METHOD OF TREATING AN EXHAUST GAS

This invention relates to a method of treating an exhaust gas, and to a method of inhibiting the accumulation of solid explosive material within a foreline for conveying a fluid stream comprising the explosive material in gaseous form from a processing chamber.

Epitaxial deposition processes are increasingly used for high-speed semiconductor devices, both for silicon and compound semiconductor applications. An epitaxial layer is a carefully grown, single crystal silicon film. Epitaxial deposition utilizes a silicon source gas, typically silane or one of the chlorosilane compounds, such as trichlorosilane or dichlorosilane, in a hydrogen atmosphere at high temperature, typically around 800 - 1100°C, and under a vacuum condition. Epitaxial deposition processes are often doped with small amounts of boron, phosphorus, arsenic, germanium or carbon, as required, for the device being fabricated. Hydrogen chloride may also be used to clean the chamber between deposition runs.

In such deposition processes, the residence time of the deposition gases in the processing chamber is relatively short, and only a small proportion of the gas supplied to the chamber is consumed during the deposition process. Consequently, the majority of the deposition gases supplied to the chamber are exhausted from the chamber together with by-products from the deposition process.

A problem associated particularly with epitaxial deposition processes is that the by-products can adhere to, or be deposited on, the inner wall surface of the foreline extending between the processing chamber and the vacuum pump. Such by-products tend to be compounds of silicon and chlorine, or compounds of silicon and hydrogen. These by-products may include chlorosilane polymers of the form $Si_xCl_yH_z$. These polymers can be converted to self-ignitable or explosive materials, for example polysiloxanes, if exposed

to moisture contained in the atmosphere. Consequently, if this material is allowed to accumulate within the foreline, there is a risk that when the foreline is exposed to air, for example when the foreline is dissembled during maintenance to remove the polymers deposited within the foreline, or due to the accidental ingress of air into the foreline due to a leakage in the foreline, an explosion may occur.

It is an aim of at least the preferred embodiment of the present invention to seek to solve this and other problems.

In a first aspect, the present invention provides a method of inhibiting the accumulation of solid explosive material within a foreline for conveying a fluid stream comprising the explosive material in gaseous form from a processing chamber, said method comprising the steps of supplying to the fluid stream an oxidant for reacting with the explosive material to form non-explosive material, and inhibiting the migration of oxidant into the processing chamber.

By supplying a controllable amount of oxidant to the fluid stream for reacting with the gaseous explosive material, this material can be converted into a non-explosive material before it condenses on the inner surfaces of the foreline, thereby increasing safety. The oxidant is preferably supplied directly to the foreline, and preferably as close as possible to the processing chamber in order to reduce the extent of the foreline in which explosive material may still accumulate.

In order to prevent ingress of the oxidant into the processing chamber, where it may undesirably react with gases supplied to the processing chamber, means are provided for inhibiting the migration of oxidant from the foreline into the processing chamber. The isolating means is preferably provided by a pumping mechanism, which may be provided upstream from an oxidant inlet through which the oxidant is supplied to the foreline. This pumping mechanism can partially compress the gases exhaust from the processing

chamber, and thereby isolate the chamber from significant ingress of the oxidant. Alternatively, the isolating means may be provided by an orifice located in the foreline upstream from the oxidant inlet.

As opposed to supplying the oxidant directly to the foreline, the oxidant may be supplied to an oxidant inlet of a vacuum pump incorporating the pumping mechanism, which oxidant inlet is preferably located downstream from the pumping mechanism so that this pumping mechanism can inhibit the migration of oxidant into the processing chamber. For example, if the vacuum pump is a multi-stage pump, the oxidant inlet may be located between stages of the pump.

In a second aspect, the present invention provides a method of treating a gas exhaust from a chamber, the exhaust gas comprising an explosive material in gaseous form, said method comprising the steps of supplying to the exhaust gas an oxidant for reacting with the explosive material to form non-explosive material, and inhibiting the migration of oxidant into the chamber.

In a third aspect, the present invention provides a system for inhibiting the accumulation of solid explosive material within a foreline for conveying a fluid stream comprising the explosive material in gaseous form from a processing chamber, the system comprising means for supplying to the fluid stream an oxidant for reacting with the explosive material to form non-explosive material, and means for inhibiting the migration of oxidant into the processing chamber.

In a fourth aspect, the present invention provides a system for treating a gas exhaust from a chamber, the exhaust gas comprising an explosive material in gaseous form, said system comprising means for supplying to the exhaust gas an oxidant for reacting with the explosive material to form non-explosive material, and means for inhibiting the migration of oxidant into the chamber.

Features described above in relation to method aspects of the invention are equally applicable to system aspects, and vice versa.

By way of example, an embodiment of the invention will now be described with reference to the following figure, which illustrates schematically a system for inhibiting the accumulation of solid explosive material within a foreline 10 conveying a fluid stream, or exhaust gas, from a processing chamber 12 to a vacuum pump 14. The system finds particular use with a processing chamber 12 in which an epitaxial deposition process is performed, as such processes can result in the exhaust of explosive material in gaseous form. Such explosive material is typically polymeric material, and typically comprises silicon and chlorine, for example a chlorosilane polymer. However, the system is not limited to the use with such a processing chamber, as it may be used in combination with any other chamber that exhausts explosive material.

The system comprises a source 16 of an oxidant, for example, at least one of oxygen, ozone, air, fluorine, peroxide and water vapour, and preferably of controlled humidity, for reacting with the explosive material within the exhaust gas stream to form non-explosive material. In the illustrated embodiment, the oxidant is continuously, or periodically, conveyed from the source directly into the foreline 10 through an oxidant inlet 18, which is preferably located as close as possible to the processing chamber 12 in order to minimise the length of foreline in which explosive material may still accumulate. The supply of the oxidant to the foreline 10 is controlled by a controller 20, which supplies signals to a valve 22 or other variable flow conductance device to control the oxidant supply to the foreline 10. As illustrated, the controller 20 may also be configured to supply process gases to the processing chambers from respective gas sources 24, 26, 28 (three are illustrated in the drawing, although any number may be provided). This can enable the periodic supply of oxidant to the foreline to be synchronised with the supply of one or more of the process gases to the processing chamber 12.

To inhibit the migration of oxidant from the foreline 10 into the processing chamber 12, in this example an additional pumping mechanism is provided between the processing chamber 12 and the oxidant inlet 18. As illustrated, this pumping mechanism may form part of a pump 30 located within the foreline 10. An example of a suitable pumping mechanism is a Roots pumping mechanism. The pumping mechanism partially compresses the exhaust gas drawn from the processing chamber 12, thereby isolating the processing chamber 12 from significant ingress of the oxidant. Further, this pumping mechanism may be used to control the temperature and pressure of the foreline 10, and thus assist in ensuring that the explosive material remains in gaseous form within the foreline 10.

As an alternative to providing an additional pumping mechanism for inhibiting the migration of oxidant into the processing chamber, an orifice may be located in the foreline 10 upstream from the oxidant inlet 18.

CLAIMS

1. A method of inhibiting the accumulation of solid explosive material within a foreline for conveying a fluid stream comprising the explosive material in gaseous form from a processing chamber, said method comprising the steps of supplying to the fluid stream an oxidant for reacting with the explosive material to form non-explosive material, and inhibiting the migration of oxidant into the processing chamber.

2. A method according to Claim 1, wherein the oxidant is supplied directly to the foreline.

3. A method according to Claim 1 or Claim 2, wherein the oxidant is supplied to the foreline proximate to the processing chamber.

4. A method according to any preceding claim, wherein a pumping mechanism is provided upstream from an oxidant inlet through which the oxidant is supplied to the fluid stream to inhibit the oxidant migration into the processing chamber.

5. A method according to Claim 4, wherein the pumping mechanism forms part of a vacuum pump located within the foreline and between the processing chamber and the oxidant inlet.

6. A method according to any of Claims 1 to 3, wherein an orifice is provided in the foreline at a position upstream from an oxidant inlet through which the oxidant is supplied to the fluid stream to inhibit the oxidant migration into the processing chamber.

7. A method according to any preceding claim, wherein the oxidant is continuously supplied to the foreline.

8. A method according to any of Claims 1 to 6, wherein the oxidant is periodically supplied to the foreline.

9. A method according to any preceding claim, wherein the explosive material comprises a polymeric material.

10. A method according to Claim 9, wherein the explosive material comprises a compound of at least silicon and chlorine.

11. A method according to any preceding claim, wherein the oxidant comprises at least one of oxygen, ozone, air, fluorine, peroxide and water vapour.

12. A method according to any preceding claim, wherein the humidity of the oxidant is controlled.

13. A method of treating a gas exhaust from a chamber, the exhaust gas comprising an explosive material in gaseous form, said method comprising the steps of supplying to the exhaust gas an oxidant for reacting with the explosive material to form non-explosive material, and inhibiting the migration of oxidant into the chamber.

14. A system for inhibiting the accumulation of solid explosive material within a foreline for conveying a fluid stream comprising the explosive material in gaseous form from a processing chamber, the system comprising means for supplying to the fluid stream an oxidant for reacting with the explosive material to form non-explosive material, and means for inhibiting the migration of oxidant into the processing chamber.

15. A system according to Claim 14, wherein the supply means is configured to supply oxidant directly to the foreline.

16. A system according to Claim 14 or Claim 15, wherein the supply means is configured to supply oxidant to the foreline proximate to the processing chamber.

17. A system according to any of Claims 14 to 16, wherein the isolating means comprises a pumping mechanism provided upstream from an oxidant inlet through which the oxidant is supplied to the fluid stream to inhibit the oxidant migration into the processing chamber.

18. A system according to Claim 17, wherein the pumping mechanism forms part of a vacuum pump located within the foreline and between the processing chamber and the oxidant inlet.

19. A system according to any of Claims 14 to 16, wherein the isolating means comprises an orifice located in the foreline upstream from an oxidant inlet through which the oxidant is supplied to the fluid stream to inhibit the oxidant migration into the processing chamber.

20. A system according to any of Claims 14 to 19, wherein the oxidant comprises at least one of oxygen, ozone, air, peroxide and water vapour.

21. A system for treating a gas exhaust from a chamber, the exhaust gas comprising an explosive material in gaseous form, said system comprising means for supplying to the exhaust gas an oxidant for reacting with the explosive material to form non-explosive material, and means for inhibiting the migration of oxidant into the chamber.