**Supplemental document: Impact of unintentional Sb in the tensile electron well of type-II InAs/InAsSb superlattices grown on GaSb by molecular beam epitaxy**

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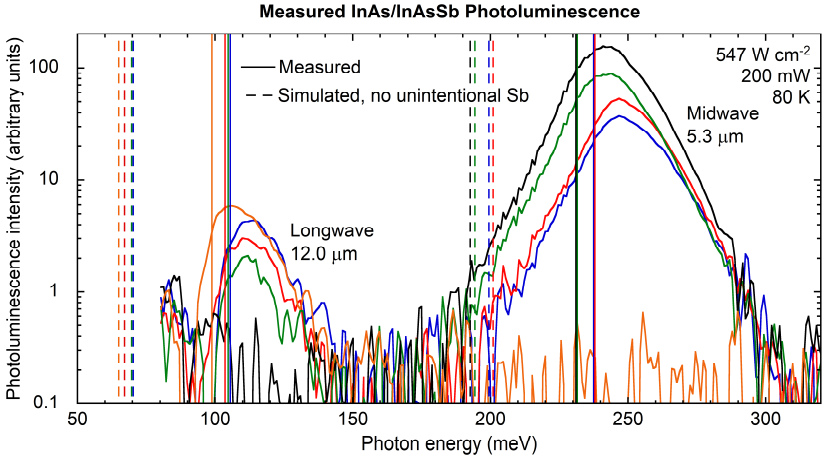
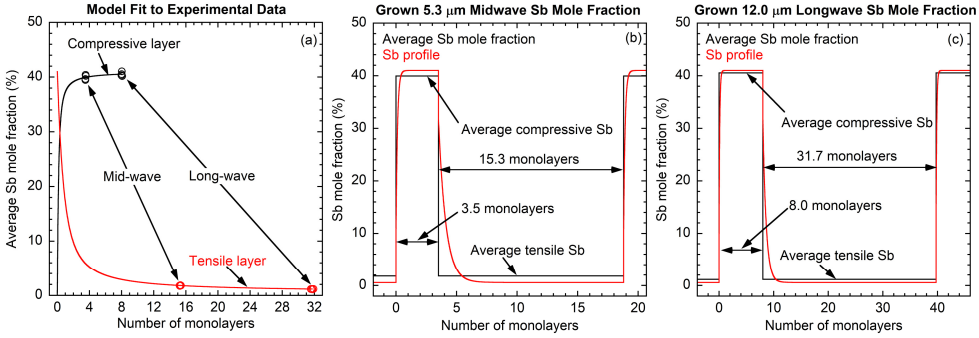
The figure below shows the photoluminescence spectra from four 5.3 µm midwave and four 12.0 µm longwave InAs/InAsSb superlattices, measured at 80 K with an 808 nm pump power of 200 mW. The solid vertical lines indicate the superlattice bandgap energy extracted from each spectra. The dashed lines indicate the expected bandgap position for a structure with a pure tensile InAs layer. The blue shift in the measured bandgap indicates the presence of unintentional Sb in the tensile InAs layer.




In the figure below, left panel (a) shows measured Sb mole fractions in the compressive layer as open black circles and the tensile layer as open red circles for the mid and long wave structures. The fit to the model is shown as solid black and red curves for the tensile and compressive layers respectively. The mole fraction versus monolayer number is shown in panels (b) and (c) for the mid and long wave InAs/InAsSb superlattices; the Sb profile is in red and the average of the profile is in black.




The average structure of the grown midwave and longwave InAs/InAsSb superlattices is shown in the table below. The layer thicknesses and Sb mole fractions are averages and are labeled as the "Grown" structure. For comparison, an "Ideal" structure with no unintentional Sb in the tensile InAs layer is also shown. The 80 K bandgap, compressive Sb mole fraction, and tetragonal distortion are the same for both the grown and ideal structures. The grown structures have a significantly thicker tensile layer. a slightly thinner compressive layer, and a smaller electron-hole wavefunction overlap.

| Superlattice type | Superlattice tetragonal distortion (%) | 80 K Bandgap (meV) | 80 K Bandgap (µm) | Structure | Sb mole fraction (%) Tensile InAs(Sb) | Sb mole fraction (%) Comp. InAsSb | Thickness (nm) Tensile InAs(Sb) | Thickness (nm) Comp. InAsSb | Electron-hole overlap squared (%) |
|---|---|---|---|---|---|---|---|---|---|
| Mid-wave | -0.0013 | 233 | 5.3 | Grown | 1.8 | 40.0 | 4.61 | 1.12 | 58.2 |
| | | | | Ideal | 0 | 40.0 | 3.87 | 1.18 | 63.1 |
| Long-wave | 0.0269 | 103 | 12.0 | Grown | 1.2 | 40.5 | 9.56 | 2.56 | 22.2 |
| | | | | Ideal | 0 | 40.5 | 8.54 | 2.62 | 24.8 |