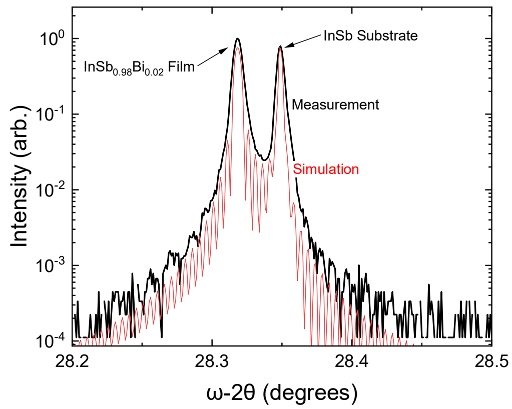


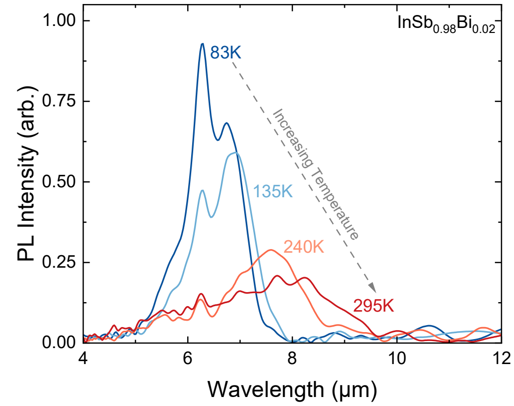
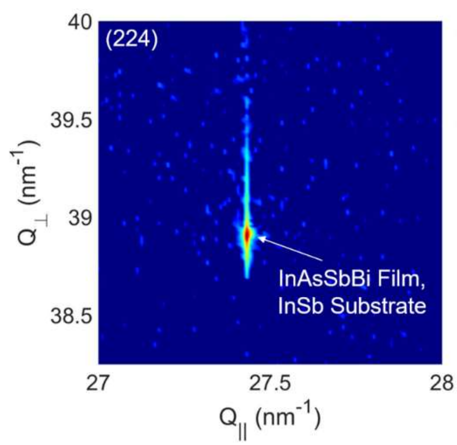


Figure 1 (left) X-ray diffraction ω-2θ measurement of a 1 μm thick $InSb_{0.98}Bi_{0.02}$ film taken around the (004) peak of InSb demonstrated an increase in lattice constant with bismuth incorporation as expected due to its large atomic size. **(right)** Photoluminescence spectra of the $InSb_{0.98}Bi_{0.02}$ film at temperatures ranging from 83 K to 295 K demonstrating the first long-wave infrared emission from a III-V-Bi alloy. With increasing temperature, the $InSb_{1-x}Bi_x$ alloy exhibited emission at longer wavelengths consistent with an interband optical transition as expected for a III-V alloy.



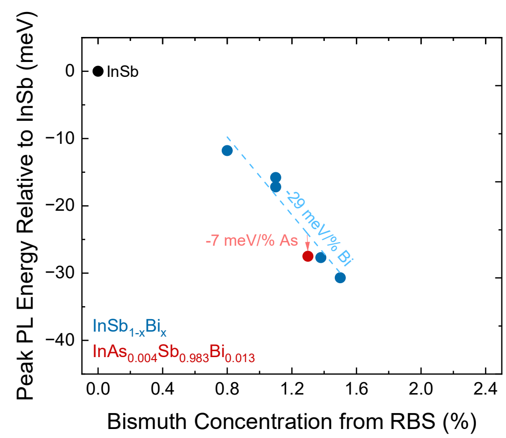
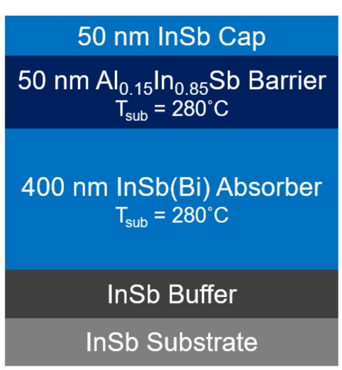


Figure 2 (left) Reciprocal space map of an $InAs_{0.004}Sb_{0.983}Bi_{0.013}$ film grown on InSb taken around the (224) reflection of InSb demonstrated lattice-matching to the substrate. **(right)** Peak photoluminescence energy as a function of bismuth concentration demonstrating a bismuth-induced bandgap reduction of ~29 meV/% Bi in $InSb_{1-x}Bi_x$. From photoluminescence of $InAs_{0.004}Sb_{0.983}Bi_{0.013}$, an additional arsenic-induced bandgap reduction of ~7 meV/% As was observed. From these estimates, only ~4.5% bismuth and ~1.5% arsenic incorporation is necessary to span the entirety of the LWIR with a lattice-matched III-V-Bi alloy.



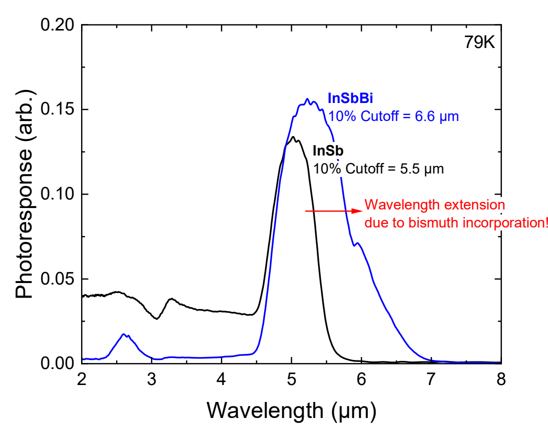


Figure 3 (left) Layer stack for the $InSb_{0.99}Bi_{0.01}$ and InSb unipolar barrier (nBn) detectors employing 400 nm thick InSb(Bi) absorbers grown under the optimized conditions for high-quality $InSb_{1-x}Bi_x$ and 50 nm thick $Al_{0.15}In_{0.85}Sb$ barriers grown at the same low temperature to avoid unintentional annealing of the absorber. **(right)** Spectral response for the $InSb_{0.99}Bi_{0.01}$ detector and the InSb detector highlighting significant wavelength extension of ~1 μm (~35 meV/% Bi) due to the significant bismuth-induced bandgap reduction.