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Tunnelling through a GaAs/(AlGa)As coupled double-quantum-well heterostructure

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Abstract:

A splitting of the main resonant peaks is observed in the current-voltage characteristics of a double-quantum-well resonant tunnelling device, due to coupling between well states. Under a high magnetic field applied in the current direction, the peaks collapse into a single peak and from the magnetotunnelling data we are able to estimate the energy splitting between the coupled states

Keywords: quantum wells; semiconductors; tunneling

Resumen

Un desdoblamiento de los picos de resonancia es observado en la curva característica corriente-voltaje de un dispositivo de tunelamiento resonante de doble pozos cuánticos debido al acoplamiento entre los estados cuánticos de ambos pozos. En la presencia de un campo magnético, paralelo a la direcci6n de tunelamiento, cada par de picos colapsan en un único pico, a partir de los datos de magnetotunelamiento se puede estimar el orden de magnitud del desdoblamento del pico de resonancia.

Palabras Clave: Pozos cupánticos; semiconductores; tunelamiento.

1. Introduction

The continuous increase of the interest in semiconductor quantum wells and superlattices over the years is a result of great improvements in crystal growth techniques and also because these structures are more promising for device applications than bulk materials. Furthermore, investigations of quantum well structures have provided a new insight into fundamental quantum mechanical problems such as tunnelling and space quantization. In particular, double-barrier resonant tunnelling devices have attracted a lot of attention in the last years due to their potential use in ultra-high speed applications. However, it is worth noting that there has been little work on the effect of a magnetic field on resonant tunnelling devices incorporating a double-quantum-well. These structures have been widely used recently to study electron and hole dynamics [1,2,3,4] and tunnelling times.[5,6]

Theoretical and experimental reports show that the electron localization can be tuned by an external electric field applied along the growth direction of an asymmetric double-quantum-well heterostructure.[1,5,6] Such a device consists of two quantum wells of different widths separated by a thin barrier. At low bias the wide well ground state is at a lower energy than the corresponding state of the narrow well and the electron wave function is mainly localized at the wider well. Resonant coupling between wide and narrow well states occurs at a certain applied bias, when a state in one well is at the same energy of a state in the second well, producing an anticrossing of the levels. When the coupled states are brought into resonance with the emitter state, resonant tunnelling across the whole structure takes place. Therefore, at those biases where the resonance condition is satisfied, peaks will be produced in

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