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InSb-Based Heterostructures for Transport Experiments and Electronic Device Applications

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Abstract

In narrow-gap semiconductors, electrons have properties that are much different than in GaAs or Si. For example, the effective mass of electrons in InSb is two orders of magnitude smaller than the mass in free space. This property can be exploited in electronic device applications, including field-effect transistors [1], magnetic-field detectors [2] and ballistic transport devices [3], where a high mobility or a long mean free path is required. The strength of the interaction between an electron's spin and a magnetic field is also enhanced in InSb. The consequences of a small effective mass and large spin-orbit coupling are seen in far-infrared spectroscopy [4] and charge transport measurements [5] performed on structures with nanometer-scale dimensions in one or more directions.

Crystalline defects, due to MBE growth on lattice-mismatched GaAs substrates, are an important factor limiting the electron mobility in $InSb/Al_xIn_{1-x}Sb$ heterostructures. InSb quantum-well structures with the highest room-temperature mobility (40,000 cm^2/Vs for an electron density of $4.6\times10^{11}cm^{-2}$) employ $Al_xIn_{1-x}Sb$ interlayers to reduce the density of threading dislocations [6]. We have also produced *p*-type InSb quantum-well structures for potential use in digital circuits that require both *p*-type and *n*-type devices. The effects of strain and confinement on the effective mass of holes in InSb quantum wells are seen in magneto-optical experiments [7]. This research was performed with collaborators in the Center for Semiconductor Physics in Nanostructures at the University of Oklahoma and the University of Arkansas.

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