METHOD OF PROCESSING SUBSTRATE, METHOD OF MANUFACTURING SEMICONDUCTOR DEVICE, ~~METHOD OF PROCESSING SUBSTRATE,~~ SUBSTRATE PROCESSING APPARATUS, AND PROGRAM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2020-157656, filed on September 18, 2020, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to a method of manufacturing a semiconductor device, a method of processing a substrate, a substrate processing apparatus, and a program.

BACKGROUND

[0003] With the recent miniaturization and complexity of device shapes in the LSI manufacturing process, a technique of burying the interior of a concave portion such as a trench or a hole formed on the surface of a substrate with a film (gap fill technique) is used. In the related art, among the gap fill techniques, there is a method of supplying a film-forming inhibition gas to an upper portion in the concave portion formed on the surface of the substrate to form a film in the concave portion while lowering a deposition rate in the upper portion in the concave portion.

[0004] However, even when this method is used, the film-forming inhibition effect by the film-forming inhibition gas may not be sufficiently obtained, whereby sufficient burial characteristics cannot be obtained.

SUMMARY

[0005] Some embodiments of the present disclosure provide a technique that improves burial characteristics when burying an interior of a concave portion with a film.

WHAT IS CLAIMED IS:

1. A method of processing a substrate~~manufacturing a semiconductor device~~, comprising:

(a) forming a base film, which has a reactivity with a film-forming inhibitor higher than a reactivity between the film-forming inhibitor and an inner surface of a concave portion formed on a surface of the~~a~~ substrate, at least in an upper portion in the concave portion by supplying a pre-treatment gas to the substrate;

(b) forming a film-forming inhibition layer on a portion of a surface of the base film, which is formed in the upper portion in the concave portion, by supplying the film-forming inhibitor to the substrate; and

(c) growing a film starting from a portion in the concave portion where the film-forming inhibition layer is not formed, by supplying a film-forming gas to the substrate, wherein the base film is made of a first material and the film is made of a second material that is different from the first material.

2. The method of Claim 1, wherein in (a), an oxygen-containing film is formed as the base film.

3. The method of Claim 1, wherein in (a), a silicon- and oxygen-containing film is formed as the base film.

4. The method of Claim 1, wherein in (a), a silicon oxide film is formed as the base film.

5. The method of Claim 1, wherein in (a), the base film is selectively formed in the upper portion in the concave portion.

6. The method of Claim 5, wherein in (a), the base film is selectively deposited in the upper portion in the concave portion by supplying a precursor gas as the pre-treatment gas under a condition in which a gas phase reaction is predominant.

7. The method of Claim 5, wherein in (a), the base film is selectively deposited in the upper portion in the concave portion by alternately supplying a precursor gas and a modifying gas as the pre-treatment gas under a condition in which at least one selected from the group of consumption and deactivation of at least one selected from the group of the precursor gas and the modifying gas occurs in the upper portion in the concave portion.

8. The method of Claim 5, wherein in (a), a surface of a portion other than the upper portion in the concave portion is exposed with the base film left in the upper portion in the concave portion by supplying the pre-treatment gas, under a condition in which step coverage is deteriorated, to deposit the base film in the concave portion and then supplying an etching gas under a condition in which the base film is conformally etchable.

9. The method of Claim 5, wherein in (a), a surface of the upper portion in the concave portion is selectively modified to selectively form the base film in the upper portion in the concave portion by supplying a modifying gas as the pre-treatment gas under a condition in which at least one selected from the group of consumption and deactivation of the modifying gas occurs in the upper portion in the concave portion.

10. The method of Claim 1, wherein in (b), a fluorine-terminated layer is formed as the film-forming inhibition layer by supplying a fluorine-containing gas as the film-forming inhibitor.

11. The method of Claim 1, wherein in (b), a hydrocarbon group-terminated layer is formed

as the film-forming inhibition layer by supplying a hydrocarbon group-containing gas as the film-forming inhibitor.

12. The method of Claim 1, wherein in (a), the base film is formed entirely in the concave portion.

13. The method of Claim 12, wherein in (a), the base film is formed in the concave portion by alternately supplying a precursor gas and a modifying gas as the pre-treatment gas to deposit the base film in the concave portion or by supplying the modifying gas as the pre-treatment gas to modify the inner surface of the concave portion.

14. The method of Claim 12, wherein in (b), the film-forming inhibition layer is selectively formed on a portion of the surface of the base film, which is formed in the upper portion in the concave portion.

15. The method of Claim 14, wherein in (b), the film-forming inhibitor is supplied under a condition in which at least one selected from the group of consumption and deactivation of the film-forming inhibitor occurs in the upper portion in the concave portion.

16. The method of Claim 14, wherein in (b), a fluorine-terminated layer is formed as the film-forming inhibition layer by supplying a fluorine-containing gas as the film-forming inhibitor.

17. The method of Claim 14, wherein in (b), a fluorine-terminated layer is formed as the film-forming inhibition layer by supplying a fluorine-containing gas as the film-forming inhibitor under a condition in which the fluorine-containing gas is thermally decomposed.

18. The method of Claim 14, wherein in (b), a fluorine-terminated layer is formed as the film-forming inhibition layer by plasma-exciting and supplying a fluorine-containing gas as the film-forming inhibitor.

19. The method of Claim 14, wherein in (b), a fluorine-terminated layer is formed as the film-forming inhibition layer by supplying a fluorine-containing gas and an additive gas reacting with the fluorine-containing gas as the film-forming inhibitor.

20. The method of Claim 14, wherein in (b), a hydrocarbon group-terminated layer is formed as the film-forming inhibition layer by supplying a hydrocarbon group-containing gas as the film-forming inhibitor.

21. The method of Claim 1, wherein before the film grows to the upper portion in the concave portion in (c), the film-forming inhibition layer for which at least one selected from the group of removal and invalidation is performed by an action of the film-forming gas is formed in (b).

22. A method of ~~processing a substrate~~manufacturing a semiconductor device, comprising:

(a) forming a base film, which has a reactivity with a film-forming inhibitor higher than a reactivity between the film-forming inhibitor and an inner surface of a concave portion formed on a surface of a substrate, at least in an upper portion in the concave portion by supplying a pre-treatment gas to the substrate;

(b) forming a film-forming inhibition layer on a portion of a surface of the base film, which is formed in the upper portion in the concave portion, by supplying the film-forming inhibitor to the substrate; and

(c) growing a film starting from a portion in the concave portion where the film-forming inhibition layer is not formed, by supplying a film-forming gas to the substrate, wherein the base film is made of a first material and the film is made of a second material that is different from the first material.

23. A substrate processing apparatus comprising:

a process chamber in which a substrate is processed;

a pre-treatment gas supply system configured to supply a pre-treatment gas to the substrate in the process chamber~~container~~;

a film-forming inhibitor supply system configured to supply a film-forming inhibitor to the substrate in the process chamber~~container~~;

a film-forming gas supply system configured to supply a film-forming gas to the substrate in the process chamber~~container~~; and

a controller configured to be capable of controlling the pre-treatment gas supply system, the film-forming inhibitor supply system, and the film-forming gas supply system to perform a process in the process chamber, the process including: (a) forming a base film, which has a reactivity with the film-forming inhibitor higher than a reactivity between the film-forming inhibitor and an inner surface of a concave portion formed on a surface of the substrate, at least in an upper portion in the concave portion by supplying the pre-treatment gas to the substrate; (b) forming a film-forming inhibition layer on a portion of a surface of the base film, which is formed in the upper portion in the concave portion, by supplying the film-forming inhibitor to the substrate; and (c) growing a film starting from a portion in the concave portion where the film-forming inhibition layer is not formed, by supplying the film-forming gas to the substrate, wherein the base film is made of a first material and the film is made of a second material that is different from the first material.

24. A program that causes, by a computer, a substrate processing apparatus to perform a process in a process chamber of the substrate processing apparatus, the process comprising:

(a) forming a base film, which has a reactivity with a film-forming inhibitor higher than a reactivity between the film-forming inhibitor and an inner surface of a concave portion formed on a surface of a substrate, at least in an upper portion in the concave portion by supplying a pre-treatment gas to the substrate;

(b) forming a film-forming inhibition layer on a portion of a surface of the base film, which is formed in the upper portion in the concave portion, by supplying the film-forming inhibitor to the substrate; and

(c) growing a film starting from a portion in the concave portion where the film-forming inhibition layer is not formed, by supplying a film-forming gas to the substrate, wherein the base film is made of a first material and the film is made of a second material that is different from the first material.

25. The method of Claim 1, wherein after (a) is performed, (b) and (c) are performed a predetermined number of times.

26. The method of Claim 1, wherein after (a) is performed, (b) and (c) are performed alternately a predetermined number of times.

27. The method of Claim 1, wherein after (a) is performed, (b) and (c) are performed a plural number of times.

28. The method of Claim 1, wherein after (a) is performed, (b) and (c) are performed alternately a plural number of times.