What is claimed is:

1. A micro light emitting diode (LED) chip structure, comprising:

a semiconductor substrate;

an electrical contact layer on a surface of the semiconductor substrate;

a first type of conductive layer on the semiconductor substrate;

an active light emitting layer on the first type of conductive layer; and

a second type of conductive layer on the active light emitting layer;

wherein a thickness of the second-type of conductive layer is smaller than a thickness of the first-type of conductive layer, and a surface of the second-type of conductive layer is obtained after an organic material layer is removed.

2. A micro light emitting diode (LED) chip structure, comprising:

a semiconductor substrate;

an electrical contact layer on a surface of the semiconductor substrate;

a first type of conductive layer on the semiconductor substrate;

an active light emitting layer on the first type of conductive layer; and

a second type of conductive layer on the active light emitting layer;

wherein a surface of the second-type of conductive layer is obtained after an organic material layer is removed.

3. The micro LED chip structure according to claim 1 or claim 2, further comprising a second type of spacer layer between the active light emitting layer and the second type of conductive layer, wherein the second type of spacer layer is used for forming a PN junction structure with the active light emitting layer and the first type of conductive layer, and the second type of conductive layer includes one or more of second type of conductive transition layers.

4. The micro LED chip structure according to claim 1 or claim 2, wherein the first type of conductive layer is an N-type layer, and the second type of conductive layer is a P-type layer.

5. The micro LED chip structure according to claim 1 or claim 2, wherein the semiconductor substrate is an integrated circuits (IC) substrate.

6. The micro LED chip structure according to claim 1 or claim 2, wherein the electrical contact layer is a metal bonding layer, and the semiconductor substrate and the first type of conductive layer are bonded together through a bonding process.

7. The micro LED chip structure according to claim 1 or claim 2, wherein the second type of conductive layer is a P-type GaP layer, and the first type of conductive layer is an N-type GaAs layer.

8. The micro LED chip structure according to claim 1 or claim 2, further comprising a first type of cladding layer between the first type of conductive layer and the active light emitting layer.

9. The micro LED chip structure according to claim 8, further comprising an oxide layer within the first type of cladding layer.

10. The micro LED chip structure according to claim 8, further comprising an oxide layer between the first type of conductive layer and the first type of cladding layer.

11. The micro LED chip structure of claim 1 or claim 2, further comprising a second type of cladding layer between the second type of conductive layer and the active light emitting layer.

12. The micro LED chip structure according to claim 11, further comprising an oxide layer within the second type of cladding layer.

13. The micro LED chip structure according to claim 11, further comprising an oxide layer between the second type of conductive layer and the second type of cladding layer.

14. The micro LED chip structure according to any one of claims 9, 10, 12, and 13, wherein material of the oxide layer is $Al_xOGa_{1-x}As$, and x is greater or equal to 0.9 and less than 1.

15. The micro LED chip according to claim 8, wherein material of the first type of cladding layer is AlInP.

16. The micro LED chip according to claim 11, wherein the second type of cladding layer includes one or more layers of AlInP, $Al_xGa_{1-x}InP$ (x is greater than 0 and less than 1), and GaInP.

17. The micro LED chip according to claim 1 or claim 2, wherein the organic material layer is an ultraviolet (UV) curable bonding layer.

18. The micro LED chip structure according to claim 1 or claim 2, wherein a ratio of a thickness of the second type of conductive layer to a thickness of the first type of conductive layer is 0.025 to 100.

19. The micro LED chip structure according to claim 1 or claim 2, wherein a ratio of a thickness of the second type of conductive layer to a thickness of the first type of conductive layer is 1.5 to 2.

20. The micro LED chip structure of claim 1 or claim 2, further comprising a second type of cladding layer between the second type of conductive layer and the active light emitting layer, wherein the second type of conductive layer includes a second type of conductive transition layer.

21. The micro LED chip structure of claim 20, wherein a ratio of a thickness of the second type of cladding layer to a thickness of the second type of conductive transition layer is 0.02 to 120.

22. The micro LED chip structure according to claim 20, wherein a ratio of a thickness of the second type of cladding layer to a thickness of the second type of conductive transition layer is 1 to 2.5.

23. The micro LED chip structure according to claim 1 or claim 2, wherein the second type of conductive layer comprises sequentially a lower second type of conductive transition layer, a middle second type of conductive transition layer, and an upper second type of conductive transition layer in a direction from the semiconductor substrate to the first type of conductive layer.

24. The micro LED chip structure according to claim 23, wherein a conductivity of the lower second type of conductive transition layer is less than that of the middle second type of conductive transition layer, and the conductivity of the middle second type of conductive transition layer is less than the upper second type of conductive transition layer.

25. The micro LED chip according to claim 11, wherein the second type of cladding layer includes one or more layers of AlInP, and $Al_xGa_{1-x}InP$ (x is greater than or equal to 0 and less than or equal to 1).

26. An epitaxial structure for a micro light emitting diode (LED), comprising:

a semiconductor substrate;

an electrical conductive layer of a first conductivity type on the semiconductor substrate;

a cladding layer of the first conductivity type on the electrical conductive layer of the first conductivity type;

a first oxide layer within the cladding layer of the first conductivity type;

an active light emitting layer on the cladding layer of the first conductivity type;

a cladding layer of a second conductivity type on the active light emitting layer; and

an electrical conductive layer of the second conductivity type on the cladding layer of the second conductivity type.

27. The epitaxial structure for the micro LED according to claim 26, further comprising: a second oxide layer within the cladding layer of the second conductivity type.

28. The epitaxial structure for the micro LED according to claim 26, further comprising: a second oxide layer between the cladding layer of the second conductivity type and the electrical conductive layer of the second conductivity type.

29. An epitaxial structure for a micro light emitting diode (LED), comprising:

a semiconductor substrate;

an electrical conductive layer of a first conductivity type on the semiconductor substrate;

a cladding layer of the first conductivity type on the electrical conductive layer of the first conductivity type;

a first oxide layer between the electrical conductive layer of the first conductivity type and the cladding layer of the first conductivity type;

an active light emitting layer on the cladding layer of the first conductivity type;

a cladding layer of a second conductivity type on the active light emitting layer; and

an electrical conductive layer of the second conductivity type on the cladding layer of the second conductivity type.

30. The epitaxial structure for the micro LED according to claim 29, further comprising: a second oxide layer between the cladding layer of the second conductivity type and the electrical conductive layer of the second conductivity type.

31. The epitaxial structure for the micro LED according to claim 29, further comprising: a second oxide layer within the cladding layer of the second conductivity type.

32. An epitaxial structure for a micro light emitting diode (LED), comprising:

a semiconductor substrate;

an electrical conductive layer of a first conductivity type on the semiconductor substrate;

a cladding layer of the first conductivity type on the electrical conductive layer of the first conductivity type;

an active light emitting layer on the cladding layer of the first conductivity type;

a cladding layer of a second conductivity type on the active light emitting layer;

a first oxide layer within the cladding layer of the second conductivity type; and

an electrical conductive layer of the second conductivity type on the cladding layer of the second conductivity type.

33. The epitaxial structure for the micro LED according to claim 32, further comprising: a second oxide layer within the cladding layer of the first conductivity type.

34. The epitaxial structure for the micro LED according to claim 32, further comprising: a second oxide layer between the cladding layer of the first conductivity type and the electrical conductive layer of the first conductivity type.

35. An epitaxial structure for a micro light emitting diode (LED), comprising:

a semiconductor substrate;

an electrical conductive layer of a first conductivity type on the semiconductor substrate;

a cladding layer of the first conductivity type on the electrical conductive layer of the first conductivity type;

an active light emitting layer on the cladding layer of the first conductivity type;

a cladding layer of a second conductivity type on the active light emitting layer;

an electrical conductive layer of the second conductivity type on the cladding layer of the second conductivity type; and

a first oxide layer between the cladding layer of the second conductivity type and the electrical conductive layer of the second conductivity type.

36. The epitaxial structure for the micro LED according to claim 35, further comprising: a second oxide layer between the cladding layer of the first conductivity type and the electrical conductive layer of the first conductivity type.

37. The epitaxial structure for the micro LED according to claim 35, further comprising: a second oxide layer within the cladding layer of the first conductivity type.

38. The epitaxial structure for the micro LED according to any one of claims 26, 29, 32, or 35, wherein the first oxide layer is formed as an oxide ring from an oxide layer precursor $Al_xGa_{1-x}As$, and x is greater or equal to 0.9 and less than 1.

39. The epitaxial structure for the micro LED according to any one of claims 26, 29, 32, or 35, wherein the cladding layer of the first conductivity type includes one or more layers.

40. The epitaxial structure for the micro LED according to any one of claims 26, 29, 32, or 35, wherein the cladding layer of the second conductivity type includes one or more layers.

41. The epitaxial structure for the micro LED according to any one of claims 26, 29, 32, or 35, further comprising: between the semiconductor substrate and the electrical conductive layer of the first conductivity type, sequentially a buffer layer of the first conductivity type and an etch-stop layer of the first conductivity type in a direction from the semiconductor substrate to the electrical conductive layer of the first conductivity type.

42. The epitaxial structure for the micro LED according to any one of claims 26, 29, 32, or 35, further comprising: a spacer layer of the first conductivity type located on a bottom of the active light emitting layer, and a spacer layer of the second conductivity type located on a top of the active light emitting layer.

43. The epitaxial structure of the micro LED according to any one of claims 26, 29, 32, or 35, wherein the electrical conductive layer of the second conductivity type comprises one or more conductive transition layers.

44. The epitaxial structure for the micro LED according to any one of claims 26, 29, 32, or 35, wherein the electrical conductive layer of the second conductivity type comprises sequentially a lower conductive transition layer of the second conductivity type, a middle conductive transition layer of the second conductivity type, and an upper conductive transition layer of the second conductivity type in a direction from the semiconductor substrate to the electrical conductive layer of the first conductivity type.

45. The epitaxial structure of the micro LED according to claim 44, wherein a conductivity of the lower conductive transition layer of the second conductivity type is less than that of the middle conductive transition layer of the second conductivity type, and the conductivity of the middle conductive transition layer of the second conductivity type is less than the upper conductive transition layer of the second conductivity type.

46. The epitaxial structure for the micro LED according to any one of claims 26, 29, 32, or 35, wherein material of the first oxide layer is $Al_xOGa_{1-x}As$, and x is greater or equal to 0.9 and less than 1.

47. The epitaxial structure for a micro LED according to any one of claims 26, 29, 32, or 35, wherein material of the cladding layer of the first conductivity type is AlInP.

~~48. The epitaxial structure for the micro LED according to any one of claims 26, 29, 32, or 35, wherein material of the cladding layer of the second conductivity type includes one or more layers of AlInP, and $Al_xGa_{1-x}InP$ (x is greater than or equal to 0 and less than or equal to 1).~~

AMENDED CLAIMS
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1. A micro light emitting diode (LED) chip structure, comprising:

a semiconductor substrate;

an electrical contact layer on a surface of the semiconductor substrate;

a first type of conductive layer on the semiconductor substrate;

an active light emitting layer on the first type of conductive layer; and

a second type of conductive layer on the active light emitting layer;

wherein a thickness of the second-type of conductive layer is smaller than a thickness of the first-type of conductive layer, and a surface of the second-type of conductive layer is obtained after an organic material layer is removed.

2. A micro light emitting diode (LED) chip structure, comprising:

a semiconductor substrate;

an electrical contact layer on a surface of the semiconductor substrate;

a first type of conductive layer on the semiconductor substrate;

an active light emitting layer on the first type of conductive layer; and

a second type of conductive layer on the active light emitting layer;

wherein a surface of the second-type of conductive layer is obtained after an organic material layer is removed.

3. The micro LED chip structure according to claim 1 or claim 2, further comprising a second type of spacer layer between the active light emitting layer and the second type of conductive layer, wherein the second type of spacer layer is used for forming a PN junction structure with the active light emitting layer and the first type of conductive layer, and the second type of conductive layer includes one or more of second type of conductive transition layers.

4. The micro LED chip structure according to claim 1 or claim 2, wherein the first type of conductive layer is an N-type layer, and the second type of conductive layer is a P-type layer.

5. The micro LED chip structure according to claim 1 or claim 2, wherein the semiconductor substrate is an integrated circuits (IC) substrate.

6. The micro LED chip structure according to claim 1 or claim 2, wherein the electrical contact layer is a metal bonding layer, and the semiconductor substrate and the first type of conductive layer are bonded together through a bonding process.

7. The micro LED chip structure according to claim 1 or claim 2, wherein the second type of conductive layer is a P-type GaP layer, and the first type of conductive layer is an N-type GaAs layer.

8. The micro LED chip structure according to claim 1 or claim 2, further comprising a first type of cladding layer between the first type of conductive layer and the active light emitting layer.

9. The micro LED chip structure according to claim 8, further comprising an oxide layer within the first type of cladding layer.

10. The micro LED chip structure according to claim 8, further comprising an oxide layer between the first type of conductive layer and the first type of cladding layer.

11. The micro LED chip structure of claim 1 or claim 2, further comprising a second type of cladding layer between the second type of conductive layer and the active light emitting layer.

12. The micro LED chip structure according to claim 11, further comprising an oxide layer within the second type of cladding layer.

13. The micro LED chip structure according to claim 11, further comprising an oxide layer between the second type of conductive layer and the second type of cladding layer.

14. The micro LED chip structure according to any one of claims 9, 10, 12, and 13, wherein material of the oxide layer is $Al_xOGa_{1-x}As$, and x is greater or equal to 0.9 and less than 1.

15. The micro LED chip according to claim 8, wherein material of the first type of cladding layer is AlInP.

16. The micro LED chip according to claim 11, wherein the second type of cladding layer includes one or more layers of AlInP, $Al_xGa_{1-x}InP$ (x is greater than 0 and less than 1), and GaInP.

Claims

1. A micro light emitting diode (LED) chip structure, comprising:

a semiconductor substrate;

an electrical contact layer on the semiconductor substrate;

a first-type conductive layer on the electrical contact layer;

an active light emitting layer on the first-type conductive layer; and

a second-type conductive layer on the active light emitting layer,

wherein a surface of the micro LED chip structure close to the second-type conductive layer is obtained after a substrate layer is removed.

2. The micro LED chip structure according to claim 1, wherein a surface of the second-type conductive layer is obtained after an organic material layer is removed.

3. The micro LED chip according to claim 2, wherein the organic material layer is an ultraviolet (UV) curable bonding layer.

4. The micro LED chip structure according to claim 1, wherein a thickness of the second-type conductive layer is smaller than a thickness of the first-type conductive layer.

5. The micro LED chip structure according to claim 1, further comprising a second-type spacer layer between the active light emitting layer and the second-type conductive layer,

wherein the second-type spacer layer is used for forming a PN junction structure with the active light emitting layer and the first-type conductive layer, and

wherein the second-type conductive layer includes one or more second-type conductive transition layers.

6. The micro LED chip structure according to claim 1, wherein the first-type conductive layer is an N-type layer and the second-type conductive layer is a P-type layer, or wherein the first-type conductive layer is a P-type layer and the second-type conductive layer is an N-type layer.

7. The micro LED chip structure according to claim 1, wherein the semiconductor substrate is an integrated circuits (IC) substrate.

8. The micro LED chip structure according to claim 1, wherein the electrical contact layer is a metal bonding layer, and wherein the semiconductor substrate and the first-type conductive layer are bonded together through a bonding process.

9. The micro LED chip structure according to claim 1, further comprising a first-type cladding layer between the first-type conductive layer and the active light emitting layer.

10. The micro LED chip structure according to claim 9, further comprising an oxide layer within the first-type cladding layer or between the first-type conductive layer and the first-type cladding layer.

11. The micro LED chip structure according to claim 10, wherein material of the oxide layer is $Al_xOGa_{1-x}As$, and x is greater than or equal to 0.9 and less than 1.

12. The micro LED chip structure of claim 1, further comprising a second-type cladding layer between the second-type conductive layer and the active light emitting layer.

13. The micro LED chip structure according to claim 12, further comprising an oxide layer within the second-type cladding layer or between the second-type conductive layer and the second-type cladding layer.

14. The micro LED chip structure according to claim 13, wherein material of the oxide layer is $Al_xOGa_{1-x}As$, and x is greater than or equal to 0.9 and less than 1.

15. The micro LED chip structure according to claim 1, wherein a ratio of a thickness of the second-type conductive layer to a thickness of the first-type conductive layer is 1.5 to 2.

16. The micro LED chip structure according to claim 12, wherein the second-type conductive layer includes one or more second-type conductive transition layers, and wherein a ratio of a thickness of the second-type cladding layer to a total thickness of the one or more second-type conductive transition layers is 1 to 2.5.

17. The micro LED chip structure according to claim 1, wherein the second-type conductive layer includes one or more second-type conductive transition layers,

wherein the one or more second-type conductive transition layers comprise sequentially a lower second-type conductive transition layer, a middle second-type conductive transition layer, and an upper second-type conductive transition layer in a direction from the semiconductor substrate to the first-type conductive layer, and

wherein a conductivity of the lower second-type conductive transition layer is less than that of the middle second-type conductive transition layer, and the conductivity of the middle second-type conductive transition layer is less than that of the upper second-type conductive transition layer.

18. An epitaxial structure for a micro light emitting diode (LED), comprising:

a semiconductor substrate;

an electrical conductive layer of a first conductivity type on the semiconductor substrate;

a cladding layer of the first conductivity type on the electrical conductive layer of the first conductivity type;

a first oxide layer within the cladding layer of the first conductivity type or between the electrical conductive layer of the first conductivity type and the cladding layer of the first conductivity type;

an active light emitting layer on the cladding layer of the first conductivity type;

a cladding layer of a second conductivity type on the active light emitting layer; and

an electrical conductive layer of the second conductivity type on the cladding layer of the second conductivity type.

19. An epitaxial structure for a micro LED according to claim 18, further comprising a second oxide layer within the cladding layer of the second conductivity type or between the cladding layer of the second conductivity type and the electrical conductive layer of the second conductivity type.

20. An epitaxial structure for a micro light emitting diode (LED), comprising:

a semiconductor substrate;

an electrical conductive layer of a first conductivity type on the semiconductor substrate;

a cladding layer of the first conductivity type on the electrical conductive layer of the first conductivity type;

an active light emitting layer on the cladding layer of the first conductivity type;

a cladding layer of a second conductivity type on the active light emitting layer;

an electrical conductive layer of the second conductivity type on the cladding layer of the second conductivity type; and

a first oxide layer within the cladding layer of the second conductivity type or between the cladding layer of the second conductivity type and the electrical conductive layer of the second conductivity type.