P-i-n photodiode

FIELD OF INVENTION

The invention relates generally to a p-i-n (*pin*) photodiode.

BACKGROUND

Effort has been devoted in Silicon (Si) compatible photonics during the last two decades, especially in the field of active devices. Active building blocks have been fabricated on Si optical modulators and Germanium (Ge) photodetectors, with some showing integration with standard complementary metal-oxide-semiconductor (CMOS) circuits or other optical components.

Ge has been investigated for active photonics devices, particularly for light detection at optical communication wavelengths (of around 1.3 to1.55 μm). High performance Ge photodetectors have been realized due to its favorable absorption coefficient at these wavelengths.

A Ge photodetector needs low dark current, high responsivity and high bandwidth for optimum performance. Doping profiles must be optimized such that the electron-hole generation region remains intrinsic during operation. Phosphorus diffusion in Ge is extremely fast, resulting in non-abrupt junctions and higher dopant concentrations in intrinsic regions. This effectively increases device capacitance at a fixed operating bias and reduces photodetector bandwidth (RC-limit).

A low annealing temperature at 500 °C would be able to restrict dopant diffusion. However, this is at the expense of higher dopant activation and limits device integration compatibility with backend CMOS processes which uses temperatures of up to 600 – 700 °C.

There is thus a need to address the above drawbacks for existing photodetectors.

SUMMARY

According to one aspect of the invention, there is provided a p-i-n photodetector comprising: a dopant diffusion barrier layer disposed within an active light absorbing region of the p- i-n photodetector, wherein the dopant diffusion barrier

layer has a thickness less than 5nm; a first semiconductor layer having a region doped to a first polarity; a second semiconductor layer having a region doped to a second polarity, the second polarity being opposite to the first polarity, wherein the dopant diffusion barrier layer is disposed between the first semiconductor layer and the second semiconductor layer for reducing doping of the first polarity into the region between the dopant diffusion barrier layer and the second semiconductor layer, and wherein the region doped to the first polarity of the first semiconductor layer has a higher doped portion and wherein the region doped to the second polarity of the second semiconductor layer has a higher doped portion, so that the higher doped portion of the second polarity and the higher doped portion of the first polarity form a pn junction of the p-i-n photodetector.

According to another aspect, there is provided a method of fabricating a p-i-n photodetector, the method comprising: providing a first semiconductor layer having a region doped to a first polarity; providing a second semiconductor layer having a region doped to a second polarity, the second polarity being opposite to the first polarity; providing a dopant diffusion barrier layer between the first semiconductor layer and the second semiconductor layer, the dopant diffusion barrier layer having a thickness of less than 5nm and configured to reduce doping of the first polarity into the region between the dopant diffusion barrier layer and the second semiconductor layer; doping the first semiconductor layer to a higher doped portion within the region doped to a first polarity; doping the second semiconductor layer to a higher doped portion within the region doped to a second polarity; and forming a pn junction of the p-i-n photodetector using the higher doped portion of the second polarity and the higher doped portion of the first polarity.

Herein disclosed is~~According to one aspect of the invention, there is provided~~ a *pin* photodetector comprising a dopant diffusion barrier layer disposed within an active light absorbing region of the *pin* photodetector.

T~~According to another aspect of the invention, t~~here is also provided a~~A~~ method of fabricating a *pin* photodetector, the method comprising: providing a first