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Effect of Interface Roughness in Ultra-Thin Semiconductor Quantum Wells[1] YU SONG, Princeton University, RAJARAM BHAT, CHUNG-EN ZAH, Corning Incorporated, CLAIRE GMACHL, Princeton University — Ultra-thin, few monolayer semiconductor quantum well (QW) structures are extensively used in optoelectronic devices, especially when the effective mass is high ($\geq 0.1m_e$). Traditionally, interfaces roughness in QWs are either ignored, or treated as a 2D scattering potential ideally localized on the interface plane. This treatment is valid when roughness is small compared to the layer thickness. But in situations of ultra-thin QWs, a more systematic model is needed. In this work, we model the potential associated with the interface roughness as a 3D function with dependence on the actual interface position. With the help of Green's function we show that this potential, when averaged in-plane, produces an effective grading potential out of the plane which significantly alters the energy spectrum. This effect is reaffirmed by the experimental results from the measurement of intersubband (ISB) optical transitions in III-Nitride thin QWs. The general expression of the scattering matrix element for carrier transport is also derived, which requires full 3D calculation and significantly differs from the traditional treatment. The scattering lifetimes are calculated for the example of III-nitride ISB devices, and the results are being compared to that from the traditional formulas.

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