Electron Transport in Strained $In_{0.64}Al_{0.36}As$

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The ternary semiconductor InAlAs has proven to be useful in a variety of device applications. Recently, it has become useful in hot carrier solar cells [1], particularly for cells with materials lattice matched to InAs [2]. We use a series of methods to examine the band structure and transport properties of the electrons in $In_{0.64}Al_{0.36}As$ is strained to the InAs lattice constant. We demonstrate that it has reasonably good properties for use in third generation hot carrier solar cells, both as a barrier and as the active absorber layer. These properties include the band structure, mobility, hot carrier velocity, and distribution functions of the electrons in various valleys under continuous solar irradiation. In particular, we evaluate the low field properties using Rode's method and the hot carrier properties are determined with ensemble Monte Carlo simulations that examine all three relevant valleys of the conduction band, including the transfer of carriers between these valleys. The band structure determined by empirical pseudopotential methods, including non-local and full zone spin-orbit splitting. Then, we examine the low field mobility and Hall factors as a function of lattice temperature. Finally, we turn to a careful examination of the hot electron properties with the ensemble Monte Carlo procedure.

[1] Hirst L C, *et al.*, 2014 *IEEE J. Photovolt.* **4** 1526

[2] Esmalelpour H, *et al.,* 2017 *J. Appl. Phys.* **121** 235301

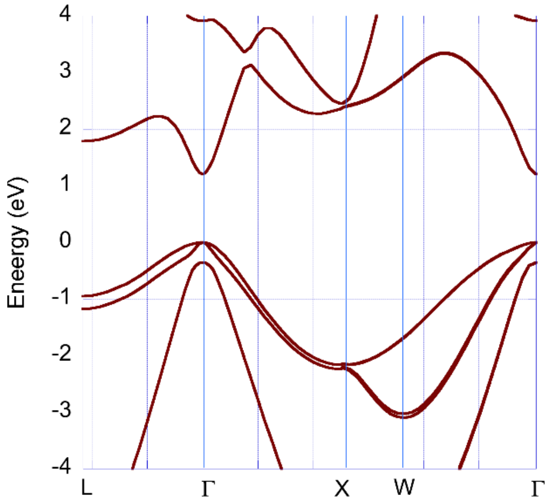

Fig.1: Band structure of $In_{64}Al_{.36}As$ strained to the InAs lattice constant.

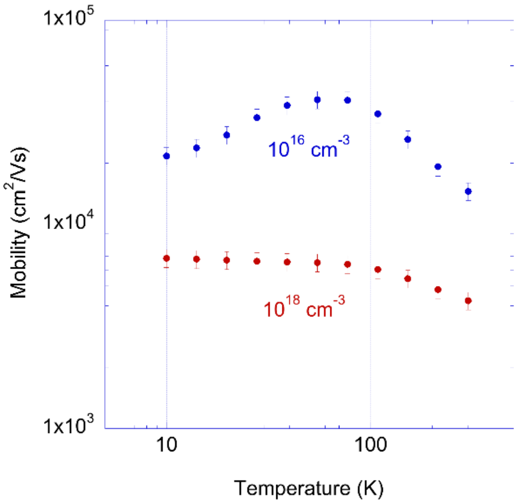

Fig.2 Electron mobility as a function of temperature for a doping density of 1x10^{18} cm^{-2}.

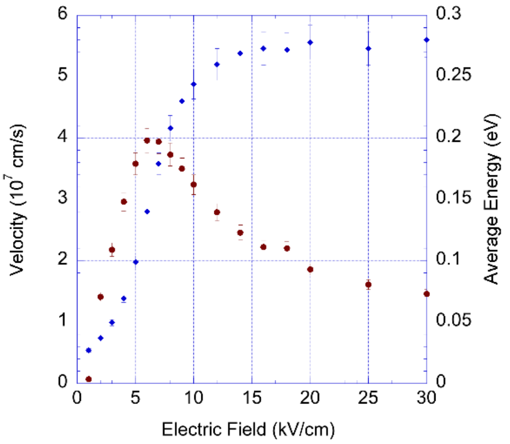

Fig.3: Electron velocity and average ener as a function of electric field for a carrier density of 1x10^{18} cm^{-2}.

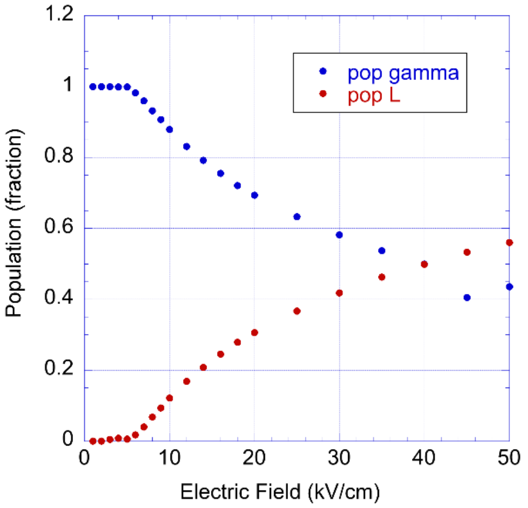

Fig.4: Relative populations of the Γ and L valleys of the conduction band as a function of the electric field.

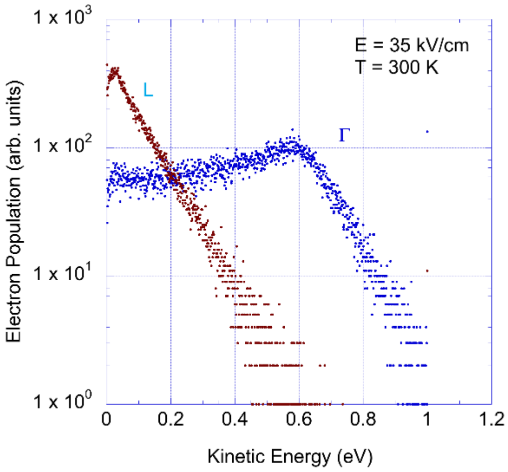

Fig.5 Population of the Γ and L valleys of the conduction band as a function of the kinetic energy of the carriers at 35 kV/cm..