SUMMARY

[0007] In one exemplary embodiment, an etching method of etching a multilayered film is provided. The multilayered film includes a first film and a second film that have different permittivities and are alternately stacked on top of each other. The etching method includes preparing, within a processing vessel of a plasma processing apparatus, a processing target object having the multilayered film and a mask formed on the multilayered film; and etching the multilayered film (simply referred to as "etching of the multilayered film") by generating plasma within the processing vessel of the plasma processing apparatus. In the etching of the multilayered film, a first processing gas containing a hydrogen gas, a hydrogen bromide gas, a fluorine-containing gas and a hydrofluorocarbon gas and a second processing gas containing a hydrocarbon gas and a fluorocarbon gas are supplied from a first supply unit configured to supply a gas toward a central region of the processing target object and from a second supply unit configured to supply a gas toward outer region than the central region such that a flow rate ratio of the second processing gas to the first processing gas supplied from the first supply unit is same as a flow rate ratio of the second processing gas to the first processing gas supplied from the second supply unit; the second processing gas is supplied from either one of the first supply unit and the second supply unit such that the flow rate ratio of the second processing gas to the first processing gas supplied from the first supply unit becomes different from the flow rate ratio of the second processing gas to the first processing gas supplied from the second supply unit; and the first processing gas and the second processing gas are excited.

[0008] In this etching method, a protective film containing fluorocarbon originated from the fluorocarbon gas is formed on a sidewall surface of the multilayered film that forms a space formed by the etching. Further, hydrogen originated from the hydrocarbon gas suppresses the protective film from being formed in an excessively large thickness. Accordingly, a reduction of an opening size of the mask can also be suppressed and verticality of the space formed in the multilayered film can be improved. In addition, in the above etching method, the second processing gas containing the hydrocarbon gas and the fluorocarbon gas is supplied from either

WE CLAIM

1. An etching method of etching a multilayered film including a first film and a second film that have different permittivities and are alternately stacked on top of each other, the etching method comprising:

preparing, within a processing vessel of a plasma processing apparatus, a processing target object having the multilayered film and a mask formed on the multilayered film; and

etching the multilayered film by generating plasma within the processing vessel of the plasma processing apparatus,

wherein in the etching of the multilayered film, a first processing gas containing a hydrogen gas, a hydrogen bromide gas, a fluorine-containing gas and a hydrofluorocarbon gas and a second processing gas containing a hydrocarbon gas and a fluorocarbon gas are supplied from a first supply unit configured to supply a gas toward a central region of the processing target object and from a second supply unit configured to supply a gas toward outer region than the central region such that a flow rate ratio of the second processing gas to the first processing gas supplied from the first supply unit is same as a flow rate ratio of the second processing gas to the first processing gas supplied from the second supply unit; the second processing gas is supplied from either one of the first supply unit and the second supply unit such that the flow rate ratio of the second processing gas to the first processing gas supplied from the first supply unit becomes different from the flow rate ratio of the second processing gas to the first processing gas supplied from the second supply unit; and the first processing gas and the second processing gas are excited.

2. The etching method of Claim 1,

wherein the first supply unit is configured to supply the second processing gas.

3. The etching method of Claim 1,

wherein the second supply unit is configured to supply the second processing gas.

4. The etching method of Claim 1,

wherein the fluorocarbon gas is a C_3F_8 gas, a C_4F_6 gas or a C_4F_8 gas.

5. The etching method of Claim 1,

wherein the hydrofluorocarbon gas is a CH_2F_2 gas, a CH_3F gas or a CHF_3 gas.

6. The etching method of Claim 1,

wherein the fluorine-containing gas is a NF_3 gas or a SF_6 gas.

7. The etching method of Claim 1,

wherein the hydrocarbon gas is a CH_4 gas.

8. The etching method of Claim 1,

wherein the first film is a silicon oxide film, and the second film is a silicon nitride film.

9. The etching method of Claim 1,

wherein the first film is a silicon oxide film, and the second film is a polysilicon film.

10. The etching method of Claim 1,

wherein the first film and the second film are stacked in twenty-four or more layers in total.

11. The etching method of Claim 1,

wherein the mask is made of amorphous carbon.