

What is claimed is:

1. An image sensor comprising:

a substrate, the substrate including a unit pixel region, the unit pixel region including a pixel transistor formation region and at least one pixel region, the substrate including a first surface and a second surface, the first surface and the second surface facing each other, the second surface configured to be a light-incident surface;

a first semiconductor photoelectric conversion element inside the substrate such that the first semiconductor photoelectric conversion element is at least partially enclosed by the substrate;

an organic photoelectric conversion element on the second surface of the substrate;

a first floating diffusion region on the first surface of the substrate;

a first transfer transistor having a first end connected to the first semiconductor photoelectric conversion element and a second end connected to the first floating diffusion region; and

a second transfer transistor having a first end connected to the organic photoelectric conversion element and a second end connected to the first floating diffusion region,

wherein the at least one pixel region includes a first pixel region, and the first semiconductor photoelectric conversion element, the first floating diffusion region, and the first transfer transistor and the second transfer transistor are in the first pixel region.

2. The image sensor of claim 1, further comprising:

a first penetration electrode connected to the organic photoelectric conversion element, the first penetration electrode including at least a first portion and a second portion, the first portion of the first penetration electrode extending from the first surface of the substrate to the second surface of the substrate;

a first contact extending from the first surface of the substrate in a first direction, the first contact including a first surface and a second surface, the second surface of the first contact facing the first surface of the first contact, the second surface of the first contact is in contact with the first penetration electrode; and

a second contact extending from the first surface of the substrate in the first direction, the second contact including a third surface and a fourth surface, the fourth surface facing the third surface, the fourth surface in contact with a source region of the second transfer transistor,

wherein the first direction is a direction extending from the second surface of the substrate toward the first surface of the substrate, and

the first surface of the first contact and the third surface of the second contact are substantially coplanar.

3. The image sensor of claim 2, wherein

the first transfer transistor includes a first transfer gate that is configured to transfer a first electric charge to the first floating diffusion region, the first electric charge generated by the first semiconductor photoelectric conversion element, and

the second transfer transistor includes a second transfer gate that is configured to transfer a second electric charge to the first floating diffusion region, using the first penetration electrode, the first contact, and the second contact, the second electric charge generated by the organic photoelectric conversion element.

4. The image sensor of claim 2 or claim 3, further comprising:
an etch stop film on the first surface of the substrate such that the etch stop film covers the first penetration electrode, the first transfer transistor, the second transfer transistor, and the first floating diffusion region,
wherein the first contact and the second contact penetrate the etch stop film.
5. The image sensor of any one of claims 2 to 4, wherein the first penetration electrode is in the first pixel region.
6. The image sensor of any one of claims 1 to 5, further comprising:
a reset transistor configured to reset the first floating diffusion region, a first end of the reset transistor being connected to a power supply voltage and a second end of the reset transistor being connected to the first floating diffusion region; and
a source follower transistor having a gate connected to the first floating diffusion region,
wherein the reset transistor and the source follower transistor are in the pixel transistor formation region.
7. The image sensor of any one of claims 1 to 6, wherein
the at least one pixel region further includes a second pixel region spaced apart from the first pixel region, and
the second pixel region includes
a second semiconductor photoelectric conversion element inside the substrate such that the second semiconductor photoelectric conversion element is at least partially enclosed by the substrate;
a second floating diffusion region on the first surface of the substrate;

a third transfer transistor having a first end connected to the second semiconductor photoelectric conversion element and a second end connected to the second floating diffusion region; and

a fourth transfer transistor having a first end connected to the organic photoelectric conversion element and a second end connected to the second floating diffusion region.

8. The image sensor of claim 7, further comprising:

a first color filter between the first semiconductor photoelectric conversion element and the organic photoelectric conversion element; and

a second color filter between the second semiconductor photoelectric conversion element and the organic photoelectric conversion element.

9. An image sensor comprising:

a substrate, the substrate including a first surface and a second surface, the first surface and the second surface facing each other, the second surface configured to be a light-incident surface;

a first semiconductor photoelectric conversion element inside the substrate such that the first semiconductor photoelectric conversion element is at least partially enclosed by the substrate;

an organic photoelectric conversion element on the second surface of the substrate;

a first floating diffusion region on the first surface of the substrate;

a first penetration electrode configured to electrically connect the organic photoelectric conversion element with the first floating diffusion region, the first

penetration electrode including at least a first portion and a second portion, the first portion of the first penetration electrode penetrating the substrate;

a first contact extending from the first surface of the substrate in a first direction, the first contact including a first surface and a second surface, the second surface of the first contact facing the first surface of the first contact, the second surface of the first contact is in contact with the first penetration electrode; and

a second contact extending from the first surface of the substrate in the first direction, the second contact including a third surface and a fourth surface, the fourth surface facing the third surface, the fourth surface in contact with the first floating diffusion region,

wherein the first direction is a direction from the second surface of the substrate toward the first surface of the substrate, and

the first surface of the first contact and the third surface of the second contact are substantially coplanar,

the image sensor further comprising:

a first transfer transistor having a first end connected to the first semiconductor photoelectric conversion element and a second end connected to the first floating diffusion region;

a second transfer transistor having a first end connected to the organic photoelectric conversion element and a second end connected to the first floating diffusion region,

wherein the substrate includes a unit pixel region, the unit pixel region including a pixel transistor formation region and at least one pixel region,

the at least one pixel region includes a first pixel region, and

the first semiconductor photoelectric conversion element, the first floating diffusion region, and the first transfer transistor and the second transfer transistor are in the first pixel region.

10. The image sensor of claim 9, wherein

the first transfer transistor includes a first transfer gate,

the second transfer transistor includes a second transfer gate,

the first transfer gate is configured to transfer a first electric charge to the first floating diffusion region, the first electric charge generated by the first semiconductor photoelectric conversion element, and

the second transfer gate is configured to transfer a second electric charge using the first penetration electrode and the first contact, the second electric charge generated by the organic photoelectric conversion element.

11. The image sensor of claim 9 or claim 10, further comprising:

an etch stop film on the first surface of the substrate such that the etch stop film covers the first penetration electrode, the first transfer transistor, the second transfer transistor, and the first floating diffusion region,

wherein the first contact and the second contact penetrate the etch stop film.

12. The image sensor of any one of claim 9, further comprising:

a first transfer gate on the first surface of the substrate, the first transfer gate configured to transfer a first electric charge to the first floating diffusion region, the first electric charge generated by the first semiconductor photoelectric conversion element;

a second transfer gate on the first surface of the substrate, the second transfer gate configured to transfer a second electric charge to the first floating diffusion region, using the first penetration electrode and the first contact, the second electric charge generated by the organic photoelectric conversion element,

wherein the substrate includes a unit pixel region, the unit pixel region including a pixel transistor formation region and at least one pixel region,

the at least one pixel region includes a first pixel region, and

the first semiconductor photoelectric conversion element, the first floating diffusion region, and the first transfer gate and the second transfer gate are in the first pixel region.

13. The image sensor of claim 12, further comprising:

a reset transistor configured to reset the first floating diffusion region, a first end of the reset transistor being connected to a power supply voltage, and a second end thereof being connected to the first floating diffusion region; and

a source follower transistor having a gate connected to the first floating diffusion region,

wherein the reset transistor and the source follower transistor are in the pixel transistor formation region.

14. An image sensor comprising:

a substrate including a first surface and a second surface, the first surface and the second surface facing each other, the second surface configured to be a light-incident surface;

a first semiconductor photoelectric conversion element inside the substrate such that the first semiconductor photoelectric conversion element is at least partially enclosed by the substrate;

an organic photoelectric conversion element on the second surface of the substrate;

a first floating diffusion region on the first surface of the substrate;

a first transfer gate which is on the first surface of the substrate and configured to transfer a first electric charge to the first floating diffusion region, the first electric charge generated by the first semiconductor photoelectric conversion element;

a first penetration electrode connected to the organic photoelectric conversion element, the first penetration electrode including at least a first portion and a second portion, the first portion of the first penetration electrode extending from the first surface of the substrate to the second surface of the substrate; and

a second transfer gate on the first surface of the substrate and configured to transfer a second electric charge to the first floating diffusion region, using the first penetration electrode, the second electric charge generated by the organic photoelectric conversion element, wherein

the substrate includes a unit pixel region, the unit pixel region including a pixel transistor formation region and at least one pixel region,

the at least one pixel region includes a first pixel region, and

the first semiconductor photoelectric conversion element, the first floating diffusion region, and the first transfer gate and the second transfer gate are in the first pixel region.

15. The image sensor of claim 14, further comprising:

a reset transistor which configured to reset the first floating diffusion region, a first end of the reset transistor being connected to a power supply voltage, and a second end thereof being connected to the first floating diffusion region; and

a source follower transistor having a gate connected to the first floating diffusion region,

wherein the reset transistor and the source follower transistor are in the pixel transistor formation region.

16. The image sensor of claim 14 or claim 15, wherein

the at least one pixel region further includes a second pixel region spaced apart from the first pixel region, and

the second pixel region includes

a second semiconductor photoelectric conversion element disposed the substrate such that the second semiconductor photoelectric conversion element is at least partially enclosed by the substrate;

a second floating diffusion region on the first surface of the substrate;

a third transfer transistor having a first end connected to the second semiconductor photoelectric conversion element, and a second end connected to the second floating diffusion region; and

a fourth transfer transistor having a first end connected to the organic photoelectric conversion element, and a second end connected to the second floating diffusion region.

17. The image sensor of claim 16, further comprising:

a first color filter between the first semiconductor photoelectric conversion element and the organic photoelectric conversion element; and

a second color filter between the second semiconductor photoelectric conversion element and the organic photoelectric conversion element.

18. The image sensor of any one of claims 14 to 17, further comprising:

a first contact extending from the first surface of the substrate in a first direction, the first contact including a first surface and a second surface, the second surface of the first contact facing the first surface of the first contact, the second surface of the first contact is in contact with the first penetration electrode; and

a second contact extending from the first surface of the substrate in the first direction, the second contact including a third surface and a fourth surface, the fourth surface facing the third surface, the fourth surface in contact with the first floating diffusion region,

wherein the first direction is a direction from the second surface of the substrate toward the first surface of the substrate, and

the first surface of the first contact and the third surface of the second contact are substantially coplanar.