W accommodated in the FOUP 16 placed on each load port 17 kept in an ambient atmosphere to the process modules 13 whose interior is kept in a vacuum atmosphere. Each of the load-lock modules 19 includes a buffer plate 21 configured to hold two sheets of wafers W. Further, each of the load-lock modules 19 includes a gate valve 22a for securing airthightness against the loader module 18 and a gate valve 22b for securing airtightness against the transfer module 12. Further, a gas introduction system and a gas exhaust system (both not shown) are coupled to each of the load-lock module 19 through respective pipes such that the interior of each of the load-lock modules 19 can be switched between the atmospheric atmosphere and the vacuum atmosphere.

[0024] The transfer module 12 loads an unprocessed wafer W from the loading/unloading part 11 into the process module 13, and unloads a processed wafer W from the respective process module 13 to the loading/unloading part 11. The transfer module 12 includes a rectangular housing whose interior is kept in a vacuum atmosphere. The transfer module 12 includes two transfer arms 14, a rotary base 23, a rotary mounting table 24, and guide rails 25. The transfer arms 14 hold and move two wafers W. The rotary base 23 supports the two transfer arms 14 in a rotatable manner. The rotary mounting table 24 mounts the rotary base 23 thereon. The guide rails 25 guide the rotary mounting table 24 to be movable in the longitudinal direction of the transfer module 12. The transfer module 12 is coupled to the load-lock modules 19 of the loading/unloading part 11 via the gate valves 22b and the process modules 13 via respective gate valves 26 to be described later. In the transfer module 12, the transfer arms 14 transfer two wafers W from the load-lock modules 19 to each process module 13. The transfer arms 14 unload two processed wafers W from the respective process module 13 to another process module 13 or the load-lock module 19.

[0025] In the processing system 10, each process module 13 executes any of the SiN film etching process and the heating process. That is, among the six process modules 13, a predetermined number of process modules 13 are used for the SiN film etching process, and the remaining process modules are used for the heating process to remove residues obtained after the etching of the SiN film. The number of the process modules 13 for the SiN film etching

WHAT IS CLAIMED IS:

1. A method of selectively etching a silicon nitride film, the method comprising:

a first step of disposing a target substrate having the silicon nitride film formed thereon in a processing space;

a second step of introducing a gas containing H and F into the processing space; and

a third step of selectively etching the silicon nitride film by selectively introducing radicals of an inert gas into the processing space via a partition plate equipped with an ion trap mechanism including at least a first plate-shaped member in which a plurality of first slits are formed and a second plate-shaped member in which a plurality of second slits are formed, the plurality of first slits and the plurality of second slits being arranged not to overlap each other when the partition plate is viewed from the processing space.

2. The method of Claim 1, wherein the second step and the third step are repeated multiple times while the target substrate is being processed.

3. The method of Claim 1, wherein the gas containing H and F is a HF gas.

4. The method of Claim 1, further comprising:

a step of purging the processing space after each of the second step and the third step.

5. The method of Claim 4, wherein the step of purging an interior of the processing space is performed by vacuum-exhausting the interior of the processing space.

6. The method of Claim 4, wherein the step of purging an interior of the processing space is performed by introducing the inert gas into the processing space.

7. The method of Claim 4, wherein the step of purging an interior of the processing space is performed by introducing the inert gas into the processing space and vacuum-exhausting an interior of the processing space.

8. The method of Claim 1, wherein the processing space is defined by partitioning a processing container using the partition plate equipped with the ion trap mechanism, the processing space is formed below the partition plate, a plasma production space is formed above the partition plate, and the target substrate is disposed in the processing space,

wherein the second step is performed by supplying the gas containing H and F into the processing space, and

wherein the third step is performed by producing a plasma of the inert gas in the plasma production space, and introducing the radicals in the plasma into the processing space while trapping ions in the plasma by the ion trap mechanism.

9. The method of Claim 1, wherein any of an Ar gas, a He gas, a Kr gas, a Ne gas, and a Xe gas is used as the inert gas to form the radicals.

10. The method of Claim 1, wherein the second step and the third step are performed in a state where a temperature of the target substrate falls within a range of -15 to 35 degrees C.

11. The method of Claim 1, wherein the second step is performed at a pressure ranging from 1.33 to 200 Pa.

12. The method of Claim 1, wherein the third step is performed at a pressure ranging from 1.33 to 133 Pa.

13. The method of Claim 1, wherein a heating process is performed one or more times while the second step and the third step are being repeated, and/or after each of the second step and the third step, to remove an etching residue and a reaction product.

14. The method of Claim 1, wherein, in the target substrate, at least one selected from a group consisting of a SiO_2 film, a Si film, a SiGe film, a W film, a TiN film, and a TaN film, coexists with the silicon nitride film, and the silicon nitride film is selectively etched with respect to the coexisting film.

15. An apparatus for selectively etching a silicon nitride film, comprising:

a processing container configured to accommodate a target substrate having the silicon nitride film formed thereon, at least during selective etching of the silicon nitride film;

a partition plate configured to partition the processing container into a plasma production space defined at an upper portion and a processing space defined at a lower portion;

an ion trap mechanism provided in the partition plate and including at least a first plate-shaped member in which a plurality of first slits are formed and a second plate-shaped member in which a plurality of second slits are formed, the ion trap mechanism being configured to trap ions and allow radicals to pass therethrough, the plurality of first slits and the plurality of second slits being arranged not to overlap each other when the partition plate is viewed from the processing space;

a first gas source configured to supply an inert gas to the plasma production space;

a plasma production mechanism configured to produce a plasma of the inert gas in the plasma production space;

a placement stage provided in the processing space to place the target substrate thereon;

a second gas source configured to supply a gas containing H and F into the processing space;

an exhaust mechanism configured to vacuum-exhaust an interior of the processing container; and

a controller configured to perform a control to execute:

a first step of disposing the target substrate having the silicon nitride film formed thereon in the processing space;

a second step of introducing the gas containing H and F into the processing space; and

a third step of selectively etching the silicon nitride film by producing the plasma in the plasma production space and introducing the radicals in the plasma into the processing space via the partition plate while trapping the ions in the plasma by the ion trap mechanism.

16. The apparatus of Claim 15, wherein the controller performs the control to repeat multiple times, the second step and the third step while the target substrate is being processed.

17. The apparatus of Claim 15, wherein the gas containing the H and F is an HF gas.

18. The apparatus of Claim 15, further comprising:

a heat shield plate provided below the partition plate,

wherein the gas containing H and F is introduced into the processing space through the heat shield plate.

19. A method of selectively etching a silicon nitride film, the method comprising:

a first step of disposing a target substrate having the silicon nitride film formed thereon in a processing space;

a second step of introducing a gas containing H and F into the processing space; and

a third step of selectively introducing radicals of an inert gas into the processing space,

wherein the gas containing H and F is a HF gas,

wherein the second step and the third step are performed in a state where a temperature of the target substrate falls within a range of -15 to 35 degrees C, and

wherein an O_2 gas is not introduced into the processing space.