[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 horizontal 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

the dopant gas into the reaction chamber 100.

[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.

[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.

[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 horizontal direction. This prevents the gallium-containing gas and the nitrogen-containing gas from

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).

[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 and the nitrogen source 1202 (i.e., the dopant gas source 1203 shares the fifth gas channel 1101e with the nitrogen source 1202).

[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 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 1203 does not share any gas channel with either the gallium source 1201 or the nitrogen source 1202.

[0056] Please refer to FIGS. 1, and 7 to 9 simultaneously, a gap 130 is provided between the top surface of the susceptor 102 and the bottom surface of the gas feeding device 110.

[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 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 outlet of the gas channel formed by the gap 130 and the susceptor is 0.

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 pipes 1102 may also be less than the number of gas channels 1101. 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 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 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, 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 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 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 horizontal 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