Claims

1. A photodetector comprising:

a first layer (102) comprising a first semiconductor material having a first band gap energy (206) adapted to absorb light of wavelength within an intended range; and

a second layer (104) interfaced with an adjacent side of the first layer (102), the second layer (104) comprising a second semiconductor material having a second band gap energy (208) higher than the first band gap energy (206);

wherein a distribution of a doping concentration in at least one of the first layer (102), the second layer (104) and a region between the first and second layers is such that a non-zero electric field established within the second layer (104) is smaller than an electric field established within the first layer (102) under a same reverse bias condition.

2. A photodetector according to claim 1, wherein:

the doping concentration is such that at least a portion of the first layer (102) is substantially in a depleted state under said reverse bias condition; and/or

the doping concentration in the second layer (104) is higher than the doping concentration in the first layer (102).

3. A photodetector according to claim 1 or claim 2, wherein:

the doping concentration in a region of the first layer (102) adjacent to the second layer (104) is higher than the doping concentration in a substantial part of the first layer (102) outside said region of the first layer (102); or

the doping concentration in a region of the second layer (104) adjacent to the first layer (102) is higher than the doping concentration in a substantial part of the second layer (104) outside said region of the second layer (104).

4. A photodetector according to any one of claims 1 to 3, wherein the second semiconductor material is a lightly *n*-type doped semiconductor material.

5. A photodetector according to any one of claims 1 to 4, wherein the first band gap energy (206) and the second band gap energy (208) are substantially uniform along a thickness of the first layer (102) and the second layer (104).

6. A photodetector according to any one of claims 1 to 5, further comprising:

a third layer (105) interfacing the first layer (102) with the second layer (104), the third layer (105) comprising a third semiconductor material having a graded band gap energy along a thickness of the third layer (105).

7. A photodetector according to claim 6, wherein the graded band gap energy increases from a value substantially equal to the first band gap energy (206), at a side of the third layer (105) facing the first layer (102), to a value substantially equal to the second band gap energy (208), at a side of the third layer (105) facing the second layer (104).

8. A photodetector according to claim 6 or claim 7, wherein:

the third semiconductor material has a graded composition that gradually varies from a composition substantially equal to the first semiconductor material, at the side of the third layer (105) facing the first layer (102), to a composition substantially equal to the second semiconductor material, at the side of the third layer (105) facing the second layer (104); and/or

the third semiconductor material comprises a region doped with a dopant of a same type as the dopant of the second layer (104).

9. A photodetector according to any one of claims 5 to 8, wherein said third layer (105) is comprised in the second layer (104) and/or in the first layer (102), the third layer (105) being provided at an end side of the second layer (104) and/or of the first layer (102).

10. A photodetector according to claim any one of claims 1 to 9, further comprising:

a first ohmic contact (114) adapted to be coupled to an external electrical circuit; and

a fourth layer (110) disposed between the first ohmic contact (114) and an adjacent side of the first layer (102) opposite to the second layer (104), the fourth layer (110) comprising a fourth semiconductor material having a fourth band gap energy and a fourth doping concentration;

wherein the fourth layer (110) is adapted to serve as a current spreading layer for facilitating extraction of a transport current from the first layer (102) into the first ohmic contact (114).

11. A photodetector according to claim 10, wherein the fourth band gap energy is higher than the first band gap energy (206) such that the fourth layer (110) is a window layer.

12. A photodetector according to claim any one of claims 1 to 11, further comprising:

a second ohmic contact (120) adapted to be coupled to an external electrical circuit; and

Claims

1. A photodetector comprising:

a first layer (102) comprising a first semiconductor material having a first band gap energy (206) adapted to absorb light of wavelength within an intended range; and a second layer (104) interfaced with an adjacent side of the first layer (102), the second layer (104) comprising a second semiconductor material having a second band gap energy (208) higher than the first band gap energy (206);

wherein a distribution of a doping concentration in at least one of the first layer (102), the second layer (104) and a region between the first and second layers is such that a non-zero electric field established within the second layer (104) is smaller than an electric field established within the first layer (102) under a same reverse bias condition

wherein the first semiconductor material comprises a GaAs compound and the second semiconductor material comprises an AlGaAs compound.

2. The photodetector according to claim 1, wherein:

the doping concentration is such that at least a portion of the first layer (102) is substantially in a depleted state under said reverse bias condition; and/or

the doping concentration in the second layer (104) is higher than the doping concentration in the first layer (102).

3. The photodetector according to claim 1 or claim 2, wherein:

the doping concentration in a region of the first layer (102) adjacent to the second layer (104) is higher than the doping concentration in a substantial part of the first layer (102) outside said region of the first layer (102); or

the doping concentration in a region of the second layer (104) adjacent to the first layer (102) is higher than the doping concentration in a substantial part of the second layer (104) outside said region of the second layer (104).

4.The photodetector according to any one of claims 1 to 3, wherein the second semiconductor material is a lightly n-type doped semiconductor material.

5. The photodetector according to any one of claims 1 to 4, wherein the first band gap energy (206) and the second band gap energy (208) are substantially uniform along a thickness of the first layer (102) and the second layer (104).

6.The photodetector according to any one of claims 1 to 5, further comprising:

a third layer (105) interfacing the first layer (102) with the second layer (104), the third layer (105) comprising a third semiconductor material having a graded band gap energy along a thickness of the third layer (105).

7. The photodetector according to claim 6, wherein the graded band gap energy increases from a value substantially equal to the first band gap energy (206), at a side of the third layer (105) facing the first layer (102), to a value substantially equal to the second band gap energy (208), at a side of the third layer (105) facing the second layer (104).

8. A photodetector according to claim 6 or claim 7, wherein:

the third semiconductor material has a graded composition that gradually varies from a composition substantially equal to the first semiconductor material, at the side of the third layer (105) facing the first layer (102), to a composition substantially equal to the second semiconductor material, at the side of the third layer (105) facing the second layer (104); and/or

the third semiconductor material comprises a region doped with a dopant of a same type as the dopant of the second layer (104).

9. The photodetector according to any one of claims 6 to 8, wherein said third layer (105) is comprised in the second layer (104) and/or in the first layer (102), the third layer (105) being provided at an end side of the second layer (104) and/or of the first layer (102).

10. The photodetector according to claim any one of claims 1 to 9, further comprising:

a first ohmic contact (114) adapted to be coupled to an external electrical circuit; and a fourth layer (110) disposed between the first ohmic contact (114) and an adjacent side of the first layer (102) opposite to the second layer (104), the fourth layer (110) comprising a fourth semiconductor material having a fourth band gap energy and a fourth doping concentration;

wherein the fourth layer (110) is adapted to serve as a current spreading layer for facilitating extraction of a transport current from the first layer (102) into the first ohmic contact (114).

11. The photodetector according to claim 10, wherein the fourth band gap energy is higher than the first band gap energy (206) such that the fourth layer (110) is a window layer. 12. A photodetector according to claim any one of claims 1 to 11, further comprising:

a second ohmic contact (120) adapted to be coupled to an external electrical circuit; and

a fifth layer (116) being disposed between the second ohmic contact (120) and an adjacent side of the second layer (104) opposite to the first layer (102), the fifth layer (116) comprising a fifth semiconductor material having a fifth band gap energy and a fifth doping concentration;

wherein the fifth layer (1 16) is adapted to serve as a current spreading layer for facilitating extraction of a transport current from the second layer (104) into the second ohmic contact (120).

13. The photodetector according to any one of claims 10 to 12, wherein at least one of the first and the second ohmic electrodes has a ring shape.

14. The photodetector according to claim any one of claims 1 to 13, further comprising:

a seventh layer (122) disposed between the second layer (104) and the fifth layer (116), the seventh layer (122) comprising a seventh semiconductor material having a seventh band gap energy and a seventh doping concentration,

wherein the seventh band gap energy is higher than the second band gap energy (208) and the fifth band gap energy such that the flow of minority carriers across the seventh layer (122) is blocked.

15. The photodetector according to any of claims 11 to 14, further comprising a barrier layer (122) disposed between the drift layer (104) and the n-side spreading layer (116);

wherein the band gap energy of the barrier layer (122) is larger than both the band gap energy of the adjacent drift layer (104) and the n-side current spreading layer (116); and`

wherein the barrier layer is made of an n-doped AlGaAs compound with a thickness of 20 nm.

16. The photodetector according to any of claims 1 to 15 wherein the light absorption layer (102) further comprising an intrinsic GaAs semiconductor material, the drift layer (104) further comprising an intrinsic or lightly n-doped AlGaAs compound and the grading layer (105) further comprising a lightly n-doped $Al_xGai_{-x}As$ compound with a graded concentration x of aluminium;

wherein concentration x adopts a value of substantially zero (GaAs), at the side directly adjacent to the light absorption layer (102), and gradually increases across the grading layer (105) towards the side directly adjacent to the drift layer (104) wherein the concentration x of the $Al_xGa_{1-x}As$ compound of the grading layer (105) directly adjacent to the drift layer (104) is similar to the x concentration of the $Al_xGa_{1-x}As$ compound used for the drift layer (104).