

CLAIMS

What is claimed is:

1. A method for fabricating a semiconductor structure, the method comprising:
fabricating a photonic crystal structure of a first material;
selectively removing the first material within a predefined part of the photonic crystal structure; and
replacing the first material within the predefined part of the photonic crystal structure with one or more second materials by selective epitaxy.
2. The method as claimed in claim 1, wherein the predefined part of the photonic crystal structure is a central part of the photonic crystal structure.
3. The method as claimed in claim 1, wherein fabricating the photonic crystal structure comprises:
providing a wafer comprising a layer of the first material; and
patterning the layer of the first material, thereby fabricating the photonic crystal structure of the first material.
4. The method as claimed in claim 3, wherein the wafer is a silicon-on-insulator wafer comprising a silicon layer on an insulating layer.
5. The method as claimed in claim 3, wherein replacing the first material with the one or more second materials comprises growing the one or more second materials in a lateral direction of the wafer.
6. The method as claimed in claim 5, further comprising growing the one or more second materials with a predefined doping profile in the lateral direction of the wafer.
7. The method as claimed in claim 5, further comprising growing two different second materials in the lateral direction of the wafer, thereby forming one or more lateral heterojunction.

8. The method as claimed in claim 1, wherein selectively removing the first material within the predefined part of the photonic crystal structure comprises:
- encapsulating the photonic crystal structure of the first material with a third material;
 - selectively removing a part of the third material in the predefined part of the photonic crystal structure to provide a window to the first material; and
 - selectively removing a part of the first material through the window, thereby creating a template structure of the third material, wherein a remaining part of the first material forms a seed structure for the one or more second materials.
9. The method as claimed in claim 8, wherein selectively removing the predefined part of the first material through the window comprises performing a selective etching of the first material.
10. The method as claimed in claim 8, wherein replacing the first material with the one or more second materials comprises growing the one or more second materials within the template structure of the third material from the seed structure.
11. The method as claimed in claim 1, wherein the photonic crystal structure of the first material comprises a plurality of rods of the first material.
12. The method as claimed in claim 8, further comprising removing the seed structure of the first material after the growing of the one or more second materials within the template structure.
13. The method as claimed in claim 1, further comprising providing electrical contacts to the one or more second materials.
14. The method as claimed in claims in claim 1, wherein patterning the first material comprises performing an etching based on HBr chemistry.
15. The method as claimed in claim 1, wherein the growing of the one or more second materials is performed by one of: metal organic chemical vapor deposition (MOCVD);

atmospheric pressure CVD; low or reduced pressure CVD; ultra-high vacuum CVD; molecular beam epitaxy (MBE); atomic layer deposition (ALD) and hydride vapor phase epitaxy.

16. The method as claimed in claim 1, wherein the one or more second materials are optically active materials.

17. The method as claimed in claim 1, wherein the one or more second materials are selected from the group consisting of: InP; InGaAs; AlGaAs; GaAs; GaN; InGaN; AlGaN; a ternary or a quaternary alloy thereof; group II-VI semiconductors and group IV semiconductors.

18. The method as claimed in claim 1, wherein the first material is silicon.

19. The method as claimed in claim 1, wherein the third material from the seed structure is a dielectric material, in particular an oxide.

20. A semiconductor device obtainable by the method according to claim 1.

21. A semiconductor device, comprising:
a semiconductor substrate;
an insulating layer on the semiconductor substrate; and
a photonic crystal structure on the insulating layer, the photonic crystal structure comprising a first material in an outer part and one or more second materials in a central part of the photonic crystal structure, wherein the one or more second materials are epitaxially grown semiconductor materials forming a gain structure which extends in a lateral direction of the substrate.

22. The semiconductor device according to claim 21, wherein the first material is silicon and the one or more second materials are selected from the group consisting of: InP; InGaAs; AlGaAs; GaAs; GaN; InGaN; AlGaN; a ternary or a quaternary alloy thereof; group II-VI semiconductors and group IV semiconductors.

23. The semiconductor device according to claim 21, wherein the one or more second materials comprise a predefined doping profile in the lateral direction of the substrate.
24. The semiconductor device according to claim 21, wherein the central part comprises two different semiconductors materials forming a heterojunction in the lateral direction of the substrate.
25. The semiconductor device according to claim 21, wherein the photonic crystal structure is 1-dimensional, 2-dimensional, or 3-dimensional photonic crystal lattice.