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. 2020-163759, filed on September 29, 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] In the related art, with the scaling of semiconductor devices, processing dimensions are becoming finer and processes are becoming more complicated. A high-precision patterning process may have to be performed many times, which leads to an increase in costs in semiconductor device manufacture to perform fine and complicated processing. In recent years, selective growth has been attracting attention as a method that can be expected to provide high precision and cost reduction. The selective growth is a technique of forming a film by selectively growing the film on a surface of a desired base among two or more types of bases exposed on a surface of a substrate.

[0004] However, when the selective growth is continued, local film formation may proceed even on a surface of a base other than the desired base among two or more types of bases, resulting in a decrease in selectivity.

SUMMARY

[0005] Some embodiments of the present disclosure provide a technique of improving selectivity

WHAT IS CLAIMED IS:

1. A method of processing a substrate, comprising:

(a) modifying a surface of a first base of the substrate having the first base and a second base on its surface, wherein (a) includes:

(a1) supplying a first modifier to the substrate, the first modifier containing one or more atoms to which at least one first functional group including an amino group or a substituted amino group and at least one second functional group including a hydrocarbon group are directly bonded;

(a3) supplying an oxygen- and hydrogen-containing substance to the substrate; and

(a2) supplying a second modifier to the substrate, the second modifier containing an atom to which at least one first functional group including an amino group or a substituted amino group and at least one second functional group including a hydrocarbon group are directly bonded, wherein the number of the at least one first functional group contained in one molecule of the second modifier is smaller than the number of the at least one first functional group contained in one molecule of the first modifier; and

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

2. The method of Claim 1, wherein in (a), (a1), (a3), and (a2) are non-simultaneously performed.

3. The method of Claim 2, wherein in (a), (a3) is performed between (a1) and (a2).

4. The method of Claim 1, wherein (a1), (a3), and (a2) are performed in this order.

5. The method of Claim 4, wherein in (a1), the first modifier is adsorbed on the surface of the first base,

wherein in (a3), the at least one first functional group of a portion of the first modifier adsorbed on the surface of the first base is substituted with at least one hydroxyl group, and

wherein in (a2), the second modifier is adsorbed on the at least one hydroxyl group.

6. The method of Claim 5, wherein in (a1), a portion of the first modifier is adsorbed on the surface of the first base in a state where the portion of the first modifier contains the at least one first functional group.

7. The method of Claim 5, wherein in (a1), the first modifier is adsorbed on the surface of the first base in a state where the first modifier contains the at least one second functional group, and

wherein in (a2), the second modifier is adsorbed on the at least one hydroxyl group in a state where the second modifier contains the at least one second functional group.

8. The method of Claim 5, wherein the at least one hydroxyl group includes a plurality of hydroxyl groups, and wherein in (a1), a portion of the first modifier is adsorbed on the surface of the first base by using a reaction between two hydroxyl groups present on the surface of the first base and adjacent to each other and the one molecule of the first modifier.

9. The method of Claim 5, wherein in (a), (a1) and (a3) are performed one or more times, or (a1), (a3), and (a2) are performed one or more times.

10. The method of Claim 4, wherein in (a3), a H_2O gas as the oxygen- and hydrogen-containing substance is supplied to the substrate.

11. The method of Claim 1, wherein the number of the at least one first functional group contained in the one molecule of the first modifier is two, and the number of the at least one first functional group contained in the one molecule of the second modifier is one.

12. The method of Claim 1, wherein both the first modifier and the second modifier have a structure containing a tetravalent atom to which the at least one first functional group and the at least one second functional group are directly bonded.

13. The method of Claim 1, wherein a substituent of the substituted amino group includes an alkyl group.

14. The method of Claim 1, wherein the hydrocarbon group includes an aliphatic hydrocarbon group or an aromatic hydrocarbon group.

15. The method of Claim 1, wherein the hydrocarbon group includes an alkyl group.

16. The method of Claim 1, wherein (a) further includes (a4) exposing the surface of the substrate to a hydrogen fluoride aqueous solution before performing (a1).

17. The method of Claim 1, wherein the first base is an oxide film, and the second base is a film other than the oxide film.

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

(a) modifying a surface of a first base of a substrate having the first base and a second base on its surface, wherein (a) includes:

(a1) supplying a first modifier to the substrate, the first modifier containing one or more atoms to which at least one first functional group including an amino group or a substituted

amino group and at least one second functional group including a hydrocarbon group are directly bonded,

(a3) supplying an oxygen- and hydrogen-containing substance to the substrate; and

(a2) supplying a second modifier to the substrate, the second modifier containing an atom to which at least one first functional group including an amino group or a substituted amino group and at least one second functional group including a hydrocarbon group are directly bonded, wherein the number of the at least one first functional group contained in one molecule of the second modifier is smaller than the number of the at least one first functional group contained in one molecule of the first modifier; and

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

19. A substrate processing apparatus comprising:

a first modifier supply system configured to supply a first modifier to a substrate, wherein the first modifier contains one or more atoms to which at least one first functional group including an amino group or a substituted amino group and at least one second functional group including a hydrocarbon group are directly bonded;

a second modifier supply system configured to supply a second modifier to the substrate, wherein the second modifier contains an atom to which at least one first functional group including an amino group or a substituted amino group and at least one second functional group including a hydrocarbon group are directly bonded and wherein the number of the at least one first functional group contained in one molecule of the second modifier is smaller than the number of the at least one first functional group contained in one molecule of the first modifier;

a film-forming gas supply system configured to supply a film-forming gas to the substrate;

an oxygen- and hydrogen-containing substance supply system configured to supply an oxygen- and hydrogen-containing substance to the substrate; and

a controller configured to be capable of controlling the first modifier supply system, the second modifier supply system, the film-forming gas supply system, and the oxygen- and hydrogen-containing substance supply system to perform a process, the process including:

(a) modifying a surface of a first base of the substrate having the first base and a second base on its surface, wherein (a) includes:

(a1) supplying the first modifier to the substrate;

(a3) supplying the oxygen- and hydrogen- containing substance to the substrate; and

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

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

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

(a) modifying a surface of a first base of a substrate having the first base and a second base on its surface, wherein (a) includes:

(a1) supplying a first modifier to the substrate, the first modifier containing one or more atoms to which at least one first functional group including an amino group or a substituted amino group and at least one second functional group including a hydrocarbon group are directly bonded;

(a3) supplying an oxygen- and hydrogen-containing substance to the substrate; and

(a2) supplying a second modifier to the substrate, the second modifier containing an atom to which at least one first functional group including an amino group or a substituted amino group and at least one second functional group including a hydrocarbon group are directly bonded, wherein the number of the at least one first functional group contained in one molecule of the second modifier is smaller than the number of the at least one first functional group

contained in one molecule of the first modifier; and

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