CLAIMS

1. An etching method for etching an object to be processed by using a substrate processing apparatus including a process chamber including a first electrode and a second electrode disposed opposite to the first electrode to receive the object to be processed thereon, the method comprising a step of:

removing at least one of a first polymer and a second polymer by etching the object to be processed on which a pattern of the first polymer and the second polymer is formed by phase separation of a block copolymer containing the first polymer and the second polymer at a temperature lower than or equal to 10 degrees C by using plasma of a process gas that can selectively etch the at least one of the first polymer and the second polymer.

2. The etching method as claimed in claim 1,

wherein the first polymer is polystyrene,

wherein the second polymer is poly(methylmethacrylate), and

wherein the process gas contains oxygen gas and argon gas.

3. The etching method as claimed in claim 2,

wherein the object to be processed includes at least a neutral film and the block copolymer sequentially stacked on a substrate, and

wherein the step of removing the at least one of the first polymer and the second polymer is a step of removing poly(methylmethacrylate) and the neutral film under poly(methylmethacrylate).

4. The etching method as claimed in claim 2, wherein the process gas contains carbon monoxide or carbon dioxide.

5. The etching method as claimed in claim 1, wherein the step of removing the at least one of the first polymer and the second polymer includes a step of etching the object to be processed at a temperature lower than or equal to -10 degrees C.

6. The etching method as claimed in claim 1, wherein the substrate processing apparatus includes a first high frequency power source configured to supply first high frequency power for plasma generation to the at least one of the first electrode and the second electrode and a second high frequency power source configured to supply second high frequency power for bias, and

wherein an output of the first high frequency power is in a range of 100 W to 300 W, and an output of the second high frequency power is in a range of 0 W to 100 W.

7. The etching method as claimed in claim 6, wherein the second high frequency power is intermittently supplied in the step of removing the at least one of the first polymer and the second polymer.

8. The etching method as claimed in claim 1, further comprising a step of:

performing a film quality improvement process before or after the step of removing the at least one of the first polymer and the second polymer.

9. The etching method as claimed in claim 8, wherein the step of performing the film quality improvement process includes a step of performing a plasma process on the polymer by plasma of a hydrogen-containing gas or irradiating the polymer with ultraviolet light.

10. The etching method as claimed in claim 9, wherein the hydrogen-containing gas is a mixed gas of hydrogen and argon, or a mixed gas of hydrogen, nitrogen and methane.

11. The etching method as claimed in claim 1, wherein a total flow rate of the process gas in the step of removing the at least one of the first polymer and the second polymer is lower than or equal to 1000 sccm.

12. The etching method as claimed in claim 2, wherein a partial pressure of oxygen gas in the step of removing the at least one of the first polymer and the second polymer is lower than or equal to 1.1 mTorr.

13. The method as claimed in claim 1, wherein a value of residence time expressed as P*V / S is in a range of 2 seconds to 13 seconds when an effective chamber volume obtained by multiplying an area of the object to be processed by a distance between the first electrode and the second electrode is expressed as V (L), a pressure in the process chamber is expressed as P (mTorr), and a flow rate of the process gas is expressed as S (sccm).