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Mobilities of Structurally Modified Quantum Wells

We have studied the effect of additional layering within a semiconductor quantum well on carrier mobility compared to a simple quantum well. The previous report indicated results concerning modification of the phonon dispersion of the quantum well with additional layering and enhanced scattering from interface phonons accompanied by a reduction in confined phonon scattering. New results for this report are calculated relaxation times for transitions into all subbands of the quantum well structures and subsequent mobilities.

We have found that mobilities are enhanced in structurally modified quantum well systems compared to simple quantum wells. Structurally modified quantum wells have additional thin layers of barrier material inside the well regions. For the case considered here, we have studied GaAs/AlAs quantum wells with thin AlAs layers, 8 Å in width, at room temperature. We have found that structurally modified quantum wells in the approximate ranges of 50-90 Å, 200-250 Å, and 370-400 Å show higher mobilities when compared to simple quantum wells of comparable widths. Mobilities increase when the separation between subbands is unfavorable for single phonon emission or absorption. Upon reaching resonance there is a sharp decrease in the mobilities until conditions become favorable again.

GaN/AlN Quantum Wells

We have studied the effect of electron-phonon interaction on carrier mobility in GaN/AlN and GaAs/AlAs quantum wells. Our studies indicate a larger carrier mobility in the GaN/AlN quantum wells as compared to GaAs/AlAs. This can be explained by higher phonon energies and as a result of these longer relaxation times occur. We expect that structural modification of the quantum well will also increase the mobilities of the GaN/AlN quantum wells.

SiC/SiO₂ Quantum Wells

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As electronic device size and integrated circuit size continues to decrease, quantum effects will strongly dominate the behavior of the electronics. It is with this view that we have begun studying the role of electron-phonon scattering on impact ionization and subsequent avalanche breakdown in the oxide layer of the silicon devices. This work is preliminary at present.

Accomplishments

One conference paper

Two invited talks (Johns Hopkins, Boucher International Conference)

1998 Doctoral Dissertation of Thomas F. Forbang partially supported by grant

Dissertation: Electron-Phonon Scattering Rates and Mobilities in GaAs/AlAs and GaN/AlN Quantum Wells

P. I. Recipient of Sigma Xi Distinguished Scientific Lecturer Award, 1999-2001

Student Support

One recent recipient of the Ph. D.

One Masters of Arts Student 1998-1999

One undergraduate research assistant