

Description

A film deposition apparatus, vaporization detection device and vaporization detection method

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Technical Field

The present invention relates to a technical field of semiconductor processing, and in particular to a film deposition apparatus, a vaporization detection device, a vaporization detection method, and a computer-readable storage medium.

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Background

During semiconductor fabrication processing, film deposition apparatus typically use vaporized liquid precursors as reactants, such as tetraethoxysilane (TEOS) and water, etc. Therefore, a vaporization device is required to vaporize these liquid reactants and convert them into a gaseous state.

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After passing through the vaporization device, the liquid reactants typically need to be transported over a long path before being delivered to a reaction chamber of a film deposition apparatus where the deposition reaction takes place. Owing to the specific properties of the reaction gas, stainless steel pipes are typically used as the material for delivery pipelines. And owing to the extremely low thermal conductivity of stainless steel, it is difficult to heat the delivery pipelines. During the delivery process, if vaporization of the liquid reaction precursors is insufficient or gaseous reactants condense midway, tiny liquid droplets are likely to form. These tiny liquid droplets can affect the quality of final film deposition, resulting in a series of problems such as particle contamination and non-uniform deposition of films.

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To solve the above-mentioned problems in the prior art, there is an urgent need in the art for a film deposition technology that can effectively detect the vaporization rate of the reaction gas to be introduced into the reaction chamber, thereby avoiding a series of problems such as particle contamination and non-uniform deposition of films during the deposition process caused by incomplete vaporization of the reaction

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gas.

Summary

A brief overview of one or more aspects is provided below to provide a basic understanding of these aspects. The summary is not an extensive overview of all of the aspects that are contemplated, and is not intended to identify key or decisive elements in all aspects. The sole purpose of the summary is to present some concepts of one or more aspects in a simplified form as a prelude to the more detailed description that is presented later.

To overcome the above-mentioned defects in the prior art, the present invention provides a film deposition apparatus, a vaporization detection device, a vaporization detection method, and a computer-readable storage medium. The present invention can effectively detect the vaporization rate of the reaction gas to be introduced into the reaction chamber, thereby avoiding a series of problems such as particle contamination and non-uniform deposition of films during the deposition process caused by incomplete vaporization of the reaction gas.

Specifically, according to the above-mentioned film deposition apparatus provided in a first aspect of the present invention, it comprises: a vaporizer, configured to vaporize a liquid reactant to form a reaction gas; a reaction chamber, connected to the vaporizer via a pipeline, and configured to obtain the reaction gas from the vaporizer to perform film deposition; and a vaporization detection device, disposed between the vaporizer and the reaction chamber, and configured to detect a vaporization degree of the liquid reactant to permit or prevent a vaporized liquid reactant from entering the reaction chamber.

Further, in some embodiments of the present invention, the vaporized liquid reactant comprises an intermediate gas. The vaporization detection device comprises a detection chamber, provided with an absorption plate at a top thereof, and filled with a standard gas. By means of a density of the standard gas, a gas-liquid separation of the intermediate gas is performed to obtain the reaction gas, which rises upward to the absorption plate and is absorbed thereby.

Further, in some embodiments of the present invention, the density of the standard gas in the detection chamber is higher than a density of the reaction gas and

lower than a density of a reaction liquid in the intermediate gas. The reaction gas in the intermediate gas floats upward in the standard gas environment, and the reaction liquid in the intermediate gas falls downward in the standard gas environment.

Further, in some embodiments of the present invention, the standard gas comprises nitrogen gas with a density of 0.9 g/cm³, the reaction liquid comprises water with a density of 1 g/cm³, and the reaction gas comprises water vapour with a density of 0.6 g/cm³.

Further, in some embodiments of the present invention, the absorption plate comprises an absorbent that undergoes a chemical absorption reaction with the reaction gas.

Further, in some embodiments of the present invention, the film deposition apparatus further comprises a heating device, wherein the heating device is at least disposed in the detection chamber to heat the standard gas.

Further, in some embodiments of the present invention, the vaporization detection device comprises a front-end separator. The front-end separator performs an initial gas-liquid separation of the intermediate gas, and introduces a separated gaseous reactant into the detection chamber.

Further, in some embodiments of the present invention, the front-end separator comprises a centrifugal device, and the reaction gas in the intermediate gas is separated by a high-speed rotation of the centrifugal device.

Additionally, according to the above-mentioned vaporization detection device provided in a second aspect of the present invention, it comprises a detection chamber, provided with a gas inlet for obtaining an intermediate gas composed of a vaporized liquid reactant, wherein the detection chamber is filled with a standard gas; and an absorption plate, disposed at a top of the detection chamber, and performing a gas-liquid separation of the intermediate gas by means of a density of the standard gas to obtain a reaction gas, wherein the reaction gas rises upward to the absorption plate and is absorbed thereby, and a vaporization degree of the vaporized liquid reactant is determined based on a weight change of the absorption plate before and after absorption and an initial weight of the liquid reactant.

Additionally, according to the above-mentioned vaporization detection method, it comprises following steps: obtaining an intermediate gas composed of a vaporized liquid reactant; performing a gas-liquid separation of the intermediate gas according to a density of a standard gas, to obtain a reaction gas; and absorbing the reaction gas through an absorption plate, and determining a vaporization degree of the vaporized

liquid reactant based on a weight change of the absorption plate before and after absorption and an initial weight of the liquid reactant.

Additionally, according to a fourth aspect of the present invention, there is further provided a computer-readable storage medium, having a computer instruction stored thereon. When the computer instruction is executed by a processor, the above-mentioned vaporization detection method provided in the third aspect of the present invention is implemented.

Brief Description of the Drawings

The above features and advantages of the present invention will be better understood after reading the detailed description of the embodiments of the present disclosure in conjunction with the following figures. In the figures, components are not necessarily drawn to scale, and components having similar related features may have the same or similar reference numerals.

Figure 1 is a block diagram illustrating a film deposition apparatus provided in accordance with some embodiments of the present invention;

Figure 2 is a schematic diagram illustrating a vaporization detection device provided in accordance with some embodiments of the present invention; and

Figure 3 is a flow chart illustrating a vaporization detection method provided in accordance with some embodiments of the present invention.

Reference numerals

10	film deposition apparatus;
100	vaporizer;
200	vaporization detection device;
210	detection chamber;
211	absorption plate;
220	standard gas;
230	front-end separator;

231 gas inlet;
232 gas outlet;
300 reaction chamber;
410 reaction gas;
5 420 reaction liquid; and
S310~S330 steps.

Detailed Description of Embodiments

10 The embodiments of the present invention are described in the following detailed description. Other advantages and effects of the present invention will be readily apparent to those skilled in the art from this disclosure. Although the description of the present invention will be described in conjunction with the preferred embodiments, this is not a limitation of the present invention. On the contrary, the invention is described in connection with the embodiments so as to cover
15 other alternatives or modifications that are possible in the embodiments of the present invention. In order to provide a thorough understanding of the present invention, many specific details are included in the following description. The present invention may also be practiced without these details. In addition, some specific details are omitted in the description in order to avoid confusing or obscuring the present
20 invention.

In the description of the present invention, it should be noted that the terms "installation", "connecting", and "connected" should be understood broadly unless explicitly stated and defined otherwise. For example, the terms "installation", "connecting", and "connected" may be either a fixed connection, a detachable
25 connection, or an integral connection; the terms may be either a mechanical connection or an electrical connection; the terms also may be either a direct connection, an indirect connection through an intermediate medium, or an internal connection between two components. The specific meaning of the above terms in the present invention can be understood in a specific case by those skilled in the art.

30 In addition, "up", "down", "left", "right", "top", "bottom", "horizontal", "vertical" used in the following description shall be understood as the orientation

described in the paragraph and shown in the related figure. The relative term is used for convenience of description only, and does not mean that the device described therein is to be manufactured or operated in the specific orientation, and therefore should not be construed as limiting the present invention.

Understandably, although the terms "first", "second", "third", etc. may be used to describe various components, regions, layers and/or portions to distinguish different components, regions, layers and/or portions, the order of these components, regions, layers and/or portions described above should not be limited by the terms. Therefore, a first component, region, layer and/or portion mentioned below may be also mentioned as a second component, region, layer and/or portion without departing from some embodiments of the present invention.

As mentioned above, during semiconductor fabrication processing, film deposition apparatus typically use vaporized liquid precursors as reactants, such as tetraethoxysilane (TEOS) and water, etc. Therefore, a vaporization device is required to vaporize these liquid reactants and convert them into a gaseous state. After passing through the vaporization device, the liquid reactants typically need to be transported over a long path before being delivered to a reaction chamber of a film deposition apparatus where the deposition reaction takes place. Owing to the specific properties of the reaction gas, stainless steel pipes are typically used as the material for delivery pipelines. And owing to the extremely low thermal conductivity of stainless steel, it is difficult to heat the delivery pipelines. During the delivery process, if vaporization of the liquid reaction precursors is insufficient or gaseous reactants condense midway, tiny liquid droplets are likely to form. These tiny liquid droplets can affect the quality of final film deposition, resulting in a series of problems such as particle contamination and non-uniform deposition of films.

To overcome the above-mentioned defects existing in the prior art, the present invention provides a film deposition apparatus, a vaporization detection device, a vaporization detection method, and a computer-readable storage medium. The present invention can effectively detect the vaporization rate of the reaction gas to be introduced into the reaction chamber, thereby avoiding a series of problems such as particle contamination and non-uniform deposition of films during the deposition

process caused by incomplete vaporization of the reaction gas.

In some non-limiting embodiments, the above-mentioned vaporization detection device provided in the second aspect of the present invention may be configured in the film deposition apparatus provided in the first aspect of the present invention as described above. Additionally, the vaporization detection method provided in the third aspect of the present invention as described above may also be implemented by the vaporization detection device provided in the second aspect of the present invention as described above.

First, please refer to Figure. 1. Figure 1 is a block diagram illustrating a film deposition apparatus provided in accordance with some embodiments of the present invention.

As shown in Figure 1, in some embodiments of the present invention, a film deposition apparatus 10 may mainly comprise: a vaporizer 100, configured to a vaporize liquid reactant to form a reaction gas; and a reaction chamber 300, which may be connected to the vaporizer 100 via a pipeline, and configured to obtain the reaction gas from the vaporizer 100 to perform film deposition. In practice, during the vaporization process in the vaporizer 100, the vaporization rate of liquid reactants cannot reach 100%. Consequently, the resulting reaction gas contains tiny liquid droplets. If such droplets enter the subsequent reaction chamber 300, the quality of the deposited film will be adversely affected. Therefore, a vaporization detection device 200 may be disposed between the vaporizer 100 and the reaction chamber 300, which is primarily configured to detect a vaporization degree of the liquid reactant, thereby further permitting or preventing a vaporized liquid reactant from entering the reaction chamber 300.

After the vaporization detection device 200 detects that the vaporization degree of the liquid reactant meets a target vaporization degree, the liquid reactant may continue to be fed into the vaporizer 100 for vaporization, and the remaining reaction gas that has been detected by the vaporization detection device 200 may be introduced into the reaction chamber 300. If the vaporization detection device 200 detects that the vaporization degree of the liquid reactant does not meet the target vaporization degree, a valve disposed in the delivery pipeline between the vaporization detection

device 200 and the reaction chamber 300 may be closed to cut off the pipeline, thereby preventing the reaction gas from being introduced into the reaction chamber 300.

Specifically, please refer to Figure 2. Figure 2 is a schematic diagram illustrating a vaporization detection device provided in accordance with some embodiments of the present invention.

In some embodiments, the reaction gas obtained directly via vaporization in the vaporizer 100 contains tiny liquid droplets. For ease of description, in the present invention, the reaction gas containing tiny liquid droplets is defined as an intermediate gas, which requires further processing. That is to say, a vaporized liquid reactant may be defined as the intermediate gas.

As shown in Figure 2, the vaporization detection device 200 may comprise a detection chamber 210, provided with an absorption plate 211 at a top thereof. And the detection chamber 210 is filled with a standard gas 220. By means of a density of the standard gas 220, a gas-liquid separation of the intermediate gas can be performed to obtain the reaction gas 410. The reaction gas 410 rises upward until it comes into contact with the absorption plate 211 and is absorbed by the absorption plate 211.

Specifically, the density of the standard gas in the detection chamber 210 can be higher than a density of the reaction gas in the intermediate gas, and lower than a density of a reaction liquid in the intermediate gas. As shown in Figure 2, in this manner, the reaction gas 410 in the intermediate gas can float upward and rise in the environment of the standard gas 220 inside the detection chamber 210, while the reaction liquid 420 in the intermediate gas can fall downward in the environment of the standard gas 220 inside the detection chamber 210, thereby achieving the gas-liquid separation.

For example, optionally, the intermediate gas used as a reactant for film deposition may comprise water vapour and liquid water. The reaction liquid 420 in the intermediate gas may be liquid water with a density of 1 g/cm^3 . Correspondingly, the reaction gas 410 in the intermediate gas may be water vapour with a density of 0.6 g/cm^3 . In this regard, in the sealed detection chamber 210, the standard gas 220 may be nitrogen gas with a density of approximately 0.9 g/cm^3 . In the sealed detection chamber 210 filled with nitrogen gas, since the density of nitrogen gas is higher than that of water vapour and lower than that of liquid water, nitrogen gas can facilitate the upward floating of water vapour with a lower density. The water vapour in the

intermediate gas can float upward and suspend in the nitrogen gas-filled environment by virtue of the buoyancy of nitrogen gas, while the liquid water in the intermediate gas falls downward in the nitrogen gas-filled environment, thereby achieving the effect of separating vapour and liquid droplets. Furthermore, since the amount of the intermediate gas introduced is small, the air pressure inside the detection chamber 210 will not change in a short period of time, thereby preventing the effect of density-based separation from being affected.

Further, in some preferred embodiments, a heating device (not shown in Figure 2) may be disposed inside the detection chamber 210. The heating device is used to convert the standard gas (e.g., nitrogen gas) inside the detection chamber 210 into a high-temperature gas, thereby forming a sealed and high-temperature detection environment, which can prevent the reaction gas (e.g., water vapour) from liquefying due to cooling.

Those skilled in the art will understand that the solution in which the reaction gas 410 is water vapour, the reaction liquid 420 is liquid water, and the standard gas 220 is nitrogen gas is merely a non-limiting embodiment provided by the present invention. This embodiment is intended to clearly demonstrate the main concept of the present invention and provide a specific solution that is convenient for the public to implement, rather than to limit the protection scope of the present invention. Those skilled in the art may select different standard gases 220 filled into the detection chamber 210 and corresponding absorbents for the absorption plate 211 according to different reactants, and thus the present invention has an extremely wide scope of application.

In some embodiments, the absorption plate 211 inside the detection chamber 210 may contain an absorbent. The absorbent in the absorption plate 211 may undergo a chemical absorption reaction with the reaction gas. For example, in the embodiment where the aforementioned reaction gas 410 is water vapour, the absorbent in the absorption plate 211 may be anhydrous calcium chloride, calcium hydroxide, or other absorbents capable of undergoing an absorption reaction with water.

In the aforementioned preferred embodiments, the absorption plate 211 is disposed at a top inside the detection chamber 210. The reaction gas 410 separated needs to float upward to the top of the detection chamber 210 to be absorbed by the absorption plate 211, which helps to further increase the space between the separated reaction gas 410 and reaction liquid 420 in the intermediate gas, and prevents the

absorption plate 211 from inadvertently reacting chemically with the reaction liquid 420, thereby avoiding adverse effects on the accuracy of subsequent vaporization detection.

In some embodiments of the present invention, the vaporization degree of the liquid reactant can be determined based on a weight change of the absorption plate 211 before and after absorbing the reaction gas 410, and an initial weight of the liquid reactant.

Specifically, determine the initial weight A_0 of the absorber plate 211. After the absorption plate 211 has completely absorbed the reaction gas 410 (e.g., water vapour), determine the weight A_1 of the absorption plate 211 again. Obtain the weight difference ($A_1 - A_0$) between the initial weight A_0 and the current weight A_1 of the absorption plate 211. Obtain the initial weight B_1 of the liquid reactant before it enters the vaporizer 100. The vaporization degree of the vaporized liquid reactant can be determined based on the ratio of the weight difference ($A_1 - A_0$) to the initial weight B_1 of the liquid reactant, where the vaporization degree is calculated as $(A_1 - A_0) / B_1$, thus completing the vaporization rate detection.

Furthermore, as shown in Figure. 2, in other preferred embodiments, to achieve a complete separation of the reaction gas 410 and reaction liquid 420 from the vaporized liquid reactant, the vaporization detection device 200 may further comprise a front-end separator 230. The front-end separator 230 may be disposed outside the detection chamber 210 and connected to the detection chamber 210 via a pipeline. Optionally, as shown in Figure. 2, the front-end separator 230 may also be disposed inside the detection chamber 210 to reduce the overall space occupancy rate of the vaporization detection device 200.

The front-end separator 230 may be used to perform an initial gas-liquid separation of an initial intermediate gas vaporized by the vaporizer 100, and introduce a separated gaseous reactant into the detection chamber 210. The gaseous reactant undergoes a secondary gas-liquid separation inside the detection chamber 210 by means of the standard gas 220 and the absorption plate 211, followed by vaporization detection.

As shown in Figure. 2, in some optional embodiments, the front-end separator

230 may comprise a centrifugal device (not shown in Figure. 2). Due to the extremely high flow rate of gases used in semiconductor processing (e.g., 8–80 m/s), the separator including a centrifugal device can meet the applicable requirements. The initial intermediate gas vaporized by the vaporizer 100 enters the front-end separator 230 through the gas inlet 231. Driven by a centrifugal force generated by a high-speed rotation of the centrifugal device, the reaction liquid in the initial intermediate gas flies out along the tangential direction of the rotation direction, thereby enabling the separation of the reaction gas from the airflow of the initial intermediate gas (the airflow direction of the initial intermediate gas is indicated by the spiral shape in Figure. 2). The intermediate gas that has completed the initial gas-liquid separation is discharged through the gas outlet 232. The discharged reaction gas 410 and reaction liquid 420 are then subjected to the aforementioned secondary gas-liquid separation based on the density of the standard gas 220. Since the centrifugal force exerted on the reaction liquid 420 is much greater than its gravitational force and inertial force, the separation efficiency of gas-liquid separation performed by the centrifugal structure is relatively high.

Returning to Figure. 1, after the vaporization degree of the liquid reactant is detected by the vaporization detection device 200, it is possible to further determine whether to permit or prevent the vaporized liquid reactant from entering the reaction chamber 300.

Specifically, in some embodiments, a valve may be comprised in the pipeline connecting the vaporization detection device 200 and the reaction chamber 300. A vaporization threshold may be preset to correspond to a target vaporization degree. In response to the detected vaporization degree of the liquid reactant exceeding the vaporization threshold, it indicates that the current vaporization degree of the liquid reactant has reached the target vaporization degree and meets the vaporization requirements. The vaporized liquid reactant contains no tiny liquid droplets or an extremely small amount of tiny liquid droplets; therefore, it may be continuously introduced into the reaction chamber 300. If, in response to the detected vaporization degree of the liquid reactant being less than the vaporization threshold, it indicates that the current vaporization degree of the liquid reactant has not reached the target

vaporization degree and fails to meet the vaporization requirements. The vaporized liquid reactant contains a relatively large amount of tiny liquid droplets. The valve may be selectively closed to prevent the vaporized liquid reactant from entering the reaction chamber 300. Further, optionally, the reactant with substandard vaporization
5 may be continuously transported to the vaporizer 100 through another pipeline for secondary vaporization thereof.

Next, refer to Figure. 3. Figure 3 is a flow chart illustrating a vaporization detection method provided in accordance with some embodiments of the present invention.

10 As shown in Figure. 3, in some embodiments of the present invention, the vaporization detection method may mainly comprise the following steps:

Step S310: obtaining an intermediate gas composed of a vaporized liquid reactant.

Specifically, in some embodiments, in the present invention, the reaction gas
15 containing tiny liquid droplets, which is obtained by direct vaporization through the vaporizer 100, is defined as the intermediate gas.

Further, in some preferred embodiments, an initial gas-liquid separation may be performed on an initial intermediate gas vaporized by the aforementioned vaporizer 100. Specifically, this may be achieved by the front-end separator 230 in the
20 vaporization detection device 200, which may comprise a centrifugal device (not shown in Figure. 2). The initial intermediate gas vaporized by the vaporizer 100 enters the front-end separator 230 through the gas inlet 231. Driven by a centrifugal force generated by a high-speed rotation of the centrifugal device, the reaction liquid in the initial intermediate gas flies out along the tangential direction of the rotation
25 direction, thereby enabling the separation of the reaction gas from the airflow of the initial intermediate gas. The intermediate gas that has completed the initial gas-liquid separation is discharged through the gas outlet 232. The discharged reaction gas 410 and reaction liquid 420 are then subjected to the aforementioned secondary gas-liquid separation based on the density of the standard gas 220. Since the centrifugal force
30 exerted on the reaction liquid 420 is much greater than its gravitational force and inertial force, the separation efficiency of gas-liquid separation performed by the

centrifugal structure is relatively high.

Subsequently, step S320 may be performed: performing a gas-liquid separation of the intermediate gas according to a density of a standard gas, to obtain a reaction gas.

5 In some embodiments, the vaporization detection device 200 may comprise a detection chamber 210, provided with an absorption plate 211 at a top thereof. And the detection chamber 210 is filled with a standard gas 220. By means of a density of the standard gas 220, a gas-liquid separation of the intermediate gas can be performed to obtain the reaction gas 410. The reaction gas 410 rises upward until it comes into
10 contact with the absorption plate 211 and is absorbed by the absorption plate 211.

Specifically, the density of the standard gas in the detection chamber 210 can be higher than a density of the reaction gas in the intermediate gas, and lower than a density of a reaction liquid in the intermediate gas. In this manner, the reaction gas 410 in the intermediate gas can float upward and rise in the environment of the
15 standard gas 220 inside the detection chamber 210, while the reaction liquid 420 in the intermediate gas can fall downward in the environment of the standard gas 220 inside the detection chamber 210, thereby achieving a secondary gas-liquid separation.

For example, optionally, the intermediate gas used as a reactant for film
20 deposition may comprise water vapour and liquid water. That is to say, the reaction liquid 420 in the intermediate gas may be liquid water, with a density of 1 g/cm^3 . Correspondingly, the reaction gas 410 in the intermediate gas may be water vapour, with a density of 0.6 g/cm^3 . In this regard, in the sealed detection chamber 210, the standard gas 220 may be nitrogen gas, with a density of approximately 0.9 g/cm^3 . In
25 the sealed detection chamber 210 filled with nitrogen gas, since the density of nitrogen gas is higher than that of water vapour and lower than that of liquid water, nitrogen gas can facilitate the upward floating of water vapour with a lower density. The water vapour in the intermediate gas can float upward and suspend in the nitrogen gas-filled environment by virtue of the buoyancy of nitrogen gas, while the liquid
30 water in the intermediate gas falls downward in the nitrogen gas-filled environment, thereby achieving the effect of secondary separation of vapour and liquid droplets.

Subsequently, step S330 may be performed: absorbing the reaction gas through an absorption plate, and determining a vaporization degree of the vaporized liquid reactant based on a weight change of the absorption plate before and after absorption
35 and an initial weight of the liquid reactant.

Specifically, in some embodiments, determine the initial weight A0 of the absorber plate 211. After the absorption plate 211 has completely absorbed the reaction gas 410 (e.g., water vapour), determine the weight A1 of the absorption plate 211 again. Obtain the weight difference (A1-A0) between the initial weight A0 and the current weight A1 of the absorption plate 211. Obtain the initial weight B1 of the liquid reactant before it enters the vaporizer 100. The vaporization degree of the vaporized liquid reactant can be determined based on the ratio of the weight difference (A1-A0) to the initial weight B1 of the liquid reactant, where the vaporization degree is calculated as (A1-A0)/B1, thus completing the vaporization rate detection.

Although the method is illustrated and described as a series of actions for the purpose of simplifying the explanation, it should be understood and appreciated that these methods are not limited by the order of the actions. Those skilled in the art may understand that some actions may occur in different orders and/or concurrently with other actions that are illustrated and described herein or that are not illustrated and described herein, in accordance with one or more embodiments.

In another aspect of the present invention, a computer-readable storage medium is further provided, having a computer instruction stored thereon. When the computer instruction is executed by a processor, the above-mentioned vaporization detection method provided in the third aspect of the present invention is implemented.

Those skilled in the art will understand that the above embodiments of the vaporization detection method are merely some non-limiting implementations provided by the present invention, which are intended to clearly demonstrate the main concept of the present invention and provide some specific schemes convenient for the public to implement, rather than to limit all working modes or all functions of the aforementioned vaporization detection device 200 and the film deposition apparatus 10. Similarly, the aforementioned vaporization detection device 200 and film deposition apparatus 10 are also merely one non-limiting implementation provided by the present invention, and do not constitute a limitation on the implementation subjects of the various steps in the vaporization detection method.

In summary, the present invention provides a film deposition apparatus, a

vaporization detection device, a vaporization detection method, and a computer-readable storage medium. The present invention can effectively detect the vaporization rate of the reaction gas to be introduced into the reaction chamber, thereby avoiding a series of problems such as particle contamination and non-uniform deposition of films during the deposition process caused by incomplete vaporization of the reaction gas.

The previous description of the disclosure is provided to enable any person skilled in the art to make or use the disclosure. Various modifications to the present disclosure will be obvious to those skilled in the art, and the general principles defined herein may be applied to other variations without departing from the spirit or scope of the disclosure. Thus, the present disclosure is not intended to be limited to the examples and designs described herein, but is to be accorded the broadest scope of the principles and novel features disclosed herein.

Claims

1. A film deposition apparatus, comprising:

a vaporizer, configured to vaporize a liquid reactant to form a reaction gas;

5 a reaction chamber, connected to the vaporizer via a pipeline, and configured to obtain the reaction gas from the vaporizer to perform film deposition; and

a vaporization detection device, disposed between the vaporizer and the reaction chamber, and configured to detect a vaporization degree of the liquid reactant to permit or prevent a vaporized liquid reactant from entering the reaction chamber.

10 2. The film deposition apparatus according to claim 1, wherein the vaporized liquid reactant comprises an intermediate gas,

the vaporization detection device comprises a detection chamber, provided with an absorption plate at a top thereof, and filled with a standard gas, and

15 by means of a density of the standard gas, a gas-liquid separation of the intermediate gas is performed to obtain the reaction gas, which rises upward to the absorption plate and is absorbed thereby.

20 3. The film deposition apparatus according to claim 2, wherein the density of the standard gas in the detection chamber is higher than a density of the reaction gas and lower than a density of a reaction liquid in the intermediate gas, the reaction gas in the intermediate gas floats upward in the standard gas environment, and the reaction liquid in the intermediate gas falls downward in the standard gas environment.

25 4. The film deposition apparatus according to claim 3, wherein the standard gas comprises nitrogen gas with a density of 0.9 g/cm^3 , the reaction liquid comprises water with a density of 1 g/cm^3 , and the reaction gas comprises water vapour with a density of 0.6 g/cm^3 .

30 5. The film deposition apparatus according to claim 2, wherein the absorption plate comprises an absorbent that undergoes a chemical absorption reaction with the reaction gas.

6. The film deposition apparatus according to claim 2, further comprising a heating device, wherein the heating device is at least disposed in the detection chamber to heat the standard gas.

7. The film deposition apparatus according to claim 2, wherein the vaporization detection device comprises a front-end separator, and the front-end separator performs an initial gas-liquid separation of the intermediate gas, and introduces a separated gaseous reactant into the detection chamber.

8. The film deposition apparatus according to claim 7, wherein the front-end separator comprises a centrifugal device, and the reaction gas in the intermediate gas is separated by a high-speed rotation of the centrifugal device.

9. A vaporization detection device, comprising:
a detection chamber, provided with a gas inlet for obtaining an intermediate gas composed of a vaporized liquid reactant, wherein the detection chamber is filled with a standard gas; and
an absorption plate, disposed at a top of the detection chamber, and performing a gas-liquid separation of the intermediate gas by means of a density of the standard gas to obtain a reaction gas, wherein the reaction gas rises upward to the absorption plate and is absorbed thereby, and a vaporization degree of the vaporized liquid reactant is determined based on a weight change of the absorption plate before and after absorption and an initial weight of the liquid reactant.

10. A vaporization detection method, comprising following steps:
obtaining an intermediate gas composed of a vaporized liquid reactant;
performing a gas-liquid separation of the intermediate gas according to a density of a standard gas, to obtain a reaction gas; and
absorbing the reaction gas through an absorption plate, and determining a vaporization degree of the vaporized liquid reactant based on a weight change of the absorption plate before and after absorption and an initial weight of the liquid reactant.

11. A computer-readable storage medium, having a computer instruction stored thereon, wherein when the computer instruction is executed by a processor, the

vaporization detection method according to claim 10 is implemented.