

Listing of Claims

What is claimed is:

1. A layered structure, comprising:
a substrate including a first porous multilayer having a first porosity;
5 an active quantum well capping layer epitaxially grown over the first porous multilayer;
a second porous multilayer having the first porosity over the active quantum well capping layer,
wherein the second porous multilayer aligns with the first porous multilayer.
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2. The layered structure of claim 1, wherein the substrate is composed of germanium or gallium arsenide.
3. The layered structure of claim 1, wherein the second porous multilayer has the first
15 porosity, and
a stack of the first porous multilayer, at least a first part of the active quantum well capping layer that aligns with the first porous multilayer, and the second porous multilayer allows a first light wave at a first wavelength to pass through the stack
- 20 4. The layered structure of claim 1, further comprising:
a first epitaxial distributed Bragg reflector multilayer grown over the substrate between the first porous multilayer and the active quantum well capping layer,
wherein the second porous multilayer includes a second epitaxial distributed Bragg reflector multilayer over the active quantum well capping layer, and
25 wherein a first reflectivity of the first epitaxial distributed Bragg reflector multilayer is different from a second reflectivity of the second epitaxial distributed Bragg reflector multilayer thereby causing a stack of the first porous multilayer, the first epitaxial distributed Bragg reflector multilayer, and the second epitaxial distributed Bragg reflector multilayer to allow a first light wave at a first wavelength to pass through the stack.
- 30 5. The layered structure of claim 1, wherein the first porous multilayer and the second porous multilayer aligns with a first region on the active quantum well capping layer, and the substrate includes a third porous multilayer, and
wherein the layered structure further comprises:

a fourth porous multilayer having the second porosity over the active quantum well capping layer,

wherein the second porous multilayer and the fourth porous multilayer are porous portions of a bulk layer grown over the active quantum well capping layer, and

5 wherein the third porous multilayer and the fourth porous multilayer aligns with a second region on the active quantum well capping layer.

6. The layered structure of claim 5, wherein the first porous multilayer and the third porous multilayer have different dimensions or different porosities, and
10 the second porous multilayer and the fourth porous multilayer have different dimensions or different porosities.

7. The layered structure of claim 5, wherein the first porous multilayer, at least the first region of the active quantum well capping layer, and the second porous multilayer form a
15 first VCSEL that allows a first light wave at a first wavelength to pass through, and the third porous multilayer, at least the second region of the active quantum well capping layer and the fourth porous multilayer form a second VCSEL that allows a second light wave at a second wavelength to pass through.

20 8. The layered structure of claim 1, wherein the second porous multilayer is a porous portion of a bulk layer grown over the active quantum well capping layer, and wherein the bulk layer has a plurality of spatially distributed porous multilayers, each porous multilayer from the plurality having a porosity selected to yield a specific reflectivity of the each porous multilayer to allow a light wave at a specific wavelength to pass through.

25 9. The layered structure of claim 5, further comprising:
a pseudomorphic high-electron-mobility transistor or a heterojunction bipolar transistor integrated into the bulk wafer at a space between the second porous multilayer and the fourth porous multilayer.

30 10. The layered structure of claim 5, wherein the second porous multilayer and the fourth porous multilayer have a same porosity and are connected to each other as a continuous porous multilayer in the bulk wafer.

11. The layered structure of claim 9, further comprising:
a pin diode integrated into the substrate at a space between the first porous multilayer and the third porous multilayer.
- 5 12. The layered structure of claim 10, wherein the continuous porous multilayer includes a fifth porous multilayer aligning with the pin diode, and the fifth porous multilayer has a third porosity that allows the fifth porous multilayer to reflect the first light wave at the first wavelength emitted from the active quantum well capping layer to a direction of the pin diode.
- 10 13. The layered structure of claim 11, wherein the substrate includes a sixth porous multilayer in proximity to the pin diode, and the sixth porous multilayer is configured to allow the first light wave at the first wavelength to pass through to reach the pin diode.
- 15 14. The layered structure of claim 1, further comprising:
one or more vertical porous multilayers perpendicular to and across the first porous multilayer, the active quantum well capping layer and the second porous multilayer,
wherein the one or more porous multilayers divides a stack of the first porous multilayer, the active quantum well capping layer and the second porous multilayer to form
20 multiple VCSELs.
15. The layered structure of claim 13, wherein thickness and porosity of at least one vertical porous multilayer is selected to form a porous filter that allows a third light wave at a third wavelength to pass between two adjacent VCSELs from the multiple VCSELs.
- 25 16. The layered structure of claim 13, wherein thickness and porosity of at least one vertical porous multilayer is selected to form a porous isolation that allows no light wave passage between two adjacent VCSELs from the multiple VCSELs.
- 30 17. A layered structure, comprising:
a substrate;
a first epitaxial distributed Bragg reflector multilayer grown over the substrate;
an active quantum well capping layer epitaxially grown over the first epitaxial distributed Bragg reflector multilayer; and

a porous multilayer composed of a same material with the substrate, the porous multilayer over the active quantum well capping layer.

18. The layered structure of claim 16, further comprising:

- 5 a second epitaxial distributed Bragg reflector multilayer grown over the active quantum well and between the active quantum well and the porous multilayer, wherein a first reflectivity of the first epitaxial distributed Bragg reflector multilayer is different from a second reflectivity of the second epitaxial distributed Bragg reflector multilayer thereby causing a stack of the porous multilayer, the first epitaxial distributed Bragg reflector multilayer, and the second epitaxial distributed Bragg reflector multilayer to
10 allow a first light wave at a first wavelength to pass through the stack.

19. A circular layered structure, comprising:

- a circular substrate;
15 a first radial porous distributed Bragg reflector multilayer radially beneath the circular substrate;
a circular active quantum well capping layer radially beneath the first radial porous distributed Bragg reflector multilayer; and
a second radial porous distributed Bragg reflector multilayer radially beneath the
20 circular active quantum well capping layer.

20. The circular layered structure of claim 18, wherein the first radial porous distributed Bragg reflector multilayer has a same radial porosity with the second radial porous distributed Bragg reflector multilayer.

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21. The circular layered structure of claim 18, wherein the first radial porous distributed Bragg reflector multilayer, the circular active quantum well capping layer and the second radial porous distributed Bragg reflector multilayer form a focused VSCEL that allows a first light wave at a first wavelength to pass through.

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