

What is claimed is:

1. A method for processing a target object, comprising:

5 a first step of electrostatically attracting the target object on an electrostatic chuck provided in a processing chamber of a plasma processing apparatus, the target object including a substrate containing silicon, an etching target layer formed on the substrate, an organic polymer layer formed on the etching target layer, and a
10 resist mask formed on the organic polymer layer;

a second step of exposing the target object through the resist mask to a plasma of a first gas generated in the processing chamber so that the organic polymer layer is etched;

15 a third step, after the second step, of detaching the target object from the electrostatic chuck while generating a plasma of a second gas in the processing chamber;

a fourth step, after the third step, of peeling off the resist mask;

20 a step, after the fourth step, of forming a neutral film in an opening of the organic polymer layer and on the etching target layer;

a fifth step, after the step of forming a neutral film, of forming on the organic polymer layer and the neutral film
25 a self-assemblable block copolymer layer including a first polymer and a second polymer;

a sixth step of processing the target object such that a first region including the first polymer and a second region including the second polymer are formed in the block copolymer layer; and

5 a seventh step, after the sixth step, of etching the second region and a portion of the neutral film which is directly below the second region, by using the plasma processing apparatus,

10 wherein the second gas is oxygen gas or a gaseous mixture of oxygen gas and a rare gas having an atomic weight lower than an atomic weight of argon gas.

2. The method of claim 1, wherein the organic polymer layer contains polystyrene, or a random copolymer of styrene
15 and methyl methacrylate.