WHAT IS CLAIMED IS:

1. A cleaning method comprising:

modifying a deposited film, which is formed on an inner surface of a reaction container, into a film including an oxide layer and a nitride layer by performing a cycle a predetermined number of times, the cycle including:

(a) oxidizing the deposited film by supplying an oxygen-containing gas into the reaction container and plasma-exciting the oxygen-containing gas; and

(b) nitriding the deposited film by supplying a nitrogen-containing gas into the reaction container and plasma-exciting the nitrogen-containing gas; and

(c) lowering a temperature in the reaction container from a temperature of the reaction container in (a) and (b) to modify the deposited film into a film including the oxide layer and the nitride layer having different coefficients of thermal expansion, which is in a state of being capable of being peeled off.

2. The cleaning method of Claim 1, further comprising:

(d) after (c), removing the film including the oxide layer and the nitride layer from an inner wall of the reaction container.

3. The cleaning method of Claim 2, wherein (d) is performed by peeling off the film including the oxide layer and the nitride layer from the inner wall of the reaction container.

4. The cleaning method of any one of Claims 1 to 3, wherein the deposited film is a Si-containing film, the oxide layer is a Si-containing oxide layer, and the nitride layer is a Si-containing nitride layer.

5. The cleaning method of any one of Claims 1 to 4, wherein the deposited film is an oxide film.

6. The cleaning method of any one of Claims 1 to 5, wherein power of an electromagnetic field applied to plasma-excite the oxygen-containing gas in (a) is lower than power of an electromagnetic field applied to plasma-excite the nitrogen-containing gas in (b).

7. The cleaning method of any one of Claims 1 to 6, wherein a pressure in the reaction container in (a) is higher than a pressure in the reaction container in (b).

8. The cleaning method of any one of Claims 1 to 7, wherein an execution time of (a) per cycle is shorter than an execution time of (b) per cycle.

9. The cleaning method of any one of Claims 1 to 8, wherein the cycle is performed a plurality of times, and power of an electromagnetic field applied to plasma-excite the oxygen-containing gas in (a) during a first cycle is higher than power of an electromagnetic field applied to plasma-excite the oxygen-containing gas in (a) during a second cycle performed after the first cycle.

10. The cleaning method of any one of Claims 1 to 9, wherein the cycle is performed a plurality of times, and a pressure in the reaction container in (a) during a first cycle is lower than a pressure in the reaction container in (a) during a second cycle performed after the first cycle.

11. The cleaning method of any one of Claims 1 to 10, wherein the cycle is performed a plurality of times, and an execution time of (a) during a first cycle is longer than an execution

time of (a) during a second cycle performed after the first cycle.

12. The cleaning method of any one of Claims 1 to 11, wherein (a) and (b) are performed in a state that a substrate is not accommodated in the reaction container.

13. The cleaning method of any one of Claims 1 to 8, further comprising performing, before performing the cycle including (a) and (b):

(e) oxidizing a surface of a substrate by supplying the oxygen-containing gas into the reaction container where the substrate is loaded and plasma-exciting the oxygen-containing gas; and

(f) after (e), unloading the substrate from the reaction container.

14. The cleaning method of Claim 13, wherein power of an electromagnetic field applied to plasma-excite the oxygen-containing gas in (a) is lower than power of an electromagnetic field applied to plasma-excite the oxygen-containing gas in (e).

15. The cleaning method of Claim 13 or 14, wherein a pressure in the reaction container in (a) is higher than a pressure in the reaction container in (e).

16. The cleaning method of any one of Claims 13 to 15, wherein an execution time of (a) is shorter than an execution time of (e).

17. A cleaning method comprising:

modifying a deposited film, which is formed on an inner surface of a reaction container, into a film including an oxide layer and a nitride layer by performing a cycle a predetermined number of times, the cycle including:

(a) oxidizing the deposited film by supplying an oxidizing species, generated by plasma-exciting an oxygen-containing gas, into the reaction container; and

(b) nitriding the deposited film by supplying a nitriding species, generated by plasma-exciting a nitrogen-containing gas, into the reaction container; and

(c) lowering a temperature in the reaction container from a temperature of the reaction container in (a) and (b) to modify the deposited film into a film including the oxide layer and the nitride layer having different coefficients of thermal expansion, which is in a state of being capable of being peeled off.

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

(a) modifying a surface of a substrate by supplying a process gas into a reaction container where the substrate is accommodated and plasma-exciting the process gas;

(b) after (a), unloading the substrate from the reaction container;

(c) oxidizing a deposited film, which is formed on an inner surface of the reaction container in (a) by supplying an oxygen-containing gas into the reaction container and plasma-exciting the oxygen-containing gas;

(d) nitriding the deposited film by supplying a nitrogen-containing gas into the reaction container and plasma-exciting the nitrogen-containing gas;

modifying the deposited film into a film including an oxide layer and a nitride layer by performing a cycle, which includes (c) and (d), a predetermined number of times; and

(e) lowering a temperature in the reaction container from a temperature of the reaction container in (a) and (b) to modify the deposited film into a film including the oxide layer and the nitride layer having different coefficients of thermal expansion, which is in a state of being capable of being peeled off.

19. A program that causes, by a computer, a substrate processing apparatus to perform:

(a) oxidizing a deposited film, which is formed on an inner surface of a reaction container of the substrate processing apparatus, by supplying an oxygen-containing gas into the reaction container and plasma-exciting the oxygen-containing gas;

(b) nitriding the deposited film by supplying a nitrogen-containing gas into the reaction container and plasma-exciting the nitrogen-containing gas;

modifying the deposited film into a film including an oxide layer and a nitride layer by performing a cycle, which includes (a) and (b), a predetermined number of times; and

(c) lowering a temperature in the reaction container from a temperature of the reaction container in (a) and (b) to modify the deposited film into a film including the oxide layer and the nitride layer having different coefficients of thermal expansion, which is in a state of being capable of being peeled off.

20. A substrate processing apparatus comprising:

a reaction container in which a substrate is processed;

an oxygen-containing gas supply system configured to supply an oxygen-containing gas into the reaction container;

a nitrogen-containing gas supply system configured to supply a nitrogen-containing gas into the reaction container;

a plasma generator configured to plasma-excite the oxygen-containing gas and the nitrogen-containing gas; and

a controller configured to be capable of controlling the oxygen-containing gas supply system, the nitrogen-containing gas supply system, and the plasma generator so as to perform a process including:

modifying a deposited film, which is formed on an inner surface of the reaction container, into a film including an oxide layer and a nitride layer by performing a cycle a predetermined number of times, the cycle including:

(a) oxidizing the deposited film by supplying the oxygen-containing gas into the reaction container and plasma-exciting the oxygen-containing gas; and

(b) nitriding the deposited film by supplying the nitrogen-containing gas into the reaction container and plasma-exciting the nitrogen-containing gas; and

(c) lowering a temperature in the reaction container from a temperature of the reaction container in (a) and (b) to modify the deposited film into a film including the oxide layer and the nitride layer having different coefficients of thermal expansion, which is in a state of being capable of being peeled off.