InAs/InAs$_{1-x}$Sb$_x$ superlattices on GaSb substrates: a promising alternative type-II superlattice infrared material system

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BIOGRAPHY

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TECHNICAL ABSTRACT

As one of the many promising antimonide type-II superlattices (T2SLs), InAs/InAs$_{1-x}$Sb$_x$ T2SLs have been proposed for MWIR and LWIR light emitting diodes, lasers, and photodetectors. Although MWIR and LWIR InAs/InAs$_{1-x}$Sb$_x$ T2SL structures grown on InAs substrates and GaSb substrates were successfully demonstrated in the 1990’s, they were set aside as a potential photodetector material in favor of the InAs/Ga$_{1-x}$In$_x$Sb SL. Currently, the short minority carrier lifetime, $\sim$30 ns, of the InAs/Ga$_{1-x}$In$_x$Sb T2SL limits the detector performance as evidenced by higher than predicted dark currents and reduced quantum efficiencies.

Recent measurements using time-resolved photoluminescence (PL) on a 8-$\mu$m LWIR InAs/InAs$_{1-x}$Sb$_x$ T2SL show that the minority carrier lifetime is greater than 412 ns at 77 K, one order of magnitude greater than that of LWIR InAs/Ga$_{1-x}$In$_x$Sb SLs. The significant improvement in lifetime is mainly due to less Shockley-Read-Hall non-radiative recombination possibly due to the lack of Ga in the T2SL and is expected to improve the detector performance. Highlights of the detailed strain-balanced design, MBE growth, and structural and optical properties from high-resolution XRD, TEM, PL, time-resolved PL, and variable-temperature Hall measurements will be presented. The excellent quality of these T2SL samples exemplifies the promise of the InAs/InAs$_{1-x}$Sb$_x$ SLs for infrared device applications.

REFERENCES


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