METHOD OF PROCESSING SUBSTRATE, METHOD OF MANUFACTURING SEMICONDUCTOR DEVICE, 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. 2020-032129, filed on February 27, 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 substrate processing apparatus, and a program.

[0003]

BACKGROUND

[0004] In the related art, as a process of manufacturing a semiconductor device, a process of selectively growing a film to be formed on a surface of a specific base among a plurality of types of bases exposed on a surface of a substrate (hereinafter, this process will be referred to as selective growth or selective film formation) is often carried out.

[0005] In the selective growth, before a film is selectively grown on a surface of a specific base, a process of modifying a surface of a base on which film growth is not intended may be performed to suppress the film growth.

[0006] However, in this case, when the selective growth is continuously performed for a predetermined period of time, selective breakage may occur, thereby causing the film to grow on the surface of the base on which the film growth is not intended. When the selective breakage occurs, the film may be etched to expose the surface of the base on which the film growth is not intended and then to remodify the surface of the base on which the film growth is not intended. As a result, a throughput may be lowered due to prolonged processing time, thus lowering throughput productivity.

WHAT IS CLAIMED IS:

1. A method of processing a substrate, comprising:

(a) modifying a surface of a first base by supplying a modifying gas to the substrate including the first base and a second base on a surface of the substrate, the modifying gas including a silicon-containing gas and a first fluorine-containing gas, or a hydrocarbon group-containing gas;

(b) forming a first film on a surface of the second base by supplying a first film-forming gas to the substrate after performing (a);

(c) etching the first film formed on the surface of the first base and remodifying the surface of the first base by supplying a second fluorine-containing gas to the substrate after the first film is formed on the surface of the first base after performing (b); and

(d) forming a second film on the first film formed on the surface of the second base by supplying a second film-forming gas to the substrate after performing (c).

2. The method according to Claim 1, wherein in (c), the act of etching the first film and the act of remodifying the surface of the first base are performed under a same processing condition.

3. The method according to Claim 1 or 2, wherein in (c), the act of etching the first film and the act of remodifying the surface of the first base are performed under a processing condition in which the surface of the first base is not etched.

4. The method according to any one of Claims 1 to 3, wherein (c) includes modifying the surface of the first base to be fluorine-terminated.

5. The method according to any one of Claims 1 to 4, wherein (a) includes modifying the surface of the first base to be fluorine-terminated.

6. The method according to any one of Claims 1 to 5, wherein (a) includes:

(a1) causing silicon contained in the silicon-containing gas to be adsorbed on the surface of the first base by supplying the silicon-containing gas to the substrate; and

(a2) modifying the surface of the first base to be fluorine-terminated by supplying the first fluorine-containing gas to the substrate to cause the first fluorine-containing gas to react with the silicon adsorbed on the surface of the first base.

7. The method according to any one of Claims 1 to 4, wherein the hydrocarbon group-containing gas includes a hydrocarbon group and an amino group-containing gas.

8. The method according to any one of Claims 1 to 4, wherein the hydrocarbon group-containing gas includes an alkylaminosilane-based gas.

9. The method according to any one of Claims 1 to 4, 7 and 8, wherein (a) includes modifying the surface of the first base to be terminated with a hydrocarbon group.

10. The method according to any one of Claims 1 to 9, wherein the first base includes an oxygen-containing film, and the second base includes an oxygen-free film.

11. The method according to any one of Claims 1 to 10, wherein the first base includes an oxide film and the second base includes a nitride film.

12. The method according to any one of Claims 1 to 11, wherein the first base includes a film containing silicon and oxygen, and the second base includes a film containing silicon and nitrogen.

13. The method according to any one of Claims 1 to 12, wherein (a), (b), (c), and (d) are performed in a non-plasma atmosphere.

14. The method according to any one of Claims 1 to 13, wherein (c) includes modifying the surface of the first base to be fluorine-terminated, and

wherein the method further comprises: (e) eliminating a fluorine termination formed on the surface of the first base by bringing a substance, which reacts with fluorine, into contact with the surface of the substrate after the first film and the second film are formed on the surface of the second base.

15. The method according to Claim 14, wherein the substance, which reacts with the fluorine, contains moisture.

16. The method according to Claim 14, wherein the substance, which reacts with the fluorine, contains H_2O.

17. A substrate processing apparatus, comprising:

a process chamber in which a substrate is processed;

a modifying gas supply system configured to supply a modifying gas to the substrate in the process chamber, the modifying gas including a silicon-containing gas and a first fluorine-containing gas, or a hydrocarbon group-containing gas;

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

a fluorine-containing gas supply system configured to supply a second fluorine-containing gas to the substrate in the process chamber; and

a controller configured to be capable of controlling the modifying gas supply system, the film-forming gas supply system, and the fluorine-containing gas supply system to perform a process in the process chamber, the process comprising:

(a) modifying a surface of a first base by supplying the modifying gas to the substrate including the first base and a second base on a surface of the substrate;

(b) forming a first film on a surface of the second base by supplying the first film-forming gas to the substrate after performing (a);

(c) etching the first film formed on the surface of the first base and remodifying the surface of the first base by supplying the second fluorine-containing gas to the substrate after the first film is formed on the surface of the first base after performing (b); and

(d) forming a second film on the first film formed on the surface of the second base by supplying the second film-forming gas to the substrate after performing (c).

18. A program that causes, by a computer, a substrate processing apparatus to perform a process comprising:

(a) modifying a surface of a first base by supplying a modifying gas to a substrate including the first base and a second base on a surface of the substrate, the modifying gas including a silicon-containing gas and a first fluorine-containing gas, or a hydrocarbon group-containing gas;

(b) forming a first film on a surface of the second base by supplying a first film-forming gas to the substrate after performing (a);

(c) etching the first film formed on the surface of the first base and remodifying the surface of the first base by supplying a second fluorine-containing gas to the substrate after the first film is formed on the surface of the first base after performing (b); and

(d) forming a second film on the first film formed on the surface of the second base by supplying a second film-forming gas to the substrate after performing (c).

19. The method according to one of Claims 1 to 6, wherein the silicon-containing gas includes a silicon- and an amino group-containing gas.

20. The method according to one of Claims 1 to 6, wherein the silicon-containing gas includes an aminosilane-based gas.

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

(a) modifying a surface of a first base by supplying a modifying gas to a substrate including the first base and a second base on a surface of the substrate, the modifying gas including a silicon-containing gas and a first fluorine-containing gas, or a hydrocarbon group-containing gas;

(b) forming a first film on a surface of the second base by supplying a first film-forming gas to the substrate after performing (a);

(c) etching the first film formed on the surface of the first base and remodifying the surface of the first base by supplying a second fluorine-containing gas to the substrate after the first film is formed on the surface of the first base after performing (b); and

(d) forming a second film on the first film formed on the surface of the second base by supplying a second film-forming gas to the substrate after performing (c).