CLAIMS

1. A laser source comprising:

a photonic crystal structure comprising:

a first domain comprising a plurality of first holes defined therein, the first domain being associated with a first set of Chern numbers; and

a second domain comprising a plurality of second holes defined therein, the second domain being associated with a second set of Chern numbers,

wherein the plurality of first holes and the plurality of second holes are arranged to define an interface region between the first domain and the second domain, the interface region defining an optical cavity for lasing,

wherein each of the first domain and the second domain is associated with a first valley and a second valley,

wherein the first set of Chern numbers comprises a first Chern number associated with the first valley of the first domain and a second Chern number associated with the second valley of the first domain,

wherein the second set of Chern numbers comprises a third Chern number associated with the first valley of the second domain and a fourth Chern number associated with the second valley of the second domain,

wherein the first Chern number and the third Chern number are opposite numbers, and

wherein the second Chern number and the fourth Chern number are opposite numbers.

2. The laser source as claimed in claim 1,

wherein the first Chern number and the third Chern number differ from each other by an integer, and

wherein the second Chern number and the fourth Chern number differ from each other by an integer.

3. The laser source as claimed in claim 1 or 2,

wherein each of the plurality of first holes comprises a shape with a 120° rotation symmetry arranged in a first orientation, and

wherein each of the plurality of second holes comprises the shape with the 120° rotation symmetry arranged in a second orientation.

4. The laser source as claimed in claim 3, wherein the shape comprises a quasi-hexagonal shape or an equilateral triangular shape.

5. The laser source as claimed in any one of claims 1 to 4, wherein the optical cavity comprises a loop cavity.

6. The laser source as claimed in any one of claims 1 to 5, wherein the optical cavity comprises at least one corner or bend.

7. The laser source as claimed in any one of claims 1 to 6, wherein the optical cavity has a triangular shape or a trapezoidal shape.

8. The laser source as claimed in any one of claims 1 to 7, further comprising at least one out-coupling agent along the optical cavity.

9. The laser source as claimed in any one of claims 1 to 8, further comprising:

an active medium over a substrate, the active medium comprising:

a first conductive layer arranged proximate to the substrate;

a second conductive layer over the first conductive layer; and

an active region sandwiched between the first conductive layer and the second conductive layer,

wherein the photonic crystal structure is formed in the active region and the second conductive layer.

10. The laser source as claimed in any one of claims 1 to 9, further comprising an optical waveguide optically coupled to the optical cavity.

11. The laser source as claimed in claim 10, further comprising at least one output coupler optically coupled to the optical waveguide.

12. The laser source as claimed in any one of claims 1 to 11, wherein the laser source comprises a quantum cascade laser.

13. A method for forming a laser source comprising:

forming a photonic crystal structure comprising:

a first domain comprising a plurality of first holes defined therein, the first domain being associated with a first set of Chern numbers; and

a second domain comprising a plurality of second holes defined therein, the second domain being associated with a second set of Chern numbers,

wherein the plurality of first holes and the plurality of second holes are arranged to define an interface region between the first domain and the second domain, the interface region defining an optical cavity for lasing,

wherein each of the first domain and the second domain is associated with a first valley and a second valley,

wherein the first set of Chern numbers comprises a first Chern number associated with the first valley of the first domain and a second Chern number associated with the second valley of the first domain,

wherein the second set of Chern numbers comprises a third Chern number associated with the first valley of the second domain and a fourth Chern number associated with the second valley of the second domain,

wherein the first Chern number and the third Chern number are opposite numbers, and

wherein the second Chern number and the fourth Chern number are opposite numbers.

14. The method as claimed in claim 13,

wherein the first Chern number and the third Chern number differ from each other by an integer, and

wherein the second Chern number and the fourth Chern number differ from each other by an integer.

15. The method as claimed in claim 13 or 14,

wherein each of the plurality of first holes comprises a shape with a 120° rotation symmetry arranged in a first orientation, and

wherein each of the plurality of second holes comprises the shape with the 120° rotation symmetry arranged in a second orientation.

16. The method as claimed in any one of claims 13 to 15, wherein the optical cavity comprises at least one corner or bend.

17. The method as claimed in any one of claims 13 to 16, further comprising forming at least one out-coupling agent along the optical cavity.

18. The method as claimed in any one of claims 13 to 17, further comprising:

forming an active medium over a substrate, the active medium comprising:

a first conductive layer arranged proximate to the substrate;

a second conductive layer over the first conductive layer; and

an active region sandwiched between the first conductive layer and the second conductive layer,

wherein forming the photonic crystal structure comprises forming the photonic crystal structure in the active region and the second conductive layer.