~~What is claimed is:~~Claims

~~1. A micro light - emitting diode (LED) pixel unit for a display panel, comprising:~~

~~a first color LED structure, formed on an IC substrate, wherein the first color LED structure includes a first light emitting layer, and a first reflective structure is formed on a bottom of the first light emitting layer;~~

~~a first dielectric bonding layer having a flat top surface, covering the first color LED structure;~~

~~a second color LED structure, formed on the flat top surface of the first dielectric bonding layer, wherein the second color LED structure includes a second light emitting layer, and a second reflective structure is formed on a bottom of the second light emitting layer;~~

~~a second dielectric bonding layer having a flat top surface, covering the second color LED structure;~~

~~a top electrode layer, covering the micro-LED pixel unit and electrically contacting with the first color LED structure and the second color LED structure; and~~

~~the IC substrate electrically connected with the first color LED structure and the second LED structure.~~

~~2. A micro-LED pixel unit, comprising:~~

~~a first color LED structure, formed on an IC substrate, wherein the first color LED structure includes a first light emitting layer, and a first reflective structure is formed on the bottom of the first light emitting layer;~~

~~a first dielectric bonding layer having a flat top surface, covering the first color LED structure;~~

~~a second color LED structure, formed on the flat top surface of the first dielectric bonding layer, wherein the second color LED structure includes a second light emitting layer, and a second reflective structure is formed on a bottom of the second light emitting layer;~~

~~a second dielectric bonding layer having a flat top surface, covering the second color LED structure;~~

a third color LED structure, formed on the flat top surface of the second dielectric bonding layer, wherein the third color LED structure includes a third light emitting layer, and a third reflective structure is formed on the bottom of the third light emitting layer;

a third dielectric bonding layer having a flat top surface, covering the third color LED structure;

a top electrode layer, covering the micro-LED pixel unit and electrically contacting with the first color LED structure, the second color LED structure and the third color LED structure; and

the IC substrate electrically connected with the first color LED structure, the second LED structure and the third LED structure.

3. The micro-LED pixel unit according to any one of claims 1-2, wherein the first dielectric bonding layer is transparent and the second dielectric bonding layer is transparent.

4. The micro-LED pixel unit according to any one of claims 2-3, wherein the first reflective structure includes at least one first high reflectivity layer, the second reflective structure includes at least one second high reflectivity layer, and the third reflective structure includes at least one third high reflectivity layer; and, the reflectivity of the first high reflectivity layer, the second high reflectivity layer or the third high reflectivity layer is above 60%.

5. The micro-LED pixel unit according to any one of claims 2-4, wherein a material of the first high reflectivity layer, the second high reflectivity layer or the third high reflectivity layer is metal selected from one or more of Rh, Al, Ag, and Au.

6. The micro-LED pixel unit according to any one of claims 2-5, wherein the first reflective structure includes at least two first high reflectivity layers which have different refractive indices; the second reflective structure includes at two second high reflectivity layers which have different refractive indices; and, the third reflective structure includes at two third high reflectivity layers which have different refractive indices.

7. The micro-LED pixel unit according to any one of claims 2-6, wherein the first reflective structure further includes a first transparent layer on the first high reflectivity layer; the second reflective structure further includes a second transparent layer on the second high

~~reflectivity layer; and, the third reflective structure further includes a second transparent layer on the third high reflectivity layer.~~

~~8. The micro-LED pixel unit according to any one of claims 2-7, wherein the first transparent layer is selected from one or more of ITO and SiO_2; the second transparent layer is selected from one or more of ITO and SiO_2; and, the third transparent layer is selected from one or more of ITO and SiO_2.~~

~~9. The micro-LED pixel unit according to any one of claims 2-8, wherein the first color LED structure further includes a first bottom electrode conductive contact layer, the second color LED structure further includes a second bottom electrode conductive contact layer, and the third color LED structure further includes a third bottom electrode conductive contact layer; the first bottom electrode conductive contact layer is electrically connected with the IC substrate by a first contact via at a bottom of the first bottom electrode conductive contact layer; the second bottom electrode conductive contact layer is electrically connected with the IC substrate by a second contact via through the first dielectric bonding layer; and, the third bottom electrode conductive contact layer is electrically connected with the IC substrate by a third contact via through the second dielectric layer and the first dielectric bonding layer.~~

~~10. The micro-LED pixel unit according to any one of claims 2-9, wherein the first bottom electrode conductive contact layer is transparent, the second bottom electrode conductive contact layer is transparent and the third bottom electrode conductive contact layer is transparent.~~

~~11. The micro-LED pixel unit according to any one of claims 2-10, wherein a first extended portion is extended from one side of the first light emitting layer; a second extended portion is extended from one side of the second light emitting layer; a third extended portion is extended from one side of the second light emitting layer; and, a top contact via connects the first extended portion, the second extended portion and the third extended portion to the top electrode layer through the second dielectric bonding layer and the third dielectric bonding layer.~~

~~12. The micro-LED pixel unit according to any one of claims 2-11, wherein a~~

micro-lens is formed on a top of the micro-LED pixel unit.

13. The micro-LED pixel unit according to claim 12, wherein a lateral dimension of the micro-lens is larger than an active emitting area of the first color LED structure; a lateral dimension of the micro-lens is larger than an active emitting area of the second color LED structure; and, a lateral dimension of the micro-lens is larger than an active emitting area of the third color LED structure.

14. The micro-LED pixel unit according to any one of claims 2-13, wherein lateral dimensions of the first color LED structure, the second color LED structure and the third color LED structure are the same.

15. The micro-LED pixel unit according to any one of claims 2-14, wherein the first LED structure, the second LED structure and the third LED structure have a same center axis.

16. The micro-LED pixel unit according to any one of claims 2-15, wherein the first dielectric bonding layer is transparent, the second dielectric bonding layer is transparent, and the third dielectric bonding layer is transparent.

17. The micro-LED pixel unit according to any one of claims 2-16, wherein a thickness of the first reflective structure is 5 nm to 10 nm; a thickness of the second reflective structure is 5 nm to 10 nm; a thickness of the third reflective structure is 5 nm to 10 nm; a thickness of the first LED structure is not more than 300 nm; a thickness of the second LED structure is not more than 300 nm; and, a thickness of the third LED structure is not more than 300 nm.

18. A micro-LED pixel unit, comprising:

a semiconductor substrate;

a light emitting region, formed on the semiconductor substrate, including at least one kind of LED structure and a bonding layer at a bottom of every LED structure, wherein each LED structure includes a light emitting layer and a bottom reflective structure at a bottom of the light emitting layer;

a top electrode layer, covering the micro-LED pixel unit and electrically contacting with every color LED structure, wherein the semiconductor substrate is electrically connected with every color LED structure;

a reflective cup structure, formed around the light emitting region; and,

a refractive structure, formed between the reflective cup structure and the light emitting region.

19. A micro-LED pixel unit, comprising:

a first color LED structure, formed on an IC substrate;

a first transparent dielectric bonding layer having a flat top surface, covering the first color LED structure;

a second color LED structure, formed on the flat top surface of the first transparent dielectric bonding layer;

a second transparent dielectric bonding layer having a flat top surface, covering the second color LED structure;

a third color LED structure, formed on the flat top surface of the second transparent dielectric bonding layer;

a third dielectric bonding layer having a flat top surface, covering the third color LED structure;

a top electrode layer, covering the micro-LED pixel unit and electrically contacting with the first color LED structure, the second color LED structure and the third color LED structure; and

the IC substrate electrically connected with the first color LED structure, the second LED structure and the third LED structure.

20. The micro-LED pixel unit according to claim 19, wherein a first reflective structure is formed at a bottom of the first color LED structure; a second reflective structure is formed at a bottom of the second color LED structure; and, a third reflective structure is formed at a bottom of the third color LED structure.

21. A micro-LED pixel unit, comprising:

an IC substrate;

a light emitting region, formed on the IC substrate, including at least one kind of LED structure and at least a dielectric bonding layer, wherein each of the dielectric bonding layer have a flat top surface covering a surface of every LED structure;

a top electrode layer, covering the micro-LED pixel unit and electrically contacting with the every color LED structure, wherein the IC substrate is electrically connected with every color LED structure; and,

a stair-shaped reflective cup structure having a cavity, surrounding the light emitting region.

22. A micro-LED pixel unit, comprising:

a semiconductor substrate;

a light emitting region, formed on the semiconductor substrate;

a reflective optical isolation structure, formed around the light emitting region; and,

a refractive structure, formed between the reflective optical isolation structure and the light emitting region.

23. A micro-LED pixel unit, comprising:

a semiconductor substrate;

a light emitting region, formed on the semiconductor substrate, including at least one kind of LED structure and at least a transparent dielectric bonding layer, wherein each of the transparent dielectric bonding layer having a flat top surface covering a surface of every LED structure;

a top electrode layer, covering the micro-LED pixel unit and electrically contacting with every color LED structure, wherein the IC substrate is electrically connected with every color LED structure;

a stair-shaped reflective cup structure, formed around the light emitting region; and,

a refractive structure, formed between the stair-shaped reflective cup structure and the light emitting region.

24. The micro-LED pixel unit according to claim 23, wherein a micro-lens is

formed on a top of the micro-LED pixel unit.

25. The micro-LED pixel unit according to claim 24, wherein the stair-shaped reflective cup structure has a top opening, the lateral area of the micro-lens is less than that of the top opening.

26. A micro-LED pixel unit, at least comprising,

a semiconductor substrate;

a light emitting region, formed on the semiconductor substrate; and,

a reflective optical isolation structure, formed around the light emitting region, wherein the top of the reflective optical isolation structure is higher than the top of the light emitting region.

27. The micro-LED pixel unit according to claim 26, further comprising a micro-lens above the top of the light emitting region.

28. The micro-LED pixel unit according to any one of claims 26-27, wherein the top of the reflective optical isolation structure is higher than that of the micro-lens.

29. The micro-LED pixel unit according to any one of claims 26-28, wherein the reflective optical isolation structure has a top opening, the lateral area of the micro-lens is less than that of the top opening.

30. A micro-LED pixel unit, comprising,

a semiconductor substrate;

a light emitting region, formed on the semiconductor substrate;

a floating reflective optical isolation structure, surrounding the light emitting region, wherein the floating reflective optical isolation structure is positioned at a distance above the semiconductor substrate.

31. A micro-LED pixel unit, comprising:

a semiconductor substrate;

a light emitting region, formed on the semiconductor substrate;

a reflective optical isolation structure, surrounding the light emitting region;

a top electrode layer, covering the light emitting region and electrically connecting the reflective optical isolation structure, wherein the top electrode layer electrically contacts the reflective optical isolation structure.

32. The micro-LED pixel unit according to claim 31, wherein an edge of the top electrode layer touches the reflective optical isolation structure.

33. The micro-LED pixel unit according to any one of claims 31-32, wherein the light emitting region includes: at least one kind of LED structure and at least a dielectric bonding layer; a top electrode layer, covering the micro-LED pixel unit and electrically contacting with every color LED structure, wherein the semiconductor substrate is electrically connected with every color LED structure.

34. The micro-LED pixel unit according to any one of claims 31-33, wherein the reflective optical isolation structure is a floating reflective structure.

35. The micro-LED pixel unit according to any one of claims 31-34, wherein the reflective optical isolation structure is a stair-shaped reflective cup structure.

36. A micro-LED pixel unit, at least comprising,

a semiconductor substrate;

a light emitting region, formed on the semiconductor substrate;

a floating reflective optical isolation structure, surrounding the light emitting region, wherein the floating reflective optical isolation structure is positioned at a distance above the semiconductor substrate; and

a top electrode layer, formed on top of the light emitting region, wherein the top electrode layer contacts with the floating reflective optical isolation structure.

37. The micro-LED pixel unit according to claim 36, wherein the light emitting region includes at least one kind of LED structure and a bonding layer at a bottom of each LED structure.

38. A micro-LED pixel unit, comprising,

a semiconductor substrate;

a light emitting region, formed on the semiconductor substrate;

a top electrode layer, covering the light emitting region and electrically contacting with the light emitting region;

a reflective cup structure, formed around the light emitting region, wherein the top electrode layer is electrically connected with the reflective cup structure;

the semiconductor substrate is electrically connected with the reflective cup structure; and,

a refractive structure, formed between the reflective cup structure and the light emitting region.

39. A micro-LED pixel unit, comprising:

a semiconductor substrate;

a light emitting region, formed on the semiconductor substrate, including at least one kind of LED structure and a bonding layer at the bottom of every LED structure, wherein the LED structure includes a light emitting layer and a reflective structure at the bottom of the light emitting layer;

a top electrode layer, covering the LED structure pixel unit and electrically contacting with every color LED structure, wherein the semiconductor substrate is electrically connected with every color LED structure; and,

a stair-like reflective cup structure, wherein the top of the stair-like reflective cup structure is higher than the top of the light emitting region.

40. A micro-LED pixel unit, comprising:

a semiconductor substrate;

a light emitting region, formed on the semiconductor substrate, including at least one kind of LED structure and a bonding layer at a bottom of every LED structure, wherein the LED structure includes a light emitting layer and a reflective structure at a bottom of the light emitting layer;

a top electrode layer, covering the micro-LED pixel unit and electrically contacting with every color LED structure, wherein the semiconductor substrate is electrically connected with every color LED structure; and,

~~a floating reflective cup structure, surrounding the light emitting region, the floating reflective cup structure is positioned a distance from the semiconductor substrate.~~

~~41. The micro-LED pixel unit according to claim 40, wherein a bottom of the floating reflective cup structure is higher than a top surface of the semiconductor substrate.~~

~~42. The micro-LED pixel unit according to any one of claims 40-41, wherein the floating reflective cup structure is a stair-shaped reflective cup structure.~~

~~43.~~1. A micro-LED pixel unit for a display panel, comprising:

a first LED structure that emits a first color, formed on an IC substrate;

a first transparent dielectric bonding layer having a first flat top surface, covering the first LED structure;

a second LED structure that emits a second color, formed on the first flat top surface of the first transparent dielectric bonding layer;

a second transparent dielectric bonding layer having a second flat top surface, covering the second LED structure; and

a top electrode layer, covering the micro-LED pixel unit and electrically contacting with the first LED structure and the second LED structure;

wherein the IC substrate is electrically connected with the first LED structure and the second LED structure~~.~~

~~The micro-LED pixel unit according to claim 43~~, and

~~44.~~ wherein the first LED structure is embedded within a first planarized transparent dielectric layer.

~~45.~~2. The micro-LED pixel unit according to claim ~~44~~1, wherein the first planarized transparent dielectric layer is composed of solid inorganic materials or plastic materials.

~~46.~~3. The micro-LED pixel unit according to ~~any one of claims 43-45~~ claim 1, wherein the second LED structure is embedded within a second planarized transparent dielectric layer.

~~47.~~4. The micro-LED pixel unit according to claim ~~46~~3, wherein the second planarized transparent dielectric layer is composed of solid inorganic materials or plastic materials.

~~48.~~5. The micro-LED pixel unit according to ~~any one of claims 43-47~~ claim 1, wherein the first transparent dielectric bonding layer is composed of solid inorganic materials or plastic materials.

~~49.~~6. The micro-LED pixel unit according to ~~any one of claims 43-48~~ claim 1, wherein:

the first LED structure includes a first bottom electrode conductive contact layer formed on a bottom of the first LED structure;

the second LED structure includes a second bottom electrode conductive contact layer formed on a bottom of the second LED structure;

the first bottom electrode conductive contact layer is electrically connected with the IC substrate by a first contact in a first via at a bottom of the first bottom electrode conductive contact layer; and

the second bottom electrode conductive contact layer is electrically connected with the IC substrate by a second contact in a second via through the first transparent dielectric bonding layer.

~~50.~~7. The micro-LED pixel unit according to ~~any one of claims 43-49~~ claim 6, wherein the first bottom electrode conductive contact layer is transparent, and the second bottom electrode conductive contact layer is transparent.

~~51.~~8. The micro-LED pixel unit according to ~~any one of claims 43-50~~ claim 1, wherein:

the first LED structure includes a first light emitting layer;

a first side portion is extended from a side of the first light emitting layer;

the second LED structure includes a second light emitting layer;

a second side portion is extended from a side of the second light emitting layer; and

a third contact in a third via connects the first side portion and the second side portion to the top electrode layer through the second transparent dielectric bonding layer.

~~52.~~9. The micro-LED pixel unit according to ~~any one of claims 43-51~~ claim 1, wherein an optical isolation structure is formed around the micro-LED pixel unit.

~~53.~~10. The micro-LED pixel unit according to ~~any one of claims 43-52~~ claim 1, wherein the optical isolation structure is a reflective cup.

~~54.~~11. The micro-LED pixel unit according to ~~any one of claims 43-53~~ claim 1, wherein lateral dimension of the first LED structure is the same as that of the second LED structure.

~~55.~~12. The micro-LED pixel unit according to ~~any one of claims 43-54~~ claim 1, wherein the first LED structure and the second LED structure have a same central axis.

~~56.~~13. The micro-LED pixel unit according to ~~any one of claims 43-55~~ claim 1, wherein a first reflective ~~layer~~ structure is formed at a bottom of the first LED structure; and a second reflective ~~layer~~ structure is formed at a bottom of the second LED structure.

~~57. The micro-LED pixel unit according to any one of claims 43-56, wherein:~~

~~a thickness of the first reflective layer is 5 to 10 nm;~~

~~a thickness of the second reflective layer is 5 to 10 nm;~~

~~a thickness of the first LED structure is not more than 300 nm; and,~~

~~a thickness of the second LED is not more than 300 nm.~~

~~58. The micro-LED pixel unit according to any one of claims 43-57, wherein a bonding metal layer is formed at a bottom of the first LED structure.~~

~~59. A micro-light emitting diode (LED) pixel unit, comprising,~~

~~a first color LED structure, formed on an IC substrate, wherein the first color LED structure includes a first light emitting layer, and a first reflective structure is formed on a bottom of the first light emitting layer;~~

~~a first bonding metal layer, formed at a bottom of the first color LED structure, and configured to bond the IC substrate and the first color LED structure;~~

~~a second bonding layer, formed on a top of the first color LED structure;~~

~~a second color LED structure, formed on the second bonding layer, wherein the second color LED structure includes a second light emitting layer, and a second reflective structure is formed on a bottom of the second light emitting layer;~~

~~a top electrode layer, covering the first color LED structure and the second color LED structure and electrically contacting with the first color LED structure and the second color LED structure, wherein the IC substrate is electrically connected with the first color LED structure and the second color LED structure; and~~

~~a reflective cup, surrounding the first color LED structure and the second color LED structure.~~

~~60. The micro-LED pixel unit according to claim 59, wherein the first reflective structure includes at least one first reflective layer and the second reflective structure includes at least one second reflective layer, reflectivity of the first reflective layer or the second reflective layer being above 60%.~~

~~61. The micro-LED pixel unit according to any one of claims 59-60, wherein a material of the first reflective layer or the second reflective layer comprises one or more of Rh, Al, Ag, or Au.~~

~~62.~~14. The micro-LED pixel unit according to ~~any one of claims 59-61~~ claim 13, wherein the first reflective structure includes two first reflective layers and refractive indices of the two first reflective layers are different, and wherein the second reflective structure includes two second reflective layers and refractive indices of the two second reflective layers are different.

~~63.~~15. The micro-LED pixel unit according to claim ~~62~~14, wherein the two first reflective layers comprise SiO_2 and Ti_3O_5 respectively, and the two second reflectivity layers comprise SiO_2 and Ti_3O_5 respectively.

~~64.~~16. The micro-LED pixel unit according to ~~any one of claims 59-63~~ claim 13, wherein the first reflective structure further includes a first transparent layer on the first reflective layer, and the second reflective structure further includes a second transparent layer

on the second reflective layer.

~~65.~~17. The micro-LED pixel unit according to claim ~~64~~16, wherein the first transparent layer comprises one or more of indium tin oxide (ITO) or SiO_2, and the second transparent layer comprises one or more of ITO or SiO_2.

~~66. The micro-LED pixel unit according to any one of claims 59-65, wherein the first color LED structure further includes a first bottom conductive contact layer, the second color LED structure further includes a second bottom conductive contact layer; the first bottom conductive contact layer is electrically connected with the IC substrate by a first contact via at the bottom of the first bottom conductive contact layer; the second bottom conductive contact layer is electrically connected with the IC substrate by a second contact via through the first dielectric bonding layer.~~

~~67. The micro-LED pixel unit according to any one of claims 59-65, wherein the first color LED structure further includes a first bottom conductive contact layer and a first top conductive contact layer, and the second color LED structure further includes a second bottom conductive contact layer and a second top conductive contact layer;~~

~~wherein the first light emitting layer is between the first bottom conductive contact layer and the first top conductive contact layer, and the second light emitting layer is between the second bottom conductive contact layer and the second top conductive contact layer;~~

~~wherein the first bottom conductive contact layer is electrically connected with the IC substrate through the first reflective structure and the first bonding metal layer through a first contact via, and the second bottom conductive contact layer is electrically connected with the IC substrate through a second contact via; and~~

~~wherein an edge of the first top conductive contact layer is in contact with the top electrode layer, and a top surface of the second top conductive contact layer is in contact with the top electrode layer.~~

~~68. The micro-LED pixel unit according to any one of claims 59-67, wherein a material of the reflective cup comprises metal.~~

~~69. The micro-LED pixel unit according to any one of claims 59-68, further~~

~~comprising a micro-lens formed above the top electrode layer.~~

~~70. The micro-LED pixel unit according to claim 69, further comprising a spacer formed between the micro-lens and the top electrode layer.~~

~~71. The micro-LED pixel unit according to claim 70, wherein a material of the spacer comprises silicon oxide.~~

~~72. The micro-LED pixel unit according to any one of claims 59-71, wherein a lateral dimension of the micro-lens is larger than that of an active emitting area of the first LED structure; and the lateral dimension of the micro-lens is larger than that of an active emitting area of the second LED structure.~~

~~73. The micro-LED pixel unit according to any one of claims 59-72, wherein the first color LED structure and the second color LED structure have a same lateral dimension.~~

~~74. The micro-LED pixel unit according to any one of claims 59-73, wherein the first color LED structure and the second color LED structure have a same center axis.~~

~~75.~~18. The micro-LED pixel unit according to ~~any one of claims 60-64~~ claim 13, wherein:

a thickness of the ~~at least one~~ first reflective ~~layer~~ structure is ~~in a range of~~ 5 ~~nm~~ to 10 nm~~,~~; and

a thickness of the ~~at least one~~ second reflective ~~layer~~ structure is ~~in a range of~~ 5 ~~nm~~ to 10 nm~~, and wherein a thickness of the first color LED structure is not more than 300 nm, and a thickness of the second color LED structure is not more than 300 nm~~.

19. The micro-LED pixel unit according to claim 1, wherein:

a thickness of the first LED structure is not more than 300 nm; and

a thickness of the second LED structure is not more than 300 nm.

20. The micro-LED pixel unit according to claim 1, wherein a bonding metal layer is formed at a bottom of the first LED structure.

~~76. A micro-LED pixel unit, comprising,~~

~~an IC substrate;~~

a light emitting region, formed on the IC substrate, including a plurality of color LED structures, a bottom of each of the plurality of color LED structures being connected to a corresponding bonding layer in the light emitting region, wherein each of the plurality of color LED structures includes a light emitting layer and a reflective structure at a bottom of the light emitting layer;

a top electrode layer, covering each of the plurality of color LED structures and electrically contacting to each of the plurality of color LED structures, wherein the IC substrate is electrically connected with each of the plurality of color LED structures; and,

a stair-shaped reflective cup forming a cavity, surrounding the light emitting region.

77. The micro-LED pixel unit according to claim 76, wherein an inner sidewall of the cavity includes a plurality of inclined surfaces.

78. The micro-LED pixel unit according to claim 77, wherein angles of the plurality of inclined surfaces relative to surface of the IC substrate from bottom to top of the cavity become smaller.

79. The micro-LED pixel unit according to any one of the claims 77-78, wherein sub-cavities formed by the plurality of inclined surfaces have different dimensions in the horizontal direction.

80. The micro-LED pixel unit according to claim 79, wherein inner sidewalls of the sub-cavities are not arranged in a same plane.

81. The micro-LED pixel unit according to any one of the claims 79-80, wherein heights of the sub-cavities are different.

82. The micro-LED pixel unit according to any one of the claims 79-81, wherein a height of a sub-cavity in middle of the cavity is less than heights of other sub-cavities.

83. The micro-LED pixel unit according to any one of the claims 79-82, wherein a height of a sub-cavity at top of the cavity is larger than a height of a sub-cavity at bottom of the cavity.

84. The micro-LED pixel unit according to any one of the claims 76-83, wherein the plurality of color LED structures further includes a top color LED structure.

85. The micro-LED pixel unit according to claim 84, wherein a top of the cavity is higher than a top of the top color LED structure.

86. The micro-LED pixel unit according to any one of the claims 76-85, wherein the cavity includes a plurality of sub-cavities, and each of the plurality of color LED structures is in a respectively different one of the sub-cavities.

87. The micro-LED pixel unit according to any one of the claims 76-86, further comprising a transparent dielectric bonding layer covering at least one of the plurality of color LED structures, wherein the transparent dielectric bonding layer comprises solid inorganic materials or plastic materials.

88. The micro-LED pixel unit according to claim 87, wherein the solid inorganic materials comprise one or more materials selected from the group consisting of SiO_2, Al_2O_3, Si_3N_4, Phosphosilicate glass (PSG), and Borophosphosilicate glass (BPSG).

89. The micro-LED pixel unit according to any one of the claims 87-88, wherein the plastic materials comprise one or more polymers selected from the group consisting of SU-8, PermiNex, Benzocyclobutene (BCB), and spin-on glass (SOG).

90. The micro-LED pixel unit according to any one of the claims 84-89, wherein each of the plurality of color LED structures includes a bottom conductive contact layer and a top conductive contact layer, and the light emitting layer is formed between the bottom conductive contact layer and the top conductive contact layer; and wherein

the bottom conductive contact layer is electrically connected with the IC substrate through the reflective structure and the corresponding bonding layer through a contact via, and

a top surface of the top conductive contact layer of the top color LED structure is in contact with the top electrode layer, and an edge of the top conductive contact layer of a color LED structure under the top color LED structure is in contact with the top electrode layer.

91. The micro-LED pixel unit according to any one of the claims 84-90, wherein an extended portion is extended from one side of the light emitting layer of a color LED structure under the top color LED structure, a contact via connecting the extended portion to the top

electrode layer.

92. The micro-LED pixel unit according to any one of the claims 84-91, wherein a lateral dimension of a micro-lens on top of the top electrode layer is larger than a light emitting dimension of each of the plurality of color LED structures.

93. The micro-LED pixel unit according to any one of the claims 76-92, wherein the plurality of color LED structures have a same center axis.

94. The micro-LED pixel unit according to any one of the claims 76-93, wherein the reflective structure includes a reflective layer and a thickness of the reflective layer is in a range of 5 nm to 10 nm, and a thickness of each of the plurality of color LED structures is not more than 300 nm.

95. The micro-LED pixel unit according to any one of the claims 76-94, wherein a material of the top electrode layer is selected from the group consisting of graphene, Indium tin oxide (ITO), Aluminum-Doped Zinc Oxide (AZO), and Fluorine doped Tin Oxide (FTO).

96. A micro-LED pixel unit, comprising,

a semiconductor substrate;

a light emitting region, formed on the semiconductor substrate, including a plurality of color LED structures, a bottom of each of the plurality of color LED structures being connected to a corresponding bonding layer in the light emitting region, wherein each of the plurality of color LED structure includes a light emitting layer and a reflective structure at a bottom of the light emitting layer;

a top electrode layer, covering each of the plurality of color LED structures and electrically contacting with each of the plurality of color LED structures, wherein the semiconductor substrate is electrically connected with each of the plurality of color LED structures;

a reflective cup, surrounding the light emitting region; and

a refractive structure, formed between the reflective cup and the light emitting region.

97. The micro-LED pixel unit according to claim 96, further comprising a micro-lens formed on a top surface of the refractive structure.

98. The micro-LED pixel unit according to claim 97, wherein a lateral dimension of the micro-lens is not less than a lateral dimension of the light emitting region.

99. The micro-LED pixel unit according to any one of the claims 97-98, wherein the reflective cup has a top opening area, and a lateral dimension of the micro-lens is less than a lateral dimension of the top opening area.

100. The micro-LED pixel unit according to any one of the claims 96-99, further comprising a bottom dielectric layer formed between a bottom of the reflective cup and the semiconductor substrate.

101. The micro-LED pixel unit according to any one of the claims 96-100, further comprising a top conductive layer formed on a top of the light emitting region, and the top conductive layer is electrically connected with the reflective cup.

102. The micro-LED pixel unit according to claim 101, wherein the top conductive layer directly contacts with a top of the reflective cup or a bottom of the reflective cup.

103. The micro-LED pixel unit according to any one of the claims 96-102, wherein a top of the refractive structure is higher than a top of the reflective cup.

104. The micro-LED pixel unit according to any one of the claims 96-103, wherein the semiconductor substrate is an IC substrate.

105. The micro-LED pixel unit according to any one of the claims 96-104, wherein the reflective cup is a stair- shaped reflective cup forming a cavity encompassing the light emitting region.

106. The micro-LED pixel unit according to claim 105, wherein sub-cavities formed by a plurality of inclined surfaces within the stair-shaped reflective cup have different dimensions in a horizontal direction.

107. The micro-LED pixel unit according to any one of the claims 96-106, wherein each of the plurality of color LED structures includes a respective extended portion extended from one side of the respective color LED structure, and the respective extended portion is electrically connected with the top electrode layer via a respective first contact via, and the bottom of each of the plurality of color LED structures is electrically connected with the

~~semiconductor substrate via a respective second contact via.~~

~~108. A micro-LED pixel unit, comprising,~~

~~a semiconductor substrate;~~

~~a light emitting region, formed on the semiconductor substrate, including a plurality of color LED structures, a bottom of each of the plurality of color LED structures being connected to a corresponding bonding layer in the light emitting region, wherein each of the plurality of color LED structures includes a light emitting layer and a reflective structure at a bottom of the light emitting layer;~~

~~a top electrode layer, covering each of the plurality of color LED structures and electrically contacting with each of the plurality of color LED structures, wherein the semiconductor substrate is electrically connected with each of the plurality of color LED structures; and~~

~~a reflective cup, surrounding the light emitting region, a top of the reflective cup being higher than a top of the light emitting region.~~

~~109. The micro-LED pixel unit according to claim 108, further comprising a micro-lens formed above the light emitting region.~~

~~110. The micro-LED pixel unit according to claim 109, wherein the top of the reflective cup is higher than a top of the micro-lens.~~

~~111. The micro-LED pixel unit according to any one of the claims 109-110, further comprising a refractive structure at a bottom of the micro-lens and formed between the reflective cup and the light emitting region.~~

~~112. The micro-LED pixel unit according to any one of the claims 108-111, wherein a bottom of the light emitting region is electrically connected with the semiconductor substrate.~~

~~113. A micro-LED pixel unit, comprising,~~

~~a semiconductor substrate;~~

~~a light emitting region, formed on the semiconductor substrate, including a plurality of color LED structures, a bottom of each of the plurality of color LED structures being connected to a corresponding bonding layer in the light emitting region, wherein each of the~~

plurality of color LED structures includes a light emitting layer and a reflective structure at a bottom of the light emitting layer;

a top electrode layer, covering each of the plurality of color LED structures and electrically contacting with each of the plurality of color LED structures, wherein the semiconductor substrate is electrically connected with each of the plurality of color LED structures; and

a floating reflective cup, surrounding the light emitting region, wherein a bottom of the floating reflective cup is above the semiconductor substrate.

114. The micro-LED pixel unit according to claim 113, wherein the bottom of the floating reflective cup is higher than a top surface of the corresponding bonding layer at a bottom of one of the plurality of color LED structures.

115. The micro-LED pixel unit according to any one of the claims 113-114, wherein the floating reflective cup is stair-shaped.

116. The micro-LED pixel unit according to any one of the claims 113-115, wherein a top of the floating reflective cup is higher than a top of the micro-lens.

117. The micro-LED pixel unit according to any one of the claims 114-116, further comprising a refractive structure at a bottom of the micro-lens and formed between the floating reflective cup and the light emitting region.

118. The micro-LED pixel unit according to any one of the claims 114-117, wherein the floating reflective cup has a top opening area, and a lateral dimension of the micro-lens is less than a lateral dimension of the top opening area.

119. The micro-LED pixel unit according to any one of the claims 113-118, further comprising a bottom dielectric layer formed between the floating reflective cup and the semiconductor substrate.

120. The micro-LED pixel unit according to any one of the claims 113-119, wherein the top electrode layer directly contacts a top of the floating reflective cup or the bottom of the floating reflective cup.

121. The micro-LED pixel unit according to any one of the claims 113-120, wherein

~~the floating reflective cup is a stair-shaped floating reflective cup that forms a cavity encompassing the light emitting region.~~

~~122. The micro-LED pixel unit according to any one of the claims 113-121, wherein a material of the floating reflective cup comprises metal.~~

~~123. The micro-LED pixel unit according to any one of the claims 113-122, wherein the reflective structure includes a reflective layer formed at the bottom of each of the plurality of color LED structures respectively.~~

~~124. The micro-LED pixel unit according to any one of the claims 113-123, wherein a thickness of the reflective layer is in a range of 5 nm to 10 nm, and a thickness of each of the plurality of color LED structures is not more than 300 nm.~~