METHOD OF MANUFACTURING SEMICONDUCTOR DEVICE, SUBSTRATE PROCESSING METHOD, 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. 2019-195237, filed on October 28, 2019, 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 substrate processing apparatus, and a program.

BACKGROUND

[0003] In the related art, as an example of a process of manufacturing a semiconductor device, a process of forming a silicon seed layer on a substrate and a process of forming a film containing silicon on the silicon seed layer are often carried out (for example, *see* Patent Document 1).

SUMMARY

[0004] The present disclosure provides some embodiments of a technique capable of improving characteristics of a film containing silicon formed on a substrate.

[0005] According to embodiments of the present disclosure, there is provided a technique that includes: (a) forming a silicon seed layer on a substrate by performing a cycle a predetermined number of times, the cycle including non-simultaneously performing: (a1) supplying a first gas containing halogen and silicon to the substrate; and (a2) supplying a second gas containing hydrogen to the substrate; and (b) forming a film containing silicon on the silicon seed layer by supplying a third gas containing silicon to the substrate, wherein a pressure of a space in which

WHAT IS CLAIMED IS:

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

(a) forming a silicon seed layer on a substrate by performing a cycle a predetermined number of times, the cycle including non-simultaneously performing:

(a1) supplying a first gas containing halogen and silicon to the substrate to form nuclei containing chlorine and silicon; and

(a2) supplying a second gas containing hydrogen to the substrate; and

(b) forming a film containing silicon on the silicon seed layer by supplying a third gas containing silicon to the substrate,

wherein a pressure of a space in which the substrate is located in (a2) is set higher than a pressure of the space in which the substrate is located in (a1).

2. The method according to Claim 1, wherein a supply flow rate of the second gas in (a2) is set higher than a supply flow rate of the first gas in (a1).

3. The method according to Claim 1, wherein a supply time of the second gas in (a2) is set longer than a supply time of the first gas in (a1).

4. The method according to Claim 1, wherein a processing temperature in (a) is set to 350 degrees C or higher and 450 degrees C or lower.

5. The method according to Claim 1, wherein a processing temperature in (a) is set to 350 degrees C or higher and 400 degrees C or lower.

6. The method according to Claim 4, wherein the pressure of the space in which the substrate is located in (a1) is set to 667 Pa or higher and 1,200 Pa or lower.

7. The method according to Claim 4, wherein the pressure of the space in which the substrate is located in (a2) is set to 1,333 Pa or higher and 13,332 Pa or lower.

8. The method according to Claim 1, wherein a thickness of the silicon seed layer formed in (a) is set at a thickness of less than one atomic layer.

9. The method according to Claim 1, wherein (a1) further comprises supplying the second gas to the substrate, and in (a1), the second gas is supplied to the substrate together with the first gas.

10. The method according to Claim 9, wherein a supply flow rate of the second gas in (a1) is set lower than a supply flow rate of the second gas in (a2).

11. The method according to Claim 1, further comprising (c) supplying the second gas to the substrate after performing (a) and before performing (b).

12. The method according to Claim 11, wherein a processing temperature in (c) is set higher than a processing temperature in (a).

13. The method according to Claim 11, wherein a processing temperature in (c) is set higher than a processing temperature in (b).

14. The method according to Claim 11, wherein a pressure of the space in which the substrate is located in (c) is set higher than the pressure of the space in which the substrate is located in (a1).

15. The method according to Claim 11, wherein a processing temperature in (c) is set to 600 degrees C or higher and 850 degrees C or lower.

16. The method according to Claim 15, wherein a pressure of the space in which the substrate

is located in (c) is set to 1,333 Pa or higher and 13,332 Pa or lower.

17. The method according to Claim 1, further comprising (d) supplying a fourth gas containing halogen and silicon to the substrate before performing (a).

18. The method according to Claim 17, wherein a supply time of the fourth gas in (d) is set longer than a supply time of the first gas in (a1).

19. A substrate processing apparatus, comprising:

a process chamber in which a substrate is processed;

a first gas supply system configured to supply a first gas containing halogen and silicon to the substrate in the process chamber;

a second gas supply system configured to supply a second gas containing hydrogen to the substrate in the process chamber;

a third gas supply system configured to supply a third gas containing silicon to the substrate in the process chamber;

a pressure regulator configured to adjust an internal pressure of the process chamber; and

a controller configured to be capable of controlling the first gas supply system, the second gas supply system, the third gas supply system, and the pressure regulator to perform a process in the process chamber, the process comprising:

(a) forming a silicon seed layer on the substrate by performing a cycle a predetermined number of times, the cycle including non-simultaneously performing:

(a1) supplying the first gas to the substrate to form nuclei containing chlorine and silicon; and

(a2) supplying the second gas to the substrate; and

(b) forming a film containing silicon on the silicon seed layer by supplying the third gas to the substrate,

wherein a pressure of a space in which the substrate is located in (a2) is set higher

than a pressure of the space in which the substrate is located in (a1).

20. 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 silicon seed layer on a substrate by performing a cycle a predetermined number of times, the cycle including non-simultaneously performing:

(a1) supplying a first gas containing halogen and silicon to the substrate to form nuclei containing chlorine and silicon; and

(a2) supplying a second gas containing hydrogen to the substrate; and

(b) forming a film containing silicon on the silicon seed layer by supplying a third gas containing silicon to the substrate,

wherein a pressure of a space in which the substrate is located in (a2) is set higher than a pressure of the space in which the substrate is located in (a1).

21. A substrate processing method, comprising:

(a) forming a silicon seed layer on a substrate by performing a cycle a predetermined number of times, the cycle including non-simultaneously performing:

(a1) supplying a first gas containing halogen and silicon to the substrate to form nuclei containing chlorine and silicon; and

(a2) supplying a second gas containing hydrogen to the substrate; and

(b) forming a film containing silicon on the silicon seed layer by supplying a third gas containing silicon to the substrate,

wherein a pressure of a space in which the substrate is located in (a2) is set higher than a pressure of the space in which the substrate is located in (a1).