

# **GAS FEEDING DEVICE AND VAPOR DEPOSITION DEVICE**

## **TECHNICAL FIELD**

**[0001]** The present disclosure relates to the field of semiconductor manufacturing technologies, and in particular, to a gas feeding device and a vapor deposition device.

## **BACKGROUND**

**[0002]** Semi-insulating gallium nitride is one of the core layers in GaN High Electron Mobility Transistor (GaN HEMT) devices, affecting device performance such as leakage current and reliability.

**[0003]** Currently, carbon source is a commonly used dopant source for preparing semi-insulating gallium nitride, achieving semi-insulation of the gallium nitride material through an additional acceptor compensation mechanism. There are generally two ways to realize carbon doping: one is through process adjustments, such as lowering the growth temperature, reducing the V/III ratio, and increasing the growth rate, etc., to achieve unintentional doping (i.e., intrinsic doping). A disadvantage of this method is that it significantly restricts the process window. The other is to introduce an external carbon source (i.e., external doping), which can greatly expand the process window.

**[0004]** In existing gas feeding methods, the dopant gas containing an external carbon source enters the reaction chamber together with the gallium source through the same gas feeding channel. However, when growing semi-insulating gallium nitride on a silicon substrate, in order to counteract the tensile stress caused by the different coefficients of thermal expansion between the silicon substrate and the gallium nitride material during cooling, a certain compressive stress needs to be stored in the gallium nitride during epitaxial growth. As a result, the wafer is in a convex state, leading to the temperature in the central region of the wafer being lower than that in the edge region. Since the concentration of carbon doping in gallium nitride decreases with increasing temperature, the existing gas feeding method results in a higher carbon doping concentration in the central region of the wafer than in the edge region, leading to non-uniform carbon doping across the wafer and affecting the yield of semi-insulating gallium nitride preparation. Therefore, it is necessary to adjust the gas feeding method for the dopant gas.

## SUMMARY

### TECHNICAL PROBLEM

[0005] An object of the present disclosure is to provide a gas feeding device and a vapor  
5 deposition device, which can reduce the vertical distance between the dopant gas and the  
susceptor when the dopant gas enters the reaction chamber, thereby improving the uniformity  
of the doping concentration across the entire wafer.

### TECHNICAL SOLUTION

[0006] In order to achieve the above object, the present invention is achieved through the  
10 following technical solutions:

[0007] a gas feeding device for a vapor deposition device, the vapor deposition device  
comprising a reaction chamber, a susceptor being provided at a bottom of an interior of the  
reaction chamber; where the gas feeding device comprises: a plurality of gas channels arranged  
horizontally, provided at a top of the interior of the reaction chamber; gas inlets of the plurality  
15 of gas channels are in communication with a gas source group, and gas outlets of the plurality  
of gas channels are spaced apart from the susceptor at different vertical distances;

[0008] the gas source group comprises a gallium source, a nitrogen source, and a dopant gas  
source; the gallium source and the nitrogen source being in communication with the interior of  
the reaction chamber via different gas channels, and the dopant gas source being in  
20 communication with the interior of the reaction chamber via at least one of the plurality of gas  
channels, so as to feed a gallium-containing gas, a nitrogen-containing gas, and a dopant gas  
into the reaction chamber; and

[0009] the gallium-containing gas and the dopant gas fed into the reaction chamber satisfy the  
following formula:

$$\sum_{i=1}^n a_i x_i \geq \sum_{j=1}^m b_j y_j$$

25 [0010]

[0011] where  $n$  denotes a total number of gas channels in communication with the gallium-  
containing gas;  $a_i$  denotes a vertical distance between the gas outlet of an  $i$ -th gas channel in  
communication with the gallium-containing gas and the susceptor;  $x_i$  denotes a ratio of a

volumetric flow rate of the gallium-containing gas fed through the  $i$ -th gas channel in communication with the gallium-containing gas to a total volumetric flow rate of the gallium-containing gas fed into the reaction chamber;  $m$  denotes a total number of gas channels in communication with the dopant gas;  $b_j$  denotes a vertical distance between the gas outlet of a  $j$ -th gas channel in communication with the dopant gas and the susceptor;  $y_j$  denotes a ratio of a volumetric flow rate of the dopant gas fed through the  $j$ -th gas channel in communication with the dopant gas to a total volumetric flow rate of the dopant gas fed into the reaction chamber.

[0012] Optionally, the dopant gas source shares at least one of the plurality of gas channels with the gallium source.

10 [0013] Optionally, the dopant gas source shares at least one of the plurality of gas channels with the nitrogen source.

[0014] Optionally, the dopant gas source shares none of the plurality of gas channels with either the gallium source or the nitrogen source.

[0015] Optionally, a gap is provided between a top surface of the susceptor and a bottom surface of the gas feeding device.

15 [0016] Optionally, the gas feeding device further includes a dopant gas pipe in communication with the dopant gas source and the gap, for feeding the dopant gas into the reaction chamber through the gap.

[0017] Optionally, the dopant gas pipe comprises a first vertical gas pipe provided inside the gas feeding device.

20 [0018] Optionally, the first vertical gas pipe is provided at a central position of the gas feeding device.

[0019] Optionally, the dopant gas pipe comprises a second vertical gas pipe provided inside the susceptor.

25 [0020] Optionally, the second vertical gas pipe is provided at a central position of the susceptor.

[0021] Optionally, the gas feeding device further includes: a plurality of gas supply pipes, gas inlets of the plurality of gas supply pipes are in communication with the gas source group, and gas outlets of the plurality of gas supply pipes are in communication with the gas inlet of the at least one of the plurality of gas channels.

30 [0022] Optionally, the plurality of gas supply pipes are arranged vertically.

[0023] Optionally, a buffer chamber is connected in gas circuit between mutually connected gas supply pipes and gas channels, to control a flow velocity of a corresponding gas.

[0024] Optionally, a distribution chamber is connected in gas circuit between the buffer chamber and the plurality of gas channels, and the buffer chamber is in communication with the distribution chamber through a plurality of gas distribution holes.

[0025] Optionally, the gallium-containing gas is trimethylgallium or triethylgallium, the nitrogen-containing gas is ammonia, and the dopant gas contains at least one of propane and ethylene.

[0026] In another aspect, the present disclosure also discloses a vapor deposition device, which includes: a reaction chamber; a susceptor, provided at the bottom of the interior of the reaction chamber, for supporting a wafer or multiple wafers; and a gas feeding device as described above, provided at the top of the interior of the reaction chamber.

#### **BENEFICIAL EFFECTS**

[0027] Compared with the prior art, the present disclosure has at least the following advantages:

[0028] In the gas feeding device and the vapor deposition device provided by the present disclosure, the gas channels located in the reaction chamber are arranged horizontally, the gallium source and the nitrogen source in the gas source group can communicate with the interior of the reaction chamber via different gas channels, while the dopant gas source can communicate with the interior of the reaction chamber via at least one gas channel, so as to feed the gallium-containing gas, nitrogen-containing gas, and dopant gas into the reaction chamber. The gallium-containing gas and the dopant gas fed into the reaction chamber must satisfy the constraints of a preset formula, so that the vertical distance between the dopant gas and the susceptor when it first enters the reaction chamber is smaller compared to that of the gallium-containing gas. This reduces the opportunity for the dopant gas to be transported towards the center of the wafer, allowing more dopant gas to remain at the edge of the wafer to participate in the doping reaction. This increases the doping concentration at the edge of the wafer, thereby ensuring the uniformity of the overall doping concentration across the wafer, and avoiding the problem in the prior art where the doping concentration in the central region of the wafer is higher than that at the edge region.

[0029] In the present disclosure, the gas channels are arranged horizontally, i.e., extending radially along the susceptor. This allows the gallium-containing gas, nitrogen-containing gas, and dopant gas fed into the reaction chamber through the gas channels to pass over the surface of the wafer as horizontally as possible and to be uniformly distributed over the surface of the wafer, thereby ensuring the uniformity of the film thickness and the doping concentration on the surface of the wafer.

[0030] In the present disclosure, the gas outlets of the gas channels are spaced apart from the susceptor at different vertical distances, enabling the gallium-containing gas, nitrogen-containing gas, and dopant gas to be injected into the reaction chamber in layers in the vertical direction. This prevents the gallium-containing gas and the nitrogen-containing gas from reacting prematurely before reaching the surface of the wafer.

[0031] In the present disclosure, a gap is provided between a top surface of the susceptor and a bottom surface of the gas feeding device. The gap can also serve as a gas channel communicating with the interior of the reaction chamber. When the dopant gas is fed into the reaction chamber through the gas channel formed by the gap, the constraints of the preset formula shall also be satisfied, thus further ensuring the uniformity of the overall doping concentration across the wafer.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

[0032] FIG. 1 is a schematic structural diagram of a vapor deposition device according to an embodiment of the present disclosure.

[0033] FIG. 2 is a schematic structural diagram of a gas feeding device according to an embodiment of the present disclosure, where a dopant gas source shares a second gas channel and a fourth gas channel with a gallium source, and the dopant gas source shares a fifth gas channel with a nitrogen source.

[0034] FIG. 3 is a schematic structural diagram of a gas feeding device according to an embodiment of the present disclosure, where the dopant gas source shares a second gas channel and a fourth gas channel with a gallium source.

[0035] FIG. 4 is a schematic structural diagram of a gas feeding device according to an embodiment of the present disclosure, where a dopant gas source shares a fourth gas channel

with a gallium source, and the dopant gas source shares a third gas channel and a fifth gas channel with a nitrogen source.

[0036] FIG. 5 is a schematic structural diagram of a gas feeding device according to an embodiment of the present disclosure, where a dopant gas source shares a fourth gas channel with a gallium source, and the dopant gas source shares a fifth gas channel with a nitrogen source.

[0037] FIG. 6 is a schematic structural diagram of a gas feeding device according to an embodiment of the present disclosure, where a dopant gas source does not share any gas channel with either the gallium source or the nitrogen source.

[0038] FIG. 7 is a schematic structural diagram of a gas feeding device according to an embodiment of the present disclosure, where only a first vertical gas pipe is provided.

[0039] FIG. 8 is a schematic structural diagram of a gas feeding device according to an embodiment of the present disclosure, where only a second vertical gas pipe is provided.

[0040] FIG. 9 is a schematic structural diagram of a gas feeding device according to an embodiment of the present disclosure, where both a first vertical gas pipe and a second vertical gas pipe are provided.

## **DESCRIPTION OF THE EMBODIMENTS**

[0041] The gas feeding device and the vapor deposition device proposed in the present disclosure will be further described in detail below with reference to the accompanying drawings and description of the embodiments. The advantages and features of the present invention will become clearer from the following description. It should be noted that the drawings are in a very simplified form and all use imprecise scales, which are only used to facilitate and clearly assist the purpose of illustrating the embodiments of the present invention.

In order to make the objects, features and advantages of the present invention more comprehensible, please refer to the accompanying drawings. It should be noted that the structures, proportions, sizes, etc. shown in the drawings attached to this specification are only used to match the content disclosed in the specification, for those who are familiar with this technology to understand and read, and are not used to limit the limiting condition of implementation of the present invention, so it has no technical substantive meaning, and any

modification of structure, change of proportional relationship or adjustment of size shall still fall within the scope covered by the disclosed technical content of the present invention without affecting the effect and purpose of the present invention.

**[0042]** It should be noted that in this specification, relational terms such as the first and second are only used to distinguish one entity or operation from another entities or operations, and do not necessarily require or imply that there is any such actual relationship or order between these entities or operations. Furthermore, the term “comprises”, “includes” or any other variant thereof are intended to cover non-exclusive inclusion, so that a process, method, object or equipment including a series of elements not only includes those elements, but also includes other elements not explicitly listed, or also includes elements inherent to such process, method, object or equipment. Without further limitations, an element defined by the phrase “comprising a ...” does not exclude the presence of additional identical elements in the process, method, object or equipment including the element.

**[0043]** As shown in FIGS. 1 to 9, the embodiment provides a gas feeding device 110 for a vapor deposition device. The vapor deposition device includes a reaction chamber 100. A susceptor 102 is provided at a bottom of an interior of the reaction chamber 100, and the susceptor 102 is used for supporting a single wafer or multiple wafers 101. The gas feeding device 110 includes a plurality of horizontally arranged gas channels 1101, provided at a top of the interior of the reaction chamber 100. Gas inlets of the gas channels 1101 are in communication with a gas source group 120 located outside the reaction chamber 100. Gas outlets of the gas channels 1101 are located above the susceptor 102, and the gas outlets of the gas channels 1101 are spaced apart from the susceptor 102 at different vertical distances; The gas source group 120 includes a gallium source 1201, a nitrogen source 1202, and a dopant gas source 1203. The gallium source 1201 stores a gallium-containing gas, the nitrogen source 1202 stores a nitrogen-containing gas, and the dopant gas source 1203 stores a dopant gas. The gallium source 1201 and the nitrogen source 1202 are in communication with the interior of the reaction chamber 100 via different gas channels 1101, to prevent the gallium-containing gas and the nitrogen-containing gas from mixing and reacting inside the gas channels. The dopant gas source 1203 is in communication with the interior of the reaction chamber 100 via at least one gas channel 1101, so as to feed the gallium-containing gas, the nitrogen-containing gas, and

the dopant gas into the reaction chamber 100.

5 [0044] Specifically, in the embodiment, the gallium-containing gas and the nitrogen-containing gas are process gases. That is, the gallium-containing gas and the nitrogen-containing gas fed into the reaction chamber 100 can undergo a chemical deposition reaction under preset conditions to grow a thin film on the surface of the wafer 101. The dopant gas, as an external dopant, can be fed into the reaction chamber 100 together with the process gases so that the formed thin film contains the dopant, thereby obtaining the desired semi-insulating device. Optionally, the gallium-containing gas is trimethylgallium or triethylgallium, the nitrogen-containing gas is ammonia, and the dopant gas is propane or ethylene, to achieve external carbon doping. It should be noted that since trimethylgallium and triethylgallium themselves contain carbon, the carbon in these sources also contributes to doping. This type of doping is referred to as intrinsic doping. Doping with propane or ethylene is external doping. In practice, the concentration of intrinsic doping is typically 1 to 2 orders of magnitude lower than that of external doping, thus intrinsic doping can be considered negligible.

15 [0045] Specifically, in the embodiment, the wafers 101 can be placed spaced apart along the circumference of the susceptor 102. During the processing of the wafers 101, the susceptor 102 can rotate about its own axis, and the wafers 101 can also rotate about their own axes, to achieve better uniformity in the thickness of the thin film and the doping concentration on the surfaces of the wafers 101. More specifically, the gas feeding device 110 can be positioned opposite the central region of the susceptor 102 (i.e., the region not supporting wafers), and the gas channels 1101 can extend radially along the susceptor 102. This allows the gallium-containing gas, the nitrogen-containing gas, and the dopant gas fed into the reaction chamber 100 through the gas channels 1101 to pass over the surfaces of the wafers 101 as horizontally as possible and to be uniformly distributed over the surface of the wafer 101, further ensuring the uniformity of film thickness and doping concentration on the surface of the wafer 101. However, the present disclosure is not limited thereto.

25 [0046] Specifically, in the embodiment, the gas outlets of all the gas channels 1101 are arranged spaced apart vertically, enabling the gallium-containing gas, the nitrogen-containing gas, and the dopant gas to be injected into the reaction chamber 100 in layers in the vertical direction. This prevents the gallium-containing gas and the nitrogen-containing gas from

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reacting prematurely before reaching the surfaces of the wafers 101. More specifically, the gallium-containing gas and the dopant gas fed into the reaction chamber 100 satisfy the following formula:

$$\sum_{i=1}^n a_i x_i \geq \sum_{j=1}^m b_j y_j \quad (1)$$

[0047] where  $n$  denotes a total number of gas channels in communication with the gallium-containing gas;  $a_i$  denotes a vertical distance between the gas outlet of an  $i$ -th gas channel in communication with the gallium-containing gas and the susceptor;  $x_i$  denotes a ratio of a volumetric flow rate of the gallium-containing gas fed through the  $i$ -th gas channel in communication with the gallium-containing gas to a total volumetric flow rate of the gallium-containing gas fed into the reaction chamber;  $m$  denotes a total number of gas channels in communication with the dopant gas;  $b_j$  denotes a vertical distance between the gas outlet of a  $j$ -th gas channel in communication with the dopant gas and the susceptor;  $y_j$  denotes a ratio of a volumetric flow rate of the dopant gas fed through the  $j$ -th gas channel in communication with the dopant gas to a total volumetric flow rate of the dopant gas fed into the reaction chamber.

10 Optionally, when measuring the vertical distance between the gas outlet of the gas channel 1101 and the susceptor 102, the top surface of the central region of the susceptor 102 (i.e., the horizontal plane formed by rotating an A-A line around the axis of the susceptor of FIG. 1) can be used as a reference plane. However, the present disclosure is not limited thereto.

[0049] In the embodiment, based on the constraint of formula (1), the gas channels 1101 that are vertically closer to the top surface of the susceptor 102 are preferentially selected for feeding the dopant gas into the reaction chamber 100, such that upon the start of feeding the dopant gas into the reaction chamber 100, the vertical distance to the susceptor 102 is relatively small, thereby reducing the opportunity for the dopant gas to be transported towards the center of the wafer 101 and the outer side of the susceptor 102, and more dopant gas remains at the edge of the wafer 101 to participate in the doping reaction, increasing the doping concentration at the edge of the wafer 101 and thus ensuring the uniformity of the overall doping concentration across the wafer 101.

[0050] Please refer to FIGS. 2 to 5 simultaneously. The dopant gas source 1203 may share at

least one of the gas channels 1101 with the gallium source 1201. In some embodiments, the dopant gas source 1203 may share at least one of the gas channels 1101 with the nitrogen source 1202. In some embodiments, the dopant gas source may share none of the gas channels with either the gallium source or the nitrogen source. However, the present disclosure is not limited thereto, as long as formula (1) can be satisfied.

**[0051]** Specifically, taking an example where the gas feeding device 110 is provided with five gas channels 1101, and the five gas channels 1101 are designated as a first gas channel 1101a, a second gas channel 1101b, a third gas channel 1101c, a fourth gas channel 1101d, and a fifth gas channel 1101e. In some embodiments, as shown in FIG. 2, the first gas channel 1101a and the third gas channel 1101c are respectively in communication with the nitrogen source 1202 to feed the nitrogen-containing gas into the reaction chamber 100. The second gas channel 1101b and the fourth gas channel 1101d are both simultaneously in communication with the dopant gas source 1203 and the gallium source 1201 (i.e., the dopant gas source 1203 shares the second gas channel 1101b and the fourth gas channel 1101d with the gallium source 1201) to feed the gallium-containing gas and the dopant gas into the reaction chamber 100. The fifth gas channel 1101e is in communication with the dopant gas source 1203 and the nitrogen source 1202 (i.e., the dopant gas source 1203 shares the fifth gas channel 1101e with the nitrogen source 1202) to feed the dopant gas and the nitrogen-containing gas into the reaction chamber 100.

**[0052]** In some embodiments, as shown in FIG. 3, the first gas channel 1101a is in communication with the nitrogen source 1202. The second gas channel 1101b and the fourth gas channel 1101d are both simultaneously in communication with the dopant gas source 1203 and the gallium source 1201 (i.e., the dopant gas source 1203 shares the second gas channel 1101b and the fourth gas channel 1101d with the gallium source 1201). The third gas channel 1101c and the fifth gas channel 1101e are in communication with the nitrogen source 1202.

**[0053]** In some embodiments, as shown in FIG. 4, the first gas channel 1101a is in communication with the nitrogen source 1202. The second gas channel 1101b is in communication with the gallium source 1201. The third gas channel 1101c and the fifth gas channel 1101e are both simultaneously in communication with the dopant gas source 1203 and the nitrogen source 1202 (i.e., the dopant gas source 1203 shares the third gas channel 1101c

and the fifth gas channel 1101e with the nitrogen source 1202). The fourth gas channel 1101d is in communication with the gallium source 1201 and the dopant gas source 1203 (i.e., the dopant gas source 1203 shares the fourth gas channel 1101d with the gallium source 1201).

5 [0054] In some embodiments, as shown in FIG. 5, the first gas channel 1101a and the third gas channel 1101c are respectively in communication with the nitrogen source 1202. The second gas channel 1101b is in communication with the gallium source 1201. The fourth gas channel 1101d is in communication with the gallium source 1201 and the dopant gas source 1203 (i.e., the dopant gas source 1203 shares the fourth gas channel 1101d with the gallium source 1201). The fifth gas channel 1101e is in communication with the dopant gas source 1203  
10 and the nitrogen source 1202 (i.e., the dopant gas source 1203 shares the fifth gas channel 1101e with the nitrogen source 1201).

[0055] In some embodiments, as shown in FIG. 6, the first gas channel 1101a and the third gas channel 1101c are respectively in communication with the nitrogen source 1202. The second gas channel 1101b and the fourth gas channel 1101d are respectively in communication  
15 with the gallium source 1201. The fifth gas channel 1101e is in communication with the dopant gas source 1203. In this case, the dopant gas source 2303 does not share any gas channel with either the gallium source 1201 or the nitrogen source 1203.

[0056] Please refer to FIGS. 1, and 7 to 9 simultaneously, a gap 130 is provided between the top surface of the susceptor 120 and the bottom surface of the gas feeding device 110.

20 [0057] It can be understood that the gas feeding device 110 further includes a dopant gas pipe in communication with the dopant gas source 1203 and the gap 130, for feeding the dopant gas into the reaction chamber 100 through the gap 130.

[0058] Specifically, in the embodiment, the gap 130 can also serve as a dopant gas channel communicating with the interior of the reaction chamber 100. When the dopant gas is fed into  
25 the reaction chamber 100 through the gas channel formed by the gap 130, the constraint of formula (1) shall also be satisfied, thereby ensuring the uniformity of the overall doping concentration across the wafer. In the embodiment, since the reference plane is on the same horizontal plane as the top surface of the central region of the susceptor, the vertical distance between the gap 130 and the reference plane is 0. That is, the vertical distance between the gas  
30 outlet of the gas channel formed by the gap 130 and the susceptor is 0.

**[0059]** Furthermore, in some embodiments, as shown in FIGS. 7, 8, and 9, the gap 130 serves as a dopant gas channel, and when the dopant gas is fed into the reaction chamber 100 through the gap 130, the gas channels 1101 located inside the gas feeding device 110 may be used only for feeding the gallium-containing gas and the nitrogen-containing gas into the reaction chamber 100, while all of the dopant gas is fed into the reaction chamber 100 through the gap 130. However, the present disclosure is not limited thereto.

**[0060]** Specifically, as shown in FIGS. 7 and 9, the dopant gas pipe includes a first vertical gas pipe 1103 provided inside the gas feeding device 110. The first vertical gas pipe 1103 extends through the gas feeding device 110 and is in communication with the dopant gas source 1203 and the gap 130, allowing the dopant gas to be fed into the reaction chamber 100 through the first vertical gas pipe 1103 and the gap 130. In some embodiments, the first vertical gas pipe 1103 may be provided at a central position of the gas feeding device 110 to ensure axial symmetry and uniformity of inflow of the dopant gas. However, the present disclosure is not limited thereto.

**[0061]** Specifically, as shown in FIGS. 8 and 9, the dopant gas pipe includes a second vertical gas pipe 1104 provided inside the susceptor 102. One end of the second vertical gas pipe 1104 extends through the susceptor 102 and is in communication with the gap 130, while the other end of the second vertical gas pipe 1104 is in communication with an external dopant gas source (not shown in the figures), allowing the dopant gas to be fed into the reaction chamber 100 through the second vertical gas pipe 1104 and the gap 130. In some embodiments, the second vertical gas pipe 1104 may be provided at the central position of the susceptor 102 to ensure axial symmetry and uniformity of inflow of the dopant gas. However, the present disclosure is not limited thereto.

**[0062]** Furthermore, in some embodiments, only the first vertical gas pipe 1103 may be provided, or only the second vertical gas pipe 1104 may be provided, or both the first vertical gas pipe 1103 and the second vertical gas pipe 1104 may be provided simultaneously. However, the present disclosure is not limited thereto.

**[0063]** Please refer to FIGS. 1 to 9 simultaneously, the gas feeding device further includes a plurality of gas supply pipes 1102. A gas inlet of each supply pipe 1102 is in communication with the gas source group 120, and a gas outlet of each gas supply pipe 1102 is in

communication with the gas inlet of at least one gas channel 1101.

[0064] Specifically, in the embodiment, the number of gas supply pipes 1102 is the same as the number of gas channels 1101, i.e., the gas supply pipes 1102 are arranged in one-to-one correspondence with the gas channels 1101. In some embodiments, the number of gas supply  
5 pipes 1102 may also be less than the number of gas channels 1102. In such a case, the same gas supply pipe 1102 may be connected to a plurality of gas channels 1101. However, the present disclosure is not limited thereto.

[0065] Specifically, in the embodiment, a buffer chamber (not shown in the figures) is connected in gas circuit between mutually connected gas supply pipes 1102 and gas channels  
10 1101. That is, a gas inlet of the gas supply pipe 1102 is in communication with the gas source group 120, and a gas outlet of the gas supply pipe 1102 is in communication with a gas inlet of the buffer chamber, and a gas outlet of the buffer chamber is in communication with the gas inlet of the gas channel 1101. The buffer chamber can buffer the high-velocity gas from the gas supply pipe 1102 and initially homogenize the fed gas, thereby controlling the flow velocity of  
15 the corresponding gas (the gallium-containing gas, the nitrogen-containing gas, or the dopant gas). However, the present disclosure is not limited thereto.

[0066] Specifically, in the embodiment, a distribution chamber (not shown in the figures) is connected in gas circuit between the buffer chamber and the gas channel 1101. That is, the gas outlet of the buffer chamber is in communication with the gas inlet of the distribution chamber,  
20 and the gas outlet of the distribution chamber is in communication with the gas inlet of the gas channel 1101. More specifically, the buffer chamber may be in communication with the distribution chamber through a plurality of gas distribution holes (not shown in the figures). The gas distribution holes can homogenize the gas flowing from the buffer chamber into the corresponding distribution chamber, thereby allowing the gas fed into the reaction chamber 100  
25 through the gas channel 1101 uniformly distributed. This further ensures the uniformity of the film thickness and the doping concentration on the surface of the wafer 101. However, the present disclosure is not limited thereto.

[0067] Furthermore, in some embodiments, the buffer chamber may also be connected in gas circuit between the first vertical gas pipe 1103 and the gap 130, and between the second vertical  
30 gas pipe 1104 and the gap 130. The distribution chamber may also be connected in gas circuit

between the buffer chamber and the gap 130. However, the present disclosure is not limited thereto.

[0068] On the other hand, as shown in FIG. 1, the embodiment also provides a vapor deposition device, which includes: a reaction chamber 100; a susceptor 102, provided at a bottom of an interior of the reaction chamber 100, for supporting a wafer 101; and a gas feeding device 110 as described above, provided at a top of the interior of the reaction chamber 100.

[0069] To sum up, in the gas feeding device and the vapor deposition device provided by the embodiment, the gas channels located in the reaction chamber are arranged horizontally, the gallium source and the nitrogen source in the gas source group can communicate with the interior of the reaction chamber via different gas channels, while the dopant gas source can communicate with the interior of the reaction chamber via at least one gas channel, so as to feed the gallium-containing gas, nitrogen-containing gas, and dopant gas into the reaction chamber. The gallium-containing gas and the dopant gas fed into the reaction chamber must satisfy the constraints of a preset formula, so that the vertical distance between the dopant gas and the susceptor when it first enters the reaction chamber is smaller compared to that of the gallium-containing gas. This reduces the opportunity for the dopant gas to be transported towards the center of the wafer, allowing more dopant gas to remain at the edge of the wafer to participate in the doping reaction. This increases the doping concentration at the edge of the wafer, thereby ensuring the uniformity of the overall doping concentration across the wafer, and avoiding the problem in the prior art where the doping concentration in the central region of the wafer is higher than that at the edge region. In the embodiment, the gas channels are arranged horizontally, i.e., extending radially along the susceptor. This allows the gallium-containing gas, nitrogen-containing gas, and dopant gas fed into the reaction chamber through the gas channels to pass over the surface of the as horizontally as possible and to be uniformly distributed over the surface of the wafer, thereby ensuring the uniformity of the film thickness and the doping concentration on the surface of the wafer. Furthermore, the gas outlets of the gas channels are spaced apart from the susceptor at different vertical distances, enabling the gallium-containing gas, nitrogen-containing gas, and dopant gas to be injected into the reaction chamber in layers in the vertical direction. This prevents the gallium-containing gas and the nitrogen-containing gas from reacting prematurely before reaching the surface of the wafer. In the embodiment, a

gap is provided between a top surface of the susceptor and a bottom surface of the gas feeding device. The gap can also serve as a gas channel communicating with the interior of the reaction chamber. When the dopant gas is fed into the reaction chamber through the gas channel formed by the gap, the constraints of the preset formula shall also be satisfied, thus further ensuring the  
5 uniformity of the overall doping concentration across the wafer.

**[0070]** Although the content of the present disclosure has been described in detail through the above preferred embodiments, it should be understood that the above description should not be considered as limiting the present disclosure. Various modifications and alternatives to the present invention will become apparent to those skilled in the art upon reading the foregoing  
10 disclosure. Accordingly, the protection scope of the present invention shall be limited by the appended claims.

## CLAIMS

1. A gas feeding device for a vapor deposition device, the vapor deposition device comprising a reaction chamber, a susceptor being provided at a bottom of an interior of the reaction chamber; wherein the gas feeding device comprises: a plurality of gas channels arranged horizontally, provided at a top of the interior of the reaction chamber; gas inlets of the plurality of gas channels in communication with a gas source group, and gas outlets of the plurality of gas channels spaced apart from the susceptor at different vertical distances;

the gas source group comprises a gallium source, a nitrogen source, and a dopant gas source; the gallium source and the nitrogen source being in communication with the interior of the reaction chamber via different gas channels, and the dopant gas source being in communication with the interior of the reaction chamber via at least one of the plurality of gas channels, so as to feed a gallium-containing gas, a nitrogen-containing gas, and a dopant gas into the reaction chamber; and

the gallium-containing gas and the dopant gas fed into the reaction chamber satisfy the following formula:

$$\sum_{i=1}^n a_i x_i \geq \sum_{j=1}^m b_j y_j$$

where  $n$  denotes a total number of gas channels in communication with the gallium-containing gas;  $a_i$  denotes a vertical distance between the gas outlet of an  $i$ -th gas channel in communication with the gallium-containing gas and the susceptor;  $x_i$  denotes a ratio of a volumetric flow rate of the gallium-containing gas fed through the  $i$ -th gas channel in communication with the gallium-containing gas to a total volumetric flow rate of the gallium-containing gas fed into the reaction chamber;  $m$  denotes a total number of gas channels in communication with the dopant gas;  $b_j$  denotes a vertical distance between the gas outlet of a  $j$ -th gas channel in communication with the dopant gas and the susceptor;  $y_j$  denotes a ratio of a volumetric flow rate of the dopant gas fed through the  $j$ -th gas channel in communication with the dopant gas to a total volumetric flow rate of the dopant gas fed into the reaction chamber.

2. The gas feeding device according to claim 1, wherein the dopant gas source shares at

least one of the plurality of gas channels with the gallium source.

3. The gas feeding device according to claim 1, wherein the dopant gas source shares at least one of the plurality of gas channels with the nitrogen source.

4. The gas feeding device according to claim 1, wherein the dopant gas source shares none  
5 of the plurality of gas channels with either the gallium source or the nitrogen source.

5. The gas feeding device according to claim 1, wherein a gap is provided between a top surface of the susceptor and a bottom surface of the gas feeding device.

6. The gas feeding device according to claim 5, further comprising: a dopant gas pipe in communication with the dopant gas source and the gap, for feeding the dopant gas into the  
10 reaction chamber through the gap.

7. The gas feeding device according to claim 6, wherein the dopant gas pipe comprises a first vertical gas pipe provided inside the gas feeding device.

8. The gas feeding device according to claim 7, wherein the first vertical gas pipe is provided at a central position of the gas feeding device.

15 9. The gas feeding device according to claim 6, wherein the dopant gas pipe comprises a second vertical gas pipe provided inside the susceptor.

10. The gas feeding device according to claim 9, wherein the second vertical gas pipe is provided at a central position of the susceptor.

11. The gas feeding device according to claim 1, further comprising a plurality of gas  
20 supply pipes, gas inlets of the plurality of gas supply pipes being in communication with the gas source group, and gas outlets of the plurality of gas supply pipes being in communication with the gas inlet of the at least one of the plurality of gas channels.

12. The gas feeding device according to claim 11, wherein the plurality of gas supply pipes are arranged vertically.

25 13. The gas feeding device according to claim 11, wherein a buffer chamber is connected in gas circuit between mutually connected gas supply pipes and gas channels, to control a flow velocity of a corresponding gas.

14. The gas feeding device according to claim 13, wherein a distribution chamber is connected in gas circuit between the buffer chamber and the plurality of gas channels, and the  
30 buffer chamber is in communication with the distribution chamber through a plurality of gas

distribution holes.

15. The gas feeding device according to claim 1, wherein the gallium-containing gas is trimethylgallium or triethylgallium, the nitrogen-containing gas is ammonia, and the dopant gas contains at least one of propane and ethylene.

5        16. A vapor deposition device, comprising:

a reaction chamber;

a susceptor, provided at a bottom of an interior of the reaction chamber, for supporting a wafer or multiple wafers; and

the gas feeding device according to any one of claims 1 to 15, provided at a top of the  
10 interior of the reaction chamber.