CLAIMS

1. A semiconductor device forming method, comprising:

forming a coating layer that selectively covers a portion of a recess provided in a stacked structure supported by a base member, the portion of the recess being located on a front surface side of the recess; and

etching a deep portion, which is deeper than the coating layer, of the recess with a chemical liquid so as to widen a diameter of the deep portion of the recess, wherein the forming the coating layer includes:

forming a partially packed bed that partially fills the deep portion of the recess;

supplying a water-repellent agent after forming the partially packed bed; and

removing the partially packed bed and the water-repellent agent after supplying the water-repellent agent to form the coating layer on the front surface side of the recess.

2. The semiconductor device forming method according to claim 1, wherein the removing the partially packed bed includes supplying a removal liquid to dissolve the partially packed bed.

3. The semiconductor device forming method according to claim 1, wherein:

the partially packed bed contains a substance that sublimes; and

the removing the partially packed bed includes heating the partially packed bed.

4. The semiconductor device forming method according to any one of claims 1 to 3, wherein the forming the partially packed bed includes:

forming the packed bed that fills the recess; and

partially removing the packed bed after the packed bed is formed.

5. The semiconductor device forming method according to claim 4, wherein the partially removing the packed bed includes supplying a removal liquid for removing the packed bed.

6. The semiconductor device forming method according to any one of claims 1 to 5, wherein the chemical liquid in the etching contains any of hydrofluoric acid, water, and phosphoric acid.

7. The semiconductor device forming method according to any one of claims 1 to 6, wherein a plurality of memory cells are formed in the recess.

8. The semiconductor device forming method according to any one of claims 1 to 7, wherein:

in the forming the coating layer, the coating layer selectively covers the portion of the recess, which is each of a plurality of recesses, provided in the stacked structure; and

differences between top diameters of the recesses are 5% or less.

9. The semiconductor device forming method according to claim 8, wherein the recesses are regularly arranged in the stacked structure..

10. The semiconductor device forming method according to any one of claims 1 to 9, wherein an etch stop layer is arranged between the base member and the stacked structure.

11. A substrate processing apparatus, comprises:

a processing liquid supply section that supplies a processing liquid;

a removal liquid supply section that supplies a removal liquid for removing a

packed bed formed from the processing liquid;

a water-repellent agent supply section that supplies a water-repellent agent;

a chemical liquid supply section that supplies a chemical liquid; and

a controller that controls the processing liquid supply section, the removal liquid supply section, the water-repellent agent supply section, and the chemical liquid supply section, wherein

the controller controls the processing liquid supply section, the removal liquid supply section, the water-repellent agent supply section, and the chemical liquid supply section such that:

(1) the packed bed is formed by supplying the processing liquid, the packed bed filling a recess formed in a stacked structure supported by a base member;

(2) the packed bed in the recess is partially removed by supplying the removal liquid;

(3) a coating layer is formed by supplying the water-repellent agent, the coating layer selectively covering a portion of the recess, the portion of the recess being located on a front surface side not covered with the packed bed; and

(4) a diameter of a deep portion, which is deeper than the coating layer, of the recess is widened by supplying the chemical liquid.

12. A semiconductor device forming method, comprising:

forming a coating layer that selectively covers a portion of a recess provided in a stacked structure supported by a base member, the portion of the recess being located on a front surface side of the recess; and

etching a deep portion, which is deeper than the coating layer, of the recess with a chemical liquid so as to widen a diameter of the deep portion of the recess, wherein the forming the coating layer includes:

forming a partially packed bed that partially fills the deep portion of the recess;

forming the coating layer after forming the partially packed bed; and

removing the partially packed bed.