CLAIMS

1. A manufacturing method of a semiconductor structure, comprising:

forming a first insulating layer on a substrate, wherein a plurality of active pillars are arranged at intervals along a first direction and a second direction in the first insulating layer, and the plurality of active pillars extend along a third direction;

partially removing the first insulating layer, to form a plurality of first trenches extending along the third direction, wherein each of the first trenches exposes the substrate, and is located between two adjacent columns of active pillars along the first direction;

forming an isolation layer in each of the first trenches;

removing at least a part of the first insulating layer between adjacent isolation layers, to form a first filling space, wherein the first filling space exposes a peripheral surface of a middle region of the active pillar; and

forming a gate structure on the peripheral surface of the active pillar exposed in the first filling space, wherein the gate structures are integrated along the second direction.

2. The manufacturing method according to claim 1, wherein the forming a first insulating layer on a substrate, wherein a plurality of active pillars are arranged at intervals along a first direction and a second direction in the first insulating layer, and the plurality of active pillars extend along a third direction comprises:

forming a stacked structure on the substrate, wherein the stacked structure comprises a first sacrificial layer and an active layer that are disposed alternately along the second direction;

etching the stacked structure, to form a plurality of second trenches arranged at intervals and extending along the third direction, wherein the second trenches expose the substrate, and divide the active layer into the plurality of active pillars;

removing the first sacrificial layer, to form a second filling space; and

depositing the first insulating layer in the second filling space.

3. The manufacturing method according to claim 2, wherein the removing the first sacrificial layer, to form a second filling space comprises:

depositing a second sacrificial layer in the second trench and on the stacked structure, wherein the second sacrificial layer fills up the second trench and covers a surface of the stacked structure away from the substrate;

partially removing the second sacrificial layer and the first sacrificial layer, to form at least two support spaces arranged at intervals along the third direction, wherein the at least two support spaces divide each of the active pillars into a plurality of regions;

forming a support layer in each of the support spaces; and

removing the remaining second sacrificial layer and the remaining first sacrificial layer, to form the second filling space.

4. The manufacturing method according to claim 3, after the depositing a second sacrificial layer in the second trench and on the stacked structure, wherein the second sacrificial layer fills up the second trench and covers a surface of the stacked structure away from the substrate, the manufacturing method further comprises:

flattening a surface of the second sacrificial layer away from the substrate.

5. The manufacturing method according to claim 3, wherein the partially removing the second sacrificial layer and the first sacrificial layer, to form at least two support spaces arranged at intervals along the third direction, wherein the at least two support spaces divide each of the active pillars into a plurality of regions comprises:

forming a first photoresist layer on the second sacrificial layer, wherein the first photoresist layer is provided with a first pattern, and the first pattern comprises at least two first

etched trenches extending along the first direction;

etching the second sacrificial layer by the first photoresist layer as a mask, to form a plurality of etched holes arranged at intervals; and

removing the first sacrificial layer between two adjacent ones of the etched holes along the first direction, such that the etched holes arranged along the first direction communicate, to form the support space.

6. The manufacturing method according to claim 3, wherein the plurality of isolation layers are each located between two same adjacent ones of the support layers, and a gap is formed between the isolation layer and the support layer; and

the removing at least a part of the first insulating layer between adjacent isolation layers, to form a first filling space, wherein the first filling space exposes a peripheral surface of a middle region of the active pillar comprises:

completely removing the first insulating layer between adjacent isolation layers and opposite to the isolation layer, to form the first filling space.

7. The manufacturing method according to claim 2, wherein the depositing the first insulating layer in the second filling space comprises:

depositing the first insulating layer in the second filling space and on the stacked structure, wherein the first insulating layer fills up the second filling space and covers a surface of the stacked structure away from the substrate; and

flattening a surface of the first insulating layer away from the substrate.

8. The manufacturing method according to claim 2, wherein a material of the first sacrificial layer comprises silicon germanium, and a material of the active layer comprises N-type doped silicon.

9. The manufacturing method according to claim 2, wherein the first sacrificial layer and the active layer are formed through an epitaxial growth process.

10. The manufacturing method according to claim 2, wherein an innermost layer in the stacked structure close to the substrate is the first sacrificial layer, and an outermost layer in the stacked structure away from the substrate is the active layer.

11. The manufacturing method according to any one of claims 1 to 10, wherein the partially removing the first insulating layer, to form a plurality of first trenches extending along the third direction, wherein each of the first trenches exposes the substrate, and is located between two adjacent columns of active pillars along the first direction comprises:

forming a second photoresist layer on the first insulating layer, wherein the second photoresist layer is provided with a second pattern, and the second pattern comprises a plurality of second etched trenches extending along the third direction; and

etching the first insulating layer by the second photoresist layer as a mask, to form the first trench.

12. The manufacturing method according to any one of claims 1 to 10, wherein the forming an isolation layer in each of the first trenches comprises:

depositing the isolation layer in each of the first trenches and on the first insulating layer, wherein the isolation layer fills up the first trench and covers the surface of the first insulating layer away from the substrate; and

flattening a surface of the isolation layer away from the substrate, to expose the first insulating layer.

13. The manufacturing method according to any one of claims 1 to 10, wherein the forming a gate structure on the peripheral surface of the active pillar exposed in the first filling space, wherein the gate structures are integrated along the second direction comprises:

forming a gate dielectric layer on the peripheral surface of the active pillar, wherein gaps are formed between the gate dielectric layers and between the gate dielectric layer and the isolation layer; and

forming a gate conductive layer in the remaining first filling space, and taking the gate dielectric layer and the gate conductive layer as the gate structure.

14. The manufacturing method according to any one of claims 1 to 10, after the forming a gate structure on the peripheral surface of the active pillar exposed in the first filling space, wherein the gate structures are integrated along the second direction, the manufacturing method further comprises:

forming a protective layer on the gate structure, the first insulating layer, and the isolation layer, and forming a second insulating layer on the protective layer;

etching the second insulating layer and the protective layer, to form a plurality of word line (WL) plug holes arranged at intervals, wherein each of the WL plug holes exposes one of the gate structures; and

forming a WL plug in each of the WL plug holes, wherein the WL plugs are electrically connected to the gate structures in a one-to-one correspondence.

15. The manufacturing method according to any one of claims 1 to 10, wherein a material of the isolation layer comprises silicon nitride or silicon oxynitride.