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Photovoltaic properties of SiGeSn alloys fabricated by ion implantation

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The long-term objective of this project is to develop cost-effective, versatile, and scalable, short-wave infrared detectors directly integrated into silicon. Unlike the direct bandgaps materials such as Si, Si1-xGex, and Si1-x-yGexSny provide a promising path toward Si-compatible devices for SWIR detection. In this project, Si (001) samples were implanted at room temperature with a tilt of 7 degrees, with 65keV Ge and 100 keV Sn at the Tandetron Accelerator lab, Western University, to achieve average Si0.80Ge0.15Sn0.05 concentrations over the top 100nm. After implantation, the samples were furnace-annealed at 400oC, and 600oC, for 30 minutes, in dry nitrogen gas, leaving one as 'as is'for comparison. Aluminum metal contacts were deposited at the surface of selected samples using lithography process for IV measurements, with Al round contacts of a diameter of 600 μm, 700 μm apart (Western Nanofab). Spectral response (SR), quantum efficiency (QE), current density, and the current-voltage (IV) characterization were performed on selected samples at Sciencetech Inc. In our IV measurements at room temperature, we found that the IV curves can be divided into three regions, Region 1, where we see the reverse bias current, which is the small leak current. In Region 2, Si1-x-yGexSny materials exhibit Ohmic behavior. And finally, Region 3 where the current does not change with voltage, this region operates like an ideal current source. More so, this IV curve passes through the origin, implying that it does not store energy. We see an interesting observation, in Region 2, the IV characteristic curve showed an increment in the current with respect to the voltage with the increase in the degree of annealing on the sample. All studied samples have maxima in the SR and QE responses at around 1099nm, and a broad plateau at 1600-1980 nm, respectively. Along with this, there is a slight incremental shift in the long wavelength of the spectral response for the annealed samples. Overall, there was a decrease in the maximum SR, QE, and current density of samples annealed at high temperatures, compared to asis sample.

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Keyword-2

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Keyword-3

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