

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

TECHNICAL FIELD

[0001] The present disclosure relates to a method of processing a substrate, a method of manufacturing a semiconductor device, a substrate processing apparatus, and a program.

BACKGROUND

[0002] As a process of manufacturing a semiconductor device, a process of selectively growing and forming a film on a surface of a predetermined base among a plurality of types of bases exposed on a surface of a substrate (hereinafter, the process will be referred to as selective growth or selective film formation) may be performed (*see*, for example, Japanese Patent Application Publication No. 2013-243193).

[0003] In the selective growth, before selectively growing a film on a surface of a predetermined base, a film formation inhibitor may be used to form a film formation inhibition layer on the surface of the base on which the film is not intended to be grown.

[0004] However, when the film is selectively grown after the film formation inhibition layer is formed, a processing temperature (film formation temperature) during the selective growth may not be increased to suppress desorption of the film formation inhibition layer, which may deteriorate a quality of the formed film. Further, after the selective growth, a process of removing the film formation inhibition layer may be performed, which may deteriorate a productivity.

[0005] The present disclosure provides a technique capable of enhancing a productivity while improving a film quality of a film formed by selective growth.

SUMMARY

[0006] According to some embodiments of the present disclosure, there is provided a technique that includes: (a) supplying a film formation inhibition gas to the substrate, which includes a first

WHAT IS CLAIMED IS:

1. A method of processing a substrate, comprising:
 - (a) supplying a film formation inhibition gas to the substrate, which includes a first base and a second base exposed on a surface of the substrate, to form a film formation inhibition layer on a surface of the first base;
 - (b) supplying a film-forming gas to the substrate after forming the film formation inhibition layer on the surface of the first base, to form a film on a surface of the second base; and
 - (c) supplying a halogen-free substance, which chemically reacts with the film formation inhibition layer and the film, to the substrate after forming the film on the surface of the second base, in a non-plasma atmosphere.
2. The method of Claim 1, wherein (c) is performed under a condition that enables a process of at least one selected from the group of removal and nullification of the film formation inhibition layer formed on the surface of the first base and a process of modifying the film formed on the surface of the second base.
3. The method of Claim 1, wherein in (c), a process of at least one selected from the group of removal and nullification of the film formation inhibition layer formed on the surface of the first base and a process of modifying the film formed on the surface of the second base are performed simultaneously and in parallel by an action of the halogen-free substance.
4. The method of Claim 1, wherein the halogen-free substance includes an oxidizing gas.

5. The method of Claim 1, wherein the halogen-free substance includes one or more selected from the group of an oxygen- and hydrogen-containing gas, an oxygen-containing gas, and a mixed gas of the oxygen-containing gas and a hydrogen-containing gas.
6. The method of Claim 1, wherein the halogen-free substance includes one or more selected from the group of H_2O , H_2O_2 , O_2 , O_3 , O_2+H_2 , O_3+H_2 , O_2+NH_3 , and O_3+NH_3 .
7. The method of Claim 1, wherein the halogen-free substance includes a nitriding gas.
8. The method of Claim 1, wherein the halogen-free substance includes a nitrogen- and hydrogen-containing gas.
9. The method of Claim 1, wherein the halogen-free substance includes one or more selected from the group of NH_3 , N_2H_4 , N_2H_2 , and N_3H_8 .
10. The method of Claim 2 or 3, wherein in (c), impurities contained in the film are removed by the process of modifying the film.
11. The method of Claim 2 or 3, wherein in (c), a composition ratio of the film is changed by the process of modifying the film.
12. The method of Claim 2 or 3, wherein in (c), an element that is not contained in the film and is contained in the halogen-free substance is added into the film by the process of modifying the film.

13. The method of Claim 2 or 3, wherein in (c), the film formed on the surface of the second base is changed into a film that is different in chemical structure from the film formed on the surface of the second base by the process of modifying the film.
14. The method of Claim 2 or 3, wherein in (c), a portion of a surface of the film is changed into material that is different in chemical structure from the film by the process of modifying the film.
15. The method of Claim 1, wherein a temperature of the substrate in (c) is set to be equal to or higher than a temperature of the substrate in (b).
16. The method of Claim 1, wherein the film formation inhibition gas includes a hydrocarbon group-containing gas, and
wherein hydrocarbon group terminations are formed on a surface of the film formation inhibition layer.
17. The method of Claim 1, wherein the film formation inhibition gas includes a fluorine-containing gas, and
wherein fluorine terminations are formed on a surface of the film formation inhibition layer.
18. The method of Claim 1, wherein in (b), a precursor gas and a reaction gas are alternately supplied as the film-forming gas to the substrate, or the precursor gas and the reaction gas are alternately supplied as the film-forming gas to the substrate and a catalyst gas is supplied together with at least one selected from the group of the precursor gas and the reaction gas.

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

(a) supplying a film formation inhibition gas to a substrate, which includes a first base and a second base exposed on a surface of the substrate, to form a film formation inhibition layer on a surface of the first base;

(b) supplying a film-forming gas to the substrate after forming the film formation inhibition layer on the surface of the first base, to form a film on a surface of the second base; and

(c) supplying halogen-free substance, which chemically reacts with the film formation inhibition layer and the film, to the substrate after forming the film on the surface of the second base, in a non-plasma atmosphere.

20. A substrate processing apparatus, comprising:

a process chamber in which a substrate is processed;

a film formation inhibition gas supply system configured to supply a film formation inhibition gas to the substrate in the process chamber;

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

a halogen-free substance supply system configured to supply a halogen-free substance to the substrate in the process chamber; and

a controller configured to be capable of controlling the film formation inhibition gas supply system, the film-forming gas supply system, and the halogen-free substance supply system to perform, in the process chamber:

(a) supplying the film formation inhibition gas to the substrate, which includes a first base and a second base exposed on a surface of the substrate, to form a film formation inhibition layer on a surface of the first base;

(b) supplying the film-forming gas to the substrate after forming the film

formation inhibition layer on the surface of the first base, to form a film on a surface of the second base; and

(c) supplying the halogen-free substance, which chemically reacts with the film formation inhibition layer and the film, to the substrate after forming the film on the surface of the second base, in a non-plasma atmosphere.

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

(a) supplying a film formation inhibition gas to a substrate, which includes a first base and a second base are exposed on a surface of the substrate, to form a film formation inhibition layer on a surface of the first base;

(b) supplying a film-forming gas to the substrate after forming the film formation inhibition layer on the surface of the first base, to form a film on a surface of the second base; and

(c) supplying a halogen-free substance, which chemically reacts with the film formation inhibition layer and the film, to the substrate after forming the film on the surface of the second base, in a non-plasma atmosphere.