Spectral responsivity of Ge *pin* photodiodes on silicon-on-insulator via selective epitaxial growth

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Summary of the paper

Ge has attracted much attention due to its large optical absorption at near infrared (NIR) and compatibility to Si CMOS process. Integration of Ge photodetectors on Si waveguides is promising to realization of effective electronics-photonics (E-P) convergence. Ge *pin* photodiode was fabricated by selective epitaxial growth on SOI substrate and was characterized by spectral responsivity. At 1550nm, 0.24 A/W (external quantum efficiency η_{ext}~20 %) was achieved.

In particular, we focused on strain effect on responsivity spectra. It has been known that thermally-induced tensile strain in Ge causes absorption red-shift. Compared to the Ge photodiode fabricated by blanket growth with the similar device structure, the device in this work shows attenuated red-shift. Localized reciprocal lattice mapping confirmed that Ge selective mesa with 10 μm of width is not relaxed along the shorter dimension. Furthermore, X-ray diffraction reveals that Ge grown on SOI does not contain additional strain relaxation due to viscous flow of buried oxide (BOX) layer at high temperature annealing. Therefore, we assumed that Ge mesa relaxed its strain vertically along the thickness and theoretical simulation was conducted. The simulation results showed good agreement with the measured one. It is the key to understand the strain effect on responsivity spectrum of Ge photodiode on Si in order to maximize NIR photodetectability and to realize wide-band wavelength division multiplexing (WDM).

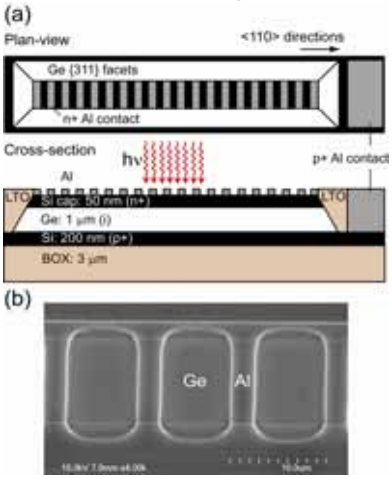

Fig. 1 (a) A schematic illustration of the device structure. (b) A SEM image of as-fabricated device.

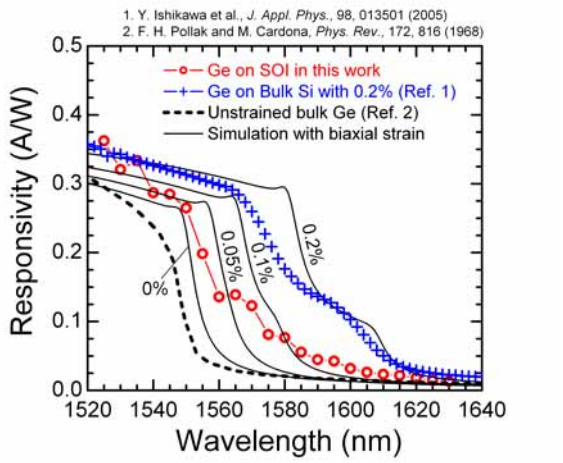

Fig. 2. Measured responsivity spectrum compared with reported results and simulated results with various biaxial tensile strain.

Comment

It is a great honor to receive the student research award. On the behalf of the co-workers of this work, I would like to express my sincere thanks to IEICE-OPE committee for selecting our work. I have been working on Si microphotonics over the past 2 years and mostly focusing on Ge photodetector integration to other Si microphotonics components. Since then, I have been fascinated by huge technological paradigm shift that Si microphotonics must bring to current electronics industries. Also, I have witnessed drastic growth of interest all over world. I truthfully believe that Si microphotonics cannot live on without persistent two-way communication with other various fields of OPE. I hope that I am able to play an important role as a researcher in spreading Si microphotonics and bridging it to others for meaningful advancement of technology.