[redacted]

Electronic structure induced by lateral composition modulation in GaInAs alloys

T. Mattila, L. Bellaiche, L.-W. Wang, and Alex Zunger

Citation: Applied Physics Letters 72, 2144 (1998); doi: 10.1063/1.121303

View online: http://dx.doi.org/10.1063/1.121303

View Table of Contents: http://scitation.aip.org/content/aip/journal/apl/72/17?ver=pdfcov

Published by the AIP Publishing

@$\bar{1}10$# oriented atomic rows for each ~001! plane. In this in-plane view we see contraction of the inter-row distance in the Ga-rich region ~left! and an equivalent expansion in the In-rich region ~right!. This is consistent with the smaller covalent radius of Ga relative to the In atom. Surprisingly, all ~001! planes behave nearly identically, i.e., the @110# in-plane displacements are *vertically phase-locked* between the different ~001! planes despite the changing composition of

$V_2 - V_3$ valence band splitting are 16 and 14 meV for $A = 16.7\%$ and increase with A. For $A = 0$ ~representing a $n = 1.5$ SPS with no CM where the mixed GaIn layer is randomly occupied! the corresponding splittings are 4.1 and 1.3 meV. Figure 3 shows that CM+SPS act to raise the valence bands, lower the conduction band, and hence reduce the band gap. The calculated band-gap redshift for l $= 149$ Å, **u** $=$ @110# and $n = 1.5$ is shown in Fig. 3~a!; it is ; 40 (80) meV for A ; 8 (16)%. For $A = 0$ ~SPS only! we find a band-gap reduction of ; 16 meV, indicating that the pure SPS structure induces a significant contribution to the redshift. Our calculations further reveal that the dependence of the redshift on CM wavelength l is rather weak. On the other hand, the redshift *increases* as one goes from sinusoidal lateral modulation to square-wave lateral modulation (; 10 meV for A ; 16%), and as one goes from integer-period SPS to fractional-period SPS ~for $n = 2$ SPS with the same CM parameters as for SPS $n = 1.5$ we find a ; 5 meV smaller redshift!.

Effect of CM on polarization: ~i! For pure $n = 1.5$ @001# SPS we find the transition from the CBM to $V_1(V_2)$ to be polarized in the @110# ~@$\bar{1}$10#! direction. The transition probability to V_3 is small, and thus @001# polarization should not be detected among these lowest energy transitions. On the other hand, ~ii! a pure @110#