with the convection of the melt M toward the solid-liquid interface between the crystal ingot R and the melt M under the effect of the horizontal magnetic field H_M . A situation where oxygen at the inner wall of the crucible 30A reaches the solid-liquid interface between the crystal ingot R and the melt M will be described hereinafter in details in conjunction with the convection of the melt M under the effect of the horizontal magnetic field H_M .

[0036] Fig. 2 shows flow paths of the melt M under the effect of both the heater 40A in Fig. 1 and the horizontal magnetic field H_M , and the crystal pulling apparatus 1A in Fig. 1 and the flow paths in Fig. 2 are located in a same coordinate system XYZ . As shown in Fig. 1 and Fig. 2, in a plane XZ perpendicular to the horizontal magnetic field H_M , there is a large stabilizing vortex, so oxygen at the inner wall of the crucible 30A rapidly reaches a free surface of the melt M under the effect of the vortex, and thereby rapidly volatilizes. However, in a plane parallel to the horizontal magnetic field H_M , i.e., a plane XY , the melt M at the inner wall of the crucible 30A tends to flow toward a center of the entire melt M , i.e., in the plane XY , it is very difficult for oxygen generated due to the melting of the crucible 30A to flow to the free surface of the melt M in time and thereby volatilizes, and oxygen flows to the solid-liquid interface more easily, so the oxygen concentration in the crystal ingot R increases.

[0037] In this case, it should be appreciated that, in a case that the volatilization of oxygen in the melt M needs to be affected by the flow rate of the protective gas flowing over the liquid surface of the melt M : it is presumed that when the protective gas flows in a Z -axis direction or in a direction perpendicular to the horizontal magnetic field H_M , the volatilization of oxygen would not be affected by the flow rate of the

protective gas, because in this direction, most of oxygen in the melt M has already reached the free surface of the melt M and thereby volatilized. However, it is presumed that when the protective gas flows in a Y-axis direction or in a direction parallel to the horizontal magnetic field HM, the protective gas may facilitate the volatilization of oxygen in the melt M in a case that the flow rate of the protective gas is large, so less oxygen reaches the solid-liquid interface between the crystal ingot R and the melt M, and the oxygen concentration in the crystal ingot R decreases. In a case that the flow rate of the protective gas is small, the protective gas may inhibit the volatilization of oxygen in the melt M, so more oxygen reaches the solid-liquid interface between the crystal ingot R and the melt M, and the oxygen concentration in the crystal ingot R increases.

[0038] Based on the above, referring to Figs. 3 to 5, the present disclosure provides in some embodiments a reflector 10 for pulling the crystal ingot R in Fig. 1 using a Czochralski method. As shown in Fig. 3, as a solid view, and Fig. 4, as a sectional view, a bottom 10B of the reflector 10 is provided with notches 10N, and the notches 10N are used to provide differentiated flow rates of a protective gas PG flowing over a liquid surface L of a melt M in a reference radial direction, based on varying angular orientations of the reflector 10 about a longitudinal axis 10X of the reflector itself. To be specific, presumed that a direction in which the horizontal magnetic field HM is applied is the reference radial direction, in a case that the reflector 10 is located at a position in Fig. 4 relative to the horizontal magnetic field HM, in the direction where the horizontal magnetic field HM is applied or in the Y-axis direction in Figs. 1 and 2, the protective gas PG flows through the notch 10N at the bottom 10B of the reflector 10, so the flow rate thereof is relatively large. As mentioned hereinabove, the volatilization of oxygen in the melt M is facilitated, and less oxygen reaches the solid-liquid interface between the crystal ingot R and the melt M, so the oxygen concentration in the crystal ingot R decreases. In a case that the reflector 10 is located at a position in Fig. 5 relative to the horizontal magnetic field HM, in the direction where the horizontal magnetic field HM is applied or in the Y-axis direction in Figs. 1 and 2, the protective

gas PG cannot flow through the notch 10N at the bottom 10B of the reflector 10, and instead, it merely flows through a gap between a portion of the reflector 10 without any notch 10N at the bottom 10B and the liquid surface L of the melt M, so the flow rate thereof is relatively small. As mentioned hereinabove, the volatilization of oxygen in the melt M is inhibited, and more oxygen reaches the solid-liquid interface between the crystal ingot R and the melt M, so the oxygen concentration in the crystal ingot R increases.

[0039] In other words, the present disclosure provides in some embodiments the reflector 10 with the notches 10N at the bottom 10B, so as to regulate the oxygen concentration in the crystal ingot R, based on varying angular orientations of the reflector 10 about the longitudinal axis 10X of the reflector itself.

[0040] In a possible embodiment of the present disclosure, as shown in Figs. 3 and 4, the quantity of notches 10N is two, and the two notches are arranged opposite to each other in a radial direction of the reflector 10. As mentioned hereinabove, for the volatilization of oxygen in the melt M, a region affected by the flow rate of the protective gas PG flowing over the liquid surface L of the melt M extends throughout the entire radial direction, so through the two notches 10N arranged opposite to each other in the radial direction, it is able to make full use of this region. For example, in a case that the oxygen concentration in the pulled crystal ingot R needs to be low, as compared with a situation where the reflector 10 is provided with merely one notch 10N, through the two notches 10N arranged opposite to each other in the radial direction, it is able to facilitate the volatilization of oxygen from the melt M in a better manner, thereby to reduce the oxygen concentration.

[0041] For the pulled crystal ingot R, the oxygen concentration therein possibly needs to be high. In a possible embodiment of the present disclosure, as shown in Fig. 5, the reflector 10 is configured such that a connection line between the two notches 10N is perpendicular to the horizontal magnetic field HM applied to the melt M. Fig. 5 is a sectional view, so the notches 10N are not shown. It should be appreciated that, the connection line between the two notches 10 of the reflector 10 is perpendicular to a

plane of Fig. 5. In this case, for the protective gas PG flowing over the liquid surface L of the melt M, in the direction parallel to the horizontal magnetic field HM, its flow rate is minimum, because the protective gas PG merely flows through a gap between a portion without any notch 10N at the bottom 10B and the liquid surface L of the melt M, i.e., the protective gas PG merely flows through a gap between a protruded portion at the bottom 10B of the reflector 10 relative to the notch 10N and the liquid surface L of the melt M. This gap is minimum in the entire circumferential direction of the reflector 10.

[0042] For the pulled crystal ingot R, the oxygen concentration therein possibly needs to be low. In addition, apart from meeting the requirement on the oxygen concentration in the entire crystal ingot R, the oxygen concentration further needs to be uniform in the circumferential direction of the crystal ingot R.

[0043] In a possible embodiment of the present disclosure, as shown in Fig. 4, the reflector 10 is configured such that a connection line between the two notches 10N is parallel to the horizontal magnetic field HM applied to the melt M. Fig. 4 is a sectional view obtained after rotating the longitudinal axis 10X of the reflector 10 in Fig. 5 by 90°, or Fig. 5 is a sectional view obtained after rotating the longitudinal axis 10X of the reflector 10 in Fig. 4 by 90°. Hence, in Fig. 4, the connection line between the two notches 10N of the reflector 10 is included in a cross section.

[0044] In this case, for the protective gas PG flowing over the liquid surface L of the melt M, the flow rate of the protective gas PG is maximum in the direction parallel to the horizontal magnetic field HM, because the protective gas PG flows through the notches 10N at the bottom 10B of the reflector 10m, i.e., in an entire circumferential direction of the reflector 10, a gap between a portion with the notch 10N at the bottom 10B and the liquid surface L of the melt M is maximum.

[0045] For the uniformity of the oxygen concentration in the circumferential direction of the crystal ingot R, as mentioned hereinabove, oxygen in the crystal ingot R mainly comprises oxygen entering the melt M in a case that the crucible 30A is melted at a high temperature. However, due to the effect of the horizontal magnetic field HM,

the temperature of the melt M is not uniform in its circumferential direction. To be specific, Fig. 6 shows the temperature distribution of the melt M in a plane parallel to the liquid surface under the effect of the heater 40A in Fig. 1. As shown in Fig. 6, in the direction parallel to the horizontal magnetic field HM, the melt M in the vicinity of the crucible 30A has a high temperature, so a large part of the crucible 30A is melted and more oxygen enters the melt M. In the direction perpendicular to the horizontal magnetic field HM, the melt M in the vicinity of the crucible 30A has a low temperature, so a small part of the crucible 30A is melted and less oxygen enters the melt M. In a case that the convection caused by the horizontal magnetic field HM in Fig. 2 is not taken into consideration, or presumed that oxygen in the melt M has a same possibility to reach the solid-liquid interface between the crystal ingot R and the melt M, more oxygen enters the melt M in the direction parallel to the horizontal magnetic field HM, so more oxygen enters the crystal ingot R. In the direction perpendicular to the horizontal magnetic field HM, less oxygen enters the melt M, so less oxygen enters the crystal ingot R. In this regard, the oxygen concentration in the crystal ingot R in the circumferential direction is not uniform, and more specifically, the oxygen concentration in the direction parallel to the horizontal magnetic field HM is greater than the oxygen concentration in the direction perpendicular to the horizontal magnetic field HM. In addition, due to the convection in Fig. 2, as mentioned hereinabove, it is very difficult for oxygen in the melt M to volatilize in the direction parallel to the horizontal magnetic field HM, so the oxygen concentration in the crystal ingot R increases. Oxygen in the melt M volatilizes easily in the direction perpendicular to the horizontal magnetic field HM, so the oxygen concentration in the crystal ingot R is inhibited. In other words, the non-uniformity of the oxygen concentration in the crystal ingot R in the circumferential direction is further increased or degraded. In the embodiments of the present disclosure, as mentioned hereinabove, the flow rate of the protective gas PG flowing over the liquid surface of the melt M is maximum in the direction parallel to the horizontal magnetic field HM, so as to facilitate the volatilization of oxygen in the melt M to the greatest extent. Minimum oxygen reaches

the solid-liquid interface between the crystal ingot R and the melt M, so the oxygen concentration in the crystal ingot R in the radial direction parallel to the horizontal magnetic field HM is minimized, and thereby it is able to reduce the non-uniformity of the oxygen concentration in the crystal ingot R in the circumferential direction to the greatest extent.

[0046] In a possible embodiment of the present disclosure, as shown in Fig. 3, the notch 10N is of a rectangular shape. In this way, for the protective gas PG flowing over the liquid surface L of the melt M, in a case that it is necessary to calculate the flow rates at different positions in the circumferential direction of the reflector 10, it is able to simplify the calculation.

[0047] In a possible embodiment of the present disclosure, as shown in Fig. 7, the notch 10N is gradually enlarged toward the bottom 10B of the reflector 10. In this way, in a case that the notch 10N is obtained through removing part of a material, it is able to form the reflector 10 with the notch 10N more easily.

[0048] As shown in Fig. 8, the present disclosure further provides in some embodiments a crystal pulling apparatus 1 for pulling a crystal ingot R using a Czochralski method. The crystal pulling apparatus 1 comprises the above-mentioned reflector 10.

[0049] In a possible embodiment of the present disclosure, the crystal pulling apparatus 1 further comprises: a body 20 defining a chamber 20C; and a crucible 30 arranged in the chamber 20C. The melt M is received in the crucible 30.

[0050] In a possible embodiment of the present disclosure, as shown in Fig. 8, the crystal pulling apparatus 1 further comprises a heater 40. The heater 40 is arranged within the chamber 20C and along a periphery of the crucible 30, and configured to heat the crucible 30 to allow a solid-state material received in the crucible 30 to be melted into the melt M.

[0051] In a possible embodiment of the present disclosure, as shown in Fig. 8, the crystal pulling apparatus 1 further comprises a thermal insulation element 50, and

the thermal insulation element 50 is arranged on an inner wall of the body 20 to inhibit heat generated by the heater 40 from being dissipated via the body 20.

[0052] Unless otherwise defined, any technical or scientific term used herein shall have the common meaning understood by a person of ordinary skills. Such words as “first” and “second” used in the specification and claims are merely used to differentiate different components rather than to represent any order, number or importance. Similarly, such words as “one” or “one of” are merely used to represent the existence of at least one member, rather than to limit the number thereof. Such words as “include” or “including” intends to indicate that an element or object before the word contains an element or object or equivalents thereof listed after the word, without excluding any other element or object. Such words as “connect/connected to” or “couple/coupled to” may include electrical connection, direct or indirect, rather than to be limited to physical or mechanical connection. Such words as “on”, “under”, “left” and “right” are merely used to represent relative position relationship, and when an absolute position of the object is changed, the relative position relationship will be changed too.

[0053] It should be appreciated that, the technical solutions in the embodiments of the present disclosure may be combined randomly in a case of no conflict.

[0054] The above are merely the preferred embodiments of the present disclosure, but shall not be construed as limiting the scope of the present disclosure. Any person skilled in the art may make modifications and substitutions without departing from the spirit of the present disclosure, and these modifications and substitutions shall also fall within the scope of the present disclosure. Hence, the scope of the present disclosure shall be subject to the scope defined by the appended claims.

What is claimed is:

1. A reflector for pulling a crystal ingot using a Czochralski method, wherein a bottom of the reflector is provided with notches, and the notches are used to provide differentiated flow rates of a protective gas that flows over a liquid surface of a melt in a reference radial direction, based on varying angular orientations of the reflector about a longitudinal axis of the reflector.

2. The reflector according to claim 1, wherein the quantity of notches is two, and the two notches are arranged opposite to each other in a radial direction of the reflector.

3. The reflector according to claim 2, wherein the reflector is configured such that a connection line between the two notches is parallel to a horizontal magnetic field applied to the melt.

4. The reflector according to claim 2, wherein the reflector is configured such that a connection line between the two notches is perpendicular to a horizontal magnetic field applied to the melt.

5. The reflector according to any one of claims 1 to 4, wherein the notch is of a rectangular shape.

6. The reflector according to any one of claims 1 to 4, wherein the notch is gradually enlarged toward the bottom of the reflector.

7. A crystal pulling apparatus for pulling a crystal ingot using a Czochralski method, comprising the reflector according to any one of claims 1 to 6.

8. The crystal pulling apparatus according to claim 7, further comprising:
a body defining a chamber; and
a crucible arranged in the chamber, wherein the melt is received in the crucible.

9. The crystal pulling apparatus according to claim 8, further comprising a heater, wherein the heater is arranged within the chamber and along a periphery of the crucible, and configured to heat the crucible to allow a solid-state material received in the crucible to be melted into the melt.

10. The crystal pulling apparatus according to claim 9, further comprising a thermal insulation element, wherein the thermal insulation element is arranged on an inner wall of the body to inhibit heat generated by the heater from being dissipated via the body.