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DESCRIPTION

EXHAUST GAS PRETREATING METHOD AND EXHAUST GAS
PRETREATING DEVICE AND DEDUSTING DEVICE USED THEREFOR

5 TECHNICAL FIELD

The present invention relates to exhaust gas pretreating method and exhaust gas pretreating device, and dedusting device used therefor, and more particularly to method and device effective for pretreating exhaust gas used in production process or film forming process of modules of semiconductor or liquid crystal display.

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BACKGROUND ART

Hitherto, gases used in film forming process of modules of semiconductor or liquid crystal display include, for example, silane (SiH_4) and ammonia (NH_3) for forming a film, and fluorine gas for cleaning. Film forming gases such as silane and ammonia (or combustible gases) can be treated, for example, by plasma discharging in a chamber to form Si film or SiN film on a substrate, while cleaning gases such as NF_3 and fluorine gas (or combustion assisting gases) can be treated by discharging the residual Si in the chamber to out of the system in a form of SiF_4 .

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Such exhaust gases containing film forming gas and cleaning gas are sequentially treated so far by combustion type pretreating means and cleaning type dedusting means installed in the post-stage of the vacuum chamber of film forming device as shown in Fig. 5.

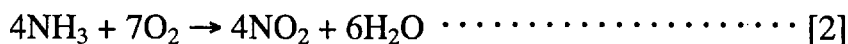
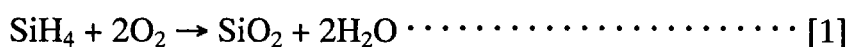
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In the pre-stage of the combustion type pretreating means and immediately after the vacuum chamber, means for removing SiF_4 from the cleaning exhaust gas is often installed. This SiF_4 removing means is provided near the gas discharge port

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from the film forming chamber, and is designed to supply water to the exhaust gas, and catch and collect SiF_4 as SiO_2 (silica), and further filter to remove the SiF_4 from the exhaust gas system.

In combustion type pretreating means of exhaust gas, combustible gas and combustion assisting gas are oxidized by combustion, and chemical reactions as shown in formulas [1] to [3] are induced.



Further, in cleaning type dust collecting means, the combustion gas is neutralized in water containing alkali, and cleaned and dust particles are collected, and SiO_2 is caught and collected, while acidic components (NO_2 , F_2) are separated as waste liquid.

So far, however, precipitates are generated in the SiO_2 catching and collecting means, subsequent piping, cleaning type dust collecting means, and subsequent piping, thereby leading to closure of piping and clogging in the cleaning device. Hence, frequent washing of cleaning type dust collecting means and piping was required. For cleaning of precipitates, hydrofluoric acid is used, and due attention to safety is needed. Besides, owing to such cleaning and maintenance, the operation rate of the process is lowered.

The invention is devised to alleviate maintenance works and improve the safety of the works in the pretreating process of exhaust gas generated in production device of semiconductor or liquid crystal module such as film forming device.

DISCLOSURE OF THE INVENTION

The present inventors analyzed precipitates in the exhaust gas pretreating process, and mainly discovered calcium silicofluoride (CaSiF_6) in the process after the cleaning type dust collecting means, and mainly detected ammonium silicofluoride ($(\text{NH}_4)_2\text{SiF}_6$) in the process from the film forming device to the combustion type pretreating means.

As causes of such precipitates were searched, calcium silicofluoride is disclosed to be derived from SiO_2 contained in exhaust gas and combustion gas, hydrofluoric acid generated during combustion, and calcium contained in cleaning water and process water. It was found, Ammonium silicofluoride was derived from SiO_2 , hydrofluoric acid (HF), and ammonia gas in exhaust gas.

These precipitates are SiO_2 contained in exhaust gas, and the following findings were obtained: in the cleaning type dust collecting means, SiO_2 is not caught and collected efficiently but is left over inside, and in the pre-stage of the combustion type pretreating means, the SiF_4 removing means does not function effectively, and SiO_2 produced by chemical reaction with water is not caught and collected sufficiently but leaks out into the exhaust gas. In particular, in the cleaning type dust collecting means, fine particles of SiO_2 in particle size of about 0.1 to 1 μm are likely to be left over, and the dust collecting rate was only about 50%.

In the exhaust gas treating process, comprising the Si removing means immediately after the film forming device and the cleaning type dust collecting means immediately after the combustion type pretreating means, the catching and collecting function of Si components (SiH_4 , SiF_4 , SiO_2 , etc.) is found to be not so effective as expected, which was a great surprise for those skilled in the art. The present inventors found promotion of generation of precipitates due to high Ca

concentration in the process water, and detected residue of Si components for the first time.

Hence the inventors discovered that the problems of the prior art can be solved by installing dedusting (device) means in the pre-stage of the cleaning type dusts
5 collecting means. The inventors also found that the problems of the prior art can be solved by sustaining the inside of the piping from the film forming device to the combustion type pretreating means at a temperature not forming precipitates in these areas, and finally devised the invention.

That is, the abstract of the invention is as follows.

10 (1) An exhaust gas pretreating method, being a pretreating method of exhaust gas containing Si components comprising:

a combustion treating step of exhaust gas,

a dedusting step of removing dust particles containing Si from combustion exhaust gas generated by combustion treatment, and

15 a cleaning step of washing the dedusted combustion exhaust gas in water.

(2) The exhaust gas pretreating method of (1), in which a bag filter is used as dedusting (device) means in the dedusting step.

(3) The exhaust gas pretreating method of (2), in which the dedusting (device) means has a filter in its dedusting route, compressed gas is supplied to the filter in
20 the dedusting step of the dedusting (device) means, and gas flow is applied to the outside of the filter to direct the dust discharge side from near the filter surface.

(4) The exhaust gas pretreating method of (2) or (3), in which at least m sets (m being an integer of 3 or more) of dedusting means are provided in the dedusting step, and are used by changing over so that the dedusting step is realized by at least
25 one dedusting (device) means and that the dust collecting step is realized by at most

(m-1) sets of dedusting (device) means.

(5) The exhaust gas pretreating method of any one of (1) to (5), in which the gas dedusted in the dedusting step is discharged at an air flow rate depending on the discharge pressure of the gas.

5 (6) The exhaust gas pretreating method of any one of (1) to (5), in which the water introduced for cleaning in the cleaning step is pure water or water of hardness of up to 0.

(7) The exhaust gas pretreating method of any one of (1) to (6), in which the exhaust gas introduced into the combustion treating step is sustained at a
10 temperature not forming precipitates possible to be generated in a pre-stage of the combustion treating step.

(8) An exhaust gas pretreating method, being a pretreating method of exhaust gas containing Si components comprising:

a combustion treating step of exhaust gas, and

15 a dedusting step of removing dust particles containing Si from combustion exhaust gas generated by combustion treatment,

in which the exhaust gas introduced into the combustion treating step is sustained at a temperature not forming precipitates possible to be generated in a pre-stage of the combustion treating step.

20 (9) An exhaust gas pretreating device, being a pretreating device of exhaust gas containing Si components comprising:

means for combustion treatment of exhaust gas,

dedusting means for removing dust particles containing Si from combustion exhaust gas generated by combustion treatment, and

25 cleaning means for washing the dedusted combustion exhaust gas in water.

(10) The exhaust gas pretreating device of (9), in which a bag filter is used as dedusting means in the dedusting step.

(11) The exhaust gas pretreating device of (10), in which the dedusting means of the bag filter has a filter in the route of the bag filter to supply compressed gas to the filter, and also has gas introducing means for applying a gas flow to the outside
5 of the filter to direct the dust discharge side from near the filter surface.

(12) The exhaust gas pretreating device of (10) or (11), in which the dedusting means has at least m sets (m being an integer of 3 or more) of dedusting means, and they are used by changing over so that the dedusting step is realized by at least one
10 dedusting means and that the dust collecting step is realized by at most $(m-1)$ sets of dedusting (device) means.

(13) The exhaust gas pretreating device of any one of (9) to (12), in which the water introduced for cleaning in the cleaning step is pure water or water of hardness of up to 0.

15 (14) The exhaust gas pretreating device of any one of (9) to (13), further comprising means for sustaining the exhaust gas introduced into the combustion treating means at a temperature not forming precipitates possible to be generated in a pre-stage of the combustion treating means.

(15) The exhaust gas pretreating device of any one of (9) to (14), further
20 comprising exhaust means for varying the flow rate depending on the gas pressure discharged from the dedusting means.

(16) An exhaust gas pretreating device, being a pretreating device of exhaust gas containing Si components comprising:

means for combustion treatment of exhaust gas,

25 dedusting means for removing dust particles containing Si from combustion

exhaust gas generated by combustion treatment, and

means for sustaining the exhaust gas introduced into the combustion treating means at a temperature not forming precipitates possible to be generated in a pre-stage of the combustion treating means.

5 (17) A dedusting device, being a device for removing particles containing Si components comprising a bag filter, in which the bag filter has a filter as one of the components, and also has, as filter dust shaking-down means, gas introducing means for supplying compressed gas to the filter and applying a gas flow to the outside of the filter for directing the dust discharge side from near the filter surface.

10 (18) The dedusting device of (17), in which the dust discharge port of the dedusting device has a valve, which is closed when dust is collected on the filter, and is opened when dedusting by supply of compressed gas and gas flow.

According to the invention of aspects (1) to (7) and (9) to (15), since dust particles containing Si components are removed in the dedusting step or by
15 dedusting means, and therefore deposition of precipitates is suppressed by the cleaning step or means. Hence, the process or device is operated stably, and the maintenance work is alleviated. Further, the cleaning step can be executed without spending a huge volume of cleaning water.

By using a bag filter in the dedusting step or dedusting means, fine SiO_2
20 particles of about 0.1 to 1 μm can be caught and collected efficiently. Further, in the step of shaking down dust from the filter, by applying the gas flow in addition to supply of compressed gas, fine dust particles floating in the atmosphere in the dedusting means can be effectively collected and discharged by the compressed gas. Moreover, by applying the gas flow, the inside of the dedusting means is replaced
25 with atmospheric gas, and an atmosphere for smoothly catching and collecting dust

particles containing Si components is formed. By discharging at an air flow rate suited to the discharge pressure of the gas after dedusting, an appropriate discharge amount depending on the pressure loss is assured always in the dedusting step or means.

5 In the cleaning step or means, by using cleaning water ranging from pure water to water of hardness of up to 0, generation of precipitates containing Si components is suppressed in the cleaning step or means or subsequent step or means, and stable operation is realized, so that the maintenance work may be simplified.

10 According to the invention as set forth in aspects (7) and (8) or (15) and (16), the exhaust gas introduced in the combustion process step or means is sustained at a temperature not forming precipitates possible to be formed in a pre-stage of the combustion treating step or means, and generation of precipitates containing Si components in the exhaust gas piping can be avoided up to the combustion treating step or means, so that a stable exhaust gas pretreating step can be executed.

15 The bag filter of the invention can effectively remove dust particles containing Si components of fine particle size (in particular, about 0.1 to 1 μm) floating in the housing of the bag filter.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Fig. 1 is a diagram explaining exhaust gas pretreating device and exhaust gas pretreating method of the invention, Fig. 2 is a diagram showing a bag filter of the invention, Fig. 3 is a schematic diagram of exhaust gas pretreating device in a second preferred embodiment of the invention, Fig. 4 is a schematic diagram of exhaust gas pretreating device in a third preferred embodiment of the invention, and
25 Fig. 5 is a diagram showing a conventional exhaust gas pretreating step.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the invention are described in detail below.

The exhaust gas pretreating method, exhaust gas pretreating device, and
5 dedusting device of the invention are applicable to exhaust gas containing Si
components. Such exhaust gas is generated in the manufacturing process or device
of semiconductors or liquid crystal modules, particularly in the film forming process
or film forming device. Therefore, the exhaust gas pretreating method, exhaust gas
pretreating device, and dedusting device of the invention are preferred to be applied
10 in such process or device. In the film forming process, in particular, obvious effects
will be obtained when applied in exhaust gas generated in the vapor phase
deposition process or device of CVD, plasma CVD or the like.

(Preferred embodiment 1)

Fig. 1 is a schematic diagram of exhaust gas pretreating device and exhaust gas
15 pretreating process in a preferred embodiment of the invention.

A pretreating device 2 comprises combustion treating means 4, dedusting
(device) means 14, and cleaning means 44. Fig. 1 shows a manufacturing device of
thin film or the like in which this pretreating device is installed or disposed, and
specifically it is a film forming device of plasma CVD in this preferred embodiment.

20 The combustion treating means 4 is realized by a known oxidation combustion
device. As combustible gas, oxygen is supplied from outside, and flame is supplied
by a burner or the like, and exhaust gas components are burned and oxidized at high
temperature. In the combustion treating means 4, as mentioned above, exhaust
gases of various combustible gases (silane, ammonia, phosphine, etc.) and
25 combustion assisting gases (nitrogen trifluoride, etc.) produce oxides of

corresponding elements such as SiO₂ (silica) or NO₂, or water or fluorine, etc. Therefore, combustion exhaust gas contains these combustion exhaust gases aside from particles of SiO₂ and others.

Combustion exhaust gas discharged from the combustion treating means 4 is introduced into the dedusting (device) means 14. The dedusting (device) means 14 may be realized by various known dedusting devices. For example, centrifugal separator, scrubber, and bag filter can be used, and the bag filter is particularly preferred. The bag filter is especially high in dust removing effect of fine particles of about 0.1 to 1 μm.

Various methods are known hitherto as the bag filter. Usually, depending on the method of shaking down dust particles from the filter, mechanical vibration system, backward washing system, ultrasonic cleaning system, reverse jet system, and pulse air system are known, and a proper system may be selected depending on the design conditions or the like. In particular, a pulse air system bag filter is preferred.

Fig. 2 shows a preferred example of bag filter to be used in the invention. Usually, the pulse air system bag filter comprises a housing 16 for holding filters 18, a top plenum 20 provided in divisions in the upper part of the housing, and a dust collecting section 30 disposed in the housing lower part. The dedusting (device) means 14 of the invention includes gas feeding means 40.

Inside the housing 16, a plurality of filters 18 are installed, and the filter 18 is usually a cylindrical tube. The inside of the filter 16 communicates with the inside of the top plenum 20 by way of a tube sheet 21.

At a holding position of the filter 18 in the housing 16, there is a passage section for introducing the combustion exhaust gas to be treated supplied from

outside. The passage section 19 is opened when introducing exhaust gas, and is closed when shaking down dust.

The top plenum 20 is provided by way of the filter 16 and tube sheet 21, and communicates with the inside of the filter 16, and the cleaned gas is introduced through the filter 18, while the compressed gas can be introduced into the filter 18. That is, it comprises a discharge section 22 for discharging the cleaned gas dedusted by the filter 18, and a jet device 24 of compressed gas into the filter 18.

The discharge section 22 is opened while the exhaust gas is introduced and is being dedusted, and is closed when shaking down dust. In the jet device 24 of compressed gas, compressed gas (compressed air) is supplied from outside. A pulse valve is provided in the supply route of the compressed gas, and the compressed gas is instantly supplied into the filter 18 by opening and closing of the pulse valve. Further, although not shown, the inside of the filter 18 is designed to introduce an inducing gas for expanding the filter 18, together with supply of compressed gas.

Further, in the lower part of the housing 16, there is a tapered dust collecting section 30 gradually decreasing in the aperture downward. A dust discharge section 32 is provided in part, or preferably in the bottom of the dust collecting section 30, and it communicates with a dust discharge route 36.

The dust discharge section 32 is opened or closed by manual or automatic control. Usually, a valve 34 is provided for opening and closing.

The dust discharge section 32 is closed while the combustion exhaust gas is being introduced, and is opened when shaking down dust. When shaking down dust, carrying gas (air) is introduced in the dust discharge route 36 toward the discharge direction.

Therefore, when the dust discharge section 32 is opened during shaking down

dust, the atmosphere gas in the housing 16 is instantly forced out from the discharge section 32 to pass through the side of the discharge route 36. That is, the gas flow directing the dust discharge direction is likely to be applied from the inside of the housing 16 nearly to the surface of the filter 18.

5 Further, the dedusting (device) means 14 has gas introducing means 40. The gas introducing means 40 is a gas introducing device capable of introducing gas into the housing 16 from outside. Its structure is not particularly specified, but it is preferred to be designed to be capable of adjusting the gas introducing amount and gas introducing time.

10 The gas introducing means 40 is installed in the housing 16, preferably corresponding to the location of the filter 18, so that the gas may be supplied to this location. That is, gas can be supplied from outside of the filter 18. Whether from the side or from the top of the filter 18, it is not particularly specified as far as gas can be introduced from outside of the filter 18. Considering from the structure of
15 the device, it is preferred so that gas can be supplied from the side of the filter 18.

 The gas introducing means 40 is designed to operate when shaking down dust, and in the open state of the dust discharge section 32, it is designed to introduce gas almost simultaneously with injection of compressed gas by the jet device 24 of compressed gas. The gas introduction is not particularly specified, but is designed
20 to be controlled by the operation of the valve which is controlled to be opened and closed. The introducing gas is not specified, but is preferably air.

 The cleaning means 44 is realized by a known each liquid cleaning device for exhaust gas. Usually, by making use of cleaning medium (aqueous) capable of dissolving harmful components in exhaust gas, harmful components are dissolved
25 and removed on the cleaning medium, and cleaned gas is discharged.

As the exhaust gas treating means, various means can be used. As the contact pattern of the exhaust gas and cleaning medium, various patterns are possible. For example, exhaust gas can be introduced into a cleaning tower filled with cleaning medium, or cleaning medium can be supplied to exhaust gas by shower.

5 In the invention, it is preferred to use means capable of dedusting the exhaust gas. As a result, stable operation is assured in the means or process in a later stage. As such cleaning and dust collecting means, specifically, a scrubber is known. Various types can be used depending on the contact pattern of exhaust gas and cleaning medium. Preferably, cleaning medium is supplied to exhaust gas by
10 shower (jet scrubber, spray tower, funnel-shaped filter, Venturi scrubber), or gas and cleaning medium are introduced into a column filled with specified carrier (typically filling tower), and the filling tower is preferred.

As cleaning medium, water is used preferably in the cleaning means 44. Water is preferably soft water of hardness of 10 or less, and most preferably pure water or
15 water of hardness of up to 0. By such water, if Si components are contained in the cleaning means 44, production of precipitates containing Si components can avoided. It is because such precipitates are not produced in the absence of metal element ions of group 1 or group 2 in the periodic table such as calcium, aside from Si components (typically silica) and hydrofluoric acid produced by combustion exhaust
20 gas. Such metal element ions include calcium, sodium and potassium, and calcium is a typical example. Hardness is defined to be 1 degree when 1 mg of calcium oxide is contained in 100 cm² of water.

Since hydrofluoric acid is usually generated in the combustion exhaust gas, it is preferred that the cleaning medium should be supplied together with an aqueous
25 solution of alkali such as sodium hydroxide.

The exhaust gas pretreating process by such cleaning means 44 is explained. First, the combustible gas and combustion assisting gas supplied in the film forming device produce SiO_2 directly or by supply of water, pass through a filter for catching and collecting SiO_2 , and are introduced into the combustion processing means 4 by way of the exhaust gas piping, and thus the combustion processing means is executed.

In the combustion treating means 4, high temperature is supplied by flammable gas or flame, and the combustible gas and combustion assisting gas in the exhaust gas are burned.

Consequently, the combustion exhaust gas is introduced into the dedusting (device) means 14, and the dedusting process is executed. The gas dedusted by the dedusting (device) means 14 is introduced into the cleaning means 44 in a state of lower dust level as compared with the prior art, and the cleaning process is executed.

If dedusted effectively in the dedusting process, dedusting may not be required in the cleaning means 44. It is more effective when dedusting is executed by the cleaning means.

In the cleaning process, as cleaning medium, by using water ranging from pure water to water of hardness of up to 0, production of precipitates can be effectively avoided if Si components are present in the cleaning process, and the maintenance work is avoided, and a stable operation is assured.

The dedusting process using the dedusting (device) means shown in Fig. 2 is specifically explained below.

First, the dedusting process consists of dust collecting process and dust shaking process.

When the combustion exhaust gas is introduced, the exhaust gas passage

section 19 is opened, and the discharge section 22 is also opened. On the other hand, in the dust discharge section 32, the valve 34 is closed.

The combustion exhaust gas introduced in this state passes inward from the outer side of the filter 18, and passes through the inside of the filter 18 and inside of the top plenum 20, and is cleaned and discharged from the discharge section 22.

Inside the housing 16, since the dust discharge section 32 of the dust collecting section 30 is closed, most of fine dust particles (typically silica particles of about 0.1 to 1 μm) are floating in the housing.

When the discharge pressure of the discharge gas from the discharge section 22 is less than a specific level or when the pressure loss is more than a specific level, the dust collecting process is stopped, and the dedusting process is started. Prior to the dedusting process, introduction of combustion exhaust gas is stopped, and the passage section 19 and discharge section 22 are closed.

In the dedusting process, first, the discharge valve 34 is opened, and the dust discharge section 32 of the dust collecting section 30 is opened. At this time, in the dust discharge route 36, gas is supplied into the dust discharge direction. Therefore, a downward gas flow in the housing 16 is formed, or likely to be formed. That is, in this state, a gas flow is likely to be applied toward the dust discharge direction from near the surface of the filter 18.

In consequence, by valve adjustment of the compressed gas jet device, compressed gas is supplied into the filter 18 in pulses. As the compressed gas is supplied into the filter 18, simultaneously or with a slight time lag, the gas introducing means 40 is operated and external gas is supplied to the surface of the filter 18 from outside.

The inside of the housing 16 is configured so that gas flow toward the dust

discharge direction may be formed easily, but further by supply of such gas, such as flow is formed more powerfully. In particular, near the surface of the filter 18, a stable gas flow having such directivity is formed.

By such gas flow, fine dust particles floating in the housing are discharged
5 from the discharge section 32 of the dust collecting section 30. By this gas flow, the inside of the housing is replaced with atmosphere gas, and fine dust particles are discharged from the atmosphere gas.

In the dedusting (device) means 14, when the combustion exhaust gas is introduced, the discharge section 32 is opened, and is low in the capacity of
10 discharging fine dust particles floating in the housing, and although the floating dust particles are collected in the dust collecting process, but are discharged from the housing 16 together with dust particles sticking to the filter 18 in the dust shaking process. By such discharge mode, dust is effectively discharged from the filter 18 and atmosphere synergistically.

15 According to such dedusting (device) means 14, the combustion exhaust gas can be dedusted effectively, and the maintenance work is alleviated not only in the dedusting (device) means 14 or process but also in the subsequent processing means or process, and a stable operation is assured. In particular, since fine silica particles are removed, the filter life is extended in the dedusting (device) means 14, and
20 production of precipitates can be effectively avoided in the subsequent cleaning means or process.

Dust particles separated and discharged in the dedusting (device) means or process in preferred embodiment 1 are collected separately in dust collecting means or process. The dust collection process is executed by a known method.

25 It is preferred to detect the pressure of the cleaned gas from the dedusting

(device) means or process, and adjust the flow rate of the discharge means, typically discharging blower, on the basis of the detected pressure. By discharging the cleaned gas by supplying air flow depending on the pressure loss of the filter, at least one of the running cost and installation cost of the dust collecting process can
5 be saved. At the same time, the composition of the cleaned gas is stabilized.

(Preferred embodiment 2)

Other preferred embodiment of the invention is explained.

The exhaust gas pretreating device or process in preferred embodiment 2 particularly relates to exhaust gas supplied into the combustion treating means from
10 the film forming device.

Residual silicon (Si) in the film forming device may be transformed into SiF_4 or others because of being supplied cleaning gas such as NF_3 or so after the film forming process. Such gas may be directly discharged as exhaust gas or removed from the exhaust gas system.

15 In preferred embodiment 2, whether such gas is discharged together with exhaust gas or discharge out of the system, it is applicable to the film forming device or process having cleaning means or process.

An example of preferred embodiment 2 is explained by referring to Fig. 3. In the film forming device having cleaning means, cleaning exhaust gas such as SiF_4
20 produced in the cleaning process is introduced into the combustion treating means directly or by way of outside discharging means. In a film forming device 52 shown in Fig. 3, a system having outside discharging means 54 is shown, but this preferred embodiment does not always require to have such discharge means 54.

The outside discharging means 54 supplies cooling water to cleaning exhaust
25 gas sucked from the chamber of the film forming device 52 to cause reaction of SiF_4

and others with water, and deposits SiO_2 and hydrosilicofluoric compounds, and catches and collects them by the filter.

In spite of such means 54, these precipitates cannot be caught and collected completely, and hydrofluoric acid and SiF_4 produced at the same time may directly
5 pass through the filter.

Or, without having such discharge means 54, while the exhaust gas is cooled and vapor is liquefied in the process from discharge from the film forming device 52 and reaching up to the combustion treating means 64, similar precipitates and hydrofluoric acid are generated.

10 Preferred embodiment 2 includes, as shown in Fig. 3, means 56 for sustaining the piping 55 from the film forming device 52 to combustion treating means 64 at temperature not to form precipitates which may be generated. Precipitates which may be generated are precipitates predicted in the film forming system considering from the type of exhaust gas or the like.

15 This means 56 may be either means for heating the piping, or means for sustaining at a specific temperature by insulating the temperature of the exhaust gas. Or both means may be used.

Heating means includes means for supplying heated gas into the piping 55, or heating means provided outside or inside of the piping 55. The example in Fig. 3
20 shows the means 56 for supplying heated gas into the piping 55, and heating means 57 provided around the piping 55.

For the means 56 for supplying heated gas into the piping 55, the gas must be inert gas, and usually nitrogen gas is used. As external heating means 57, only heating source may be used, or both heating source and insulating member may be
25 used. Such heating source and insulating member are not particularly specified.

In the case of using the insulating means of temperature of exhaust gas, too, the insulating member is not particularly specified.

The temperature to be sustained in the piping 55 by such heating means or insulating means is an effective temperature for avoiding generation of predicted
5 precipitates.

Predicted precipitates vary with the composition of exhaust gas and type of cleaning gas, and in the case of exhaust gas containing Si components generated in Si film forming process, typical examples are silicofluoric compounds. In particular, when silane and ammonia are used as combustible gas and fluorine gas such as NF_3
10 is used as combustion assisting gas, ammonium silicofluoride $((\text{NH}_4)_2\text{SiF}_6)$ is predicted.

Deposition (sublimation) temperature of ammonium silicofluoride is 137°C , and by sustaining the piping 55 at higher temperature, deposition of this precipitate can be avoided. Preferably, the temperature should be 150°C or more.

15 The piping 55 from the film forming device 54 to combustion treating means 64 is preferably sustained at specific temperature on the whole by temperature sustaining means. In particular, the discharge position from the film forming device and its neighboring piping position are locations of sudden drop of exhaust gas temperature, and it is preferred to sustain the temperature including these positions.

20 In the exhaust gas pretreating device or process in preferred embodiment 2, since the piping from the film forming device 54 to combustion treating means 64 is provided with temperature sustaining means, deposition of precipitates in the piping area is suppressed, and the maintenance work is alleviated, and use of dangerous cleaning agent is avoided, and the safety is enhanced.

25 Further, in the dedusting (device) means or process in the post-stage of the

combustion treating means or process, the load of dedusting operation is lessened.

In preferred embodiment 2, in particular, the exhaust gas is explained about the piping from the film forming device 54 to combustion treating means 64 and the combustion treating process, but this mode can be also applied in the device 2 and a
5 process of various modes included in preferred embodiment 1. In particular, when the dedusting means or dedusting device of the bag filter, especially, the bag filter applied in the dust shaking process by the gas introducing means 40 is used as the dedusting device or dedusting means, if the film forming device 54 is not provided with external discharging means, precipitates can be effectively prevented up to the
10 combustion treating means, and dust particles can be effectively removed by the dedusting (device) means.

(Preferred embodiment 3)

Preferred embodiment 3 of the invention is explained.

In preferred embodiment 3, in the dedusting means or process, in particular, at
15 least m sets (m being an integer of 3 or more) of dedusting means are provided, and the dedusting means are used by changing over so that the dust shaking process is realized by at least one dedusting means and that the dust collecting process is realized by at most $(m-1)$ sets of dedusting means. The number m is preferably 6 or less, and more preferably 3.

20 An example of preferred embodiment 3 is explained by referring to Fig. 4.

Fig. 4 shows three dedusting means 74, 76, and 78 as dedusting means 72.

The dedusting means 74, 76, and 78 of preferred embodiment 3 may be any known dedusting devices, and preferably all dedusting means are bag filters, and more preferably dust shaking means are bag filters of pulse air type. Further
25 preferably, the bag filter should be capable of supplying compressed gas to the filter,

and forming a gas flow in the outside of the filter so as to direct the dust discharge side from near the filter surface. The most preferred mode in this preferred embodiment is the mode disclosed in preferred embodiment 1.

At least three dedusting means 74, 76, and 78 are arrayed parallel to the supply
5 route of combustion exhaust gas. The supply route of combustion exhaust gas coupled to the combustion treating means is branched off corresponding to the dedusting means 74, 76, and 78, and the branched pipes are provided with valves 84, 86, and 88 for adjusting the supply volume of combustion exhaust gas or presence or absence of supply. Discharge pipes for cleaned gas discharged from the
10 dedusting means 74, 76, and 78 are provided, and discharge adjusting valves 94, 96, and 98 are provided respectively.

If one of the dedusting means 74, 76, and 78 is applied in dust shaking process or maintenance, the necessary dedusting capacity is assured by the remaining two or one unit.

15 These m sets of dedusting means are preferred to have a same dedusting capacity, that is, same filtration area. In this preferred embodiment, the dedusting means 74, 76, and 78 are designed to have same dedusting capacity, that is, same filtration area.

It is also preferred to be designed so as to maintain the necessary dedusting
20 capacity, that is, necessary total filtration area by at most $(m-1)$ sets (preferably $(m-1)$ sets). Therefore, in this preferred embodiment, each dedusting means has, supposing the necessary dedusting capacity (filtration area) to be 1, a dedusting capacity (filtration area) of 0.5, and the total dedusting capacity (filtration area) is 1.5. In other words, the necessary dedusting capacity is satisfied by two sets (that is,
25 $(m-1)$ supposing m to be 3).

Using the dedusting (device) means 32 having such configuration, the dedusting process of combustion exhaust gas is explained.

In Fig. 3, the combustion exhaust gas introduced from the combustion treating means is supplied into the dedusting means 76, 78, and the dedusting process is
5 executed. Accordingly, the valves 84 and 94 are closed, and the valves 86, 88, 96, and 98 are opened.

In this case, the dedusting means 76, 78 cooperate to exhibit the necessary dedusting capacity, and the dedusting process is executed properly. If either one dedusting (device) means has enough dedusting capacity, only one unit may be put
10 in operation.

On the other hand, use of the dedusting (device) means 74 exceeds the necessary dedusting capacity, and the dedusting (device) means 74 may be applied, as required, in dust shaking process or maintenance.

Further, if either the dedusting (device) means 76 or 78 exceeds a specified
15 pressure loss and operation is stopped, introduction of combustion exhaust gas to this dedusting means is stopped, and it may be applied in dust shaking process or maintenance, and introduction of combustion exhaust gas into the dedusting (device) means 74 is started, and the dedusting process is executed.

In this way, comprising a plurality of dedusting means, if the necessary
20 dedusting capacity can be satisfied by some of them, the remaining dedusting means may be used in dust shaking or other process, and it is not necessary to consider the time required for dust shaking or maintenance by continuing operation up to the allowable range of pressure loss of the dedusting means as in the prior art, and dust shaking process or maintenance can be executed easily as required. Therefore,
25 stable operation is possible always in low pressure loss state, and further stable

dedusting is achieved, and cleaned gas of stable composition can be discharged.

In particular, in preferred embodiment 3, since all m sets of dedusting means have same dedusting capacity, and the necessary dedusting capacity is satisfied by $(m-1)$ sets, and on the whole an efficient dedusting process can be executed at
5 minimum limit of total dedusting capacity. That is, by changing over so that the dust shaking process is realized by at least one dedusting means and that the dust collecting process is realized by at most $(m-1)$ sets of dedusting means, an efficient and favorable dedusting process can be executed while keeping the pressure loss low.

10 As a matter of course, as required, by using the dedusting means over the dedusting capacity, the dedusting process can be executed simultaneously with other dedusting means.

In preferred embodiment 3, in particular, the dedusting means or process is explained, and the dedusting means or process of preferred embodiment 3 can be
15 applied also in the modes included in preferred embodiment 1 or preferred embodiment 2.

In particular, by using a discharge blower capable of varying the air flow rate depending on the pressure of the cleaned gas discharged from the dedusting means explained in preferred embodiment 2, the cost can be saved in the dedusting process,
20 especially dust collecting state, in an optimum pressure state.

Having described preferred embodiments of the invention with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit
25 of the invention as defined in the appended claims.

INDUSTRIAL APPLICABILITY

According to the invention, in pretreating process of exhaust gas generated in the production device such as semiconductors or liquid crystal modules, the
5 maintenance work is alleviated, or the safety in the work is enhanced, and great industrial merits are obtained.

CLAIMS

1. An exhaust gas pretreating method, being a pretreating method of exhaust gas containing Si components comprising:

a combustion treating step of exhaust gas,

5 a dedusting step of removing dust particles containing Si from combustion exhaust gas generated by combustion treatment, and

a cleaning step of washing the dedusted combustion exhaust gas in water.

2. The exhaust gas pretreating method of claim 1, wherein a bag filter is used as dedusting means in the dedusting step.

10 3. The exhaust gas pretreating method of claim 2, wherein said dedusting means has a filter in its dedusting route, compressed gas is supplied to the filter in the dedusting step of the dedusting means, and gas flow is applied to the outside of the filter to direct the dust discharge side from near the filter surface.

4. The exhaust gas pretreating method of claim 2 or 3, wherein at least m sets
15 (m being an integer of 3 or more) of dedusting means are provided in the dedusting step, and are used by changing over so that the dedusting step is realized by at least one dedusting (device) means and that the dust collecting step is realized by at most (m-1) sets of dedusting means.

5. The exhaust gas pretreating method of any one of claims 1 to 4, wherein the
20 gas dedusted in the dedusting step is discharged at an air flow rate depending on the discharge pressure of the gas.

6. The exhaust gas pretreating method of any one of claims 1 to 5, wherein the water introduced for cleaning in the cleaning step is pure water or water of hardness of up to 0.

25 7. The exhaust gas pretreating method of any one of claims 1 to 6, wherein the

exhaust gas introduced into the combustion treating step is sustained at a temperature not forming precipitates possible to be generated in a pre-stage of the combustion treating step.

8. An exhaust gas pretreating method, being a pretreating method of exhaust
5 gas containing Si components comprising:

a combustion treating step of exhaust gas, and

a dedusting step of removing dust particles containing Si from combustion
exhaust gas generated by combustion treatment,

wherein the exhaust gas introduced into the combustion treating step is
10 sustained at a temperature not forming precipitates possible to be generated in a pre-stage of the combustion treating step.

9. An exhaust gas pretreating device, being a pretreating device of exhaust gas
containing Si components comprising:

means for combustion treatment of exhaust gas,

15 dedusting means for removing dust particles containing Si from combustion
exhaust gas generated by combustion treatment, and

cleaning means for washing the dedusted combustion exhaust gas in water.

10. The exhaust gas pretreating device of claim 9, wherein a bag filter is used
as dedusting means in the dedusting step.

20 11. The exhaust gas pretreating device of claim 10, wherein said dedusting
means of the bag filter has a filter in the route of the bag filter to supply compressed
gas to the filter, and also has gas introducing means for applying a gas flow to the
outside of the filter to direct the dust discharge side from near the filter surface.

12. The exhaust gas pretreating device of claim 10 or 11, wherein said
25 dedusting means has at least m sets (m being an integer of 3 or more) of dedusting

means, and they are used by changing over so that the dedusting step is realized by at least one dedusting means and that the dust collecting step is realized by at most (m-1) sets of dedusting means.

13. The exhaust gas pretreating device of any one of claims 9 to 12, wherein
5 the water introduced for cleaning in the cleaning step is pure water or water of hardness of up to 0.

14. The exhaust gas pretreating device of any one of claims 9 to 13, further comprising means for sustaining the exhaust gas introduced into the combustion treating means at a temperature not forming precipitates possible to be generated in
10 a pre-stage of the combustion treating means.

15. The exhaust gas pretreating device of any one of claims 9 to 14, further comprising exhaust means for varying the flow rate depending on the gas pressure discharged from the dedusting means.

16. An exhaust gas pretreating device, being a pretreating device of exhaust
15 gas containing Si components comprising:

means for combustion treatment of exhaust gas,

dedusting means for removing dust particles containing Si from combustion exhaust gas generated by combustion treatment, and

means for sustaining the exhaust gas introduced into the combustion treating
20 means at a temperature not forming precipitates possible to be generated in a pre-stage of the combustion treating means.

17. A dedusting device, being a device for removing particles containing Si components comprising a bag filter, in which the bag filter has a filter as one of the components, and also has, as filter dust shaking-down means, gas introducing means
25 for supplying compressed gas to the filter and applying a gas flow to the outside of

the filter for directing the dust discharge side from near the filter surface.

18. The dedusting device of claim 17, wherein said dust discharge port of the dedusting device has a valve, which is closed when dust is collected on the filter, and is opened when dedusting by supply of compressed gas and gas flow.