CLAIMS

1. A vertical wave guide laser semiconductor device comprising:

a semiconductor substrate, and a layer structure formed thereon with a quantization axis of an active medium layer parallel with a vertical axis of an optical cavity, the layer structure including

a first wave guide layer with a first doping type disposed over the semiconductor substrate,

the active medium layer disposed over the first wave guide layer, and

a second wave guide layer with a second doping type;

a mesa type structure with a top surface and a side wall formed from the first wave guide layer, the active medium layer and the second wave guide layer; and

a bi-stable resistive system (BRS) formed i) in the first wave guide layer around or adjacent to the mesa type structure or ii) on the top surface of the mesa type structure.

2. The vertical wave guide laser semiconductor device of claim 1, wherein the layer structure is a vertical-cavity surface-emitting laser (VSCEL).

3. The vertical wave guide laser semiconductor device of claim 1 or claim 2, wherein the bi-stable resistive system is formed using insulator-to-metal transition (IMT) materials.

4. The vertical wave guide laser semiconductor device of claim 1 or claim 2, wherein the bi-stable resistive system is formed using threshold-switching selectors.

5. The vertical wave guide laser semiconductor device of any one of claims 1 to 4, further comprising:

a first contact layer formed over the bi-stable resistive system;

an aperture formed in the second wave guide layer; and

a second contact layer formed over the second wave guide layer and having an opening over the aperture, the second contact layer is electrically isolated from the first contact layer.

6. A vertical wave guide laser semiconductor device comprising:

a semiconductor substrate, and a layer structure formed thereon with a quantization axis of an active medium layer parallel with a vertical axis of an optical cavity, the layer structure including

a first wave guide layer with a first doping type disposed over the semiconductor substrate,

the active medium layer disposed over the first wave guide layer, and

a second wave guide layer with a second doping type and;

a mesa type structure with a top surface and a side wall formed from the first wave guide layer, the active medium layer and the second wave guide layer;

a bi-stable resistive system (BRS) formed on a bottom side of the semiconductor substrate;

a first contact layer formed over the bi-stable resistive system; and

a second contact layer formed over the second wave guide layer, the second contact layer is electrically isolated from the first contact layer.

7. The vertical wave guide laser semiconductor device of claim 6, wherein the bi-stable resistive system is formed using insulator-to-metal transition (IMT) materials.

8. The vertical wave guide laser semiconductor device of claim 6, wherein the bi-stable resistive system is formed using threshold-switching selectors.

9. A vertical wave guide laser semiconductor device comprising:

a semiconductor substrate, and a layer structure formed thereon with an quantization axis of an active medium layer parallel with a vertical axis of an optical cavity, the layer structure including

a first wave guide layer with a first doping type disposed over the semiconductor substrate,

the active medium layer disposed over the first wave guide layer, and

a second wave guide layer with a second doping type, with at least one layer of a bi-stable resistive system (BRS) formed i) within the active medium layer or ii) within one of the first wave guide layer and the second wave guide layer; and

a mesa type structure with a top surface and a side wall formed from the first wave guide layer, the active medium layer and the second wave guide layer.

10. The vertical wave guide laser semiconductor device of claim 9, further comprising:

a first contact layer formed over the first wave guide layer; and

a second contact layer formed over the second wave guide layer and having an opening over an aperture, the second contact layer is electrically isolated from the first contact layer.

11. The vertical wave guide laser semiconductor device of claim 9 or claim 10, wherein the layer structure is a vertical-cavity surface-emitting laser (VSCEL).

12. The vertical wave guide laser semiconductor device of any one of claims 9 to 11, wherein the bi-stable resistive system is formed using insulator-to-metal transition (IMT) materials.

13. The vertical wave guide laser semiconductor device of any one of claims 9 to 11, wherein the bi-stable resistive system is formed using threshold-switching selectors.

14. The vertical wave guide laser semiconductor device of any one of claims 9 to 11, wherein the at least one layer of the bi-stable resistive system (BRS) is formed within the active medium layer at a node of a stationary electromagnetic field oscillating in the optical cavity to minimize light absorption.