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The unusual band structure properties of dilute nitride GaAsN alloys[1]

AMALIA PATANE, School of Physics and Astronomy, University of Nottingham

The incorporation of low concentrations of N in GaAs leads to qualitatively new alloy phenomena and electronic properties, which have increased the power and scope of band-structure engineering as a tool for the design of a new generation of electronic devices. The large electronegativity of the N atoms combined with the stretching and compression of neighbouring bonds in GaAs strongly perturbs the band structure properties of the host crystal: N-impurities and N-clusters act to "disrupt" the extended Bloch states of GaAs at characteristic resonant energies in the conduction band [1-3]. This leads to a strongly modified energy-wavevector dispersion relation of the conduction electrons and to a large red-shift of the band gap. Here we use magneto-tunneling spectroscopy to probe directly the unusual band structure properties of GaAsN. Of particular interest is the strongly non-parabolic conduction band in which an inflection point occurs in the energy-wavevector dispersion relation at relatively modest wavevectors. We demonstrate that this property can be tailored by quantum confinement effects or by an applied hydrostatic pressure. Also it can be exploited to realize a new type of non-linear device in which electrons are accelerated by a large electric field up to and beyond the inflection point, thus leading to a large negative differential drift velocity effect of potential interest for novel emitters and detectors of high-frequency radiation. [1] W. Shan et al., Phys. Rev. Lett. 82, 1221 (1999). [2] J. Endicott et al., Phys. Rev. Lett. 91, 126802 (2003). [3] A. Lindsay and E .P. O'Reilly, Phys. Rev. Lett. 93, 196402 (2004).

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