Claims

1. A method of manufacturing a semiconductor device, the method comprising:

forming a pre-stack by alternately stacking first material layers and second material layers on a substrate;

forming a plurality of stepped grooves each having a step structure in the pre-stack;

recessing the stepped grooves to have different depths from each other;

forming an opening portion in the pre-stack, the opening portion having at least one step on a sidewall thereof having a same height as a depth difference between two of the stepped grooves.

2. The method of claim 1, wherein the recessing the stepped grooves and the forming the opening portion are simultaneously performed.

3. The method of claim 1, wherein the forming of the stepped grooves includes:

forming a first mask pattern including a plurality of first openings on the pre-stack;

etching the pre-stack by using the first mask pattern; and

performing a trimming process widening the widths of the first openings,

wherein the etching of the pre-stack and the performing of the trimming process are alternately repeated.

4. The method of claim 3, wherein in the etching of the pre-stack, the etching depth corresponds to a vertical pitch of the first material layer.

5. The method of claim 1, wherein the forming of the opening portion includes;

forming a second mask pattern including second openings exposing at positions corresponding to at least one of the stepped grooves and the opening portion;

increasing depths of the stepped grooves exposed by the second mask pattern by a first depth and forming a trench of the first depth at a position corresponding to the opening portion, by first etching the pre-stack using the second mask pattern as an etch mask;

forming a third mask pattern including third openings exposing at least one of the stepped grooves and the trench; and

increasing depths of the trench and stepped grooves exposed by the third mask pattern by a second depth, by second etching the pre-stack using the third mask pattern as an etch mask.

6. The method of claim 5, wherein an area of the second opening of the second mask pattern exposing the stepped groove is larger than an entrance area of the stepped groove.

7. The method of claim 5, wherein an area of the third opening of the third mask pattern exposing the recessed stepped groove is larger than an entrance area of the recessed stepped groove, and the area of the third opening of the third mask pattern exposing the trench is larger than an entrance of the trench.

8. The method of claim 5, wherein the etching depths of the first etching and the second etching are K times the vertical pitch of the first material layer,

wherein K is a natural number which is greater than 2 and less than N+1, and

wherein N is the number of steps of the step structure.