Applications of InAs/$InAs_{0.625}Sb_{0.375}$ Superlattice in Far-infrared Detection

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ABSTRACT

Using first-principles calculations, we calculate the electronic and optical properties of InAs/$InAs_{0.625}Sb_{0.375}$ superlattices (SL). To accurately approximate the electronic and optical properties, the modified Becke-Johnson exchange-correlation functional is pondered. After analyzing the electronic and optical characteristics of bulk InAs and InSb, we then investigated InAs/$InAs_{0.625}Sb_{0.375}$ SL. The electronic and optical properties of the InAs/$InAs_{0.625}Sb_{0.375}$ SL are studied with three lattice constants of the bulk InAs, GaSb and AlSb, respectively. It is observed that the electronic and optical properties strongly depend on the lattice constant. A considerable decrease in the energy gaps and the effective masses of the heavy-holes in the k_x-k_y plane compared to the bulk phases of the parent compounds can be obseved. We demonstrate that the electrons are s-orbitals delocalized in the entire superlattice, while the holes have mainly 5p-Sb character localized in the In(As,Sb) side of the superlattice. In the superlattice, the low-frequency absorption spectra greatly increase when the electric field is polarized orthogonal to the growth axis allowing the applicability of III-V compounds for the long-wavelength infrared detectors.