Description

This invention relates to methods and apparatus for cooling and heating semiconductor wafers during the production of integrated circuit structures. More particularly, this invention relates to wafer cooling and heating by means of a heat transfer gas.

During the plasma etching of a semiconductor wafer, such as a silicon wafer, it is desirable to cool the wafer to avoid excessive heat buildup which can interfere with the processing. For example, excess heat can cause reticulation of the photoresist resulting in reduced sensitivity of the process. Other integrated circuit production processes such as Chemical Vapor Deposition (CVD) require that the wafer be heated to support the proper chemical deposition reactions.

Wafer cooling is conventionally accomplished using a silicone rubber heat transfer pad which is mounted between the wafer and a pedestal and which functions as a wafer support and heat sink. However, it has been found that the transfer of heat from wafer to the pedestal heat sink via the silicone rubber pad is not always sufficient to dissipate the amount of heat generated during the plasma etching process. Tests and analysis indicate that the primary heat transfer mechanism is due to thermal conduction of gas rather than due to contact conduction from the wafer to the pedestal through the silicone rubber pad.

The use of gas as a thermal conductor in semiconductor wafer process is known for transmitting heat either to or from a wafer. For example, King U.S. Patent 4,261,762 discloses a method for cooling a wafer being bombarded by ions in an ion implantation apparatus wherein a wafer is clamped adjacent its periphery to a target block and a cooling gas with a high thermal conductivity such as nitrogen, neon, helium, or hydrogen is fed under pressure into the space between the wafer and the cooling block through an orifice in the cooling block.

Lamont U.S. Patents 4,680,061 and 4,743,570 describe the use of a gas to conduct heat to or from a wafer from a heat exchange means which may comprise a heater for heating the wafer or a heat sink for cooling the wafer. A pressure plate seals the periphery of a wafer carrier plate assembly against the wall of a vacuum apparatus while the wafer is either heated or cooled by the heat exchange means utilizing gas conduction heat transfer by introducing a fraction of the argon gas employed for operation of the sputter deposition source directly into the space between the heat exchange means and the wafer.

However, these prior uses of a gas as a heat transfer conductor have been limited to use of the gas in a separate chamber or compartment of the apparatus isolated from the portion of the process apparatus generating the heat, e.g., the sputter deposition chamber, either because a different gas was used for the heat transfer than the gas used in the process, or because it is desired to maintain a higher vacuum in the main process apparatus than that of the cooling chamber. To maintain this separation and pressure differential, the wafer is usually clamped and/or sealed to provide this higher pressure on the backside of the wafer.

For example, in the aforementioned King patent, the pressure or vacuum in the ion implantation process chamber is said to be 7×10^{-7} Torr 9.3×10^{-5} Pa while the pressure behind the wafer is said to vary from 0.5 to 2.0 Torr 66,6 to 267 Pa. In the aforementioned Lamont patent the argon gas is said to be admitted into the heating station at pressures of 100 to 1000 microns, which pressures are stated to be one to two orders of magnitude higher than the normal argon pressure of 10 microns in the main chamber.

While it has been thought that the use of such high pressures (relative to the processing pressures) are necessary to achieve the desired heat transfer through the gas, quite surprisingly, it has been found that good heat transfer can be obtained or achieved at the same pressure or vacuum conditions used in carrying out the plasma etching process, thus making unnecessary the prior art practice of using high pressures and sealing between the wafer and the processing chamber.

This invention provides a method of processing semiconductor wafers in a wafer processing apparatus including a processing chamber in which the wafer is located on a surface of a heat sink, the method including the steps of subjecting the exposed side of the wafer to a processing step including flowing a process gas over the surface of the wafer and cooling the wafer by directing a heat transfer gas against the rearward face of the wafer adjacent to the heat sink to transfer heat from the wafer to the sink; wherein the apparatus comprises a plasma etching chamber and the process to which the wafers are subjected in the chamber is a plasma etching process, wherein the processing gas in the chamber and heat transfer gas between the wafer and heat sink are at substantially the same pressures, wherein the heat transfer gas comprises one or more thermally conductive components of the process gas, wherein the wafer rests unheld against the surface of the sink, and wherein the heat transfer gas directed at the back of the wafer flows out between the wafer and heat sink into the plasma etching chamber.

In accordance with the invention, it has been found that good heat transfer can be obtained or achieved at the same pressures or vacuum utilized for the plasma etching process or other semiconductor manufacturing processes by using certain gases for cooling or heating which can also function as components of the process gas.

It is another feature of the present invention that a process for cooling or heating a semiconductor wa-

fer in an apparatus utilizes one or more components of the process gas as a gas conduction heat transfer gas by directing at least a portion of such one or more process gas components into contact with a surface of the wafer as such one or more process gas components pass into the apparatus while controlling the flow of process gas into the chamber to keep the total flow of process gas into the chamber constant and while monitoring the pressure or vacuum in the apparatus to maintain the desired pressure.

Preferably the heat transfer gas is directed through one or more openings in said surface of the heat sink to provide heat transfer between said rearward wafer surface and said heat sink before flowing into the plasma etching chamber.

More specifically the heat transfer gas is directed in a controlled flow of from about 1-5 sccm of said one or more components of the processing gas toward said rearward surface of said wafer.

According to a further feature of the invention the method includes the step of controlling the total flow of process gas into said plasma etching chamber to within a range of from about 130 to about 300 sccm.

In any of the above methods the heat transfer gasses comprise about 1 to about 5% of the total process gas flow and is directed toward said rear surface of said wafer.

The components of said process gas which are directed into contact with said rear surface of said wafer to provide heat transfer from said wafer to said adjacent support means may be selected from the class consisting of fluorinated 1-4 carbon, hydrocarbons and argon.

In one particular method according to the invention the plasma etching apparatus may have a total process gas flow into said apparatus of from about 130 to about 300 sccm and may comprise directing into contact with a surface of said wafer from about 1-5 sccm of at least a portion of said one or more components of said process gas selected from the class consisting of fluorinated 1-4 carbon, hydrocarbons and argon to transfer heat from said wafer to said support, and monitoring the vacuum in said plasma etching apparatus to maintain said plasma etching apparatus at a pressure of from about 5.3 Pa (40) to about 27 Pa (200 millitorr).

The invention also provides an apparatus for cooling a semiconductor wafer in a wafer processing apparatus by utilizing one or more components of the process gas used in the process as a gas conduction heat transfer gas which comprises; means for supporting said wafer on a support surface which support surface also functions as a heat sink, and means for directing a heat transfer gas into contact with a rear surface of said wafer adjacent said support surface; wherein the apparatus is a plasma etching apparatus and the support surface provides a surface on which the wafer rests to be subjected to said process gas wherein means are provided for directing a proportion of the process gas containing one or more thermally conductive components against the rear surface of said wafer adjacent the support surface to provide said heat transfer gas, and wherein the process gas and heat transfer gas are supplied at substantially the same pressures whereby the wafer can rest unheld on said support and the heat transfer gas can flow between the water and sink into the processing chamber.

The following is a description of a specific embodiment of the invention, reference being made to the accompanying drawings in which:-

Figure 1 is a flow sheet of the process of the invention; and

Figure 2 is a fragmentary cross-sectional view of a portion of a plasma etching apparatus showing the admission of some of the process gas into the chamber via prior contact with the surface of the wafer and monitoring and flow control means which may be used to control the flow of process gas through the chamber to maintain the desired vacuum in the chamber.

An aspect of the present invention comprises a method and an apparatus for cooling a semiconductor wafer in a plasma etching apparatus utilizing one or more components of the process gas used in the plasma etching process as a gas conduction heat transfer gas by directing at least a portion of such one or more components of the process gas into contact with a surface of the wafer as such one or more process gas components pass into the plasma etching apparatus. In a preferred embodiment, the flow of process gas into the chamber is controlled to keep the total flow of process gas into the chamber constant and the pressure or vacuum in the plasma etching apparatus is monitored to maintain the desired vacuum in the plasma etching apparatus.

As shown in Figure 2, a plasma etching apparatus or chamber 2 is generally indicated comprising a chamber wall 6, an evacuation port 8 which is connected through pipe 10 and throttle valve 12 to an external pumping source (not shown) to maintain the desired vacuum in chamber 2, and at least one interlock 4 through which a wafer may be introduced into chamber 2. Within chamber 2 is an rf source 20 connected to an external power supply (not shown) to generate the plasma and a wafer support pedestal 30 upon which a wafer 50 is positioned for etching by the plasma generated by rf source 20. An inlet port 14 is also provided in chamber wall 6 for admission of process gas into plasma etching chamber 2 through pipe 16 and flow control valve 18 from an external process gas source 40.

In accordance with the invention, means are provided in wafer support pedestal 30 for the direction of at least a portion of one or more components of the process gas into contact with the rear surface of wafer

50 resting on pedestal 30 comprising, in the illustrated embodiment, a central bore 32 in pedestal 30. Central bore 32 is, in turn, connected through pipe 36 and flow control valve 38 to external process gas source 40, which may comprise one or more components of the process gas used in the plasma etching process carried out in chamber 2.

The term "process gas", as used herein, is intended to define a mixture of gases which may either function as active etching components of the process gas or as carrier gases. Examples of components usually present in such plasma etching process gases are 1-4 carbon fluorinated hydrocarbons, such as CHF_3; fluorinated 1-4 carbons such as CF_4, and C_2F_6; oxygen, NF_3, and SiF_4; as well as carrier gases such as helium, nitrogen, and argon.

It should be noted, in this regard, that while process gas source 40 is shown as a single source, it will be understood that process gas source 40 may comprise individually controlled sources of each of the gases which collectively make up the process gas. Process gas source 40 may, therefore, include means to separately control the ratio of these components flowing through pipe 36 and flow control valve 38 to bore 32 and the rear surface of wafer 50 from the ratio of such gases flowing into plasma etching chamber 2 through inlet port 14.

Not all of these components of the process gas will function satisfactorily in the process of the present invention as satisfactory heat transfer agents to conduct heat from wafer 50 to pedestal 30 at the operating pressure or vacuum utilized in plasma etching apparatus 2. Therefore, the term "one or more components of the process gas" as used herein to describe the portion of the process gas which is brought into contact with the rear surface of wafer 50 through bore 32, is intended to define only those components of the process gas which will provide satisfactory heat transfer between wafer 50 and pedestal 30. Such components include argon and the aforementioned 1-4 carbon fluorinated hydrocarbons, such as CHF_3 ; or fluorinated 1-4 carbons such as C_2F_6, and CF_4.

The total amount of such process gas components which enters chamber 2 through bore 30 may be adjusted through flow control valve 38 to comprise only about 1-5%, preferably about 2% of the total amount of process gas which flows into chamber 2, with the balance flowing into chamber 2 via inlet port 14.

It should be noted that while central bore 32 is shown as the sole means for bringing such one or more components of the processing gas into contact with the rear surface of wafer 50, more than one such bore could be provided in pedestal 30 or at least the top surface of wafer support pedestal 30 could comprise a porous metal to permit exit of such processing gas components into contact with the rear surface of the wafer 50 at more than one point.

In any event, it will be noted that while wafer 50 is shown resting on pedestal 30, there is no seal or clamping type retention provided between wafer 50 and pedestal 30 to try to confine or restrict the movement into plasma etching chamber 2 of molecules of the one or more components of the process gas which have been brought into contact with the rear surface of wafer 50 through bore 32 in pedestal 30. Such sealing means are unnecessary in the practice of the present invention due both to an absence of pressure differentials between chamber 2 and the rear surface of wafer 50 as well as the use of one or more heat transfer gases which are also components of the process gas used in the plasma etching process, i.e., that heat transfer gases and the plasma etching gases are both used at the same pressure and the heat transfer gases comprise a portion of the plasma etching gases.

Pressure or vacuum monitor means 60 are also provided within plasma etching chamber 2 to monitor the total gas pressure in chamber 2. A signal from gas monitor means 60 may be fed to throttle valve 12 when the pressure exceeds a predetermined amount so that chamber 2 may be further evacuated. Alternatively or supplementally, the pressure or vacuum in chamber 2 could be controlled by controlling the flow of process gas entering chamber 2 through flow control valve 18 using control means 70.

When the pressure or vacuum in chamber 2 is controlled by throttle valve 12 through control means 70, the flow of process gas through inlet valve 18 and pipe 16 from process gas source 40 may be made constant by initial adjustment of control valves 18 and 38.

Plasma etch chamber 2 is maintained at a pressure of from about 40 to 200 millitorr, preferably about 60 millitorr. The total flow of process gas into chamber 2 which is necessary to maintain the plasma in chamber 2 ranges from about 130 to about 300 sccm. Of this amount, from at least about .05 sccm, preferably about .15 sccm, flows through bore 32 in pedestal 30 with the balance entering chamber 2 through process gas inlet port 14.

It will be noted that the silicone rubber pad conventionally placed between wafer 50 and pedestal 30 has been eliminated since the pad is not needed for conduction of heat from wafer 50 and pedestal 30. Instead, pedestal 30, which may be formed of aluminum metal, may be anodized to provide from about 1.3 x 10^{-5}m (0.5 mils) to about 5.1 x 10^{-5}m (2.0 mils) of aluminum oxide as electrical insulation between wafer 50 and pedestal 30 without materially interfering with the heat flow from wafer 50 to pedestal 30 through the process gas molecules in accordance with the invention.

To illustrate the advantages of the invention, the temperature of a silicon wafer subjected to plasma etching in a conventional etching chamber having a

silicone rubber heat transfer means was measured and found to be 115°C after a sufficient time to achieve steady state conditions, i.e., after about 3-5 minutes of etching. In contrast, the temperature of a silicon wafer cooled in accordance with the invention and etched under the same etching conditions and time period was found to be 65°C, indicating the superior heat transfer realized using the process and apparatus of the invention.

While the above preferred embodiment refers to the cooling of semiconductor wafers in plasma etching apparatus, methods and apparatus in accordance with the present invention can also advantageously heat wafers within semiconductor processing equipment. For example, in a CVD chamber a process gas can be used as a heat transfer agent by flowing it between a heated pedestal and a wafer supported over the pedestal and then into the CVD chamber. Again, the process gas used for the heat transfer can comprise a chemically active gas, an inert or carrier gas, or combinations thereof. The process gas can also include any gas not destructive to the processing of the semiconductor wafer which accomplishes the heat transfer of the present invention. For example, the process gas could be an inert gas not otherwise used in the process but which can be released into the reaction chamber without degrading the processing of the wafer.

While this invention has been discussed in terms of a single wafer system, it is equally applicable to multiple wafer systems such as the Applied Materials 8310 etcher which processes 18 wafers simultaneously. In the case of multiple wafer etcher systems, it is still desirable to maintain the total pressure of the process gasses to the range of 130 - 300 sccm, and the flow of process gas against each wafer at at least about .05 sccm. In the case of the 8310 etcher, this results in a total flow of process gasses against the wafers of at least about .9 sccm. The total gas flow for cooling is still in the range of 1 - 5 % of the process gas within the apparatus.

Thus, the invention provides an improved process and apparatus for heating or cooling a semiconductor wafer in a semiconductor processing apparatus using the process gas as the heat conducting means between the wafer surface and a heat conductor. Preferably, the flow of process gas into the chamber is controlled to keep the total flow of process gas into the chamber constant and the pressure in the apparatus is monitored to maintain the desired pressure therein.

Claims

1. A method of processing semiconductor wafers in a wafer processing apparatus including a processing chamber in which the wafer is located on a surface of a heat sink, the method including the steps of subjecting the exposed side of the wafer to a processing step including flowing a process gas over the surface of the wafer and cooling the wafer by directing a heat transfer gas against the rearward face of the wafer adjacent to the heat sink to transfer heat from the wafer to the sink; characterised in that the apparatus comprises a plasma etching chamber and the process to which the wafers are subjected in the chamber is a plasma etching process, in that the processing gas in the chamber and heat transfer gas between the wafer and heat sink are at substantially the same pressures, in that the heat transfer gas comprises one or more thermally conductive components of the process gas, in that the wafer rests unheld against the surface of the sink, and in that the heat transfer gas directed at the back of the wafer flows out between the wafer and heat sink into the plasma etching chamber.

2. A method of cooling a semi-conductor wafer as claimed in Claim 1, characterised in that the heat transfer gas is directed through one or more openings in said surface of the heat sink to provide heat transfer between said rearward wafer surface and said heat sink before flowing into the plasma etching chamber.

3. A method of cooling a semi-conductor wafer as claimed in Claim 2, characterised in that the heat transfer gas is directed in a controlled flow of from about 1-5 sccm of said one or more components of the processing gas toward said rearward surface of said wafer.

4. A method of cooling a semi-conductor wafer as claimed in Claim 3, including the step of controlling the total flow of process gas into said plasma etching chamber to within a range of from about 130 to about 300 sccm.

5. A method of cooling a semi-conductor wafer as claimed in any of Claims 1 to 4, characterised in that the heat transfer gas comprises about 1 to about 5% of the total process gas flow and is directed toward said rear surface of said wafer.

6. A method of cooling a semi-conductor wafer as claimed in any of Claims 1 to 5, characterised in that the heat transfer gas comprising one or more components of said process gas which are directed into contact with said rear surface of said wafer to provide heat transfer from said wafer to said adjacent support means are selected from the class consisting of fluorinated 1-4 carbon, hydrocarbons and argon.

silicone rubber heat transfer means was measured and found to be 115°C after a sufficient time to achieve steady state conditions, i.e., after about 3-5 minutes of etching. In contrast, the temperature of a silicon wafer cooled in accordance with the invention and etched under the same etching conditions and time period was found to be 65°C, indicating the superior heat transfer realized using the process and apparatus of the invention.

While the above preferred embodiment refers to the cooling of semiconductor wafers in plasma etching apparatus, methods and apparatus in accordance with the present invention can also advantageously heat wafers within semiconductor processing equipment. For example, in a CVD chamber a process gas can be used as a heat transfer agent by flowing it between a heated pedestal and a wafer supported over the pedestal and then into the CVD chamber. Again, the process gas used for the heat transfer can comprise a chemically active gas, an inert or carrier gas, or combinations thereof. The process gas can also include any gas not destructive to the processing of the semiconductor wafer which accomplishes the heat transfer of the present invention. For example, the process gas could be an inert gas not otherwise used in the process but which can be released into the reaction chamber without degrading the processing of the wafer.

While this invention has been discussed in terms of a single wafer system, it is equally applicable to multiple wafer systems such as the Applied Materials 8310 etcher which processes 18 wafers simultaneously. In the case of multiple wafer etcher systems, it is still desirable to maintain the total pressure of the process gasses to the range of 130 - 300 sccm, and the flow of process gas against each wafer at at least about .05 sccm. In the case of the 8310 etcher, this results in a total flow of process gasses against the wafers of at least about .9 sccm. The total gas flow for cooling is still in the range of 1 - 5 % of the process gas within the apparatus.

Thus, the invention provides an improved process and apparatus for heating or cooling a semiconductor wafer in a semiconductor processing apparatus using the process gas as the heat conducting means between the wafer surface and a heat conductor. Preferably, the flow of process gas into the chamber is controlled to keep the total flow of process gas into the chamber constant and the pressure in the apparatus is monitored to maintain the desired pressure therein.

Claims

1. A method of processing semiconductor wafers in a wafer processing apparatus including a processing chamber in which the wafer is located on a surface of a heat sink, the method including the steps of subjecting the exposed side of the wafer to a processing step including flowing a process gas over the surface of the wafer and cooling the wafer by directing a heat transfer gas against the rearward face of the wafer adjacent to the heat sink to transfer heat from the wafer to the sink; characterised in that the apparatus comprises a plasma etching chamber and the process to which the wafers are subjected in the chamber is a plasma etching process, in that the processing gas in the chamber and heat transfer gas between the wafer and heat sink are at substantially the same pressures, in that the heat transfer gas comprises one or more thermally conductive components of the process gas, in that the wafer rests unheld against the surface of the sink, and in that the heat transfer gas directed at the back of the wafer flows out between the wafer and heat sink into the plasma etching chamber.

2. A method of cooling a semi-conductor wafer as claimed in Claim 1, characterised in that the heat transfer gas is directed through one or more openings in said surface of the heat sink to provide heat transfer between said rearward wafer surface and said heat sink before flowing into the plasma etching chamber.

3. A method of cooling a semi-conductor wafer as claimed in Claim 2, characterised in that the heat transfer gas is directed in a controlled flow of from about 1-5 sccm of said one or more components of the processing gas toward said rearward surface of said wafer.

4. A method of cooling a semi-conductor wafer as claimed in Claim 3, including the step of controlling the total flow of process gas into said plasma etching chamber to within a range of from about 130 to about 300 sccm.

5. A method of cooling a semi-conductor wafer as claimed in any of Claims 1 to 4, characterised in that the heat transfer gas comprises about 1 to about 5% of the total process gas flow and is directed toward said rear surface of said wafer.

6. A method of cooling a semi-conductor wafer as claimed in any of Claims 1 to 5, characterised in that the heat transfer gas comprising one or more components of said process gas which are directed into contact with said rear surface of said wafer to provide heat transfer from said wafer to said adjacent support means are selected from the class consisting of fluorinated 1-4 carbon, hydrocarbons and argon.

* C L M S *

7. A method of cooling a semiconductor wafer as claimed in any of Claims 1 to 6, characterised in that the plasma etching apparatus has a total process gas flow into said apparatus of from about 130 to about 300 sccm comprising directing into contact with a surface of said wafer from about 1-5 sccm of at least a portion of said one or more components of said process gas selected from the class consisting of fluorinated 1-4 carbon, hydrocarbons and argon to transfer heat from said wafer to said support; and monitoring the vacuum in said plasma etching apparatus to maintain said plasma etching apparatus at a pressure of from about 5.3 Pa (40) to about 27 Pa (200 millitorr).

8. Apparatus for cooling a semiconductor wafer in a wafer processing apparatus by utilizing one or more components of the process gas used in the process as a gas conduction heat transfer gas which comprises; means (30) for supporting said wafer on a support surface which support surface also functions as a heat sink, and means (32, 36, 38, 40) for directing a heat transfer gas into contact with a rear surface of said wafer (50) adjacent said support surface; characterised in that the apparatus is a plasma etching apparatus and the support surface provides a surface on which the wafer (50) rests unheld to be subjected to said process gas in that the means are provided for directing a proportion of the process gas containing one or more thermally conductive components against the rear surface of said wafer adjacent the support surface to provide said heat transfer gas, and in that the process gas and heat transfer gas are supplied at substantially the same pressures whereby the wafer can rest unheld on said support and the heat transfer gas can flow between the wafer and sink into the processing chamber.

Patentansprüche

1. Verfahren zur Behandlung von Halbleiterwafern in einer Waferbehandlungsvorrichtung mit einer Behandlungskammer, in der der Wafer auf einer Oberfläche einer Wärmesenke angeordnet wird, wobei das Verfahren die Schritte umfaßt, die freiliegende Seite des Wafers einem Behandlungsschritt zu unterwerfen, zu dem das Strömenlassen eines Prozeßgases über die Oberfläche des Wafers und das Kühlen des Wafers durch Richten eines Wärmeübertragungsgases gegen die rückseitige Fläche des Wafers angrenzend an die Wärmesenke gehören, um Wärme von dem Wafer auf die Senke zu übertragen, dadurch gekennzeichnet, daß die Vorrichtung eine Plasmaätzkammer aufweist und daß das Verfahren, dem die Wafer in der Kammer unterworfen werden, ein Plasmaätzverfahren ist, daß das Prozeßgas in der Kammer und das Wärmeübertragungsgas zwischen dem Wafer und der Wärmesenke im wesentlichen die gleichen Drucke haben, daß das Wärmeübertragungsgas eine oder mehrere wärmeleitende Komponenten des Prozeßgases aufweist, daß der Wafer ohne gehalten zu sein auf der Oberfläche der Senke ruht und daß das Wärmeübertragungsgas, das gegen die Rückseite des Wafers gerichtet ist, zwischen dem Wafer und der Wärmesenke in die Plasmaätzkammer abströmt.

2. Verfahren zum Kühlen eines Halbleiterwafers nach Anspruch 1, dadurch gekennzeichnet, daß das Wärmeübertragungsgas durch eine oder mehrere Öffnungen in der Oberfläche der Wärmesenke gerichtet wird, um einen Wärmeübergang zwischen der rückseitigen Waferoberfläche und der Wärmesenke vor dem Strömen in die Plasmaätzkammer zu bewirken.

3. Verfahren zum Kühlen eines Halbleiterwafers nach Anspruch 2, dadurch gekennzeichnet, daß das Wärmeübertragungsgas als eingestellter Strom von etwa 1 bis 5 sccm einer oder mehrerer Komponenten des Prozeßgases gegen die rückseitige Oberfläche des Wafers gerichtet wird.

4. Verfahren zum Kühlen eines Halbleiterwafers nach Anspruch 3 mit dem Schritt, den Gesamtstrom des Prozeßgases in die Plasmaätzkammer auf innerhalb eines Bereichs von etwa 130 bis etwa 300 sccm einzustellen.

5. Verfahren zum Kühlen eines Halbleiterwafers nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß das Wärmeübertragungsgas etwa 1 bis etwa 5 % des gesamten Prozeßgasstroms aufweist und gegen die rückseitige Oberfläche des Wafers gerichtet wird.

6. Verfahren zum Kühlen eines Halbleiterwafers nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, daß das Wärmeübertragungsgas, welches eine oder mehrere Komponenten des Prozeßgases aufweist, die in Kontakt mit der rückseitigen Oberfläche des Wafers gerichtet werden, um eine Wärmeübertragung von dem Wafer auf die angrenzenden Abstützeinrichtungen zu bewirken, aus der Klasse ausgewählt wird, die aus fluorierten Kohlenwasserstoffen mit 1 bis 4 Kohlenstoffatomen und Argon besteht.

7. Verfahren zum Kühlen eines Halbleiterwafers nach einem der Ansprüche 1 bis 6, dadurch ge-

kennzeichnet, daß die Plasmaätzvorrichtung einen gesamten Prozeßgasstrom in die Vorrichtung von etwa 130 bis etwa 300 sccm aufweist, wobei etwa 1 bis 5 sccm wenigstens eines Teils einer oder mehrerer Komponenten des Prozeßgases in Kontakt mit einer Oberfläche des Wafers gerichtet wird, das aus der Klasse ausgewählt wird, die aus fluorierten Kohlenwasserstoffen mit 1 bis 4 Kohlenstoffatomen und Argon besteht, um Wärme von dem Wafer auf die Abstützung zu übertragen, und wobei das Vakuum in der Plasmaätzvorrichtung überwacht wird, um die Plasmaätzvorrichtung auf einen Druck von etwa 5,3 Pa (40) bis etwa 27 Pa (200 Millitorr) zu halten.

8. Vorrichtung zum Kühlen eines Halbleiterwafers in einer Waferbehandlungsvorrichtung unter Verwendung einer oder mehrerer Komponenten des Prozeßgases, das in dem Verfahren als ein Gasleitungswärmeübertragungsgas verwendet wird, mit Einrichtungen (30) zum Abstützen des Wafers auf einer Abstützfläche, die auch als Wärmesenke wirkt, und mit Einrichtungen (32, 36, 38, 40) zum Richten eines Wärmeübertragungsgases in Kontakt mit einer rückseitigen Oberfläche des Wafers (50) angrenzend an die Abstützfläche, dadurch gekennzeichnet, daß die Vorrichtung eine Plasmaätzvorrichtung ist und daß die Abstützfläche eine Oberfläche bildet, auf der der Wafer (50) ohne gehalten zu sein ruht, um dem Prozeßgas ausgesetzt zu werden, daß Einrichtungen zum Richten eines Anteils des Prozeßgases, das eine oder mehrere wärmeleitende Komponenten enthält, gegen die rückseitige Oberfläche des Wafers angrenzend an die Abstützfläche zur Bildung des Wärmeübertragungsgases vorgesehen sind und daß das Prozeßgas und das Wärmeübertragungsgas mit im wesentlichen gleichen Drucken zugeführt werden, wodurch der Wafer ohne gehalten zu sein auf der Abstützung ruhen und das Wärmeübertragungsgas zwischen dem Wafer und der Senke in die Behandlungskammer strömen kann.

Revendications

1. Procédé de traitement de plaquettes semiconductrices dans un dispositif de traitement de plaquettes comportant une chambre de traitement dans laquelle la plaquette est placée sur une surface d'un puits thermique, le procédé comprenant les étapes consistant à soumettre le côté exposé de la plaquette à une étape de traitement mettant en jeu le passage d'un gaz de traitement sur la surface de la plaquette et le refroidissement de la plaquette par projection d'un gaz de transfert thermique contre la face arrière de la plaquette de façon adjacente au puits thermique pour transférer la chaleur de la plaquette vers le puits;
caractérisé en ce que le dispositif comprend une chambre d'attaque au plasma et le traitement auquel les plaquettes sont soumises dans la chambre est un traitement d'attaque au plasma, en ce que le gaz de traitement se trouvant dans la chambre et le gaz de transfert thermique se trouvant entre la plaquette et le puits thermique sont sensiblement à la même pression, en ce que le gaz de transfert thermique comprend un ou plusieurs constituants thermiquement conducteurs du gaz de traitement, en ce que la plaquette repose sans être maintenue contre la surface du puits, et en ce que le gaz de transfert thermique projeté au dos de la plaquette s'écoule en sortant d'entre la plaquette et le puits thermique pour pénétrer dans la chambre d'attaque au plasma.

2. Procédé de refroidissement d'une plaquette semiconductrice selon la revendication 1, caractérisé en ce que le gaz de transfert thermique est dirigé à travers une ou plusieurs ouvertures pratiquées dans ladite surface du puits thermique pour produire un transfert thermique entre ladite surface arrière de la plaquette et ledit puits thermique avant de s'écouler dans la chambre d'attaque au plasma.

3. Procédé de refroidissement d'une plaquette semiconductrice selon la revendication 2, caractérisé en ce que le gaz de transfert thermique est dirigé sous la forme d'un débit régulé d'environ 1-5 cm^3/min (1-5 sccm) dudit un ou plusieurs constituants du gaz de traitement vers ladite surface arrière de ladite plaquette.

4. Procédé de refroidissement d'une plaquette semiconductrice selon la revendication 3, comprenant l'étape consistant à commander le débit total de gaz de traitement dans ladite chambre d'attaque au plasma afin qu'il se situe dans une gamme d'environ 130 à environ 300 cm^3/min (environ 130 à environ 300 sccm).

5. Procédé de refroidissement d'une plaquette semiconductrice selon l'une quelconque des revendications 1 à 4, caractérisé en ce que le gaz de transfert thermique représente environ 1 à environ 5% du débit de gaz de traitement total et est dirigé vers ladite surface arrière de ladite plaquette.

6. Procédé de refroidissement d'une plaquette semiconductrice selon l'une quelconque des revendications 1 à 5, caractérisé en ce que le gaz de

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transfert thermique, comprenant un ou plusieurs constituants dudit gaz de traitement qui sont dirigés pour venir au contact de ladite surface arrière de ladite plaquette pour produire un transfert de chaleur de ladite plaquette vers ledit moyen de support adjacent, est sélectionné dans la classe constituée du carbone 1-4-fluoré, d'hydrocarbures et d'argon.

7. Procédé de refroidissement d'une plaquette semiconductrice selon l'une quelconque des revendications 1 à 6, caractérisé en ce que le dispositif d'attaque au plasma reçoit un débit total de gaz de traitement d'environ 130 à environ 300 cm^3/min (environ 130 à environ 300 sccm), consistant à diriger au contact d'une surface de ladite plaquette, d'environ 1-5 cm^3/min (1-5 sccm) d'au moins une partie dudit un ou plusieurs constituants dudit gaz de traitement sélectionnés dans la classe constituée du carbone 1-4-fluoré, d'hydrocarbures et d'argon pour transférer de la chaleur de ladite plaquette vers ledit support; et en ce qu'on contrôle le vide dans ledit dispositif d'attaque au plasma afin de maintenir ledit dispositif d'attaque au plasma sous une pression d'environ 5,3 Pa (40 millitorrs) à environ 27 Pa (200 millitorrs).

8. Dispositif pour refroidir une plaquette semiconductrice dans un dispositif de traitement de plaquettes par utilisation d'un ou plusieurs constituants du gaz de traitement utilisé dans le traitement en tant que gaz de transfert thermique par conduction de gaz, qui comprend: un moyen (30) pour supporter ladite plaquette sur une surface de support, cette surface de support jouant également le rôle de puits thermique, et un moyen (32, 36, 38, 40) pour diriger un gaz de transfert thermique au contact d'une surface arrière de ladite plaquette (50) au voisinage immédiat de ladite surface de support; caractérisée en ce que le dispositif est un dispositif d'attaque au plasma et la surface de support constitue une surface sur laquelle la plaquette (50) repose sans être maintenue pour être exposée audit gaz de traitement, en ce que des moyens sont prévus pour diriger une proportion du gaz de traitement contenant un ou plusieurs constituants thermiquement conducteurs contre la surface arrière de ladite plaquette au voisinage immédiat de la surface de support, afin de fournir ledit gaz de transfert thermique, et en ce que le gaz de traitement et le gaz de transfert thermique sont introduits sous des pressions sensiblement identiques afin que la plaquette puisse reposer sans être maintenue sur ledit support et que le gaz de transfert thermique puisse s'écouler entre la plaquette et le puits pour pénétrer dans la chambre de traitement.