Mid-infrared GeSn Resonant-cavity-enhanced GeSn Photodetectors

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GeSn material system has been considered as a promising candidate for efficient mid-infrared (MIR) photodetectors (PDs) on silicon due to its narrow bandgap and CMOS-compatibility for a wide range of applications [1]. Despite the low equilibrium solid solubility of Sn in Ge, significant progress has been made to grow high-quality, high Sn content GeSn layers on silicon using low-temperature growth techniques [1]. Different types of GeSn-based PDs have also been demonstrated with extended optical responses reaching MIR spectral region. However, the responsivity is still limited. Here we present an investigation of MIR resonant-cavity-enhanced GeSn PDs on silicon-on-insulator (SOI) substrates.

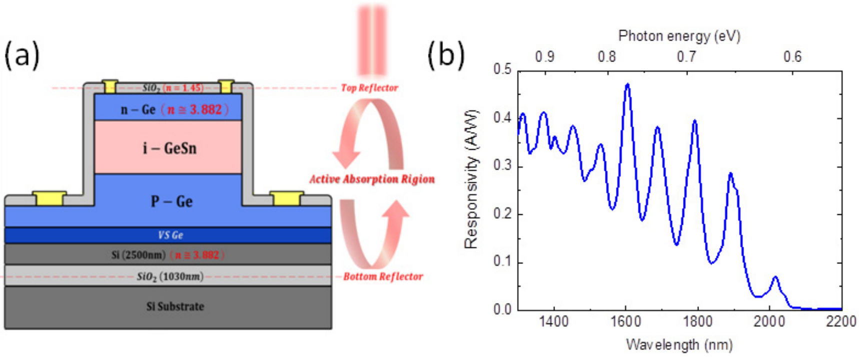

Fig. 1. (a) Schematics of GeSn resonant-cavity-enhanced PDs, (b) room-temperature responsivity spectrum.

The samples used in this study were grown on SOI substrates using low-temperature molecular beam epitaxy. The samples were then fabricated into surface-illuminated p-i-n photodiodes using CMOS-compatible processing. A schematic diagram of the fabricated devices is displayed in Fig. 1(a). Here the buried oxide (BOX) layer serves as the bottom reflector while the deposited SiO_2 layer serves as the top reflector, creating a vertical cavity structure to enhance the optical filed in the GeSn active layer. As a result, the light-emitter interaction is enhanced, considerably improving the responsivity. Figure 1(b) shows the measured room-temperature responsivity. The results shows clear ripple structures, providing clear evidence of resonant cavity modes. The cutoff wavelength is extended from 1550 nm to 2050 nm as a result of Sn-alloying in the GeSn active layer. The responsivity is also greatly enhanced by the resonant cavity, showing great promises for efficient MIR photodetection.

References

1. H. H. Tseng *et al.*, App. Phys. Lett. **102**, 182106 (2013)