Grading for control of the lattice constant and bandgap, as well as the charge distribution and band offsets at interfaces

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Compositional grading allows growth of bulk unstrained, unrelaxed InAsSb across the composition spectrum onto GaSb [1, 2]. Transmission electron microscopy (TEM), for example in Fig 1, shows that GaAlInSb grades behave as an ideal illustration of the principles outlined by Tersoff [3]. This mitigates the grade's residual strain, and the in-plane lattice constant at the top of the graded region equals the native unrelaxed lattice constant of the epilayer. Proper grading allows for virtual substrates with x-ray peak widths that are on the same order as the substrate and are coincident to the active epilayer peak (example, Fig 2).

There is limited work for the optimization of grading rates, strain offsets at the grade/virtual substrate interface, and grading species selection. TEM and x-ray diffraction data that demonstrate how these choices affect the epilayer quality. We also studied the practicality of extending Tersoff's methodology to other materials, such as InGaAs, and group V grades such as InAsSb and GaAsSb.

Another application of composition grading is maintaining a constant lattice constant while controlling charge distributions and band offsets at interfaces. Such grading requires precise composition control, and unlike the Tersoff grades, ideally occurs without dislocation formation. We will discuss our findings related to such grades.

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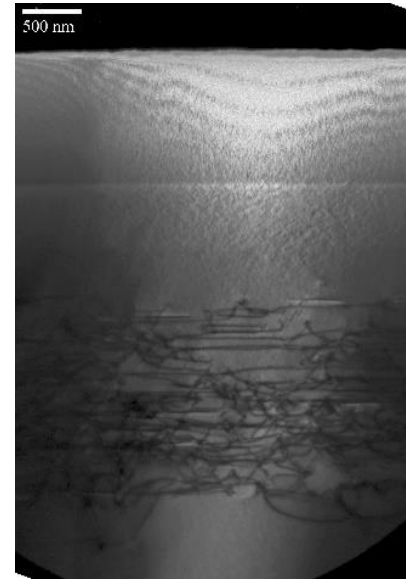+ Author for correspondence: wendy.l.sarney.civ@mail.mil
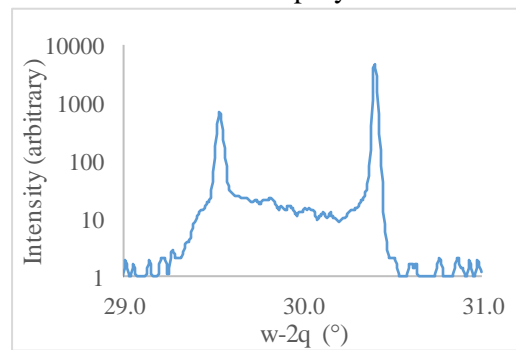
Figure 1 TEM of GaInAlSb grade with InAsSb epilayer.

Figure 2 XRD of GaInAlSb grade on GaSb and AlInSb virtual substrate and GaInAsSb active layer