

Exhausting method in film forming apparatus

The present invention relates to an exhausting method in a film forming apparatus having a reaction chamber and a preliminary vacuum chamber adjacent with each other such as a spattering device or a vapor deposition device.

Film forming apparatuses such as spattering device or vapor deposition device have been widely used in recent years for forming a thin film in the production of a semiconductor, optical disk, electronic component or the like. Most of these apparatuses have a communicating preliminary vacuum chamber adjacent to a reaction chamber for the purpose of enhancing the production tactic.

A conventional exhausting method in a spattering device having a reaction chamber and a preliminary vacuum chamber will be hereinafter described referring to Fig. 3.

First, the interior of the reaction chamber 21 is vacuum exhausted to a vacuum of 10^{-6} Torr. Next, a substrate is disposed in the preliminary vacuum chamber 22 of atmospheric pressure, after which the preliminary vacuum chamber 22 is vacuum exhausted as shown in Fig. 3. A gate valve between both chambers 21, 22 is then opened, the substrate is transferred from the preliminary vacuum chamber 22 to the reaction chamber 21, and the gate valve is closed again.

After that, argon gas is introduced in the reaction chamber 21 to set the vacuum to be about 5×10^{-3} Torr. A

direct electric current or high-frequency voltage is applied to a cathode to form a plasma inside the reaction chamber 21 so as to accumulate a predetermined film on the substrate. After that, the plasma formation is stopped, and consequently introduction of the argon gas is also stopped. The gate valve is opened, the substrate is transferred to the preliminary vacuum chamber 22, and the gate valve is closed again. Next, nitrogen gas is introduced to the preliminary vacuum chamber 22 so as to cause the pressure of the interior thereof to return to the atmospheric level, after which the substrate is taken out.

In the conventional preliminary vacuum chamber exhausting method described above, however, when the preliminary vacuum chamber 22 is opened to the air for transferring the substrate, the atmosphere flows into the preliminary vacuum chamber 22. Even though the preliminary vacuum chamber 22 is vacuated thereafter, the composition contained in the atmosphere such as oxygen and water cannot be completely exhausted, and the remains of such composition mix into the reaction chamber 21 when the gate valve is opened. Under such condition, the composition in the surface of a sputtering target or a vapor deposition material is changed due to oxidization or other chemical reaction, resulting in unstableness in thickness or composition of the film formed on the substrate. In case of sputtering a metallic material, such inmixed composition in the atmosphere may cause abnormal

or incomplete electric discharge.

In view of the foregoing, an object of the present invention is to provide an exhausting method in a film forming apparatus having a reaction chamber and a preliminary vacuum chamber, by which mixture of oxygen or water into the reaction chamber is effectively prevented.

The exhausting method in a film forming apparatus having a reaction chamber and a preliminary vacuum chamber according to the present invention comprises the steps of opening the preliminary vacuum chamber to the atmosphere, exchanging substrates, enclosing a gas of nitrogen in the preliminary vacuum chamber for compression thereof, and exhausting the preliminary vacuum chamber.

By this method, since the interior of the preliminary vacuum chamber is compressed with the nitrogen gas before being exhausted, mixture of the composition in the atmosphere such as oxygen or water into the reaction chamber can be remarkably reduced due to higher partial pressure of inactive nitrogen gas at the time of exhaustion. Accordingly, oxidization of a sputtering target or vapor deposition material can be prevented, and the thickness or composition of a film formed on the substrate can be stabilized. Also, in case of sputtering a metallic material, abnormal or incomplete electric discharge can be prevented.

It is similarly effective, if the preliminary vacuum chamber is opened to the atmosphere under a state that the

vicinity of the exit of the preliminary vacuum chamber is maintained in a nitrogen gas atmosphere when exchanging the substrates, and after that the preliminary vacuum chamber is exhausted.

5 These and other objects, features and advantages of the present invention will be apparent from the following description of the preferred embodiments of the invention in conjunction with the accompanying drawings, in which:

Fig. 1 is a flow diagram of exhausting process according
10 to one embodiment of the present invention;

Fig. 2 is a diagram showing a schematic construction of a sputtering device according to the embodiment of the present invention; and

Fig. 3 is a flow diagram of exhausting process in a
15 conventional film forming apparatus.

Preferred embodiments of the present invention will be hereinafter described referring to Fig. 1 and Fig. 2.

Fig. 2 shows a schematic construction of a sputtering device, wherein a substrate 3, on which a film is accumulated
20 by sputtering is disposed within a reaction chamber 1 in opposition to a cathode 2. Reference numerals 4 and 5 respectively denote a substrate holder and an electric power source which applies voltage to the cathode 2 for causing plasma formation on the surface thereof. The reaction chamber
25 1 is depressurized by a first vacuum exhaustion pump 6. A sputtering gas is supplied into the reaction chamber 1 through

a first gas feeding system 7. The vacuum within the reaction chamber 1 is adjusted by an adjusting valve 8.

A preliminary vacuum chamber 10 is arranged adjacent to the reaction chamber 1, and constructed such that both
5 chambers 1, 10 communicate through a gate valve 9 with each other. The preliminary vacuum chamber 10 is depressurized by a second vacuum exhaustion pump 11. A second gas feeding system 12 supplies nitrogen gas into the preliminary vacuum chamber 10, causes the same to return to the atmospheric
10 pressure, and to compress the same.

The actions of the spattering apparatus which is constructed as described above will be explained. First, the interior of the reaction chamber 1 is vacuum exhausted to a vacuum of 10^{-6} Torr with the first vacuum exhaustion pump 6.
15 As shown in Fig. 1, after placing the substrate 3 in the preliminary vacuum chamber 10 of atmospheric pressure, nitrogen gas is supplied with the second gas feeding system 12 to compress the preliminary vacuum chamber 10 to a higher pressure. After that, the preliminary vacuum chamber 10 is
20 vacuum exhausted with the second vacuum exhaustion pump 11. The gate valve 9 between both chambers 1, 10 is opened, the substrate 3 is transferred from the preliminary vacuum chamber 11 to the substrate holder 4 in the reaction chamber 1, and the gate valve 9 is closed again. Argon gas is then
25 introduced into the reaction chamber 1 with the first gas feeding system 7, and the vacuum is adjusted with the

adjusting valve 8 to be around 5×10^{-3} Torr. A direct current or high-frequency voltage is applied from the electric power source 5 to the cathode 2 to form a plasma within the reaction chamber 1 so that a predetermined film is accumulated on the substrate 3. The plasma formation is then stopped, and consequently introduction of the argon gas is also stopped. The gate valve 9 is opened, the substrate 3 is transferred to the preliminary vacuum chamber 10, and the gate valve 9 is closed again. Successively, nitrogen gas is introduced into the preliminary vacuum chamber 10 with the second gas feeding system 12 until the interior thereof returns to the atmospheric pressure, after which the substrate 3 is taken out.

As set forth above, since the interior of the preliminary vacuum chamber 10 is compressed with the nitrogen gas before being exhausted, mixture of the composition in the atmosphere such as oxygen or water into the reaction chamber 1 can be remarkably reduced due to higher partial pressure of inactive nitrogen gas at the time of exhaustion. Accordingly, oxidization of a sputtering target or vapor deposition material can be prevented, the thickness or composition of a film formed on the substrate 3 can be stabilized. Also, in case of sputtering a metallic material, abnormal or incomplete electric discharge can be prevented.

Although the interior of the preliminary vacuum chamber 10 is compressed with the nitrogen gas in the above described embodiment, it is similarly effective by making only the

vicinity of the exit of the preliminary vacuum chamber 10 to be the nitrogen gas atmosphere. However, compressing the entire interior of the preliminary vacuum chamber 10 with the nitrogen gas can be effected more simply.

5 Such method is particularly advantageous in the film forming technology in recent years, since there has been a problem of insufficient exhaustion of the preliminary vacuum chamber to the same level of the vacuum of the reaction chamber in a very short time during a high speed film forming
10 operation especially in the spattering technology for optical disks or the like.



CLAIMS

1. An exhausting method in a film forming apparatus having a reaction chamber and a preliminary vacuum chamber,
5 comprising the steps of:

opening the preliminary vacuum chamber (10) to atmospheric pressure;

exchanging substrates (3);

supplying a gas of nitrogen into the preliminary vacuum
10 chamber (10) and thereby compressing the same; and
exhausting the preliminary vacuum chamber (10).

2. An exhausting method in a film forming apparatus having a reaction chamber and a preliminary vacuum chamber,
15 comprising the steps of:

opening the preliminary vacuum chamber (10) to atmospheric pressure under a condition that a vicinity of an exit of the preliminary vacuum chamber (10) is maintained in an atmosphere of nitrogen gas;

20 exchanging substrates (3); and

exhausting the preliminary vacuum chamber (10).