

What is claimed is:

1. A method of fabricating a semiconductor device, comprising:
forming an interconnect structure over a front side of a sensor substrate;
thinning the sensor substrate from a back side of the sensor substrate;
etching trenches into the sensor substrate;
pre-cleaning an exposed surface of the sensor substrate;
epitaxially growing a charge layer directly on the pre-cleaned exposed surface of the sensor substrate; and
forming isolation structures within the etched trenches.
2. The method of claim 1, wherein the sensor substrate is a silicon photodiode.
3. The method of claim 1, wherein the charge layer comprises a material selected from boron-doped silicon, boron-doped silicon germanium, and boron-doped germanium.
4. The method of claim 3, wherein a density of charge carriers in the charge layer is between $1 \times 10^{18}/\text{cm}^3$ and $5 \times 10^{21}/\text{cm}^3$.
5. The method of claim 1, wherein the charge layer has a thickness of between 5nm and 50nm.
6. The method of claim 1, wherein the epitaxial growth of the charge layer is performed at a temperature of 450°C or less.
7. The method of claim 1, wherein the dielectric material is selected from silicon oxide and silicon nitride.
8. A method of fabricating a semiconductor device, comprising:
epitaxially growing a layer directly on a surface of a handle substrate;
epitaxially growing a semiconductor layer directly on the epitaxially grown layer;

implanting a dopant into the semiconductor layer;
etching trenches into the semiconductor layer;
forming isolation structures within the etched trenches;
forming an interconnect structure over the semiconductor layer; and
removing the handle substrate from the epitaxially grown layer.

9. The method of claim 8, wherein:
the semiconductor layer comprises silicon,
a dopant comprises boron, phosphorous, or arsenide, and
the dielectric material is selected from silicon oxide and silicon nitride.
10. The method of claim 8, wherein the charge layer comprises a material selected from boron-doped silicon, boron-doped silicon germanium, and boron-doped germanium.
11. The method of claim 10, wherein a density of charge carriers in the charge layer is between $1 \times 10^{17}/\text{cm}^3$ and $5 \times 10^{21}/\text{cm}^3$.
12. The method of claim 8, wherein the charge layer has a thickness of between 5nm and 100nm.
13. The method of claim 8, wherein the epitaxial growth of the charge layer is performed at a temperature of between 500°C and about 900°C.
14. An image sensor, comprising:
a sensor substrate having a front side and a back side;
a plurality of pixels formed within the sensor substrate on the back side;
a plurality of isolation structures formed within the sensor substrate, wherein the plurality of pixels are isolated from each other by one of the plurality of isolation structures;
an interconnect structure over the front side of the sensor substrate; and
a charge layer epitaxially grown directly on surfaces of the plurality of pixels on the back side of the sensor substrate.

15. The image sensor of claim 14, wherein the sensor substrate is a silicon photodiode.
16. The image sensor of claim 14, wherein the charge layer comprises a material selected from boron-doped silicon, boron-doped silicon germanium, and boron-doped germanium.
17. The image sensor of claim 16, wherein a density of charge carriers in the charge layer is between $1 \times 10^{18}/\text{cm}^3$ and $5 \times 10^{21}/\text{cm}^3$.
18. The image sensor of claim 14, wherein the charge layer has a thickness of between 5nm and 50nm.
19. The image sensor of claim 14, wherein the plurality of isolation structures comprise a silicon-containing dielectric material.
20. The image sensor of claim 14, wherein the plurality of isolation structures each have an aspect ratio of a width to a depth of between 50 and 100.