WHAT IS CLAIMED IS:

1. A semiconductor device comprising:

a semiconductor layer having one conductivity type formed on an insulating surface;

a carbide semiconductor region in at least a part of the semiconductor layer;

a gate insulating layer over the carbide semiconductor region;

a gate electrode over the gate insulating layer;

a first impurity region having an opposite conductivity type to the one conductivity type, the first impurity region overlapping with a part of the gate electrode and including at least the carbide semiconductor region;

a second impurity region having the one conductivity type, the second impurity region being in the first impurity region and including at least the carbide semiconductor region;

a source electrode being in contact with the first impurity region and the second impurity region; and

a drain electrode being in contact with the semiconductor layer.

2. A semiconductor device according to Claim 1,

wherein the semiconductor layer comprises single crystal silicon and the carbide semiconductor region comprises silicon carbide.

3. A semiconductor device according to Claim 1,

wherein the drain electrode is in contact with the carbide semiconductor region.

4. A semiconductor device according to Claim 1,

wherein the second impurity region is substantially outside a region under the gate electrode.

5. A semiconductor device comprising:

a semiconductor layer having one conductivity type formed on an insulating surface;

a carbide semiconductor region in at least a part of the semiconductor layer;

a gate insulating layer over the carbide semiconductor region;

a gate electrode over the gate insulating layer;

a first impurity region having an opposite conductivity type to the one conductivity type, the first impurity region overlapping with a part of the gate electrode and including at least the carbide semiconductor region;

a second impurity region having the one conductivity type, the second impurity region being in the first impurity region and including at least the carbide semiconductor region;

a third impurity region having the opposite conductivity type to the one conductivity type, the third impurity region being outside the first impurity region in the semiconductor layer;

an emitter electrode being in contact with the first impurity region and the second impurity region; and

a collector electrode being in contact with the third impurity region.

6. A semiconductor device according to Claim 5,

wherein the semiconductor layer comprises single crystal silicon and the carbide semiconductor region comprises silicon carbide.

7. A semiconductor device according to Claim 5,

wherein the second impurity region is substantially outside a region under the gate electrode.

8. A semiconductor device comprising:

a carbide semiconductor region in a part of a surface portion of a semiconductor substrate having one conductivity type;

a gate insulating layer over the carbide semiconductor region;

a gate electrode over the gate insulating layer;

a first impurity region having an opposite conductivity type to the one conductivity type, the first impurity region overlapping with a part of the gate electrode and including at least the carbide semiconductor region;

a second impurity region having the one conductivity type, the second impurity region being in the first impurity region and including at least the carbide semiconductor region;

a source electrode being in contact with the first impurity region and the second impurity region; and

a drain electrode being on an opposite surface of the semiconductor substrate from the surface portion.

9. A semiconductor device according to Claim 8,

wherein the carbide semiconductor region comprises silicon carbide.

10. A semiconductor device according to Claim 8,

wherein the second impurity region is substantially outside a region under the gate electrode.

11. A semiconductor device comprising:

a carbide semiconductor region in a part of a surface portion of a semiconductor substrate having one conductivity type;

a gate insulating layer over the carbide semiconductor region;

a gate electrode over the gate insulating layer;

a first impurity region having an opposite conductivity type to the one conductivity type, the first impurity region overlapping with a part of the gate electrode and including at least the carbide semiconductor region;

a second impurity region having the one conductivity type, the second impurity region being in the first impurity region and including at least the carbide semiconductor region;

a third impurity region having the opposite conductivity type to the one conductivity type, the third impurity region being on an opposite surface of the semiconductor substrate from the surface portion;

an emitter electrode being in contact with the first impurity region and the second impurity region; and

a collector electrode being in contact with the third impurity region.

12. A semiconductor device according to Claim 11,

wherein the carbide semiconductor region comprises silicon carbide.

13. A semiconductor device according to Claim 11,

wherein the second impurity region is substantially outside a region under the gate electrode.

14. A method for manufacturing a semiconductor device comprising:

forming a carbide semiconductor region by heating a semiconductor layer having one conductivity type in an atmosphere containing a carbide gas to carbonize a surface portion of the semiconductor layer;

forming a first impurity region having an opposite conductivity type to the one conductivity type in the semiconductor layer, the first impurity region including the carbide semiconductor region;

forming a second impurity region having the one conductivity type in the first impurity region, the second impurity region including at least the carbide semiconductor region;

forming a gate electrode over the semiconductor layer with a gate insulating layer interposed between the gate electrode and the semiconductor layer, the gate electrode overlapping with the first impurity region at least partly; and

forming a source electrode and a drain electrode, the source electrode being in contact with the second impurity region and a part of the first impurity region, and the drain electrode being in contact with the semiconductor layer.

15. A method for manufacturing a semiconductor device according to Claim 14,

wherein the carbide semiconductor region is formed by heating the semiconductor layer in an atmosphere containing a hydrocarbon gas while performing laser light irradiation.

16. A method for manufacturing a semiconductor device according to Claim

14,

wherein the semiconductor layer comprises single crystal silicon and the carbide semiconductor region comprises silicon carbide.

17. A method for manufacturing a semiconductor device according to Claim 14,

wherein the drain electrode is in contact with the carbide semiconductor region.

18. A method for manufacturing a semiconductor device according to Claim 14,

wherein the second impurity region is substantially outside a region under the gate electrode.

19. A method for manufacturing a semiconductor device comprising:

forming a carbide semiconductor region by heating a semiconductor layer having one conductivity type in an atmosphere containing a carbide gas to carbonize a surface portion of the semiconductor layer;

forming a first impurity region having an opposite conductivity type to the one conductivity type in the semiconductor layer, the first impurity region including the carbide semiconductor region;

forming a second impurity region having the one conductivity type in the first impurity region, the second impurity region including at least the carbide semiconductor region;

forming a third impurity region having the opposite conductivity type to the one conductivity type outside the first impurity region in the semiconductor layer;

forming a gate electrode over the semiconductor layer with a gate insulating layer interposed between the gate electrode and the semiconductor layer, the gate electrode overlapping with the first impurity region at least partly; and

forming a source electrode and a drain electrode, the source electrode being in contact with the second impurity region and a part of the first impurity region, and the drain electrode being in contact with the third impurity region.

20. A method for manufacturing a semiconductor device according to Claim 19,

wherein the carbide semiconductor region is formed by heating the semiconductor layer in an atmosphere containing a hydrocarbon gas while performing laser light irradiation.

21. A method for manufacturing a semiconductor device according to Claim 19,

wherein the semiconductor layer comprises single crystal silicon and the carbide semiconductor region comprises silicon carbide.

22. A method for manufacturing a semiconductor device according to Claim 19,

wherein the second impurity region is substantially outside a region under the gate electrode.

23. A method for manufacturing a semiconductor device comprising:

forming a carbide semiconductor region by heating a semiconductor substrate having one conductivity type in an atmosphere containing a carbide gas to carbonize a surface portion of one surface of the semiconductor substrate;

forming a first impurity region having an opposite conductivity type to the one conductivity type in the semiconductor substrate, the first impurity region including the carbide semiconductor region;

forming a second impurity region having the one conductivity type in the first impurity region, the second impurity region including at least the carbide semiconductor region;

forming a gate electrode over the semiconductor substrate with a gate insulating layer interposed between the gate electrode and the semiconductor substrate, the gate electrode overlapping with the first impurity region at least partly; and

forming a source electrode and a drain electrode, the source electrode being in contact with the second impurity region and a part of the first impurity region, and the drain electrode being in contact with an opposite surface of the semiconductor substrate

from the one surface.

24. A method for manufacturing a semiconductor device according to Claim 23,

wherein the carbide semiconductor region is formed by heating the semiconductor substrate in an atmosphere containing a hydrocarbon gas while performing laser light irradiation.

25. A method for manufacturing a semiconductor device according to Claim 23,

wherein the semiconductor substrate comprises single crystal silicon and the carbide semiconductor region comprises silicon carbide.

26. A method for manufacturing a semiconductor device according to Claim 23,

wherein the second impurity region is substantially outside a region under the gate electrode.

27. A method for manufacturing a semiconductor device comprising:

forming a carbide semiconductor region by heating a semiconductor substrate having one conductivity type in an atmosphere containing a carbide gas to carbonize a surface portion of one surface of the semiconductor substrate;

forming a first impurity region having an opposite conductivity type to the one conductivity type in the semiconductor substrate, the first impurity region including the carbide semiconductor region;

forming a second impurity region having the one conductivity type in the first impurity region, the second impurity region including at least the carbide semiconductor region;

forming a third impurity region having the opposite conductivity type to the one conductivity type on an opposite surface of the semiconductor substrate from the one surface;

forming a gate electrode over the semiconductor substrate with a gate

insulating layer interposed between the gate electrode and the semiconductor substrate, the gate electrode overlapping with the first impurity region at least partly; and

forming a source electrode and a drain electrode, the source electrode being in contact with the second impurity region and a part of the first impurity region, and the drain electrode being in contact with the third impurity region.

28. A method for manufacturing a semiconductor device according to Claim 27,

wherein the carbide semiconductor region is formed by heating the semiconductor substrate in an atmosphere containing a hydrocarbon gas while performing laser light irradiation.

29. A method for manufacturing a semiconductor device according to Claim 27,

wherein the semiconductor substrate comprises single crystal silicon and the carbide semiconductor region comprises silicon carbide.

30. A method for manufacturing a semiconductor device according to Claim 27,

wherein the second impurity region is substantially outside a region under the gate electrode.

WHAT IS CLAIMED IS:

1. A semiconductor device comprising:

a semiconductor layer on an insulating surface, the semiconductor layer comprising:

a semiconductor region having one conductivity type; and

a carbide semiconductor region comprising a first impurity region having an opposite conductivity type to the one conductivity type and a second impurity region having the one conductivity type;

a gate insulating layer over the carbide semiconductor region;

a gate electrode over the gate insulating layer;

a source electrode in contact with the first impurity region and the second impurity region; and

a drain electrode being in contact with the semiconductor layer,

wherein the first impurity region overlaps with a part of the gate electrode, and

wherein the second impurity region is surrounded by the first impurity region.

2. A semiconductor device according to claim 1,

wherein the semiconductor layer comprises single crystal silicon and the carbide semiconductor region comprises silicon carbide.

3. A semiconductor device according to claim 1,

wherein the drain electrode is in contact with the carbide semiconductor region.

4. A semiconductor device according to claim 1,

wherein the second impurity region is substantially outside a region under the gate electrode.

5. A semiconductor device comprising:

a semiconductor layer on an insulating surface, the semiconductor layer comprising:

a semiconductor region having one conductivity type; and

a carbide semiconductor region comprising a first impurity region having an opposite conductivity type to the one conductivity type, a second impurity region having the one conductivity type and a third impurity region having the opposite conductivity type to the one conductivity type;

a gate insulating layer over the carbide semiconductor region;

a gate electrode over the gate insulating layer;

an emitter electrode in contact with the first impurity region and the second impurity region; and

a collector electrode in contact with the third impurity region,

wherein the first impurity region overlaps with a part of the gate electrode, and

wherein the second impurity region is surrounded by the first impurity region.

6. A semiconductor device according to claim 5,

wherein the semiconductor layer comprises single crystal silicon and the carbide semiconductor region comprises silicon carbide.

7. A semiconductor device according to claim 5,

wherein the second impurity region is substantially outside a region under the gate electrode.

8. A semiconductor device comprising:

a semiconductor substrate comprising:

a semiconductor region having one conductivity type; and

a carbide semiconductor region comprising a first impurity region having an opposite conductivity type to the one conductivity type and a second impurity region having the one conductivity type, the carbide semiconductor region being in a part of a surface portion of the semiconductor substrate;

a gate insulating layer over the carbide semiconductor region;

a gate electrode over the gate insulating layer;

an insulating layer over the gate electrode;

a source electrode in contact with the first impurity region and the second impurity region; and

a drain electrode being on an opposite surface of the semiconductor substrate from the surface portion,

wherein the first impurity region overlaps with a part of the gate electrode,

wherein the second impurity is surrounded by the first impurity region,

wherein a part of the insulating layer is exposed, and

wherein a shape of the gate electrode is a circular shape.

9. A semiconductor device according to claim 8,

wherein the carbide semiconductor region comprises silicon carbide.

10. A semiconductor device according to claim 8,

wherein the second impurity region is substantially outside a region under the gate electrode.

11. A semiconductor device comprising:

a semiconductor substrate comprising:

a semiconductor region having one conductivity type; and

a carbide semiconductor region comprising a first impurity region having an opposite conductivity type to the one conductivity type, a second impurity region having the one conductivity type and a third impurity region having the opposite conductivity type to the one conductivity type, the carbide semiconductor region being in a part of a surface portion of the semiconductor substrate;

a gate insulating layer over the carbide semiconductor region;

a gate electrode over the gate insulating layer;

an emitter electrode in contact with the first impurity region and the second impurity region; and

a collector electrode in contact with the third impurity region,

wherein the first impurity region overlaps with a part of the gate electrode,

wherein the second impurity region is surrounded by the first impurity region,

wherein the third impurity region is on an opposite surface of the semiconductor substrate from the surface portion, and

wherein a shape of the gate electrode is a circular shape.

12. A semiconductor device according to claim 11,
wherein the carbide semiconductor region comprises silicon carbide.

13. A semiconductor device according to claim 11,
wherein the second impurity region is substantially outside a region under the gate electrode.

14. A semiconductor device according to claim 8,
wherein a part of the opposite surface of the semiconductor substrate is exposed.

15. A semiconductor device according to claim 8,
wherein the carbide semiconductor region is formed down to a depth of 5 nm to 15 nm from a surface of the semiconductor substrate.

16. A semiconductor device according to claim 8,
wherein a part of periphery of the insulating layer overlaps with a part of periphery of the source electrode.

17. A semiconductor device according to claim 11,
wherein a part of the opposite surface of the semiconductor substrate is exposed.

18. A semiconductor device according to claim 11,
wherein the carbide semiconductor region is formed down to a depth of 5 nm to 15 nm from a surface of the semiconductor substrate.